FOR THE
IB DIPLOMA
PROGRAMME

IN COOPERATION WITH ib

Digital Society

Eli Bomfim • Tammy Earle
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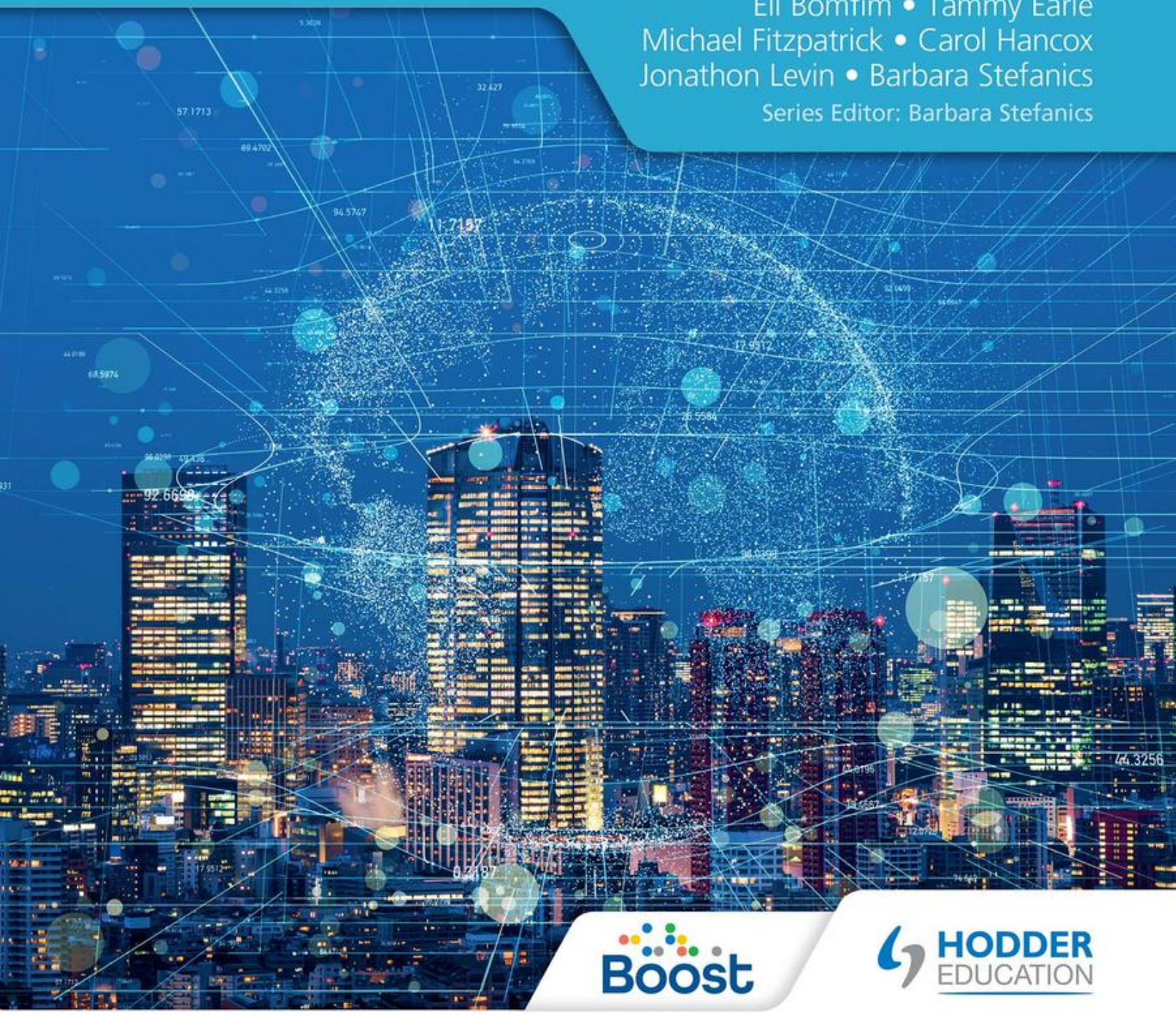
Jonathon Levin • Barbara Stefanics
Series Editor: Barbara Stefanics



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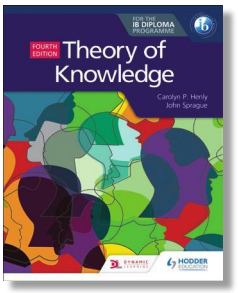

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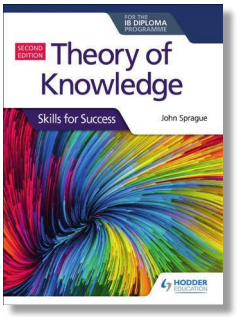

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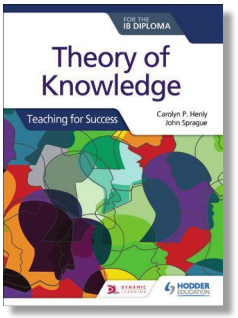

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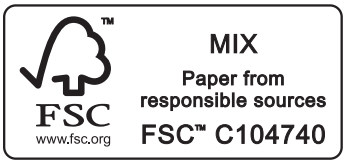

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Contents

The 'In cooperation with IB' logo signifies the content in this coursebook has been reviewed by the IB to ensure it fully aligns with current IB curriculum and offers high quality guidance and support for IB teaching and learning.

Dedication

It has been a most invigorating and rewarding pleasure to collaborate with top International Baccalaureate (IB) professionals in this field to produce what we hope is the ultimate guide for students. We wish to thank the many Information Technology in a Global Society (ITGS) colleagues and Diploma Programme (DP) educators who have contributed through online discussions, social media groups, virtual meetings, exchanges and workshops to this next significant step: the digital society.

About the authors

Hours of ongoing discussions, deliberation and collaboration between members of the authoring team has gone into producing what we believe will be a valuable resource for students. We hope that it will be the springboard for student inquiries into the impacts and implications that digital technologies are having for themselves, for other groups of individuals and for other communities in today's world.

Digital society is a constantly evolving subject, with new digital technologies and new real-life scenarios on an almost daily basis. This book takes on the challenge of providing the knowledge, understanding and skills needed to adapt to our changing digital world and the challenges that it presents.

As a team, the authors have an extensive range of experience and roles across the IB spectrum: as teachers, examiners, workshop leaders and developers, consultants, authors, bloggers, presenters and innovators in the DP. We have been involved in DP initiatives for over 40 years, and over 30 years in ITGS development, the precursor to digital society.

Eli Bomfim

Eli was born and grew up in Curitiba, Brazil, where he also had his formal education and graduated in civil engineering from the Universidade Federal do Paraná. He got his Master of Education from Framingham State University, Massachusetts. Over the years, Eli has taught English as a second language, mathematics, physics, theory of knowledge and ICT, and has been an IB coordinator, but his teaching passion is ITGS, the course predecessor of digital society, which he has been teaching for over 23 years. He taught ITGS at the International School of Curitiba between 1998 and 2010, and at the Sultan's School in Muscat, Oman, from 2010 onwards. Eli is also an online ITGS teacher for Pamoja Education, an IB examiner and an IB workshop leader.

Tammy Earle

Tammy lives in Rothesay, New Brunswick, Canada, and is the director of technology and learning initiatives at Rothesay Netherwood School. She graduated with her Bachelor of Science (mathematics) and Bachelor of Education from Dalhousie University, and a Master of Education (learning and technology) from Acadia University. Tammy continues to explore ways to redefine education through the effective use of digital technology and build new approaches to pedagogy through a culture of inquiry and design thinking. Over the last 25 years, Tammy has worked as a teacher (ITGS, mathematics, digital design and robotics), IB diploma coordinator, and has been involved with IB as an examiner, workshop leader and online curriculum developer. She also participated in DP curriculum reviews for ITGS and the digital society course.

Michael Fitzpatrick

Michael was born in Melbourne, Australia. He studied at a variety of universities in the city and has a Bachelor of Science (mathematics and information science), a Bachelor of Education, and a Master of Education (thesis: focus on constructivist learning). He has written a number of ICT textbooks for the Victorian Certificate of Education, and has presented at in-service events and conferences. When Carey Baptist Grammar School in Melbourne first began offering the IB programme in the late 1990s, he taught ITGS, the course predecessor of digital society. Over the years he has become involved with IB in various roles with ITGS, including IB examiner and IB workshop leader. He has also taught Theory of Knowledge for many years.

Carol Hancox

Carol was born and grew up in London, UK, graduated from the London School of Economics with a degree in management science, and complemented this with a Postgraduate Certificate in Education in business studies to become a teacher in 1995. Carol started as an ICT and business studies teacher, and has been working at the International School Brunei for the last 20 years, where she has been teaching computer science and ITGS. Carol has been involved with IB in various roles with ITGS since 2002, including examiner, and participated in the DP curriculum review for the new digital society course, which she is looking forward to teaching.

Jonathon Levin

Jonathon grew up in Northern California, USA. He graduated from UCLA with a degree in business economics before earning his Master of Education at LMU. Over the past decade, he has taught in a variety of contexts including public, private and charter schools in the USA, Spain, Indonesia and Israel. He has taught mathematics, computer science, graphic design, robotics, sustainable architecture, English as a foreign language and ITGS. He has worked to develop curriculums in mathematics, technology education, sustainability and robotics. Jonathon emphasizes a student-centred approach to education to ensure all students have access to engaging, meaningful and relevant learning experiences.

Barbara Stefanics (author and series editor)

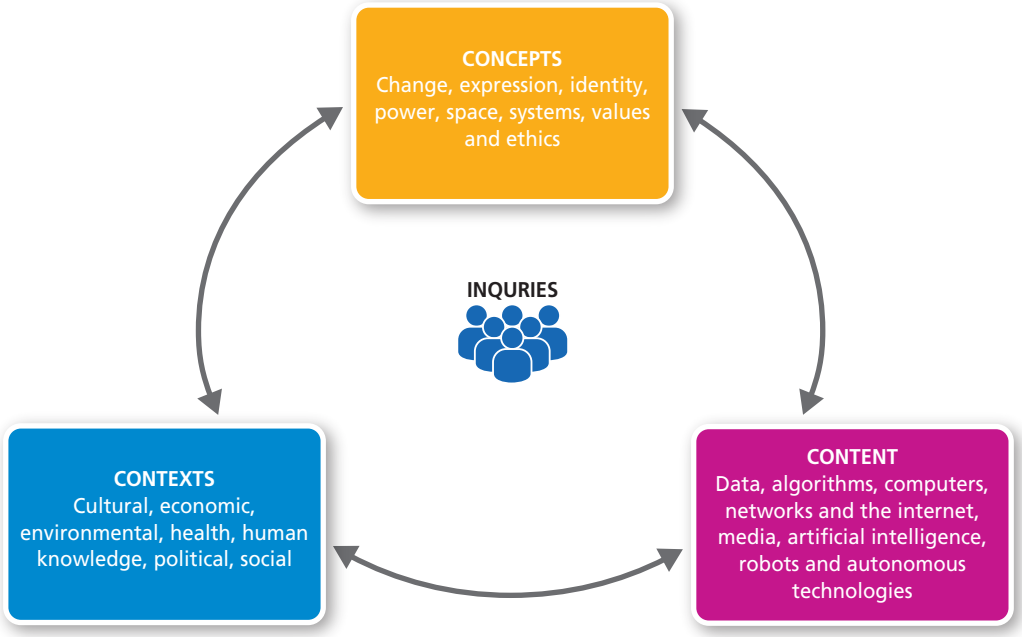
Barbara has been actively involved in IB education for over 40 years in a wide range of roles: teacher (mathematics, computer science, ITGS), head of ICT K-12 (Vienna International School), DP consultant and site visitor, workshop leader and online facilitator and developer, webinar developer (technology in the IB classroom), examiner and participant in DP curriculum reviews (computer science, ITGS, extended essay, learner profile and digital society). The next frontier, digital society, is an exciting opportunity for teachers and students to actively engage with contemporary topics and promote responsible and ethical use of digital technologies, as well as decision-making and taking action.

Welcome to digital society

We are living in a constantly evolving society where developments in digital technologies are having significant impacts. They are transforming how we think, communicate, collaborate, create and organize ourselves. It can be argued that we are living in a digital society.

This course provides a foundation for studying and understanding the impacts and implications of digital technologies for both individuals, and local and global communities. We want to gather experiences, knowledge and insights from diverse, real-world contexts in order to anticipate and prepare for future developments in digital technologies.

The Digital Society course is based on using concepts, content and contexts as a structure for approaching real-world examples, as shown in the diagram below. This digital society diagram will be referred to as the '3Cs' throughout the textbook. Take a close look. It actually consists of four important interrelated elements – the fourth being the impacts and implications for people and communities.



■ Digital society diagram – the 3Cs

The diagram captures all of the topics in the core standard level (SL) and higher level (HL) syllabus and answers the question '*what* will we learn?'.

A later chapter, 1.4 Your digital society toolbox, addresses *how* we will learn.

HL students will address three additional topics in Section 5 HL extension: challenges and interventions. These topics provide additional areas for study that extend the topics on the 3Cs diagram. The three topics and their subtopics are shown in the following diagram.

■ HL extension: challenges and interventions

The digital society textbook supports the International Baccalaureate Diploma Programme (DP) Digital Society course. You are expected to engage with the information presented both as an individual and also in collaboration with other students. You will explore digital society topics through the inquiry process. Higher level students will also be expected to use extended inquiry to investigate challenges and interventions in Sections 5 and 6. Both of these approaches – inquiry process and extended inquiry – are considered in more detail in Chapter 1.4 Your digital society toolbox.

Sections 1–4, 7, 8 and 10	Core topics for both SL and HL students
Sections 5–6	Topics for HL students only
Section 9	Guidance for the digital society extended essay

No specific prior learning or courses of study are expected in order to be successful in the Digital Society course. You are expected to engage in a high level of curiosity and engagement with the topics presented and take the initiative to explore further.

As a digital society student, you must have access to:

- the Diploma Programme *Digital Society Guide*
- a computer with internet access
- research materials available online as well as a range of media in the classroom, school library and local libraries
- research tools and online services that can be used to conduct secondary research, as well as primary research and investigations needed for some assessment components
- applications, both offline and online, for creating, storing, analysing and sharing information and for developing the required multimedia presentation.

Moreover, you are expected to take responsibility for your own learning and support the learning of other digital society students by:

- reading and completing the activities in this textbook
- developing your ATL skills and using the inquiry process throughout the course
- contributing to ongoing discussions and collaborations with other digital society students
- consulting the resources used in each chapter
- keeping abreast of emerging digital technologies and their impacts and implications for stakeholders.

You should take note of the digital technologies in your immediate environment, as well as those that have local and global implications. The first step in taking action is to share your findings and discoveries with others.

Throughout the Digital Society course we will refer to the 3Cs (concepts, content and contexts), which will be explained in the next section. However, the fourth 'C' – connections – is an important one to keep in mind throughout your studies. Digital society students are expected to take an active role in 'making connections' throughout the course. This involves analysing information and real-world examples, and linking them to:

- the 3Cs in the digital society diagram, and to various chapters and topics in the Diploma Programme *Digital Society Guide*
- other real-world examples and how they relate to each other
- the Diploma Programme core – theory of knowledge (TOK); creativity, activity, service (CAS) and extended essay (EE) – and other Diploma Programme subjects.

With this mindset, you are now ready to embark on studying the impacts and implications of digital systems on stakeholders in our digital society.

Additional resources to supplement the Digital Society textbook can be downloaded from www.hoddereducation.co.uk/ib-extras

Section 1

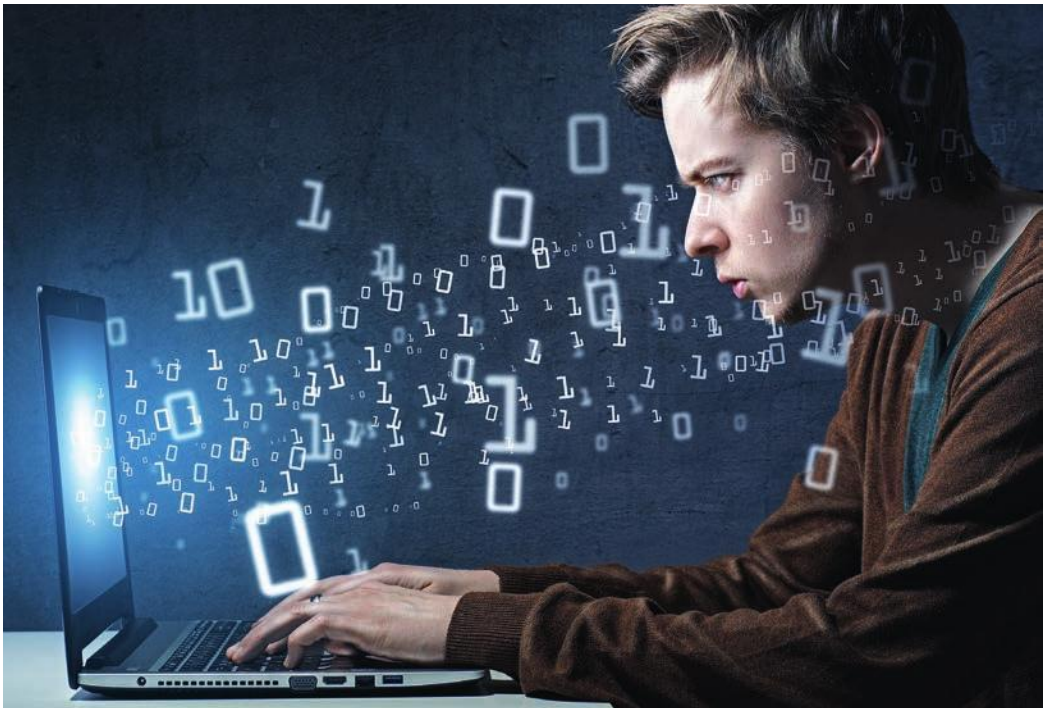
Understanding digital society

1.0 Overview of IB digital society

UNDERSTANDINGS

By the end of this section, you should understand:

- the key terminology relating to 'digital' in digital society
- the digital society diagram (the 3Cs)
- digital society in the IB context
- approaches to learning and studying digital society
- the digital society assessment model.



If we search the internet for the words 'digital society', what are the results? Links to businesses or organizations? Links to universities and university programmes? Articles about life in a digital society? In fact, all of these are likely to appear in the list of results.

For our purposes, digital society is the study of the impacts and implications of the use of digital systems and digital technologies for individuals, people and communities at a local, regional or global level. However, digital society is changing constantly due to the ubiquitous nature of digital technologies and their evolving connectivity.

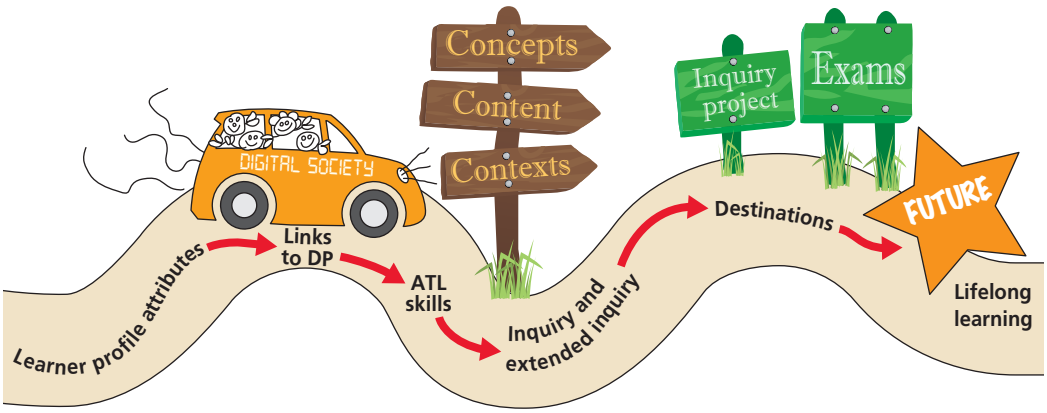
Through specific real-world examples you will develop knowledge, understanding, skills and concepts that you can apply to new situations that you encounter. The changing nature of digital technologies and their uses requires you to always look for connections to what has gone before, and apply your insights to new situations that you encounter in the future. Your first thoughts about digital society may be:

- What is the Diploma Programme Digital Society course all about?
- Why should you study digital society?

- What knowledge, understandings, skills, attributes and values will be developed in order to be successful in both assessments?
- How will studying digital society be beneficial in your future?

Path to success – making connections

When you embark on the course, you need to keep the immediate destinations (aims) in sight: success in the external assessment and Inquiry Project, and in the examinations.



Digital society path to success – making connections

Through the journey, you will be in the 'driver's seat' and taking responsibility for:

- *what you need to know* in the digital society subject (concepts, content, contexts, impacts and implications for stakeholders)
- *how you will learn* the subject, using your digital society toolbox (inquiry process – extended inquiry, developing ATL skills, learner profile attributes)
- establishing links to other Diploma Programme subjects and to the Diploma Programme core (TOK, CAS and EE)
- using digital technologies to support your learning and your inquiry project
- applying your learning critically and creatively to new scenarios in preparation for examinations
- keeping abreast of emerging digital technologies and their impacts and implications
- envisioning how digital technologies will play an important role in your future.

Due to the changing nature of any subject based on the use of digital technologies, the focus of this course is on developing knowledge, understandings and skills from the real-world examples provided, and the impacts and implications for a range of individual, local and global contexts.

1.1 What is digital society?

We are (in) a digital society. Digital systems are changing our world and transforming how we think, communicate, collaborate and create. This course invites young people to better understand this changing world and to imagine where we might go next. As partners in inquiry, students and teachers explore the impacts and implications of digital systems for people and communities in diverse real-world contexts.

Diploma Programme Digital society guide

We will use this statement as our focus into digital society.

1.1A Digital society has multiple names

There are many names associated with 'digital society' and the use of digital systems. For the purpose of this study, we will consider the following terms: information age, computer age, post-industrial society, network society and fourth industrial revolution. It is not important to compare features of each era, but to note ongoing developments that contribute to digital society.

The terminology used to describe how the developments in digital systems have taken place is sometimes confusing. For example, we often see references to the five generations in computing, however the 'fourth generation in computing' is completely different from what is meant by the 'fourth industrial revolution'. The more recent developments in the **digital revolution** from 1980 onwards are those that we will consider as contributing to the rise of digital society.

◆ **Digital revolution**: The advancement of technology from analogue electronic and mechanical devices to digital.

We have to keep in mind that dates on timelines are not distinct points in time. Dates often mark a point in time when a particular digital technology was actually used to a significant extent. Digital technologies undergo years of development before their use is actually acknowledged.

In taking a close look at the developments during the digital revolution (third industrial revolution) and the emergence of digital society (fourth industrial revolution), which digital technologies have had significant impacts and implications for individuals, people and communities?

1.1B Digital society has uneven access to digital systems

The ability to access digital technologies and the internet has become increasingly important in order to connect to the economic, political and social aspects of the world. The term **digital divide** highlights that not everyone has access to this technology. Digital divide refers to the significant gaps between members of society who have uneven access to computers or the internet, and the more privileged (wealthier, middle-class) living in urban and suburban areas who have access. Those with limited access to digital technologies may include:

◆ **Digital divide**: The gaps between members of society who have uneven access to computers or the internet, and those who do have access.

- people who are economically disadvantaged
- people living in rural areas where digital infrastructure and the internet are not easily accessible
- older people (intergenerational digital divide)

- non-native language speakers (linguistic and cultural digital divide)
- people with disabilities
- poorly educated individuals who are unable to properly use the existing IT tools.

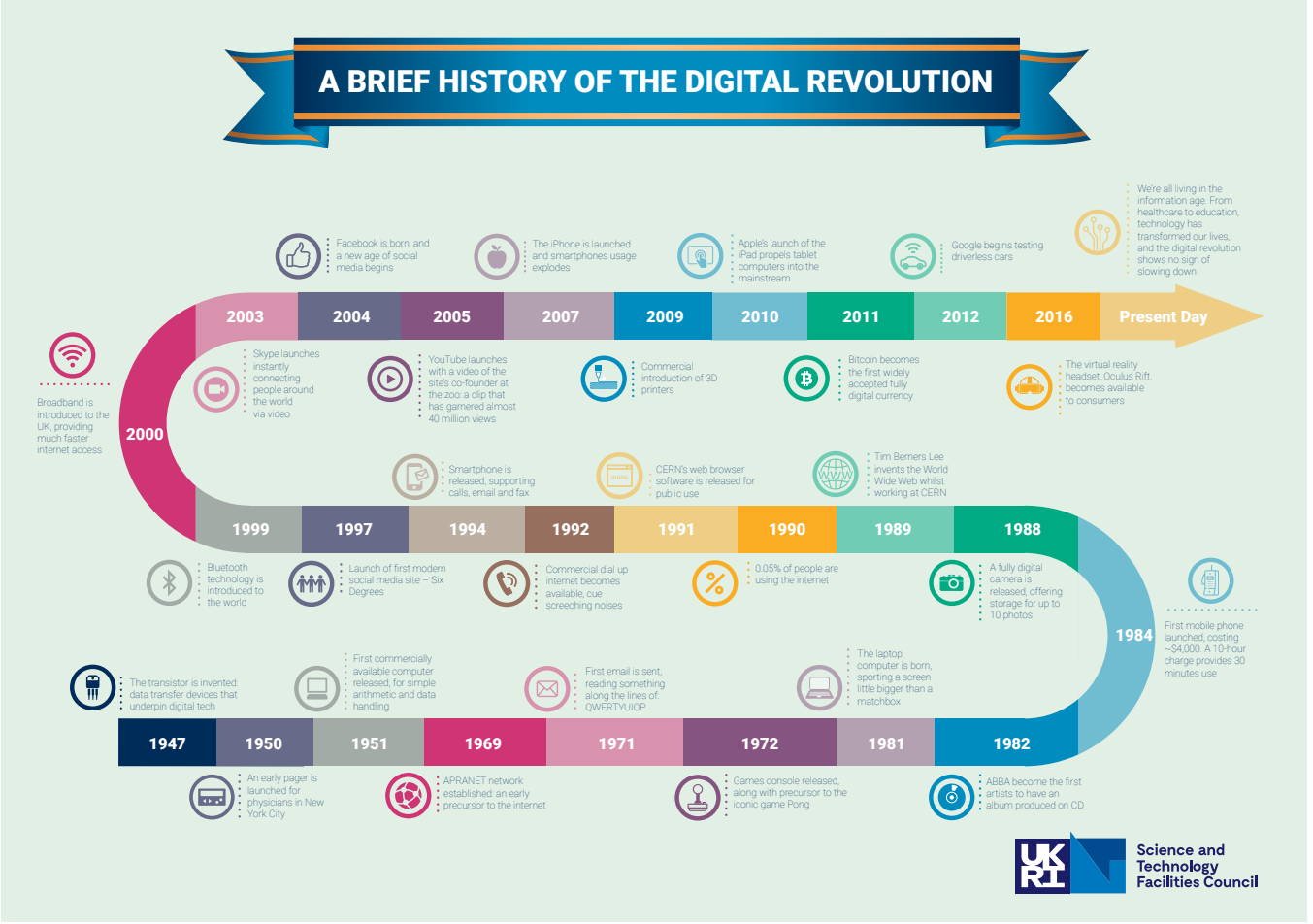
ACTIVITY

Smartphones narrow the digital divide in both a local and global context. Outline specific real-word examples of how smartphones have reduced the digital divide in rural Africa.

1.1C Milestones in the development of digital society

Milestones that have contributed to the developments in digital society span the period of time from 1947 to the present (third industrial revolution and fourth industrial revolution). There is considerable disagreement about when the digital revolution began, but 1980 is often cited because of the availability of the first personal computers.

Consider the milestones in this timeline. It includes a range of digital developments. Can you identify the following digital technologies on it: integrated circuit, microprocessor, personal computer, the internet, World Wide Web (WWW), online social networks, mobile computing and cloud computing?



ACTIVITY

Personal milestones

Add details of personal milestones for you and for one older family member in the table below, adding other milestones as needed.

First use of digital technologies	Details of this milestone for you	Date of first use	Details of this milestone for a family member	Date of first use
Accessed a personal computer at home				
Played a computer game on a computer				
Used a digital camera				
Played first online game				
Accessed the internet for the first time				
Used the WWW for the first time				
Registered for an email account				
Registered for a social media account				
Used your own cell phone or smartphone				
Uploaded a digital image to a website				
Use video conferencing				

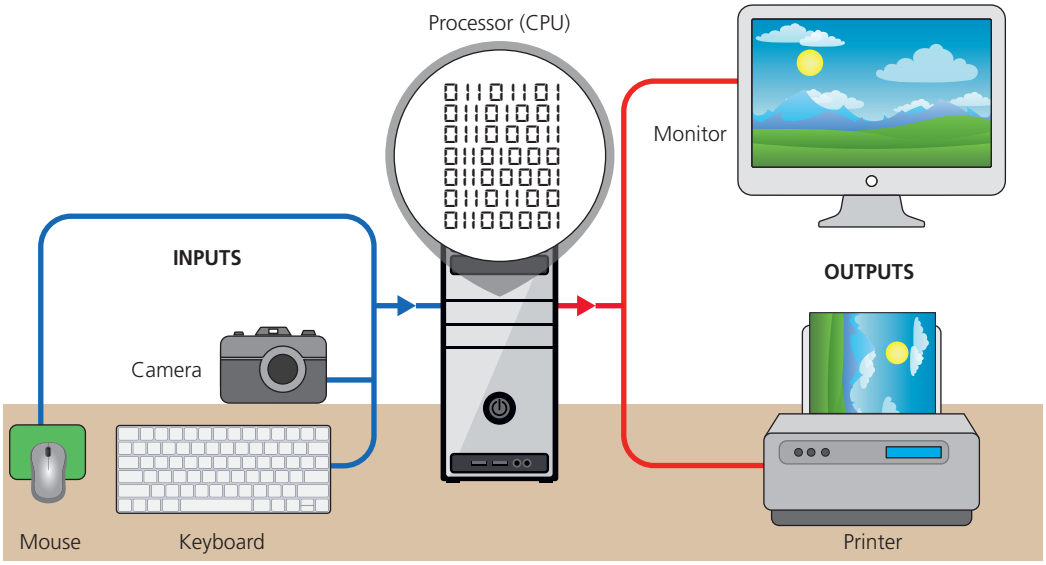
1.1D Digital systems use binary digits

The invention of the modern **binary** number system is attributed to Gottfried Leibniz, a well-known mathematician, through his article *Explication de l'Arithmétique Binaire* (Explanation of Binary Arithmetic), published in 1703, in which he used the binary number system to convert verbal logic statements into mathematical ones.

All data and information used by digital systems uses the binary digits (**bits**), 1 and 0. This includes all text, images, photos, video, audio, music, software – all data and information are represented by a sequence of 1s and 0s in all of the digital technologies we use.

◆ **Binary**: A system used to convert verbal logic statements into mathematical ones.

◆ **Bit**: A binary digit – either a 0 or a 1.



■ Data input is converted into binary for storage, manipulation and transfer

Inputs can come from a range of sources including the keyboard, mouse, cameras and scanners, including QR scanners on smartphones. For example, this QR code can be scanned by a mobile device to provide access to a website.

Can you think of other uses for QR codes?

Encoding

Strings of 1s and 0s can be encoded to represent various kinds of data and information.

Information can be stored in eight bits, called a '**byte**'. For example, a byte can represent 256 different characters of text represented from 00000000 to 11111111. ASCII (American Standard Code for Information Interchange) is the encoding standard for text. The letter 'D', for example, is represented by this byte: 01000100.

◆ **Byte**: A group of binary digits (usually eight).

Different encoding formats have been standardized to allow for compatibility between different digital systems and technologies. Examples include:

- text encoded in a text file format, e.g. TXT, CSV
- audio encoded as audio file formats, e.g. MP3, WAV, AAC
- video encoded as video file formats, e.g. MPEG-4, AVI
- images encoded as file formats, e.g. JPEG, PNG, GIF, RAW.

Data formats and file formats can only be created, saved and accessed by specific programs. Therefore, ensuring compatibility between digital technologies is often a challenge. Some formats are unique to the software used to create them, or use a file format that is no longer used by newer software.

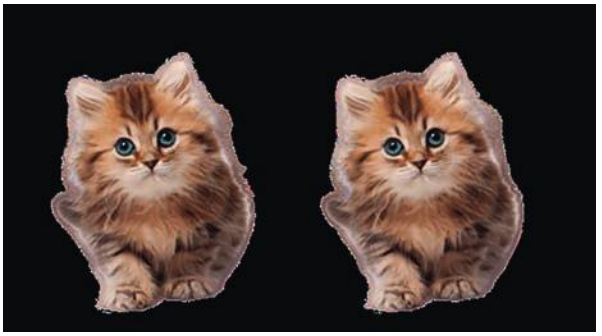
Steganography

Information stored in binary is not legible to humans. Therefore, programs, freely available on the internet, can be used to embed text within an image file. This is called 'steganography' – the practice of hiding secret text in image files.

Steganography can be used to send messages as no particular security precautions need to be taken to send the file and no one is likely to suspect that the image contains hidden text. The photo used to hide the message can be accessed as normal, and the person receiving it can use software to read the hidden message.

The images below demonstrates the use of steganography. The cat on the right has a text message (approximately 1 KB) embedded within the binary code for the image, but it looks the same as the original image on the left.

There are legitimate purposes for using steganography, for example, watermarking images as a means for copyright protection. However, steganography can also be used to hide illegal activity and communication between members of criminal or terrorist groups.



1.1E Digital is different from analogue

Analogue and digital measurements

Most people are used to using **digital** devices to measure time and temperature. Digital watches and clocks have replaced telling the time from the placement of hands on the face of clock. Likewise, the temperature of a room can be read from a digital display on the wall rather than reading a thermometer. There are instances where **analogue** measurement is still used, for example, speedometers in many cars still use a pointer to show how fast the car is travelling.

◆ **Digital**: Discrete signals with a finite set of values.

◆ **Analogue**: Continuous physical quantities and signals.

What is the difference between analogue and digital? In measurement, analogue refers to continuous physical quantities and signals. So, a clock, thermometer and speedometer will measure a continuum of values.

Digital, on the other hand, only displays digits – that is, discrete signals with a finite set of values. So, for time, digits representing hours, minutes and seconds will be represented by digits on a display.

Analogue and digital signals

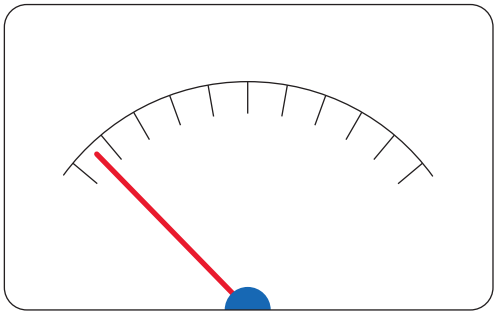
Analogue and digital can also refer to signals. Analogue signals are continuous and represented by waves. They are used for audio and video transmissions. Digital signals are discrete and are represented by 1s and 0s. They allow for the transmission of data between digital devices.

Before computers, all measurements and signals were analogue. However, digital signals have a more reliable transmission rate with less interference. They are also less expensive and more flexible.

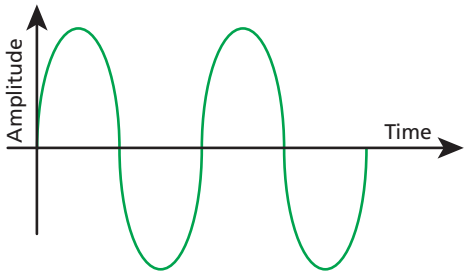
Analogue to digital, and digital to analogue

Some devices use both analogue and digital signals. Bluetooth earphones have a built-in digital-to-analogue converter (DAC) that converts the digital signal received to analogue so that it can be played and heard.

Likewise, whenever we speak into a digital microphone and save the file on our computer, an analogue-to-digital converter (ADC) makes the conversion.

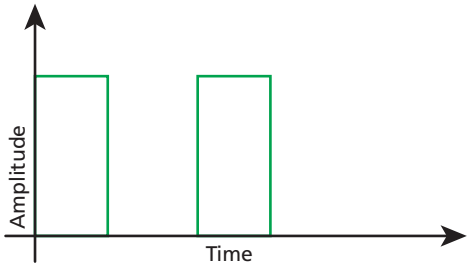


Analogue display



Analogue signal

Digital display



Digital signal

■ Analogue signals versus digital signals

1.1F Digitization

Analogue and digital information

Analogue forms such as printed photographs, printed documents and other artifacts can be converted into a digital (binary) format that can be saved on a digital device. The process of changing data and information from analogue to digital is called **digitization**. It allows us to store, process and share information between devices.

◆ **Digitization**: Changing analogue data and information to digital.

Digitization also refers to taking data that is filled in on paper forms and transferring it to a digital system or database. The data from the forms must then be stored according to the procedures and policies that have been established for the storage of personal data. Individuals may use digitization for personal purposes, to save and share personal source material on a digital device or on a cloud service.

In addition to the established procedures and policies for storing data, institutions such as museums, libraries, businesses, news agencies and governments also need to consider the actual process that will be used for the digitization of source material, such as copyright, accessibility to the digitized material and equitable digitization of cultural materials.

Digital preservation

Digitization is not the same as **digital preservation**. Digitization is only one of the steps that could be involved in the digital preservation process. Digital preservation is the process of ensuring that source material is stored and accessible in a digital format regardless of technological changes that may take place over time.

◆ **Digital preservation**: The process of ensuring that source material is stored and accessible in a digital format regardless of technological changes that may take place over time.

> *Data preservation means more than just making a backup copy of your data; it means protecting your data in a secure environment for long-term access and reuse.*
>
> *Stanford University*

Digital preservation may involve source material such as texts, documents, images, photographs, databases and spreadsheets, programs and applications, desktop files and operating systems, emails, tweets, social media, games, movies, music and sound, entire websites – indeed, anything digital accessed on a digital system.

Since digital technologies are constantly changing, the procedures and policies used for the digital preservation of source material must be able to address these changes and get around the problems caused by digital systems that are no longer available.

ACTIVITY

Obsolete digital systems

Identify five specific digital technologies, online or offline, that you or a family member used 10 years ago to create and access text, photos, music and other information that are no longer available.

To what extent is it possible to access the digital material using current digital technologies?

Digital reformatting

Digital reformatting is part of the process of preserving original materials for long term accessibility. It involves converting analogue materials into a digital format so the need to use of the original material is much less or totally eliminated. It is guided by policies and best practices to ensure that the materials being converted in the digital reformatting process are protected and that the digital version produced is of the highest quality.

Digital archives

A digital archive, also referred to as a data archive, is an information system used to store different digital resources and make them available to a specific group of users.

Digital archives can be structured in very different ways: by topic, by archive owner, by type/file format of the content (images, text, videos), by access (public or not public), by technical structure, by language, and by interaction possibility for the users (the type of navigation and search allowed).

ACTIVITY

Search for a digital archive

There are hundreds of public digital archives available from universities, libraries, museums, organizations, businesses and governments across the globe.

Use a search engine to find a public digital archive from:

- a university library
- a newspaper or magazine publisher
- a government archive
- a medical library
- a museum.

Use the words 'digital archive' along with other keywords in your topic of interest.

What are your observations about the impact and implications of making digital archives publicly accessible?

Links

This topic links to 3.1 Data and data analysis and 4.1A Arts, entertainment and popular culture.

1.1G Digitalization

The terms 'digitization', 'digitalization' and 'digital transformation' can be confused with one another, but they are all different.

Digitalization is the use of digital systems to change the structure and/or operation of a business, institution or organization. Examples include:

- a retail store introducing an online shop to sell their products
- a school deciding to use only electronic versions of textbooks
- a business deciding to store all of its data in a cloud service rather than invest in additional hardware and software to store its data on-site.

◆ **Digitalization**: The use of digital systems to change the structure and/or operation of a business, institution or organization.

Digitalization may be the result of the availability of new technologies that can be used and combined to replace the current processes that are being used. Examples of these technologies are further explored in Section 3.

Digital transformation

Digital transformation is a profound change in an entire institution, organization, business or other entity due to the need for change and the potential of digitalization to meet that need. Digital transformation can have implications for methods used, services offered, management, stakeholder involvement, ways of thinking and all other aspects of how the entity functions.

Digital transformation has been observed in education whenever natural disasters and other factors have disrupted the ability for students to attend school.

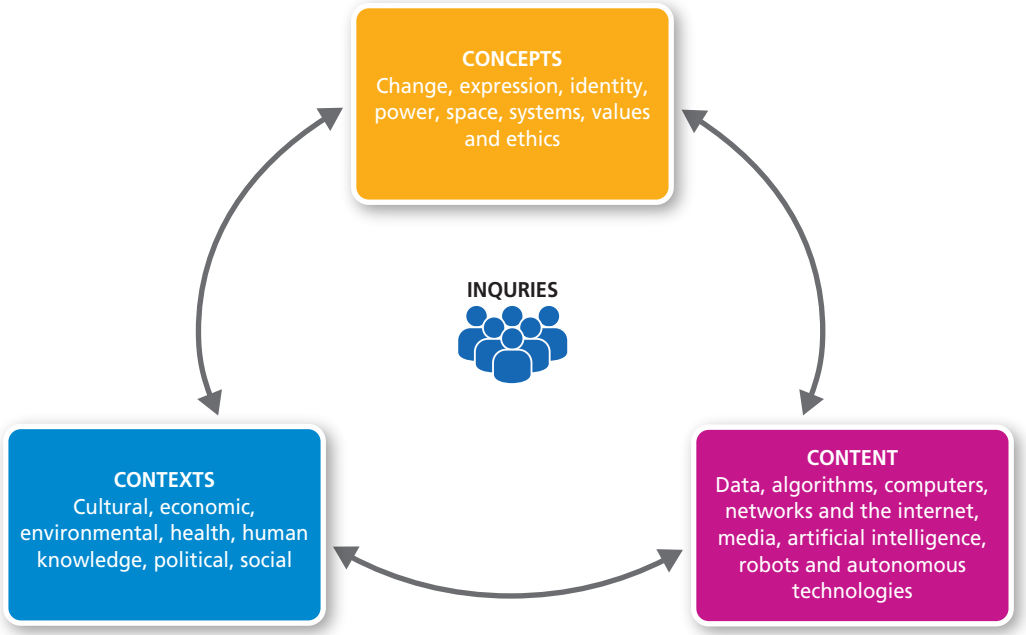
Reflection

Now that you have read this chapter, reflect on these questions:

- What is digital society, and what is the focus of our Digital Society course?
- How are all data and information stored in a digital device?
- What are the main purposes of digital preservation, digital reformatting and digital archiving?
- What are the differences between digitization, digitalization and digital transformation?

1.2 The foundations of digital society: Concepts, content and contexts

We will be applying the digital society diagram to a wide range of real-world examples throughout our study of digital society, and analysing the impacts and implications of digital systems on people and communities.



■ Digital society diagram – the 3Cs

The table below provides an overview of how real-world examples relating to digital society can be categorized under three headings: concepts, content and contexts.

■ Impacts and implications for stakeholders

Concepts	Content	Contexts
Large overarching themes that are powerful, pervasive and debatable. 2.1 Change 2.2 Expression 2.3 Identity 2.4 Power 2.5 Space 2.6 Systems 2.7 Values and ethics	Digital systems and digital technologies used in specific real-world examples. 3.1 Data and data analysis 3.2 Algorithms and code 3.3 Computing devices 3.4 Networks and the internet 3.5 Media 3.6 Artificial intelligence 3.7 Robots and autonomous technologies	Real-world examples in which the use of digital systems have impacts and implications for stakeholders. 4.1 Cultural 4.2 Economic 4.3 Environmental 4.4 Health 4.5 Human knowledge 4.6 Political 4.7 Social

If we simply consider the number of possible real-world examples that we can categorize using these three columns (concepts, content and contexts), there are 7 × 7 × 7, or 343, different possibilities. That is a significant number, and this is if we only consider one real-world example for each possibility.

In addition to considering the 3Cs when categorizing real-world examples, they can have impacts and implications for people and communities at various levels:

- individuals, groups and/or communities
- local, regional or national
- global.

This adds to the complexity of categorizing examples. It is not possible to study every possible combination of the 3Cs at all of the various levels. Therefore, it is necessary to look for similarities and make **connections** between the various real-world examples, so that the number is not overwhelming.

You will also need to have a well-organized way of saving your examples and findings, and for looking for connections to any new examples that you encounter.

Real-world examples involving the use of digital technologies can come from a wide range of sources, including:

- personal encounters and experiences
- family members, friends and acquaintances, and their experiences
- local businesses, institutions and organizations
- regional and national governments
- news items on television, radio, newspapers, magazines and other media sources
- books and published materials
- online courses, webinars, newscasts and podcasts
- anywhere.

One is never enough

One instance of a particular real-world example or news item is not enough to gain an overall perspective. We need to have a balanced overview through various sources of information from different geographical locations and different stakeholder perspectives. Every real-world example and news item will have more than one perspective.

Time changes perspective

The perspective about a particular news item or real-world example can change over time. A good example of this is illustrated by a well-known cartoon published in the *New Yorker* in 1993: 'On the internet, nobody knows you're a dog.' At that time, the cartoon suggested the internet provided anonymity.

Today, however, huge amounts of personal data are collected, stored and shared. There are alarming concerns about privacy and who has access to our data, how they acquire access, and how we can safeguard our data.

A more recent article from Digital Guardian, 6 August 2021, was titled 'On the internet, everyone knows you're a dog', which highlights how significantly the situation has changed from 1993 to 2021.

"On the Internet, nobody knows you're a dog."

ACTIVITY

What does your digital footprint look like?

Let's consider a personal real-world example. How does your involvement with digital technologies contribute – either actively or passively – to your digital footprint?

Footprints on the beach leave a trace that will wash away. The digital traces that are left intentionally or unintentionally by you, and through the actions of others, cannot be erased. They reside on servers where the information is stored, backed up, transferred, copied and shared. Even if the information is erased, we cannot be certain that it does not exist on another digital system somewhere else.

- Use a search engine to identify the key features of a 'digital footprint'.
- Use a search engine, such as Bing, Google or one of the many other internet search engines, and enter your own name. The result of the search will give you a first impression of what your digital footprint looks like. Follow this up by searching for your name on any social media account that you use frequently. What impression would your family, teachers, friends, future college admissions officer or future employer have about you from these search results? Do the results leave a positive or negative impression?

This part of your digital footprint is the result of your active posting of online, for example, social media posts, photos, videos or responses to others. Your digital footprint may also be the result of posts made by others, which can be positive, such as receiving an award, or negative, such as an embarrassing photo. These posts contribute to your passive digital footprint, which can be damaging in some instances.

Other passive contributions to your digital footprint occur when you are unaware that your actions are being collected and stored. These include data collected by browsing websites, by your internet service provider (ISP), through shopping online and similar activities.

- Conduct some initial searches and outline:
  - actions that you can take to create a positive digital footprint
  - steps that you can take to avoid having a negative digital footprint.

The concept of a digital footprint relates to the 3Cs in the digital society diagram and the table. It can be categorized as follows:

- Concepts: 2.3 Identity
- Content: 3.4 Networks and the internet
- Contexts: 4.4 Health and 4.7 Social.

We will consider the 3Cs and real-world examples in more detail in Sections 2 through 6.

Awareness of the world around us

Throughout the Digital Society course, you need to be aware of the impacts and implications of your own use of digital technologies as well as the use by others. This includes both digital technologies in our physical environments and in our virtual lives, and at all levels: individual, local and global.

As you collect real-world examples for your digital society studies, reflect on how the digital technologies that you use have an impact on you as an individual as well as the positive and negative impacts for others. Be proactive. Take whatever action is needed.

■ Keep a watchful eye on your own actions, and the actions of others

1.3 Digital society in an IB context

Digital society in the Diploma Programme

Digital society is one of the subjects in the 'individuals and societies' Diploma Programme (DP) subject group. You are encouraged to make connections between digital society and other subjects in the DP: language acquisition, studies in language and literature, mathematics, the arts, sciences and individuals and societies.

Digital society students are also expected to connect their learning to the core areas:

- **Theory of knowledge (TOK)**: Studying the nature of knowledge and knowing. How do we know that claims are true? Connections can be made in TOK classes or through learning activities in digital society.
- **Creativity, activity, service (CAS)**: Taking action in the areas of creativity, activity and service. Digital society offers many opportunities in all three areas.
- **Extended essay**: Developing a research paper based on a research question from one of your six DP subjects. We will look in depth at the digital society extended essay in Section 9. Your supervisor for an extended essay in digital society would most likely be your digital society teacher. Note the topic of the digital society research question for the extended essay (Section 9) cannot be the same as the topic for the inquiry focus for the inquiry project (Section 8).

Understandings, attributes and skills of an IB student

Through the activities in this digital society textbook, you will be seeking to develop:

- international-mindedness
- learner profile (LP) attributes
- approaches to learning (ATL) skills.

International-mindedness is how individuals view the world and see themselves connected to the global community. It also involves developing a sense of responsibility to other people. It is an awareness of the interrelationships that exist between nations, cultures and individuals, and a further recognition of the complexity of these relationships.

The relationships that exist between nations, cultures and people remind us of the 'butterfly effect', a theory associated with Edward Lorenz, a mathematician and meteorologist.

The butterfly effect theory claims:

> *… that an action as small as the flapping of a butterfly's wings can instigate a series of increasingly profound reactions that can cause something significant and meaningful to happen – sometimes on the other side of the world.*
>
> *Source:* **https://smagroupsolutions.com/blog/leading-with-intention-embracing-the-butterfly-effect**

In the context of digital society, we live in an interconnected world. This means everything you do and say is important because it has an effect on those around you, and can even have very rapid and far-reaching effects. What we say and do, no matter how insignificant it may seem, affects others whether we can see the impact or not. Dave Wright, chief innovation officer at ServiceNow claims that the 'digital butterfly effect' explains the unforeseen effects of new technologies.

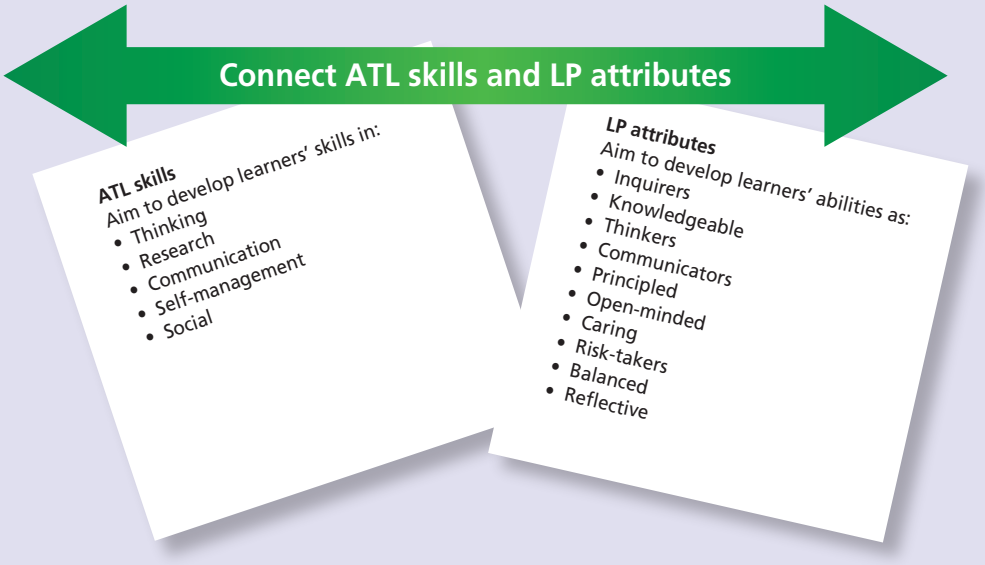
ACTIVITY

Digital butterfly effect

Identify one real-world example where someone has used a digital system in what seemed to be an insignificant way at the time, but the outcome had far-reaching impacts in another location or on other individuals.

ACTIVITY

The list of ATL skills and LP attributes overlap and complement one another in many ways. You will develop ATL skills through the activities in digital society, which will contribute to your overall learner profile attributes.



- Using a search engine, search for two diagrams and images that relate the two lists in the same diagram. Compare their effectiveness in relating ATL skills and learner profile attributes.
- Describe how each of the skills and attributes in the diagram relate to studying digital society in the IB Diploma Programme.

Connecting aims for digital society to aims for individuals and societies subjects

Individuals and societies aims

Individuals and societies subjects help young people develop a connection to our shared planet, exploring how to live sustainably and promoting the well-being of all people in our pursuit of a more peaceful world.

The aims of all the individuals and societies subjects are to equip young people to:

- explore and critically engage with multiple perspectives and ways of thinking
- investigate and evaluate the interactions between individuals and societies
- think and act as informed and principled individuals in societies
- understand and value the variety and diversity of the human experience across time and place.

Digital society aims

The Digital Society course invites SL and HL students to develop as ethical, empathetic and creative people who address the world with individual and shared understanding, imagination and action.

The course aims indicate important milestones on a student's learning journey as they:

- **focus** inquiry using course concepts, content and contexts, as well as real-world examples
- **explore** diverse sources relevant to digital society
- **investigate** impacts and implications of digital systems for people and communities
- **reflect** on emerging trends, future developments and further insights
- **share** discoveries about digital society with others.

Reflection

The aim of all IB programmes is to develop internationally-minded people who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.

IB Learner Profile, IBO, 2017

How do the aims from the subject group, individuals and societies, and the aims from digital society align with the overall aim of all IB programmes?

1.4 Your digital society toolbox

Create your digital society toolbox

The skills and attributes that you develop through your studies contribute to your skill set as a lifelong learner. You are responsible for your own learning. Some of the approaches that you may take may be successful while others may need to be refined as you progress through your study.

The use of ATL skills and the LP attributes provides a solid foundation for learning about digital society. They provide the first tools in your digital toolbox.

The question is, what do they look like in practice?

Your success as a learner depends on your success as a:

- **thinker** who demonstrates both critical and creative thinking skills, and makes responsible and ethical decisions
- **researcher** who uses reliable sources and methods, and considers a range of perspectives and practical experiences that can be used to support investigations
- **collaborator** who interacts in exchanges with others to enhance your own learning and the learning of others
- **communicator** who shares findings through a range of means and media
- **self-manager** who can organize yourself and manage the successful completion of tasks.

Close-up on self-management in your toolbox

Self-management skills are involved in both organizing and managing information emerging from the course, as well as the real-world examples that you research and analyse.

It is not possible to re-read all of the information from a two-year course in the days before examinations. An on-going systematic approach for creating and storing notes needs to be decided early on in the course. This includes how the analysis of each real-world example will be summarized and where it will be saved. Some schools provide digital spaces for students where they can store their documents, or you may wish to use a combination of hand-created notes and digital notes.

You should also consider developing a one-page template that you can use for each real-world example that you analyse. Using a template helps you to have a consistent approach for summarizing your findings.

Self-management skills are also involved in the development of the inquiry project. This will be discussed at great length in Section 8.

Other ATL skills will be developed throughout the activities in the various sections of the textbook.

Terminology in your toolbox

You need to understand the terminology related to the *Digital Society Guide*, including:

- the command terms used on all examinations and internal assessment (pages 69–70 of the *Digital Society Guide*)
- Digital Society course keywords (page 8 of the *Digital Society Guide*)
- all terminology in the *Digital Society Guide* (pages 22–38 of the *Digital Society Guide*)
- for HL students only, terminology relating to the challenges and interventions (pages 39–43 of the *Digital Society Guide*).

You will need to expand your terminology as you encounter through real-world examples and news articles:

- record any new terminology or phrases that you encounter that relate to digital society
- record the sentence from the source that used the new terminology or phrase so that the meaning is clear when you review your list of terminology
- research the meaning of the terminology or phrase.

The inquiry process in your digital toolbox

The most important approach that will be used throughout the study of Digital Society by all students is the inquiry process. It is a step-by-step process for systematically progressing from what you want to find out through the process of research, analysis, evaluation, reflection, recommendation and communication (sharing). It will be used as the primary tool in our digital society toolbox.

Experience in using the stages will be gained in Sections 2 through 4, focused on the 3Cs, and in Section 8. Additionally, HL students will use the inquiry process and the extended inquiry in Sections 5 and 6.

The command term 'recommend' refers to recommending future courses of action. When 'recommend' is used in an extended inquiry for HL students, it will refer to making a specific kind of recommendation – an intervention for a challenge. More details on this are given in Sections 5 and 6.

ACTIVITY

Understanding the inquiry process

Consider the following steps in the inquiry process. Read the descriptions carefully.

■ The steps in the inquiry process

Starting point	**FOCUS** • Select a topic for the inquiry.
Determine inquiry focus	• Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs. • Find related real-world example(s).
Explore	**EXPLORE** • Find and evaluate sources. • Conduct research, collect data and record sources. • Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.
Analyse	**INVESTIGATE** • Analyse findings with respect to the 3Cs in the digital society diagram. • Analyse the impacts for people and communities. • Analyse the implications.
Evaluate	• Evaluate the impacts and implications. • Weigh up the positive and negative impacts and implications.
Reflect	**REFLECT** • Reflect on implications. • Reflect on discoveries, trends and future developments.
Recommend	• Recommend and suggest future courses of action.
Communicate	**SHARE** • Share outcomes from the inquiry through learning activities: essay, slideshow, discussion and other means (formative activity). • Digital society internal and external assessments (summative assessments).

Notice that 'explore' refers to finding real-world examples and conducting research.

Identify a list of possible secondary sources and primary sources for research.

Compare your list of secondary and primary sources with the following list

- news sources and media
- websites
- text-based sources: books, articles and other publications
- social media sources: posts, blogs
- media sources: images, videos, podcasts, webinars
- online databases
- live experiences: performances, workshops, lectures, interviews with experts
- original documents and documentation: policies, regulations, laws and other original material.

Guiding questions for the inquiry process

The following checklist provides a more detailed approach to using the inquiry process.

■ Inquiry process checklist: ATL and the 3Cs

Starting point	Select a topic that has inspired you and you would like to find out more • Was it something you read, an activity from the book or something else? • Did the topic link to a personal experience? • Has an external source, e.g. a news article or video, been an inspiration?
Determine inquiry focus	Narrow down the topic using the 3Cs • How will you narrow down the inquiry? Are you going to use the examples in the book? Work with your teacher? Choose for yourself? • Have you identified related concept(s) and/or content and/or context(s)? • Are you able to link your focus to a particular real-life example?
Explore	Find and evaluate sources • Where will you find your sources? Will they be secondary and/or primary? • Collect enough information until you have enough to appropriately address the inquiry focus with a balance of claims and perspectives. • Have you adequately evaluated the sources?
Analyse	Investigate impacts and implications on the stakeholders • Explain how the digital technology (content) is related to the inquiry focus? What perspective does the concept bring to the investigation? • Is the analysis based on relevant supporting real-world examples (context)? • What are the positive and negative impacts on stakeholders?
Evaluate	Investigate the extent of the impacts and implications • Evaluate the significance of the impacts and implications. • Have you weighed up the positive and negative impacts and implications? • Are the impacts and implications short or long term? • Do the negative implications have solutions (interventions)?
Reflect	Reflect on the implications and synthesize your findings • How is your understanding of the inquiry focus different now to what it was at the start? • How do your findings relate to future trends and developments?
Recommend	Recommend/suggest specific solutions (interventions) for the impacts and implications
Communicate	Select how to share the inquiry • What is the main purpose of your inquiry? Is it to educate, persuade or lobby? • Who is your audience? What medium will be used to present your findings? • How will you plan and structure your response?

At first glance, the inquiry process seems to progress from top to bottom. However, there are times in the process when you will have to go back to an earlier stage and explore, analyse, evaluate or reflect further before you can adequately address your original inquiry question. It is not always a straightforward process.

You will gain experience in using the inquiry process throughout the activities in this textbook, and also whenever you encounter a topic that you want to explore further. This is called 'open inquiry', where you take responsibility for the process and for your own learning.

1.5 Learning and assessment

The destination: Assessment

In order to be successful in the course, it is important to have an overview of how it is assessed and what knowledge, skills and understandings are required.

	What do you need to know? Knowledge, skills and understandings	How will you be assessed? Internal assessment and external assessments	Sections in this book
SL and HL core	• The SL and HL syllabus includes common topics for SL and HL based on the digital society diagram (3Cs diagram). • The approach for study is using selected steps in the inquiry process and ATL skills (thinking, communication, research, self-management and social).	• SL Paper 1 and HL Paper 1 Section A, common questions • SL/HL Paper 2, common paper	**0** Welcome to digital society **1** Understanding digital society **2** Concepts **3** Content **4** Contexts **7** How to approach external assessments **10** What's next?
Inquiry project	• The approach for study is the inquiry process. • ATL skills (thinking, communication, research, self-management). No collaboration.	• SL/HL inquiry project is the common internal assessment. It consists of three components: a multimedia presentation, the inquiry process document and a list of references. • It is assessed by the teacher using the assessment criteria for the inquiry project and externally moderated by an IB examiner. • Digital technology skills	**8** Inquiry project – internal assessment
HL-only extension	• An HL-only extension includes challenge topics and relevant interventions. • The approach for study: the inquiry process and the extended inquiry for evaluating interventions. • ATL skills (thinking, communication, research, self-management). Social skills are used in the collaboration in conducting research for the HL-only extension topics and HL pre-release.	• HL Paper 1, Section B, one question. • HL-only Paper 3 based on a HL pre-released extension topic.	**5** HL extension: Challenges and interventions **6** HL extended inquiry **7** How to approach external examinations

Optional destination: Digital society extended essay

Some digital society students may choose to develop their DP extended essay in the subject.

What do you need to know? Knowledge, skills and understandings	How will you be assessed?	Sections in this book
• SL/HL common topics based on the digital society diagram. • HL students may wish to use the HL extension topics. • The approach for study is the inquiry process and may also include extended inquiry for HL students, but this is not required. • ATL skills (thinking, communication, research and self-management). No collaboration.	• Submission of the extended essay and Reflections on Planning and Progress form (RPPF). • Extended essay assessment criteria with focus on the digital society subject guidelines for the extended essay.	**9** Digital society extended essay

Assessment objectives

The assessment objectives for external and internal assessments are summarized in the following table.

Assessment alignment in digital society	SL Paper 1	HL Paper 1	SL/HL Paper 2	HL Paper 3	Inquiry project
Understand, apply, analyse, evaluate and synthesize					
Course topics, enduring understandings and areas for inquiry	✔	✔	✔	✔	✔
Real-world examples	✔	✔	✔	✔	✔
Claims and perspectives			✔		✔
Impacts and implications	✔	✔	✔	✔	✔
Emerging trends and future developments	✔	✔	✔	✔	✔
Challenges and interventions (HL only)		✔		✔	
Develop and refine digital society skills					
Managing inquiry projects	✔	✔	✔	✔	✔
Researching	✔	✔	✔	✔	✔
Critical and creative thinking	✔	✔	✔	✔	✔
Communicating	✔	✔	✔	✔	✔

1.6 Conducting secondary research and primary research

As you proceed through the Digital Society course you will use both secondary research and primary research in your inquiries, using the same research skills and techniques that are used in other subjects in 'individuals and societies'.

In addition to the information in this chapter, consult the digital society toolkit in the *Digital Society Guide* (pages 18–20) for further details about research skills.

What are secondary research and primary research?

Both of these types of research should be used when carrying out inquiries:

- In **secondary research**, someone else has collected the data and presented the findings.
- In **primary research**, you are collecting the data.

◆ **Secondary research**: Research carried out by someone else.

◆ **Primary research**: First-hand research in which you collect original data.

Secondary research involves gathering information from printed and online sources, literature searches, newspapers, reports, encyclopaedias, journals, books, magazines, videos, podcasts and television broadcasts. This information can be easy to locate but may not always be appropriate for your inquiry. Considerable attention needs to be taken to ensure the reliability of the source(s) and the veracity of the information.

Primary research is when you gather data and information. This data collection needs to be planned carefully to ensure the data collected is appropriate and reliable. It may include interviews, surveys, working with focus groups and observations.

◆ **Quantitative**: Data that can be measured and converted into numbers.

◆ **Qualitative**: Descriptive, non-numerical data.

The data gathered may be **quantitative** or **qualitative**. You will need to determine what is the most appropriate data that needs to be collected for your inquiry.

When and where to use secondary research and primary research

Secondary research is normally done first. It will help you familiarize yourself with the topic being investigated. It will also allow you to determine whether the proposed investigation is feasible. If this is the case, possible primary research methods should be explored. This may require an iterative approach before a final decision is made about the balance between primary and secondary research methods and the balance between quantitative and qualitative data.

How to ensure your secondary research is appropriate

- Find out what you can about the author, their background and qualifications.
- Skim the source to determine if it is likely to contain sufficient relevant information for your inquiry.
- Determine whether the source helps to provide a balanced research base.

- Cross-check the information in your source with information in another source to verify the information.
- Check the timeliness of the source to ensure it is not out of date.
- Investigate sources provided within the source to determine whether they will be able to provide you with more information.

How to ensure your primary research is appropriate

- Clear links can be made from the need for primary research based on findings from the secondary research.
- Check if you can complete this research safely.
- Make sure the research is ethical.
- Make sure the proposed research is feasible, for example, whether you have the time and resources to carry it out.
- Use pilot studies before you commence the research.

Types of primary research

- **Interviews**: in-person or virtual meetings with one person or a small group with questions written in advance. The responses from the interviewee can be followed-up during the meeting for more information and to clarify responses.
- **Surveys and questionnaires**: information is systematically collected from a group of people. The information collected is limited to the responses to the questions. If a sample is used, the choice of sampling technique used (random, quota, stratified) is a key decision. The design of the survey is also critical to ensure you obtain reliable, usable information.
- **Observation**: Observations and measurements usually provide information with less bias and more clarity than interviews, surveys and questionnaires.
- **Investigation**: Investigative methods are appropriate when examining original sources such as policies, laws, video footage, photographs or similar material. They are also useful to experiment and demonstrate how digital technologies can result in specific outcomes.

Before you start …

Before starting, ask yourself:

- What information do I need for the inquiry?
- What will be the balance between primary and secondary research?
- What will be the balance between quantitative and qualitative information?
- What types of primary research will be used?
- Who will be involved in the primary research?
  - Are they appropriate?
  - Are they accessible?
- Is the research methodology balanced and appropriate for the inquiry?

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Section 2
Concepts

2.0 Overview of digital society concepts

UNDERSTANDINGS

By the end of the section, you should understand:

- how to use the seven concepts as a lens to focus on important aspects of the use of digital technologies
- the range of issues with impacts and implications associated with each concept.

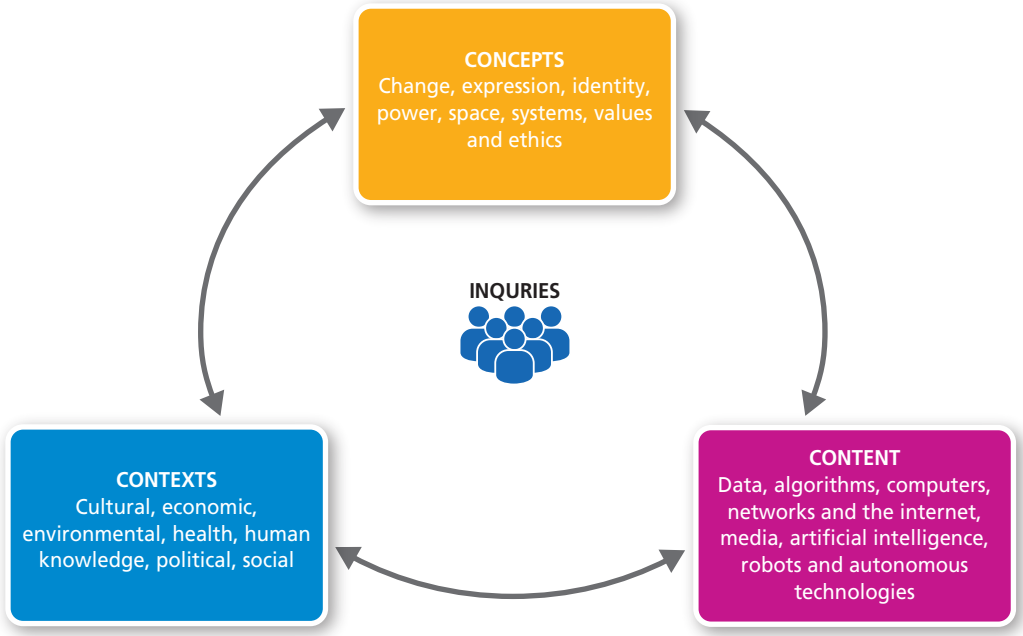
Chapter 1.2 introduced the foundations of a digital society. In this section, you will learn how to use the digital society concepts to probe and investigate our evolving digital society.

The study of the interaction of **concepts**, **content** and **contexts** will help you develop skills to transfer your learning and apply this to new situations through a series of investigations.

◆ **Concepts**: Powerful, widespread ideas that open up different perspectives and provide insight during inquiries into the real-world use of digital technologies.

◆ **Content**: The study of the digital technologies used.

◆ **Contexts**: The study of digital technologies in a variety of real-world examples.



■ Digital society: Concepts

The seven digital society concepts

The seven concepts provide different windows and perspectives that can be used to explore the digital society we are in, and the society we are evolving into. The concepts focus on elements that are applicable across our developing digital society.

It does not matter which of the concepts an inquiry may start with, as the exploration becomes deeper and broader, additional concepts will become relevant.

The starting concept is the one that is most applicable to the context and content of the inquiry. Also, when starting an inquiry with a content focus, such as databases or artificial intelligence, or a context focus, such as care for elderly people or education, the concepts will provide different ways to explore impacts and implications, and where to go next with future developments and interventions.

- **Change** is a fundamental concept as digital society is always evolving and there are many consequences that can be explored from a number of perspectives.
- **Expression** in a digital society examines how technological change has enabled different and expanded ways of thinking, communicating, collaborating and creating.
- **Identity** in a digital society considers how our personal and community identities are changing and becoming multifaceted.
- **Power** examines how digital technologies are extending and changing the way in which we influence others, control and are controlled by others, at personal, institutional and governmental levels.
- **Space** considers how our interactions with each other are changing, as well as our interactions with our physical environment.
- **Systems** thinking provides a way for understanding connections between human, natural and built environments, and the role of people and communities within them.
- **Values and ethics** looks at the consequences of change and explores their impacts and implications in the context of right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.

ACTIVITY

Using the concepts: dashcams

Dashcams are being installed in many cars by their drivers for a variety of reasons. Some drivers record their trips to protect themselves with evidence if an accident or incident happens, some share the footage online to 'shame' offending drivers, while others post the footage on special police websites to help the police catch offenders.

Each of the concepts can be used to investigate the use of dashcams.

- **Change** – identify the type of change that has been happening, not just with technology but in other areas due to the use of the dashcam footage. Identify what is new and evolving about the use of dashcams.
- **Expression** – the footage is being published in a variety of ways and in different places that can have both positive and negative impacts and implications for people and communities.
- **Identity** – publishing the footage has affected the identities of many people, impacting their privacy and anonymity.
- **Power** – the footage has provided power to individuals and institutions in society through shaming and law enforcement, and the creation of a surveillance culture.
- **Space** – with the use of dashcams, spaces now have an additional surveillance component, beyond that of the police and road authority cameras. This should be considered when we use the roads.
- **Systems** – recording, using and publishing or posting the footage involves a set of connected systems: technology-based, legal systems, and others.
- **Values and ethics** – there are calls for the control of the use of the footage due to the mixture of benefits and issues that arise from its use.

How to use this section

The activities at the end of each concept do not require a comprehensive response. They are there to start you on the path of using concepts to explore, analyse and evaluate the issues, impacts and implications of the use of digital technologies in a society. As you progress through the other sections of this book, you will need to refer back to these concepts frequently.

Some examples of how to use the concepts are given, but you are expected to find more, especially from your own experiences.

The activities at the end of each concept can be attempted in two ways: directed (teacher-led) or guided (mixture of directed and open inquiry – your teacher and you together) depending on the time and resources available. You are also encouraged to engage in further self-initiated open inquiry as well.

Learning how to apply each concept is best explored through real-world examples involving content and context also.

2.1 Change

What are the different types of change in a digital society?

These are not exclusive, and often overlap, but provide a way of analysing change in a digital society. Digital technology innovation is the creation of something new that did not exist before, but it is often used interchangeably with change.

- **Change of form** – a change in the format, function or shape. For example, phones have morphed into different forms, from a single-purpose device into a multifunctional smartphone.
- **Change of state** – a change from one state to another, but still basically the same. For example, much of the old analogue information is now stored and used digitally. We have moved from analogue to digital watches; games have moved from the real world to the virtual world.
- **Change of values** – a change in what has been thought to be important. Privacy concerns, for example, have become more important to us and our families. Anonymity is now highly prized.
- **Incremental change:**
  - **Evolutionary** – something existing can evolve into something different but still basically be the same, for example, digital technology is always evolving to become faster and have more features.
  - **Adaptive** – something can basically be the same, but be adapted to new circumstances, for example businesses need to adapt to selling online as well as in physical shops.
- **Radical change:**
  - **Transformational** – something can change from one form to another, which can be disruptive, for example, office work can be transformed into working from home.
  - **Extends/combines** – change is enabled when digital technology and their uses are extended and/or combined to create something new, for example, people can now use all-pervasive networks and powerful devices to work anywhere and at any time, extending their office to the virtual world and combining it with other activities and places.

REAL-WORLD EXAMPLE

Online shopping

The growth of online shopping illustrates the different types of change. The impact and implications of the changes due to online shopping can be seen everywhere, for example in:

- the growth of huge online businesses such as Amazon and Netflix
- the creation of new businesses that did not exist in a bricks-and-mortar world
- the disappearance of businesses due to the impact of online shopping
- businesses changing how they operate and what they sell, often combining brick-and-mortar operations
- businesses changing locations, such as selling from home
- the scramble of many businesses to have an online presence.

When investigating change, we should be asking questions such as:

- Why does change take place? Is it due to needs or desires? Is it forced or optional? Is it due to something being new? Do people shop online just because it is possible? What are the reasons why people shop online? How many of these reasons are optional or compulsory?
- When change happens, is progress made? Change always brings a mixture of positive and negative impacts and implications. To what extent can online shopping be seen as progress, or does it have negative impacts as well?
- To what extent is change disruptive? To what extent has online shopping changed the way people shop? To what extent has online shopping changed the physical shopping environment? What is the impact of online shopping on businesses as a percentage of their, and our own, activities?
- Can change be predicted? Can we predict the outcomes of change? Can we force change? To what extent do announcements about the 'next big thing' in online shopping come true? How often do online businesses succeed? Online supermarket shopping has grown but it is not a large percentage of the way we shop, so how much has changed?
- To what extent can change be beneficial? It can be transformative for people who find going to a supermarket difficult, such as people who are time-poor or have mobility problems or are sick.

ATL ACTIVITY

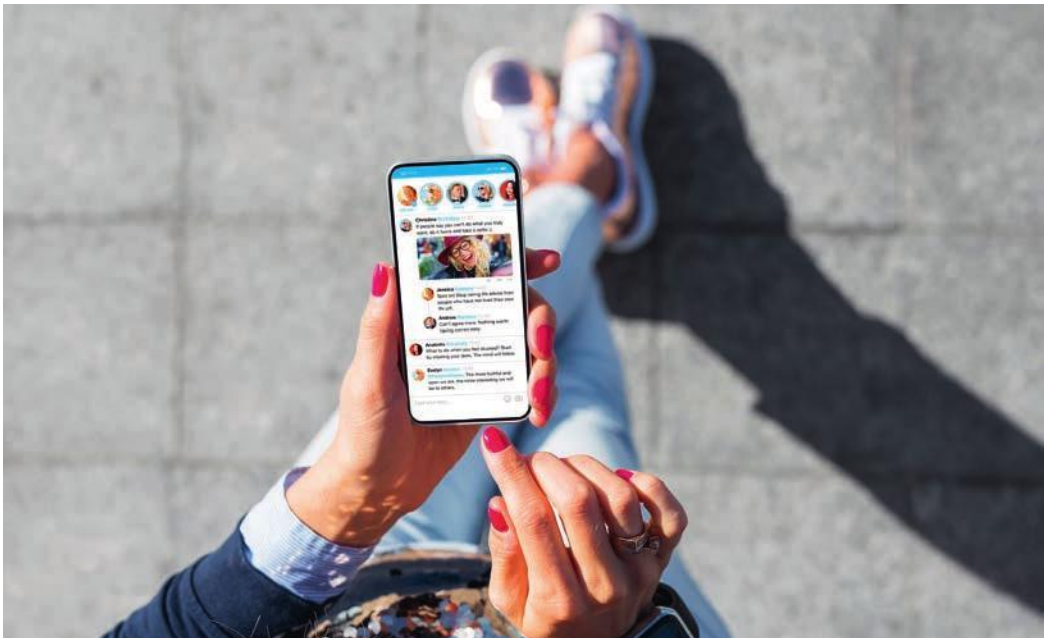
Research

Research businesses in your local area and others that you know of that have been impacted by the growth of online shopping.

- Find examples of the different types of changes.
- Investigate the positives and negatives of food delivery services from restaurants.
- Explore the positives and negatives from the perspectives of the restaurants, the consumers of the food, the delivery companies, and the delivery riders/drivers.

The next three concepts focus on the use of digital technologies by people and communities and how they are being impacted by them. People and communities include the users, developers, stakeholders and others that are involved with the design, production and management of the digital systems explored in this course.

2.2 Expression



In a digital society technological change has enabled different and expanded means of thinking, communicating, collaborating and creating.

What is an expression?

An expression is the act, process or instance of representing ideas, emotions and/or experiences using different modes and media.

What is the purpose of expression?

Expression serves many functions, including storytelling, world-building, artistic innovation and political activism.

What are the benefits of expression?

Expression brings people and communities together but also introduces significant dilemmas, as expressions can have negative impacts.

How does expression change?

Forms of expression that are now possible using digital technologies have changed compared to past modes of expressing our thoughts and ideas.

- **Evolutionary** – something that exists can evolve into something different but still basically be the same, for example, email instead of 'snail' mail.
- **Adaptive** – something can basically be the same but be changed to new circumstances, for example, the development of audio combined with digital books allow persons to access books, not only through reading, but they can listen to the text spoken with human expression. Some digital books also allow hovering over specific words to learn the meaning of the words.

- **Transformational** – something can change from one form to another, for example, keeping up with friends and family using social media and video calls instead of letters and phone calls.
- **Radical** – the creation of new forms, states or values, for example, TikTok has enabled new forms of expression as communicating through short videos on popular topics to targeted audiences was not so easy on earlier online video hosting services.

Questions to consider

Issues arise from and about these changes of expression.

- In what ways do digital systems influence how people express themselves, for example, emojis? Are these an improvement or a step backwards in effective communication?
- What different kinds of stories are possible through digital media, such as the use of Instagram and TikTok? Should some of these be censored and controlled?
- Are there forms of digital expression that should be limited, such as certain types of negative posts on Facebook?
- This raises the question of *who* decides how digital expressions are controlled, such as the creation of new laws or the use of content monitoring or **censorship**.

◆ **Censorship**: The suppression or banning of certain content, speech or other information.

ATL ACTIVITY

Social

In class, discuss your favourite forms of expression in the digital world.

- Which apps are your favourite ways of communicating with others?
- Why do you choose to use these various forms?
- Describe how you use them for thinking, communicating, collaboration and creation.
- Explore how they are different from previous pre-digital forms of communication and expression, such as letters, books, passive TV, radio and movies.
- What are some of the negative and positive impacts and implications, for you and others?
- Do you operate in a 'media **echo chamber**'? How diverse are your news and information sources? What are the impacts and implications of being in a media echo chamber?

Links

The control of digital expression through content monitoring or censorship links to 2.4 Power and 2.7 Values and ethics.

◆ **Echo chamber**: An environment in which people only hear beliefs and opinions that echo their own.

2.3 Identity

When we express ourselves in the digital world, we are exposing facets of our identity. This has impacts and implications for our various personal, group, social and community identities.

What is identity?

Identity helps to define ourselves, as well as groups, social entities and communities we belong to or identify with. Identity is defined internally by our own thoughts and feelings, but is also externally defined by our relationships with others who interact with us and form opinions about us and the groups, social entities and communities we are associated with.

What are the features of identity?

Identities are multifaceted and include aspects related to age, nationality, religion, culture, gender, sexuality, race and ethnicity, as well as social and economic class.

Is identity static?

Identity is not static – it changes over time and according to our own contexts and the perspectives of others. Identities are linked to our behaviour, both in the real world where they are continually developing and changing, and in the online world where they can be permanently stored.

Questions to consider

The following questions arise about identities from the intersection of our digital world with our other worlds:

- How do digital systems and technologies influence or construct identity?
- How different are our identities in the real world from the virtual world? Why is there a difference?
- How do our online identities change over time? Since online identities remain in the online world for a long time and long after we have changed our real-world identities, how does this impact our identity?
- How can we hide or distort our identities online?

- To what extent do different aspects of our identity appear on digital platforms?
- What are the potential harms and benefits that arise from identities created online?

ATL ACTIVITY

Thinking

Reflect on the various identities you display and use in the digital world.

- What avatars, symbols user names and pictures do you use to identify yourself online?
- How do they intersect with your other worlds?
- Why do you create different identities online?
- How have your identities online changed overtime through evolution, adaptation, transformation, and/or radical creation?
- What are the benefits of having different identities online?
- What are the drawbacks of having different identities online?

◆ **Surveillance**: Is undertaken to collect information about people which can be used for a variety of purposes, both positive and negative, even though surveillance has mainly negative connotations. Surveillance can be conducted using technology, or through observations by people. The information collected can be used to control and influence those being observed and others.

Deeper thinking

Challenges to our identity: privacy and surveillance

Privacy means that an individual or group can isolate themselves and/or information about themselves from access by others. This enables them to operate and express themselves, their ideas and opinions, without worrying about the reaction of others. When something is private to a person or group, it usually means that something is special or sensitive about it. Most people agree that there is a right to privacy that should be protected by law. However, this right does not have priority over the law.

Our identities are mainly private and we may choose to keep many aspects hidden for a range of reasons. However, many digital technologies have allowed the invasion of our privacy. This includes technologies such as **surveillance** spyware on our phones; Google tracking our movements and locations as we move around using Google Maps; the use of CCTV and facial recognition; and hidden tracking of our mobile phones as we move from one mobile transmission tower to another, and the same in larger buildings such as shopping centres when we move from one shop to another.

The impacts of our loss of privacy are many. Among these are psychological damage, financial damage, damage to your reputation, and the physical invasion of your personal space. Often there is a mixture of these impacts.

There can be positives from the use of our 'private' information if we allow it to be collected. Companies often keep records of which sites we visit, and why. This data can be used to target advertising, which provides us with links to items that we are interested in. However, this data can be sold to others, which can lead to negative impacts as well.

ATL ACTIVITY

Research

Investigate how digital technologies can be used to impact our privacy.

- Search news items and other sources for examples of how digital technologies can be used to invade our privacy.
- Investigate both the negatives and positives of these technologies.

(You will study more about these technologies and their impacts in Section 3 and how and why they are used in Section 4).

◆ **Privacy**: The ability of individuals and groups to determine for themselves when, how and to what extent information about themselves is shared with others.

Links

This section links with 4.7A Social components of identity.

2.4 Power

In the future, the digital society we live in and see evolving around us will produce a range of positive and negative impacts and implications. We will need the power to control and influence these to advance the positive and lessen the negative impacts on ourselves. Other people may also want the power to control others through the use of digital technology. As soon as we interact with others, power becomes a factor to be considered.

Power is a feature of all social relations and it involves a person's or group's capacity and ability to influence or control the actions of others.

What are the types of power?

The use of power can include more than one of these at a time:

- **Coercive** – when someone forces us to do something against our will, for example, the power of bullies on social media, the power of a person who has invaded our privacy using digital technology (sometimes resulting in blackmail and other demands for money, or influencing others for their benefit).
- **Reward** – this is the opposite of coercive power; it involves giving benefits to someone if they do something, for example, the power to get you to spend money in computer games as it helps you to win.
- **Legitimate** – the power that arises from a formal relationship between people, for example, school rules about the use of digital devices.
- **Expert** – the power that comes from someone having a higher level of skill and experience, for example, students need digital devices to study so they consult an expert to keep them working; or people pay experts to do something for them.

- **Respect** – power that comes from liking and respecting others, for example, respect for social media influencers gives them the power to encourage their followers to buy certain products.
- **Information** – power that comes from the use and control of information, for example, posting information on the internet gives one power to influence others and what they think; power also comes from collecting information about others and their device use.

All of these types of power can be used for positive good as well as to manipulate others.

Where does power reside?

At the formal level, power is structural and embedded within groups, institutions, organizations and governments. At the lowest level we need to consider how the use of digital technologies influences each of us personally. This level it is called 'soft' power and is often cultural and goes largely unnoticed.

Can we all have power?

Yes. We all influence and, to some extent, can control others, but by definition power is unequal; people either have power over us or we have power over them.

Questions to consider

Questions about power and the use of digital technologies include:

- How is power embedded or exercised through specific digital systems, technologies and platforms?
- Do digital systems and technologies enable both the use and constraint of power?
- To what extent does the use of digital technologies impact the balance of power? Ranging from our personal lives to that at an international level.
- Where and how do digital technologies have too much power? How can this power be constrained? What form does this power have?

ATL ACTIVITY

Thinking and Research

Reflect on how much power digital technologies have over you:

- Think about the devices and apps that you use and how they influence what you think and do.
- Who influences you personally, and who do you influence? How do digital technologies facilitate this? Are these influences positive and/or negative?
- Investigate the positives and negatives of the power associated with
  - facial-recognition cameras
  - social media influencers
  - apps to track and monitor children.
- Which types of power do these technologies have over you and how are they being used?
- How can this power be lessened and controlled – through digital technologies and other ways?

2.5 Space

The previous three sections focused on concepts related to how people and communities use digital technology. The next two concepts focus on investigating the perspectives of space and systems thinking as ways of investigating the use of digital technologies.

What is space?

Humans organize, construct and represent space based on physical, geographic, cultural and/or social features (for example, locations, regions, borders, zones). But now virtual spaces are being created and used more often; and they are becoming more diverse and different from other spaces being used.

What is the purpose of space?

Different spaces often serve distinct functions for people and communities. People live and operate in spaces, and spaces are constructed and used for all the different functions and things in everyday living. We cannot operate without space.

Are there different types of spaces?

Space can be understood using multiple scales and dimensions, including local, regional, national and global and, increasingly, virtual. People are spending more and more time in virtual spaces due to the widespread use of digital technologies.

What happens in these spaces?

In both real and virtual spaces, people, information and objects interact. They interact through the use of the spaces, how they access their content, and how they move between them. The use of space is often a complicated flow of people, information and objects.

Questions to consider

Questions about spaces and the use of digital technologies include:

- How does online space differ from physical space? How are they similar?
- To what extent does physical space influence virtual space, and vice versa?
- How do information and digital objects circulate through digital society? How different is this from real spaces?
- Do physical or political borders still have meaning in a digital society?
- Real spaces usually have borders and laws connected to them – how is this changing in virtual spaces?
- Physical spaces usually have borders that restrict access and create divides – are digital divides the same or different to physical borders?
- How do digital systems and technologies affect how we experience specific spaces and locations?
- How do digital systems and technologies affect how we experience objects in virtual and real spaces and locations?
- What are the advantages and disadvantages of using virtual spaces to store virtual objects?

ATL ACTIVITY

Thinking

Reflect on your own experiences.

- Using your own experiences and other resources, provide answers to some of the questions above.

This inquiry will open up new considerations and ideas about the link between the real and virtual spaces you live in. Virtual spaces will often be encountered in your study of the various contexts later in this book.

ATL ACTIVITY

Thinking

Reflect on the virtual and real spaces you live in.

- What virtual spaces do you use and live in?
- How have digital technologies enhanced your use of real spaces, for example studying or working from home?
- How has the use of virtual spaces impacted different parts of your life – education, relationships, work, communications?
- How have virtual and real spaces clashed with national and political boundaries, and with your own life and relationships?
- What are the dangers and disadvantages of the virtual spaces you live in?
- What are the advantages of the virtual spaces you live in?

ATL ACTIVITY

Research

Investigate the positive and negative impacts of these virtual spaces:

- virtual reality technologies
- augmented reality technologies
- political boundaries in the online world
- the use of encryption technologies in online communications
- the legislation of data 'boundaries' to control the flow of data and information
- the political use of cyberspace
- the use of cryptocurrencies.

2.6 Systems

The concept of space introduced the idea of the interaction between real and virtual worlds. The systems concept focuses on **systems thinking**, which provides powerful tools for understanding, representing and exploring the links between the human, natural and built environments (both real and virtual), and the role of people and communities within them. The analysis of digital and real-world systems through systems thinking is needed due to their complexity.

◆ **Systems thinking**: A way to think about structure and order in human, natural and built environments.

What components of systems are studied in digital society?

We will learn about the hardware, software and networking technologies that take the data and media and process it into information. We will also learn about the people and communities involved in these processes, and those who supply the data and use the information produced.

How does systems thinking work?

Systems thinking involves investigating sets of interacting, interdependent and/or interconnected elements, usually through models, maps and visualizations that help us understand the connections within, and between, systems, and the components within systems. It also involves the people and communities in these systems, the impacts on them and the implications for them.

Why use systems thinking?

Changes within interconnected systems may generate both intended and unintended consequences. Analysis of a system, and connected systems, enables a deeper understanding to be developed that can be further investigated using the other concepts. Systems thinking can also support investigations based on the other concepts.

How do you represent systems thinking?

Many programs and apps are available to draw diagrams of the components of a system and their interconnection. Online diagram software, such as SmartDraw and Lucidchart, can represent people and communities as sources of data; as consumers of the information produced; and as their role in the generation and production of data and information.

The representation and exploration of systems through the use of models and simulations is often dynamic. These systems can be physical but, in digital society, they are usually logical and use software such as spreadsheets, databases and specialized simulation apps and programs that use algorithms.

What is the impact of digitally based systems?

Digital networks and devices are systems that can be small, such as those found in the home, or on a much larger scale, such as the global internet. These systems interact with each other faster and in many more ways than physical systems. Physical systems, such as roads, trains, planes, are also being greatly influenced and changed by the use of digital systems.

Questions to consider

Questions that arise from the application of systems thinking to the digital world include:

- How similar and how different are digital systems from real-world built and natural systems?
- How similar and how different are digital systems from our real-world social systems of interaction?
- In what ways have digital technologies changed human, built and natural systems and environments on both a large and small scale? Examples might consider:
  - evolutionary changes – something that exists can evolve into something different, but still basically be the same
  - adaptive changes – something can be basically the same but can be adapted to new circumstances
  - transformational changes – something can change from one form to another
  - extend/combine changes – extending and/or combining systems together.
- Change is often disruptive, both positively and negatively. What are some intended and unintended consequences of new and changed digital technologies or systems, especially on people and communities? How do these impact people and communities now, and what are the implications for them in the future?
- Is it possible to fully understand connections within and between systems using models, maps and visualizations?
- Digital models, maps and visualizations only represent the real world and are always a simplification of the real-world data, people and processes. What assumptions are made about the data being used? What are the limitations of representing this data? What assumptions are made about the way the processes operate, especially with regard to people and communities?
- Are digital and real-world systems too big and complex to understand? What are the implications and impacts of the simplification? Artificial intelligence is one area where these concerns are important.

Links

See Chapters 3.1 Data and data analysis, 3.2 Algorithms and code, 3.6 Artificial intelligence and 3.7 Robots and autonomous technologies for more details about the completeness, accuracy and reliability of digital systems, data and processes. In Section 4 you will investigate the link between real and virtual systems and explore the impacts and implications for people and communities.

ATL ACTIVITY

Research

To start the process of using systems thinking, use your own experiences and other resources to provide answers for the following digital systems:

- Investigate the various digital systems used by your school and how they interact and the issues with using the systems in your school.
- Investigate how digital systems are used in your local transport systems, for example roads, trains, buses and in the cars that you use.
- Represent these systems using models, maps and visualizations, or produce a systems diagram for each using your favourite diagram software.

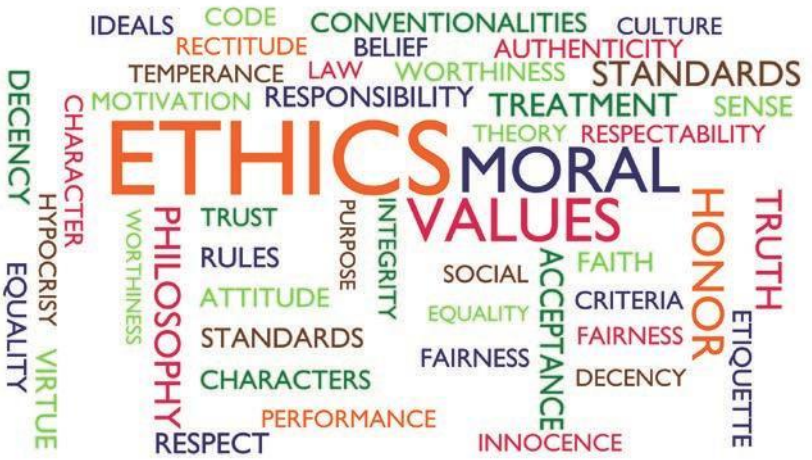
ATL ACTIVITY

Research

Digitally based simulations and models are used in many areas to explore and understand real-world systems, such as weather, economics, traffic, ecosystems and more.

- Investigate and describe some of the models and simulations they use, and compare them.
- Investigate their positive use and their impact on people and communities.
- Investigate the negative impacts and implications due to their simplification of data, people and processes.

2.7 Values and ethics



Whenever people, actions and consequences are involved, the matter of values and ethics arise. The use of digital technologies is no different to any other human activity. The impacts and implications of the use of digital technologies on people and communities can be positive and negative; and the negatives can result in physical, emotional and psychological harm.

Digital societies need to have interventions built into digital technologies to ensure that these harms do not happen or are at least minimized. This means that some uses can be labelled as being wrong or right. But who decides, and what criteria is used to make this judgement?

It is important to analyse the use of digital technologies from an ethical and values-based perspective to ensure that the positive impacts and implications are maximized.

What are values and ethics?

Values and ethics are ways to determine distinctions between right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper.

What are the sources of values and ethics?

Our values and ethics are usually based on a combination of our personal experiences and the culture that we live in. Culture can broadly be defined as the ideas, laws, customs and social behaviour that people or society live by. There are family cultures, local and national cultures, religious cultures and business cultures. Everywhere there are groups of people, there is a culture.

What is the difference between values and ethics?

Values are the principles and ideas that we think are important. They form the basis for the development and formulation of ethical rules – the moral principles, both personal and group, that guide and govern our behaviour as individuals and communities.

What is the scope of values and ethics?

Values and ethics guide human action in the world, including individual and group conduct, and decision-making. Values and ethics may be personal, shared, collective and/or professional.

How are values and ethics manifested in society?

Values and ethics range from broad philosophical considerations to specific formulations. They are expressed through ethical/moral frameworks and principles, codes of conduct, rules, policies and laws.

What is the purpose and impact of values and ethics?

Values and ethics influence and shape ideas, practices, systems and spaces. They are manifested and used at every level and instance of human activity. Wherever there is a choice we can make, that choice is based on our values/preferences and often our ethical/moral expressions.

Why are many ethical issues difficult to settle?

Most ethical principles and frameworks originate from three main different perspectives, or a combination of them, which all need to be considered but often lead to contradictory results.

Deeper thinking

Ethical perspectives

A human action consists of three parts:

- the person performing the action
- the action itself
- the consequences.

All three need to be taken into account when making ethical decisions. Choices about which is the most important of these are based on our preferences and our values. There has been no conclusive argument found that has determined which perspective should take preference over the others, and this is true across all cultures, communities and individuals. The equal importance of the three perspectives is the source of ethical conflict.

The ethical framework is described in simple terms here. Many variations, explanations and justifications are discussed in ethical debates and used by individuals and communities in everyday life, however.

- A decision about right and wrong based on the **type of person** performing the action is called **virtue/character-based ethics**. For example, this person is a good person therefore what was done by them is right.
- A decision based on the **action itself** is called **deontological/rule-based ethics**. For example, killing is always wrong, so the person who did it deserves to be punished no matter what the circumstances are or who the person is.
- A decision based on the **overall consequences** of the action is called **utilitarian/consequential-based ethics**. For example, the result of the actions of this person is good so they do not deserve to be punished.

Here is a situation that shows how the use of each framework can lead to contradictory results and intense debates:

> *A shopkeeper saw a young man acting suspiciously in his shop with a gun in his hand who seemed to be under the influence of drugs. He took his shotgun from under the counter and told the man to stand still and put his hands up. The young man turned quickly, and the shopkeeper deliberately fired and killed him.*

- Following the virtue-based ethics argument, the man was protecting himself and his shop, so he should go free.
- Following the rule-based ethics argument, the shopkeeper must go to prison as he broke the law.
- The consequential-based ethics argument is based on the consequences of his actions, which were that a dangerous person was removed from society, therefore he should go free; or, alternatively, not go free as the consequences were that a popular member of the community was killed, and people said he went 'too far'.

In order to balance the different arguments, ethical, social and legal experts need to discuss them with the aim of finding a compromise. Hopefully the compromise is a win–win situation, but compromise means that not everyone will be fully satisfied with the result. This is usually done in a court or forum set up for the purpose.

Questions to consider

Questions that arise about the use of values and ethics in a digital society include:

- Do the designers of digital technologies have an ethical obligation to their users?
- What happens when different ethical frameworks are applied to the same issue in digital society?
- Can we program values and ethics into technologies that make decisions, such as artificial intelligence?
- Who decides which ethical framework robots and artificial intelligence programs should use?

Deeper thinking

Accountability and responsibility

When a decision is made, who is responsible, and who is accountable for the consequences? Does **responsibility** mean it carries **accountability** with it as well?

Someone has to be responsible for making a decision, and for implementing it. Once the decision has been implemented there are consequences, both good and bad, and someone needs to be accountable for them, either to take the credit, fix any resulting problems or to punished if necessary.

There is usually an overlap between the two, which is often determined in a court of law or other forum. There can be many people responsible for implementing a decision, but often only one person is ultimately accountable ('the buck stops here!').

Review Section 3.6 Artificial intelligence before working through these examples.

Example 1

Bugs in an expert medical advice program have harmed a patient because it was not designed and tested properly. Who is accountable for the harm done to a patient when doctors follow the system's advice? Is it the programmer, as they worked on the production and implementation of the program? Is it the expert doctors who contributed to the knowledge base of the expert system? Is the doctor who followed the advice accountable for the consequences? Are they all accountable and responsible to some degree?

Example 2

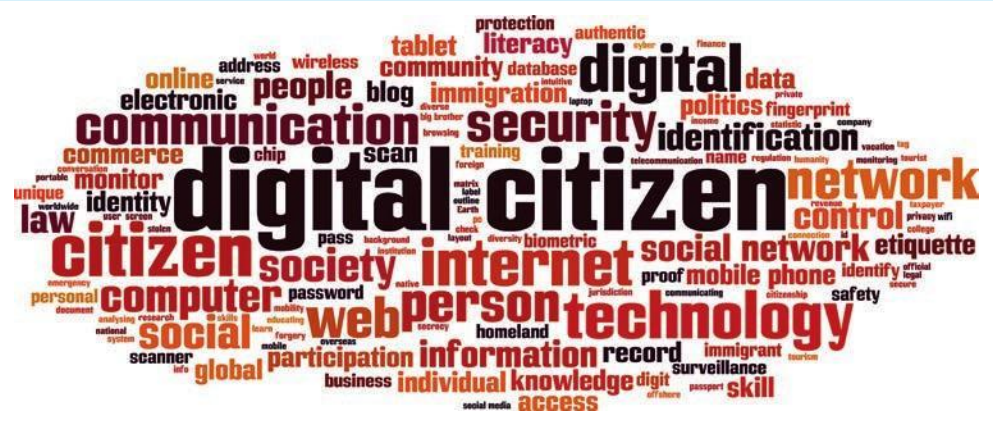
An artificial intelligence program has been trained by a programmer to diagnose cancer. Who is responsible and accountable if an unnecessary cancer operation is performed based on faulty advice from the program? Is it the surgeon who performs the operation that was not necessary? Is it the hospital administration that purchased the program? Is it the programmer? How is this different from the first example?

◆ **Responsibility**: a person is responsible for a decision that needs to be made and its implementation. Responsibility is a concept that is focused on future items that need to happen.

◆ **Accountability**: a person is accountable for the consequences arising from a decision that has been made. Accountability is a concept that is focused on what has happened. A person can be responsible for getting items done, and then can be accountable for the consequences.

Deeper thinking

Digital citizenship



The issue of ethics and digital technology is part of **digital citizenship**, which covers both the personal and business use of digital technologies. Digital citizenship is a practical topic and often can involve ethical considerations. In the Australian Curriculum technologies glossary it is defined as:

> *An acceptance and upholding of the norms of appropriate, responsible behaviour with regard to the use of digital technologies. This involves using digital technologies effectively and not misusing them to disadvantage others.*
>
> *Digital citizenship includes appropriate online etiquette, literacy in how digital technologies work and how to use them, an understanding of ethics and related law, knowing how to stay safe online, and advice on related health and safety issues such as predators and the permanence of data.*

◆ **Digital citizenship**: The responsible use of digital technology.

Deeper thinking

Digital and online etiquette – netiquette

Netiquette comes from the words *net*work and et*iquette*. Online etiquette is a set of rules that apply to your online behaviour. Similarly, digital etiquette focuses on the proper use of online data and apps/programs when you operate in an online social setting.

Netiquette is frequently interchangeable with, and is often extended to, the broader concept of a **netizen**, which comes from the words inter*net* and cit*izen*. A good netizen is a responsible person who uses the internet in a socially responsible way.

> *Almost two-thirds of children have had a negative experience online and 20 percent feel badly about something they have done online.*

◆ **Netiquette**: Rules that apply to your online behaviour to ensure the proper use of data, apps and programs.

◆ **Netizen**: A person who uses the internet in a socially responsible way.

Sample netiquette rules

Writing text online is very different from speaking to people in person, so be careful what you say. The internet and the online world are extensions of society, so be careful what you do and apply the same standards online as you do in public.

Positive rules	Negative rules
• Respect the opinions of others • Respect the privacy of others and what they communicate and share online (especially images) • Be polite in the same way that you are in person • Be accurate and factual • Be positive in your comments • Check and cite your sources of information • Be forgiving and understanding of others who do not follow the accepted rules, but discuss it with them • Read your text out loud to check it • Read your emails next day before sending them • Be kind and professional • Choose friends wisely on the internet • Keep your text short and to the point • Accept diversity of opinions and cultures • Call out online abuse and harassment where possible	• Don't abuse chat boxes for other purposes • Be careful with humour and sarcasm as it may be misunderstood and hurtful • Don't exclude others from conversations • If you would not say it, or would not do it, if your mother/father/grandparents/brother/sister were there, do not do it • Don't troll people in forums and elsewhere with negative comments – use good arguments instead • Do not post or share inappropriate material, as nothing is private on the internet • Be aware that strong language, all capitals, and exclamation marks can be misread or misunderstood • Don't post items that you do not want your family, friends, employers and others to see in years to come

Remember: the internet never forgets!

Deeper thinking

Codes of conduct

For industries and organizations that focus on the development, production, sale and use of hardware and software, a **code of conduct** is used to define principles, standards and values. The introduction to the Australian Computer Society Code of Professional Conduct says:

> *As an ACS member you must uphold and advance the honour, dignity and effectiveness of being a professional. This entails, in addition to being a good citizen and acting within the law, your conformance to the following ACS values.*
>
> *1 The Primacy of the Public Interest: You will place the interests of the public above those of personal, business or sectional interests.*
>
> *2 The Enhancement of Quality of Life: You will strive to enhance the quality of life of those affected by your work.*
>
> *3 Honesty: You will be honest in your representation of skills, knowledge, services and products.*
>
> *4 Competence: You will work competently and diligently for your stakeholders.*
>
> *5 Professional Development: You will enhance your own professional development, and that of your staff.*
>
> *6 Professionalism: You will enhance the integrity of the ACS and the respect of its members for each other.*
>
> *In a situation of conflict between the values, The Primacy of the Public Interest takes precedence over the other values.*
>
> *www.acs.org.au/governance/rules-and-regulations.html*

◆ **Code of conduct**: A set of rules outlining the standards that must be followed within an organization.

ATL ACTIVITY

Thinking

Find videos and internet sites that give you an opportunity to explore ethics and examine your own ethics, such as the Markkula Center for Applied Ethics app, https://www.scu.edu/ethics-app/

ATL ACTIVITY

Research

Examine your school's code of digital conduct for both students and staff members.

Deeper thinking

Analysing and resolving ethical issues and dilemmas

Values and ethical principles are used all the time by people to make decisions or to make claims that someone 'should' or 'should not' do something. So, it is no surprise when a dilemma arises. An ethical dilemma is a conflict between two ethically correct courses of action. The cause of the conflict is a clash between the values and principles that the different stakeholders have. A conflict can also arise when the same course of action is wanted by some stakeholders but their reasons, values and principles are different.

Ethical conflicts are best settled through discussions between the parties involved. In these discussions it often becomes clear that there will not be a resolution that pleases everyone.

Step-by-step guide for resolving ethical dilemmas associated with technology

The following step-by-step guide overlaps with the inquiry model used in this book, but it has a narrower focus on resolving a specific ethical conflict. The most appropriate place to use this ethical resolution guide is in the inquiry stage where recommendations and future steps are needed. It can also be used to help frame your extended responses to examination questions.

The ethical conflict	**1** What are the differing ethical claims about right and wrong of the various stakeholders? **2** What are the solutions that the various stakeholders want implemented? **3** Explain how these generate an ethical conflict?
Research stage	**4** What is the digital technology that is being used and how is it being used? **5** Why is the digital technology being used, developed or being changed? **6** Who are the people and communities involved, from the local to the global level? This includes stakeholders that use, develop, implement, are impacted by or control the digital technology.
Analysis stage	**7** How are people and communities **positively** impacted by digital technology? **8** How are people and communities **negatively** impacted by digital technology? **9** What are the **issues and concerns** with digital technology raised by people and communities? Issues are broader than direct negative impacts. Issues can be about positive impacts as well as negative impacts, for example 'we are not getting enough of the good impacts'. Negative impacts may be small and accepted, so are not a major issue. **10** What are the perspectives (and ethical frameworks) of the people and communities who raised the issues? What values and ethical principles are being used to justify their perspective on the issue? **11** What other principles (for example, human rights), laws, policies and rules apply or are being violated?
Evaluation stage	**12** Make a list of real and potential feasible solutions and interventions that could help to resolve the issues and dilemmas. Each stakeholder usually has one. **13** Which should be rejected? Which should be considered further as a basis for a compromise solution? **14** Which solution or intervention provides a win–win situation? Quite often it is a practical solution that each side of the issue can accept to some degree for a while.
Recommendation stage	**15** Who should be responsible and accountable for the solution when it is implemented and used? How should it be implemented? What is the timeline? What resources are needed?

Inquiry

Investigate and answer the following questions that have ethical and value dimensions. Can you think of examples of devices, programs and apps that apply to each question? Research news items that can provide examples.

1. Is it possible to program values and ethics into artificial intelligence programs and robots? For example, in self-driving cars, in medical decision-making advisory programs, in artificial intelligence that decides to allow a criminal parole, in robot soldiers, in programs that analyse behaviour using CCTV monitoring.
2. What values and ethics should be programmed into artificial intelligence programs and robots? How would they operate and work?
3. Multinational technology companies need to operate in many different countries and cultures, but the internet is fragmented and controlled by individual governments. Is it possible to have a universal system of digital ethics?
4. What is the difference between a 'black hat hacker' and a 'white hat hacker'? Can they be separated without violating ethical principles and creating ethical dilemmas?
5. What ethical obligations do the designers of digital technologies have? What are the perspectives that need to be considered?
6. Do program and app designers need to be held accountable for the use their programs and apps are used for? Do they have a duty to fix the issues that arise from the use of their programs and apps?

Section 2 summary

EXAM PRACTICE QUESTIONS

These types of evaluation and synthesis questions appear in all three digital society examination papers, especially for extended-response questions.

1. To what extent is it **ethical** for parents to monitor the activities of young people?
2. To what extent should the **power** of big-tech companies to use and share data about their users and clients be constrained?
3. Evaluate the impact of the **change** towards the increased use of online shopping on small businesses.
4. To what extent should the **expression** of freedom of speech be constrained by social media companies?
5. Using the results of your inquiries during the course, evaluate the potential impact of a stolen **identity** on a member of your family.
6. Compare the relevance of the physical borders of nations in the modern digital world filled with virtual **spaces**.
7. Data collected from the use of personal digital systems, such as your smartphone, is used in many digital **systems** that supply you with targeted information and advertising. Discuss whether this situation is beneficial to you.

TOK

Information is at the centre of all digital systems. The **completeness, reliability and accuracy** of this information is very important for us when we use the systems.

When you use information from digital systems, it needs to be assessed using TOK concepts. These concepts enable our understanding to be deepened and prevent us from being deceived.

ATL ACTIVITY

Thinking

Search for news items and articles about the impact of automation on employment and work. For each one of them, ask and answer these questions based on the TOK concepts. If this topic is not of interest to you, find articles and news items about an alternative topic or concern of yours and answer these TOK questions:

- **Evidence**: What evidence has been supplied?
- **Certainty**: To what extent does the evidence provide certainty of the conclusions?
- **Truth**: Is the complete, reliable and accurate truth presented?
- **Interpretation**: Is it possible to have a different interpretation of the evidence?
- **Power**: To what extent do the claims in the news item have the power to influence?
- **Justification**: How well were the conclusions justified? What methods were used?
- **Explanation**: Are the explanations of the reasons for and causes of the impacts and implications clear and easy to understand?
- **Objectivity**: Are objective facts presented or are they mixed with subjective ideas and opinions?
- **Perspective**: What perspective is the news item or article written from?
- **Culture**: Is the article or news item impacted in a positive or negative way by the culture of the context and author?
- **Values**: What values and ethical principles are used?
- **Responsibility**: To what extent are we responsible for checking all of the above?

Extended essay (EE)

The purpose of the extended essay is to give you an opportunity to research an area of interest from the topics in the Digital Society course. You may decide to write an extended essay that has one or more of the concepts as its focus. The research and essay will enable you to add knowledge to the existing body of research connected to the concepts. Your research into the broad concepts needs to be narrowed down to specific contexts and digital technologies in order to be manageable. A good way of doing this is to focus on your local area.

Concepts and possible research topics to explore include:

- **Change**: To what extent have the changes in digital technology been positive for education in your school?
- **Expression**: Many businesses, large and small, now use Facebook, Instagram and other social media to advertise and communicate with clients and customers in your local area in conjunction with, or as a replacement for, a dedicated website. To what extent has this been successful?
- **Identity**: Avatars are used by most people, young and old, when playing online games. Investigate the range of avatars and the reasons why they have been chosen?
- **Power**: To what extent has the impact of influencers in social media, such as Instagram, had a negative impact on boys and girls at your school?
- **Space**: To what extent have government authorities in your city/town/region successfully transitioned into the use of virtual spaces and communications with citizens?
- **Systems**: To what extent have your local authorities used digital technologies to improve the use and operation of your city?
- **Values and ethics**: Some families control the use of digital technologies strictly, and some do not. What are the range of ethical principles and moral values that are used by families in your local area?

Creativity, activity, service (CAS)

The creativity, activity, service (CAS) component of the IB Diploma core provides an excellent way to make links between the Digital Society course and practical real-world experiences. For your CAS project you could connect your digital society skills and knowledge, and your inquiries and activities, with meaningful and practical CAS experiences.

- **Change**: Investigate and instigate/facilitate a change that is needed in the way that digital technologies are used, or need to be used, in a sporting, musical, artistic or cultural activity.
- **Expression**: Create an internal school website that enables students to express themselves creatively.
- **Identity**: Create and run internal websites or private social media groups for various groups in your school that need an opportunity to make themselves known.
- **Power**: Use digital technologies to empower students about school issues through digital surveys.
- **Space**: Create a virtual reality or augmented reality game for a teacher to help in their teaching.
- **Systems**: Volunteer to run and maintain some digital technologies that are used by the school and students.
- **Values and ethics**: Organize and conduct sessions for students and parents about the dangers for students on social media and the impacts of their digital footprints.

Reflection

Now that you have read this section, reflect on these questions:

- How much change have you seen with the digital devices that you have used during your life?
- How dependent are you on using social media to express yourself, and to communicate?
- How many identities do you have on social media, and what is the difference between them?
- How much power and influence do you exercise through your use of social media?
- How much time do you spend in digital spaces compared to physical spaces?
- Are you aware of how far your digital footprint extends because of the interlinking of digital systems?
- Reflect on the times that your actions on social media have resulted in benefits and negative impacts?

Section 3
Content

3.0 Overview of digital systems

UNDERSTANDINGS

By the end of this section, you should be able to:

- investigate different digital systems through different perspectives using the concepts and apply these to examination-style questions in Papers 1 and 2
- understand the digital systems that will be used in context and apply these to examination-style questions in Papers 1 and 2
- investigate in more detail a digital system that will be a focus of the inquiry project
- discuss the digital systems that are creating challenges or providing interventions for real-life challenges for the higher-level topics
- investigate in more detail the digital system in the prescribed case study for Paper 3.

When studying digital society, it is important to have an understanding of the underlying technologies and terms associated with the digital systems being used in society today. Page 8 of the Diploma Programme *Digital Society Guide* states:

> *Digital systems include technologies, applications and platforms that create, store, process and distribute digital data and information. Smartphones, gaming platforms, AI-enabled personal assistants and robots are types of digital systems.*

It is important that you must gain a more precise understanding of the terms and technologies used by digital systems in this section, as you are now a digital society scholar. Very often people have a colloquial or common-sense understanding of the terms that you will come across in this course. They are not always correct, and you will be required to understand these in more detail.

This section consists of seven chapters:

- Data and data analysis
- Algorithms and code
- Computing devices
- Networks and the internet
- Media
- Artificial intelligence
- Robotics and autonomous technologies.

The importance of the content section

Chapter 3.1 starts with an in-depth study of data. Data is at the heart of all digital systems. In the same way that the heart pumps blood around the human body, digital systems are essential for processing and managing data. Without data there is nothing to process; without data we have no information; without data we cannot train artificial intelligence systems. So, as you can see, data is a vital component of any digital system. In this chapter, we will investigate the difference between data and information, look at the different types and uses of data, and the data life cycle. We will also consider the great responsibility that comes with handling data, and will have an opportunity to discuss and conduct inquiries into the issues surrounding the use of data.

Chapter 3.2, the study of algorithms and what they are, will provide an insight into how data is used by digital systems. Understanding algorithms will provide a greater understanding of the 'thinking' behind digital systems, because they govern how digital systems work and the outputs generated. Combining algorithms with the developments in artificial intelligence and how it is being used raises issues around bias and transparency.

Chapters 3.3 and 3.4 – Computing devices, and Networks and the internet – the 'nuts and bolts' of the underlying technologies used by all digital systems. It is interesting to see how these technologies have evolved over time and how technologies from the past are still influencing the technologies of today.

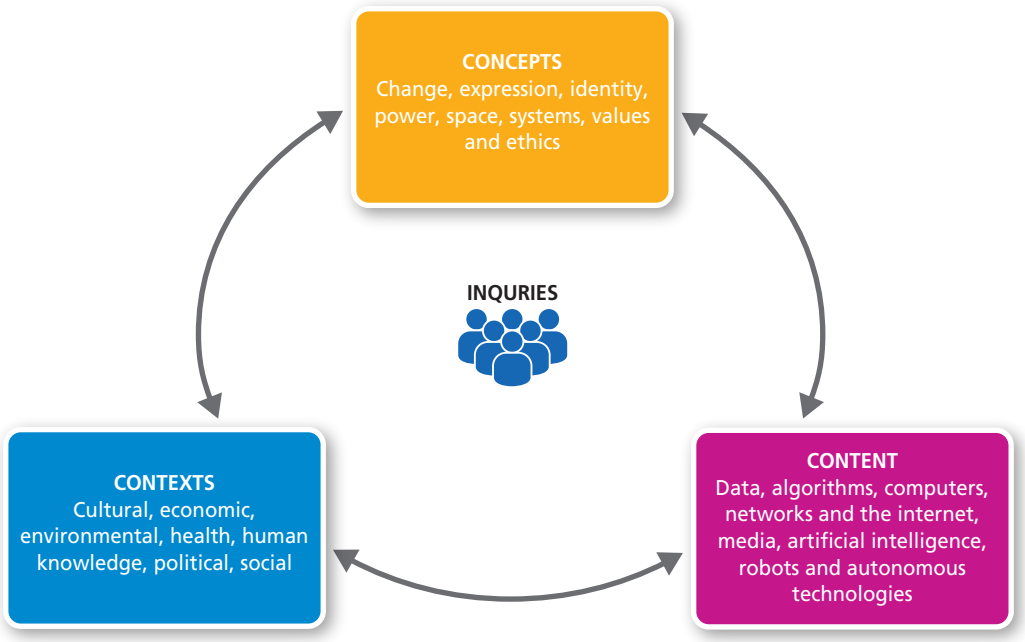
Chapter 3.5 looks at how the evolution of the internet and the World Wide Web have changed the digital media landscape. 'Traditional' media is now available in a wide range of formats, and can be interactive and shared easily. Digital media is creating new online and virtual spaces that were not possible before, creating a wide range of concerns along with it that need to be addressed by all those who are part of the digital society.

The final two chapters in this section, Chapters 3.6 and 3.7, go hand in hand: developments in artificial intelligence and parallel developments in robotics and autonomous technologies. As these technologies become ubiquitous in our lives, their influence is changing everything from what we watch and whose posts we see, to the scope of our jobs. Developments in artificial intelligence are creating a lot of buzz today, as well as uncertainty for the future, with legislation and regulations struggling to keep up. This makes it an interesting area for further investigation.

Each chapter will provide an in-depth study of the prescribed areas of inquiry, with supporting real-life examples, some engaging activities to try out and opportunities for inquiry and practice questions. In Section 1, you were introduced to the inquiry process. You will be given opportunities to develop your skills by completing activities which focus on some or all of the stages in the inquiry process. When attempting practice questions use the guidance given in Section 7 on how to approach the different command terms used. The topics will also include CAS and TOK ideas, as well tips for your extended essay (EE), which you can go back to once you start your EE journey. Although this section covers all of the supporting details for each prescribed area, the course does not require all to be covered.

Content and the 3Cs

By completing inquiries in the content chapters, you will be able to go back to the previous section on course concepts and have a deeper understanding of the technologies discussed. When you study the different contexts in Section 4, you will be more equipped to investigate the technologies being used in each area.



■ Digital society: Content

Remember, there is no right or wrong way to use this book – you can choose to visit each chapter in order or mix it up, jumping between the 3Cs as guided by your inquiries.

3.1 Data and data analysis

UNDERSTANDINGS

By the end of this chapter, you should understand:

- there are many types, uses and ways of representing data
- big data and data analytics involve extracting and processing useful information in ways that are often impossible for humans
- there are significant opportunities and dilemmas associated with data in digital society.

The focus of the first of the 'content' chapters is data. Data is at the heart of any digital society. It comes in many forms and has a wide range of uses. Data may be as small as one bit, represented by 1s and 0s in binary, or as large as 'big data' when used in data analysis. In this chapter we will thoroughly investigate the data life cycle and the dilemmas that arise.

3.1A Data as distinct from information, knowledge and wisdom

People talk about data and information interchangeably in everyday language but, as a student on the Digital Society course, it is important to distinguish between the two and also to understand that information can lead to knowledge and then wisdom.

Data refers to the collection of raw and unorganized facts and figures, which may be in the form of numbers, letters, characters or images. Data is often composed of facts and observations. It is an individual unit containing raw material that does not have any meaning and is measured in bits and bytes. For example, data collected by a heat sensor, 50, or a test score, 75.

Information, on the other hand, refers to the output after data has been processed, organized or structured to convert it into something that is more reliable, easier to measure, and ready to be visualized or analysed. Information may be based on questions such as 'who', 'what', 'where' and 'when'. Information provides context for the data and is measured in different units, for example, temperature 50°C or a test score of 75%.

◆ **Data**: Raw and unorganized facts and figures, which may be in the form of numbers, letters, characters or images.

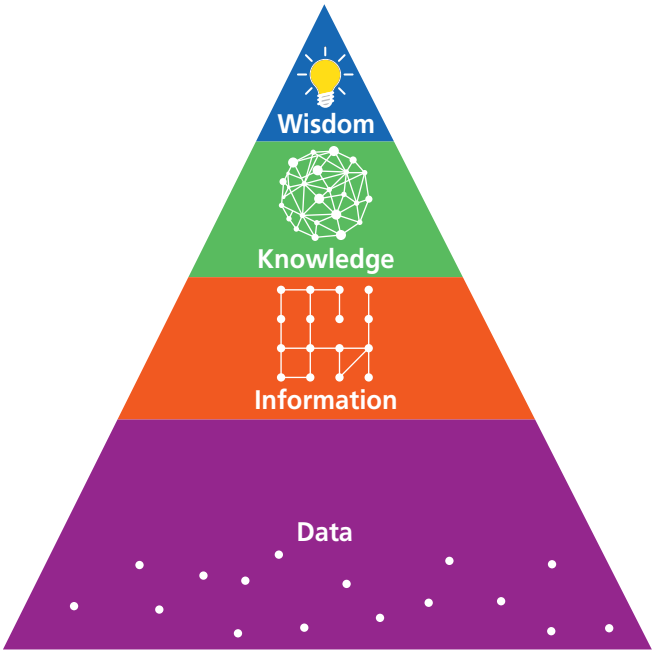
◆ **Information**: The output after data has been processed, organized or structured, to convert it into something that is ready to visualize or analyse; it provides context for the data.

Knowledge comes next and refers to when more meaning can be derived from information, which is then applied to achieve a set goal. Examples of 'how' information can be used include a meteorologist using rainfall information to determine if flooding is likely, or a teacher using test results to determine how successful a student is.

Wisdom follows on from knowledge and is when knowledge can be applied in action. One may ask questions such as 'why' and use knowledge and insight to make decisions, determine patterns and make predictions. For example, a meteorologist may predict if the country will have a heatwave, or a teacher could determine a student's predicted grade.

The data, information, knowledge, wisdom (DIKW) pyramid is a diagram that represents the relationship between data, information, knowledge and wisdom. Each block builds on the previous block, answering different questions about the initial data and how to add value to it.

- **Knowledge**: Meaning can be derived from information and applied to achieve a set goal.
- **Wisdom**: The application of knowledge.



Data, information, knowledge, wisdom (DIKW) pyramid

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline the steps that need to be taken in order for humans to gain wisdom from knowledge. *[4 marks]*

2 Distinguish between knowledge and data. *[4 marks]*

ATL ACTIVITY

Social

Work in a small group to conduct a simple experiment using a digital fitness tracker/watch.

- Each student should perform a small fitness activity, for example, run a short circuit around the school.
- Review the sort of data collected by the fitness tracker/watch and what information is shown on the app.
- Review the data that is manually entered into the app.
- Discuss the results with each other.
- Create a DIKW pyramid to demonstrate how the data collected can be used to create information, knowledge and wisdom.

ATL ACTIVITY

Thinking

Discuss each of these questions in a small group:

- Will there ever be too much data?
- Is it possible for computers to have wisdom?
- How does our data define our identity?

You can have data without information, but you cannot have information without data.

Daniel Keys Moran

3.1B Types of data

Information technology (IT) systems operating in a range of contexts, for example, cultural, economic, environmental and health, and are used to create, collect and store different types of data. A financial system may store **quantitative** data about a company's sales with numbers that can be computed, for example, while a marketing department may conduct a survey to collect **qualitative** data about customer feedback, which is more descriptive. Now we will briefly introduce the different types of data that you will study in more detail under the different contexts.

Financial data

Financial data consists of information that is related to the finances of a business, such as cash flow statements, balance sheets, and profit and loss accounts. Specialized software is often used for financial data management to analyse, report and provide data visualization tools. Good financial data management also ensures that businesses meet existing regulations and legal requirements.

Links

This section links to Chapter 4.2 Economic.

Medical data

Medical data is collected, analysed and stored during the ongoing care of a patient. For example, hospitals keep electronic health records that are updated after each visit. Patients' details may be entered on disease registries, which keep details of data for medical conditions such as Alzheimer's, cancer, diabetes and asthma. Additionally, patients may register for clinical trials to take part in the testing of new treatments.

ATL ACTIVITY

Research

Complete the following research activity and document the process used.

- Conduct research to find out about the different types of data that your Ministry of Health collects.
- Find details about the statistics that it publishes.
- Write a step-by-step guide on the research process used.

Links

This section links to Chapter 4.4 Health.

Meteorological data

Instruments are used to collect data about the weather and climate. Basic instruments include thermometers, rain gauges, barometers and anemometers. More sophisticated technologies include doppler radar, which can detect precipitation, rotation of thunderstorm clouds, wind strength and direction, and tornado debris; radiosondes, which are launched into the air using weather balloons can collect data about the upper atmosphere, and weather satellites that monitor the Earth from space can capture images that are then analysed.

ATL ACTIVITY

Research

Use effective research skills to download historical weather data.

- Ask the humanities or science teachers if your school has a weather station, or research weather data that is available for download (this data may be local or national weather, or weather from another country).
- Save the data in a suitable format (you will use this data later on in this chapter).

Meteorological data is used, for example, in weather forecasting and to predict extreme weather conditions, as well as climate modelling.

Geographical data

Location data, also known as geospatial data, refers to data related to the positioning of an object in a geographic space. It is usually collected using global positioning system (GPS) technologies, which may be used by a phone to provide location services or provide data for mapping applications. Location data has a wide range of uses.

REAL-WORLD EXAMPLE

Accessing location data without authorization: Australian Federal Police (AFP)

According to Australian Computer Society's *Information Age*, in 2021 the Australian Federal Police (AFP) were being investigated for accessing location data without gaining the correct authorization. The investigation covered a period of five years from 2015 to 2020 in which there were 1700 instances of police accessing location data, with compliance for only 100 of these.

https://ia.acs.org.au/article/2021/afp-misused-metadata-powers.html

Links

This section links to Chapter 4.3 Environmental.

Links

This section links to Chapter 4.3 Environmental.

ATL ACTIVITY

Communication

Explain in your own words how GPS technologies work.

- Conduct research into how GPS technologies work and their uses.
- Create a simple diagram to explain how GPS technologies provide location data.
- Describe what format the location data is presented in.
- Describe two real-life examples of when GPS data is used.
- Use your diagram to explain your understanding of GPS technologies to a friend.

Scientific data

Scientific data refers to the research carried out by scientists that has been published in peer-reviewed journals.

To support a hypothesis, a scientist must collect data either through an experiment or by observation. To automate the collection of data in an experiment a scientist may use sensors. Sensors are small devices used to measure a specific property of data and send this as a signal to a computer. Usually the signal is an analogue (continuous) signal that needs to be converted to a digital signal before it can be understood by the computer. This is done using an analogue-to-digital converter (ADC). Examples of sensors include temperature, light, pressure, moisture, chemical and gas.

ATL ACTIVITY

Thinking

Revisit an experiment that was conducted in one of your Group 4 subjects. Revisit your notes and data collected from the experiment, or re-run the experiment. Use this information to help answer these questions:

- What was the purpose of the experiment?
- Describe the tools used to collect the data, for example, sensors.
- What type of data was collected and what units were measured?
- What conclusions were drawn from the data?

REAL-WORLD EXAMPLE

Citizen scientists

During 2020–21, there was a marked increase in bird watching, which generated an increase in data. Many people were working from home during this time due to the COVID-19 pandemic, and large numbers joined projects to collect and share data about birds in the form of pictures, sound recordings and observations. One such citizen-science project, Project Safe Flight, asked users to record birds injured by flying into windows, while eBird allowed citizens to update sightings of the different species of birds.

In many cases, the number of people registered to these projects doubled, and so did the amount of data uploaded. From this data, scientists could see changes in bird behaviour, although it was not clear whether this could be attributed to the increase in observations, or whether the birds were actually changing their behaviour.

www.wired.com/story/pandemic-bird-watching-created-a-data-boom-and-a-conundrum

Links

This section links to Chapter 3.6, 3.7 – IoT and 4.5 Human knowledge.

Metadata

In addition to storing data, IT systems also store data about the data they are storing, which is known as **metadata**. Metadata is a set of data that describes and gives information about other data. For example, a document may store details such as the author, the size of the file and the date it was created.

◆ **Metadata**: A set of data that describes and gives information about other data.

ATL ACTIVITY

Research

Use research skills to investigate different examples of metadata. For each of the following, write up the metadata found for a

- website
- document
- image
- video.

Consider why this data might be useful?

Links

This section links to Chapter 3.5 Media.

3.1C Uses of data

With storage costs declining and advances in storage technologies and artificial intelligence, organizations are becoming more able to identify trends and patterns in their data, which they can use to inform their decision-making. What once would have taken individuals months to compute, can now be done at speed and with greater accuracy. **Data mining** is the term used to describe the process of finding patterns and correlations, as well as anomalies, within large sets of data.

◆ **Data mining**: The process of finding patterns and correlations, as well as anomalies, within large sets of data.

REAL-WORLD EXAMPLE

Data analysis in employment

Data is collected widely by both people and communities. In employment, for example, artificial intelligence can be used to analyse data generated by detailed questionnaires to identify which employees would be suitable for new job opportunities.

In the health industry, data analysis can be used to determine staffing levels. Too many staff can lead to overspending on labour costs, while understaffing can create a stressful working environment and lower the quality of medical care. Data can be used to solve this issue.

In addition to analysing data within one set of data, data can be gathered from multiple sources of data in order to create new connections, determine new relationships and discover new information. **Data matching** is when two different sets of data are compared with the aim of finding data about the same entity. For example, data matching can be used to compare the prices of the same product on different platforms, or used in fraud detection when identifying suspicious transactions. Another example is in the medical field, where medical researchers have been able to find connections between environmental factors and diseases, such as exposure to the sun and skin cancer.

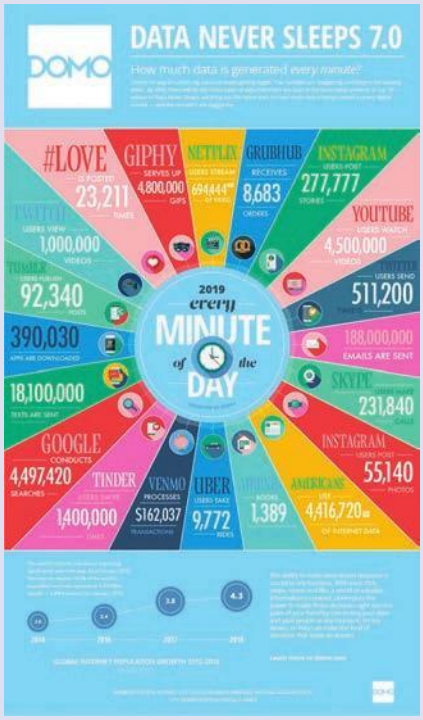
◆ **Data matching**: The process of comparing two different sets of data with the aim of finding data about the same entity.

ATL ACTIVITY

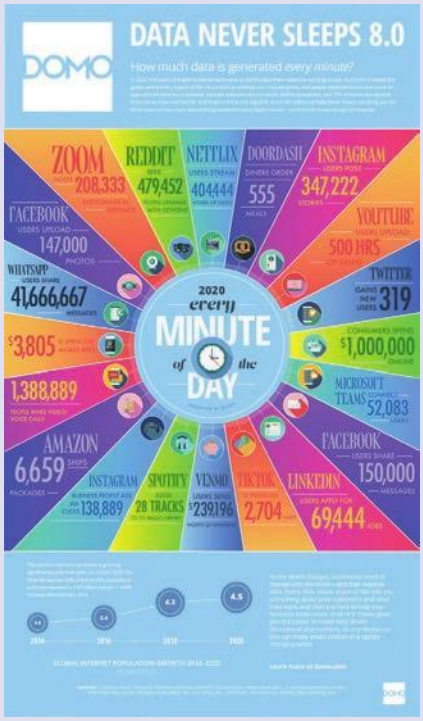
Communication

Domo is an organization that aims to bring people, data and systems into one place for a digitally connected business. The following infographics are from the resource centre on their website.

- Study the two infographics Data Never Sleeps 7.0 and Data Never Sleeps 8.0.
- List the data each of the infographics shown.
- Describe the similarities and differences that you notice.
- From your knowledge of the apps, websites and terms in the infographics, suggest possible reasons for any changes.



Data Never Sleeps 7.0



Data Never Sleeps 8.0

3.1D Data life cycle

The data life cycle has five stages. Organizations and data scientists use it to manage the flow of data, which can improve efficiency as well as help with adherence to data governance regulations.

Stages of the data life cycle

Stage 1: Data creation

The first stage of the data life cycle is the creation of data. New data may be created through manual data entry by a member of the organization, through the completion of an online form, or collected automatically through the use of sensors. As we discussed earlier, this data may be in many different formats.

Stage 2: Storage

Once the data has been created, it needs to be stored and protected with the appropriate level of security and access configured. Organizations will set what data can be accessed by who, as well as the different levels of access rights, so that users can either read, modify or have full control of the data.

Stage 3: Usage

Data is collected and stored for many reasons. At this stage of the data life cycle, the data can be viewed in its raw format, be processed so that it can be presented in a more visually appealing manner, or specific information can be extracted out. Once processed, the data can be analysed or shared with others. IT systems may be required to use data that has been previously collected by another organization or for a different purpose, or third parties may be given access to the data.

Stage 4: Preservation

Following the analysis of data, it is important that this data is preserved by the organization. One reason is to ensure that the data is maintained to support current analysis and decision-making. It also allows data to be reused in the future.

Stage 5: Destruction

Although organizations may wish to keep this data forever, as the volume of data grows so does the cost of storage. Compliance with data protection regulations may also mean that data must be destroyed once the agreed retention period is over.

ATL ACTIVITY

Thinking

Demonstrate a personal relevance to this activity by analysing a file in the recycle bin.

- Select one file from your computer's recycle bin.
- Analyse the file using the data life cycle by answering the questions in this table.

Name of file:		
Stage	**Question to be addressed**	**Answers**
1 Data creation	How was the file created? Was it manual or automatic? What file type?	
2 Storage	Where was the file being stored (location on the computer)? How was the file being kept secure? Who had access to the file? Was the file being shared?	
3 Usage	What was the purpose of the file? How did you use the file? Was the file used in its raw format or processed to create a different format?	
4 Preservation	How long did you intend to use the file? What was the intended future use of the file?	
5 Destruction	When did you add the file to the recycle bin?	

3.1E Ways to collect and organize data

Data creation | Storage | Usage | Preservation | Destruction

At the data creation stage there are two main categories of data: primary data and secondary data. **Primary data** is original data collected for the first time for a specific purpose. This may be an interview as part of your extended essay, or it may be data collected by cameras for facial recognition. **Secondary data** is data that has already been collected by someone else for a different purpose. For your extended essay this may be in the form of a website or online news article, or may include a set of training data for a facial-recognition system.

◆ **Primary data**: Original data collected for the first time for a specific purpose.

◆ **Secondary data**: Data that has already been collected by someone else for a different purpose.

Data creation | **Storage** | Usage | Preservation | Destruction

Once data has been collected, it is important that organizations or users are able to store this data. **Databases** are often used to store large volumes of data in one place. Data is organized and structured using tables, which makes finding information quick and easy. A table consists of columns (**field names**) and rows (**records**). Databases organize data about **entities**. For example, an entity could be a book, movie, house or country.

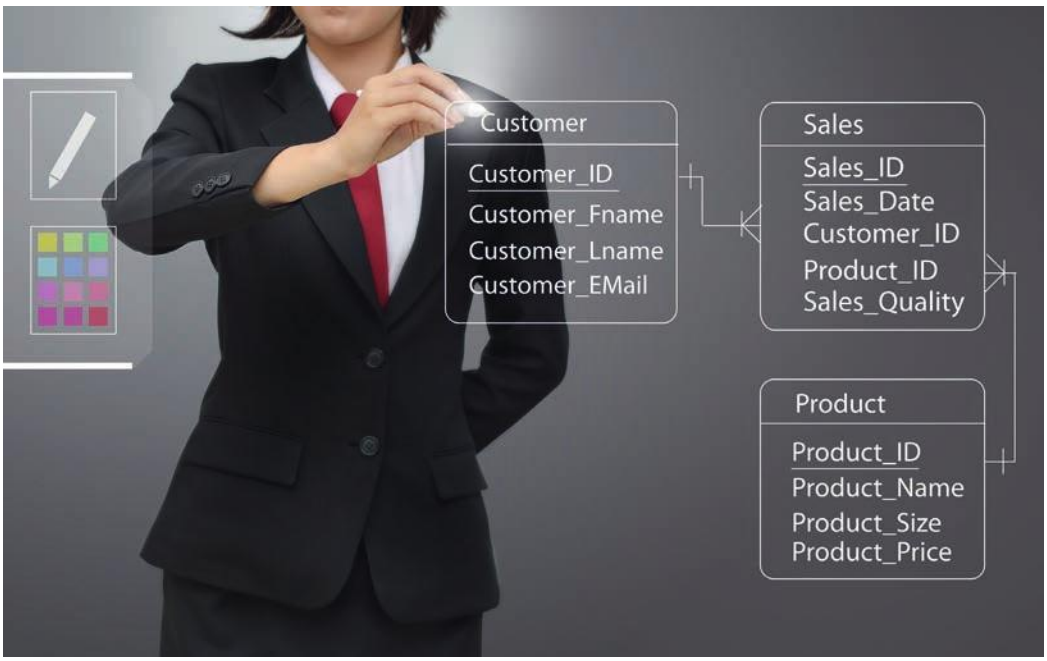
When designing a database, one must think about what **attributes** needs to be stored (what specific data) about the entity. For example, a database about students (entity) may store data such as their name, date of birth, telephone number and address (attributes). The fields that store these attributes are predefined by size and **data type**. The most common types are integers, floating point numbers, characters, strings, Boolean values and dates. For example, name and address would be string, date of birth would be date.

A database that has more than one table is called a **relational database**, with tables linked by their primary key and corresponding foreign key. A field is assigned to be a primary key when it contains unique values. It is important for records in relational databases to have a unique identifier.

◆ **Relational database**: A database that has more than one table.

Links

This section links to Chapter 1.6 Conducting secondary research and primary research and Section 9 Digital society extended essay.



■ Example of an entity–relationship diagram (ERD) for a relational database

It is important during database design to reduce data entry errors and promote integrity, so that the data being input is valid, accurate and consistent.

Two methods to improve the accuracy of data in a database are validation and verification.

Validation in database design means that only valid (suitable) data can be entered. This can be done in various ways, such as setting the field length, assigning data types, using input masks, configuring range checks and designing lookup tables. Incorporating these into the database ensures that errors are minimized at the time of data entry. Should unsuitable data be entered, users will receive an error message.

On the other hand, **verification** checks that the data entered is the actual data that you want, or that the data entered matches the original source of data. Two common methods of data verification include double entry (for example, being asked to enter a password twice when registering a username for a new website) or having a second person check the data visually.

◆ **Validation**: In databases, this means that only valid (suitable) data can be entered.

◆ **Verification**: In databases, these are checks that the data entered is the actual data that you want, or that the data entered matches the original source of data.

Multiple users can access databases at any one time, and it is easy to add and modify data. Databases can be sorted so that information can be:

- presented in an organized manner
- searched in order to find specific information
- analysed to find trends or patterns.

In databases, searches are sometimes called **queries**. A query can be designed and saved, then executed whenever the user needs it. Queries are often presented in the form of a **report**, which can be designed to make the information extracted more visually appealing to the recipient.

As part of the process of organizing and structuring data, data needs to be classified into **categories**. Categorization may be done by defining fields in a database or through data tagging. Classification can make accessing information easier and more searchable, as well as for security purposes, such as classifying documents as confidential. Some standard categories of information include:

- public information, for example an organization's name, address and telephone number
- confidential information, for example bank details
- sensitive information, for example biometric data
- personal information, for example ethnic origin or political opinions.

When classifying data is it important to determine the relative risk associated with each set of data. Public data, which is easy to recover, is low-risk, whereas sensitive personal information or data that is necessary for an organization to function will be high risk.

Links

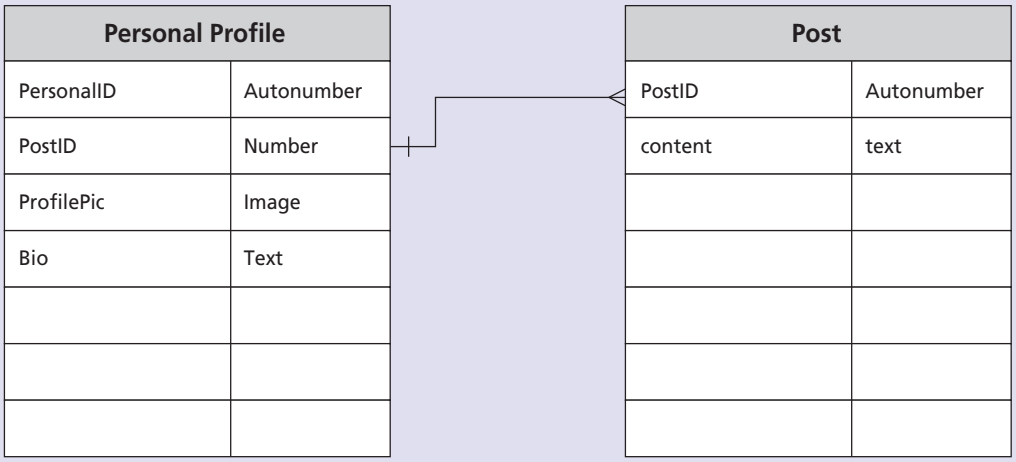
This content links to Section 4.7A Social components of identity.

ATL ACTIVITY

Thinking

Analyse the database behind a social media website.

- Select one of your social media accounts.
- Study the chosen account and make notes of the data that was entered to set up the profile.
- Next, study the sort of data that would be entered and automatically created every time a post is made.
- Describe the different formats of data that are used, for example images, date/time, text, integer, video, sound.
- Select a suitable drawing program to create an entity–relationship diagram (ERD) for your social media account. Use the example ERD below.



ERD template for social media

- Complete the following table to classify the data in your social media account.

Type of information	Summary of data found in the social media account
Public	
Personal	
Sensitive	
Confidential	

3.1F Ways of representing data

Data creation → Storage → Usage → Preservation → Destruction

Data collected can be presented in different ways to make it both easier to understand and more interesting to read.

Numerical data, such as financial, meteorological, scientific and statistical data, are often presented in a visual manner in the form of charts and tables. The type of chart will often depend on the type of data being represented. For example, rainfall is often presented as a bar chart, whereas temperature is presented as a line graph. These may also be combined with text to create a report. **Data visualization** is the process by which large sets of data are converted into charts, graphs or other visual presentations.

◆ **Data visualization**: The process of converting large sets of data into charts, graphs or other visual presentations.

ATL ACTIVITY

Communication

Earlier in this chapter, you downloaded a set of weather data. Use your spreadsheet skills to present this data.

- First, identify which spreadsheet software to use.
- Import the downloaded weather data into the software.
- Use formatting tools to present the data in an easier-to-read format – consider the use of fonts, colours, borders and shading.
- Use simple functions, such as average, minimum and maximum, to make calculations on the data.
- Use chart tools to create suitable charts for the weather data. Tools may include selecting the chart type, formatting the horizontal and vertical axes, labelling the axes, adding titles and a legend.

If your spreadsheet skills need refreshing, find suitable online tutorials to assist you in each of these activities.

Infographics are an alternative way to provide an easy-to-understand overview of a topic. They can contain images, charts and text.

ATL ACTIVITY

Research

Throughout the course, there will be numerous occasions when you will be required to present your findings in an easy-to-understand manner. Research and try out at least two online infographic creators.

- Research the most recommended online infographic creators.
- Select two and try them out.
- Create a table and compare their features.
- Make a decision on which one to use for this course.
- Write a short justification of your choice.

Infographic design template

3.1G Data security

Data creation → Storage → Usage → Preservation → Destruction

It is of paramount importance that data is secure at the time of storage but also in transmission. This may be when the data is collected or shared between systems or organizations. One method to ensure that data is kept secure is encryption.

Encryption

Encryption is the process of converting readable data into unreadable characters to prevent unauthorized access. Encryption is based on cryptography, where an algorithm transforms information into unreadable ciphertext. For the intended person or computer to be able to make sense of this encoded data, they must use a key to decrypt it back to its original form, called plaintext.

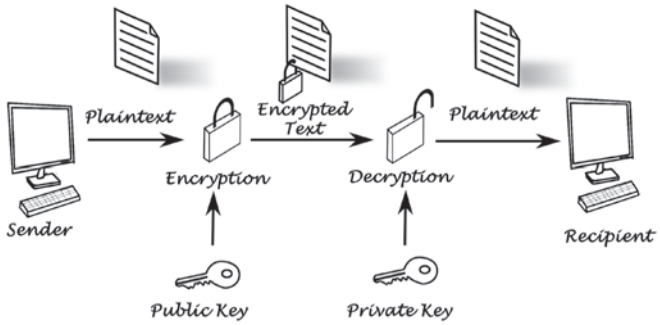
◆ **Encryption**: The process of converting readable data into unreadable characters to prevent unauthorized access.

There are two types of encryption:

- symmetric key
- public key.

Symmetric key encryption is where the key to encode and decode the data is the same. Both computers need to know the key to be able to communicate or share data. The advanced encryption standard (AES) uses 128-bit or 256-bit keys, which are currently considered sufficient to prevent a brute force attack (trying every possible combination to find the right key). For example, a 256-bit key can have 2^{256} possible combinations. This type of encryption is commonly used in wireless security, security of archived data and security of databases.

Public key (asymmetric) encryption uses two different keys to encode and decode the data. The private key is known by the computer sending the data, while the public key is given by the computer. It is shared with any computer that the original computer wishes to communicate with. When sending data, the public key of the destination computer is used. During transmission, this data cannot be understood without the private key. Once received by the destination computer the private key is used to decode the data.



Public key encryption

Public-key encryption is found in **Secure Socket Layer (SSL)** and **Transport Layer Security (TLS)** internet security protocols. The 'http' in the address line will be replaced with 'https' to provide secure transmission of data over the internet, especially when confidential and sensitive data is collected. It is commonly used in digital signatures, time stamping of electronic documents, electronic transfers of money, email, WhatsApp, Instagram, and sim card authentication.

◆ **Secure Socket Layer (SSL)**: is a protocol developed for sending information securely over the Internet by using an encrypted link between a web server and a browser.

◆ **Transport Layer Security (TLS)**: is an improved version of SSL and is a protocol that provides security between client and server applications communicating over the Internet.

ATL ACTIVITY

Social

Work in a small group to try out Caesar's cipher (Julius Caesar used a substitution technique, shifting three letters up, so C became F, D became G, and so on).

- Teach a friend how to use Caesar's cipher.
- Try coding and decoding messages with each other.

Data masking

Encryption is essential for the trusted delivery of sensitive information; however, cyber threats still exist and the implementation of more stringent data protection legislation means that organizations must ensure that sensitive data is kept private. One method of doing this is called **data masking**. Data masking is the process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.

◆ **Data masking**: The process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.

As we all know data is a valuable commodity and, once collected, it can be stored, used and shared. However, organizations face privacy problems should they do this without user consent. By anonymizing data an organization can both protect the privacy of their customers while using the data for application testing or business analytics, and/or sharing their data with third parties. Classifying data at stage 2 of the data life cycle makes this process much easier.

Data erasure

At the final stage of the data life cycle, data needs to be destroyed. **Data erasure** can be either physical or by a software-based method.

◆ **Data erasure**: The destruction of data at the end of the data life cycle.

Two physical methods are the use of degaussers, which use powerful electromagnetic fields to remove data (often used for magnetic media), and shredders, which break storage media down into tiny particles (an effective way of destroying solid-state storage devices and smartphones). Data-erasing software, on the other hand, permanently removes the original data on a storage device by overwriting it with zeros and ones.

Data erasure must not be confused with the term **data deletion**. As a computer user, you can delete files on your computer or cloud storage and send them to the recycle bin, or you can even reformat your storage device. However, with the right tools, deleted data can be recovered and is therefore not secure, especially if you are disposing of hardware.

◆ **Data deletion**: The sending of the file to the recycle bin, which removes the file icon and pathway of its location.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline two methods of data erasure. *[4 marks]*

2 Explain why an organization may wish to use data masking to anonymize data. *[6 marks]*

ATL ACTIVITY

Communication

Orally present to your peers a summary of a data breach.

- Using effective online searching skills, investigate a recent article about a data breach due to the improper disposal of computer hardware.
- Summarize your findings.
- Create prompt cards and practice presenting your findings using them.
- Orally present your findings to a group of friends.

REAL-WORLD EXAMPLE

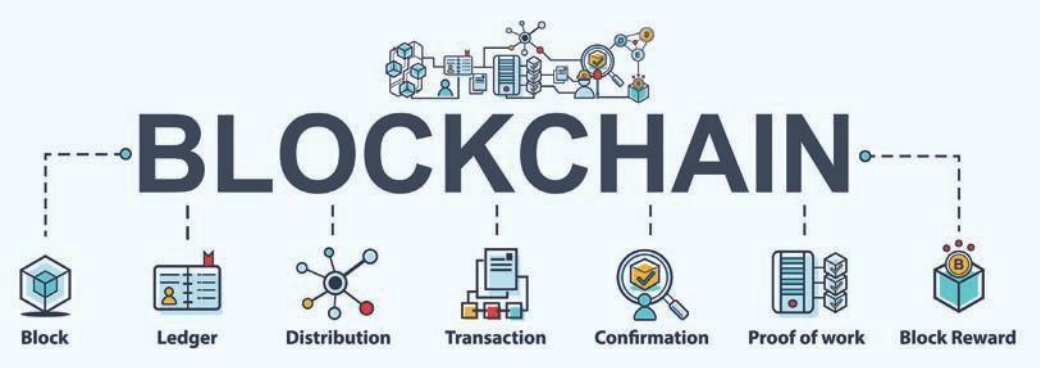
Data breaches from lack of data erasure

In 2010, some photocopiers that were used to copy sensitive medical information were sent to be resold without wiping the hard drives. Three hundred pages of individual medical records containing drug prescriptions and blood test results were still on the hard drive of the copiers. The US Department of Health and Human Services settled out of court with the original owner of the copiers for the violation of the Health Insurance Portability and Accountability Act (HIPAA) for US$1.2 million.

In 2015, a computer at Loyola University that contained names, social security numbers and financial information for 5800 students was disposed of before the hard drive was wiped.

https://njbmagazine.com/njb-news-now/the-challenge-of-recycling-office-electronics

Blockchain



With increasing numbers of reports of hacking in the news, many individuals, organizations and governments are looking for alternative systems that are more secure and transparent. **Blockchain** uses a shared ledger in the process of recording transactions, allowing the trading and tracking of anything of value, such as copyrights, property and loyalty card points. To participate in blockchain, users need to be part of the blockchain network, which will give them access to the distributed ledger. When a transaction occurs, it is recorded as a block of data. Each block forms a chain of data as the ownership of the asset changes hands, with details such as time and sequence of the transaction being recorded. Each additional block strengthens the verification of the previous block, which makes it very difficult to tamper with the transaction.

◆ **Blockchain**: a digital ledger of transactions that is duplicated and distributed across a network of computers.

There are many real-life examples of uses of blockchain; four are given here:

- Microsoft's Authenticator app for digital identity
- the health care industry is using blockchain technology for patient data
- blockchain technology can provide a single unchangeable vote per person in digital voting
- the US Government is using blockchain to track weapon and gun ownership.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

IBM collaborated with Raw Seafoods in the USA to digitize the supply chain in 2019. Data would be uploaded to the IBM Food Trust platform at each stage of the supply chain. This included data on the time and location when the seafood was caught, when the boat docked at the port, when and where the seafood was packed, details about the shipping and delivery to supermarkets and restaurants. This included images and video. Blockchain technologies were used by the platform to reduce the level of fraud and increase confidence in the quality and freshness of the seafood.

1 a Identify two types of data recorded on the IBM Food Trust platform. *[2 marks]*

b Outline two benefits of using the IBM Food Trust platform for seafood customers such as restaurants. *[4 marks]*

2 Explain step-by-step how blockchain technology can be used to reduce the level of fraud. *[4 marks]*

Inquiry

In Section 1.4 you were introduced to the Inquiry Process. In this inquiry we will focus on only two of the stages. Use the guiding questions for each stage to help you complete the activity.

3.1G Data security (content) and 4.1B Home, leisure and tourism (context)

Research one use of blockchain in the home, leisure or tourism industry. Make sure that you have enough sources to be able to:

Starting point	**FOCUS** • Identify a real life example of blockchain.
Determine inquiry focus	• Identify which context this applies to from Section 4.1. • Suggest suitable concepts that could be applied. • Draft three suitable inquiry questions.

3.1H Characteristics and uses of big data and data analytics

Data creation → Storage → **Usage** → Preservation → Destruction

The term **big data** has been around since the 1990s and was made popular by John R Mashey, who worked for Silicon Graphics at the time. Big data is the term used to describe large volumes of data, which may be both structured or unstructured. Big data can be characterized by the 4Vs: volume, velocity, variety and veracity.

◆ **Big data**: Term used to describe large volumes of data, which may be both structured or unstructured.

Characteristics of big data

1. **Volume** – big data consists of very large volumes of data that is created every day from a wide range of sources, whether it is a human interaction with social media or the collection of data on an internet of things (IoT) network.
2. **Velocity** – the speed that data is being generated, collected and analysed.
3. **Variety** – data consists of a wide variety of data types and formats, such as social media posts, videos, photos and pdf files.
4. **Veracity** – refers to the accuracy and quality of the data being collected.

Uses of big data

Big data analytics is when large and varied data sets are processed to identify trends and patterns. This may be used to analyse past behaviour in order to improve customer service, streamline operations or identify new revenue streams.

REAL-WORLD EXAMPLE

Big data in banking and finance

Big data is allowing banks to see customer behaviour patterns and market trends. American Express is using big data to get to know its customers using predictive models to analyse customer transactions.

It is also being used to monitor the efficiency of internal processes to optimize performance and reduce costs. JP Morgan has used historical data from billions of transactions to automate trading.

A third use of big data has been to improve cybersecurity and detect fraudulent transactions. Citibank has developed a **real-time** machine learning and predictive modelling system that uses data analysis to detect potentially fraudulent transactions.

https://algorithmxlab.com/blog/big-data

◆ **Real-time**: Happening now or live.

> *Big data is at the foundation of all of the megatrends that are happening today, from social to mobile to the cloud to gaming.*
>
> *Chris Lynch*

REAL-WORLD EXAMPLE

Big data in the sports industry

Bundesliga, Germany's professional association football league, introduced Match Facts in 2021 to give match insights to its viewers. During a match, 24 cameras are positioned on the field to collect and stream data during the 90-minute game. This data is then converted into metadata and used with past data to provide insights for the fans, such as which player is being most closely defended or the likelihood of a goal being scored.

https://searchbusinessanalytics.techtarget.com/feature/Bundesliga-delivering-insight-to-fans-via-AWS

Inquiry

In this inquiry we will focus on only two of the stages. After your initial research, use the guiding questions for each stage to help you complete the activity.

3.1H Characteristics and uses of big data and data analytics (content) and 4.4 Health (contexts)

Research how big data is being used in medical diagnostics or medical care.

Determine inquiry focus

- Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs.
- Find related real-world example(s).

Explore

EXPLORE

- Find and evaluate sources.
- Conduct research, collect data and record sources.
- Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.

From your research:

- narrow down your focus to a particular application of big data used
- describe the use of big data for this real life example
- select three articles that you found to be useful and correctly list them in a bibliography.

Activity: HL Extended Inquiry

Once you have been guided through the extended inquiry process in Section 6 and learned the prescribed area of inquiry in Section 5.3A – make the connection with this topic and complete the extended inquiry.

3.1 Data and data analysis (content) and 5.3A Climate change and action

Research and evaluate one intervention for climate change that uses big data.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

3.1I Data dilemmas

Alongside the ownership of data comes a huge responsibility to ensure that data dilemmas are addressed at every stage of the data life cycle.

Stage 1: Collection of data

Organizations must consider whether the data was **collected ethically** and complies with data protection regulations. For example, there should be no excessive collection of data and consent should be obtained. Careful consideration should also be placed on what data is collected so as to avoid **biased data sets** that may ultimately skew outcomes in machine learning.

REAL-WORLD EXAMPLE

Bias in facial recognition

In 2019 the National Institute of Standards and Technology (NIST) published a report analysing the performance of facial-recognition algorithms. Many of these algorithms were less reliable in identifying the faces of black or East Asian people, with American Indian faces being the most frequently misidentified. The main factor was the non-diverse set of training images used.

https://jolt.law.harvard.edu/digest/why-racial-bias-is-prevalent-in-facial-recognition-technology

Stage 2: Storage of data

Where data is stored, who owns it, who is responsible for it, who has control of it and who has access to it, all impact **data privacy**. Organizations must comply with the local data protection regulations of the country that the data is stored in. Failure to do so can cost an organization a huge amount in legal fees and compensation should a data breach occur.

Security of data and levels of access can impact the **reliability** and **integrity** of the data. Unauthorized changing of data could deem data invalid and useless.

The problem with unreliable data is that it is often used to make decisions and can lead to faulty predictions and inaccurate forecasting. It is therefore important to identify the common problems that lead to unreliable data.

1. **Biased data**: We looked at data bias earlier in this chapter. This could be due to using biased data sets or bias by humans when selecting the data.
2. **Viruses and malware**: Stored data can be vulnerable to these external threats. Data can be changed, and therefore lose its integrity, or be corrupted and ultimately lost.
3. **Reliability and validity of sources**: Data can be generated from a number of online sources; if these sources have not been evaluated, this can lead to unreliable data being used by the IT systems.

◆ **Data privacy**: The ability for individuals to control their personal information.

◆ **Data reliability**: Refers to data that is complete and accurate.

◆ **Data integrity**: Refers to the trustworthiness of the data and whether it has been compromised.

4 **Outdated data**: Many IT systems collect and store data that is changing; if data is not updated it becomes unreliable data. Consider the telephone numbers of parents at school, for example – if a parent does not inform the school of a change in number, this data cannot be relied on to contact parents.

5 **Human error and lack of precision**: Any form of manual data entry is prone to human error. Automating data entry is crucial for reducing these types of errors. It is also easy for users to accidentally delete files, move them or even forget the name of the file and where it was saved. Effective file management procedures are essential to reduce these types of errors.

REAL-WORLD EXAMPLE

Reliability and validity of COVID-19 data

In June 2020, the *Guardian* reported on a study that was published online about the effect of the anti-parasite drug Ivermectin on COVID-19 patients. The data in the study was obtained from the Surgisphere website using the QuartzClinical database, which claimed to be monitoring real-time data from 1200 international hospitals. However, as doctors around the world started using this data, they soon became concerned regarding the amount of anomalies they found. This resulted in prestigious medical journals reviewing studies that were based on this unreliable data and the World Health Organization stopping their research into the potential COVID-19 treatment.

www.theguardian.com/world/2020/jun/04/unreliable-data-doubt-snowballed-covid-19-drug-research-surgisphere-coronavirus-hydroxychloroquine

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Distinguish between data reliability and data integrity. *[4 marks]*

Top tips

There are many terms and keywords when discussing data. Make sure you know the difference between reliability and integrity, data matching and data mining, and validation and verification.

Stage 3: Use of data

The use of data should be ethical and comply with local data protection regulations. For example, data should only be used for the intended purpose and should not be shared without the user's consent. When investigating the uses of data, one must also question who the data is shared with and for what purpose, as well as whether data has been anonymized before sharing with third parties.

Individuals may choose to be anonymous for legitimate reasons, such as seeking personal advice or advice on embarrassing health conditions. However, too often, the use of privacy conceals the identity of criminals, terrorists or computer hackers from law enforcement agencies. It may also be used in **cyberbullying** or to conduct internet searches without being traced.

◆ **Cyberbullying**: Bullying carried out online, for example, on social media.

Stage 4 & 5: Archiving and storage of data

Again, organizations must comply with local data protection regulations when it comes to the retention and security of archived data.

Deeper thinking

Privacy

◆ **GDPR (General Data Protection Regulation)**: Legislation designed to harmonize data privacy laws across the EU.

Throughout the Digital Society course, there will be many times when the impact of a digital technology creates a breach of privacy. So, what does privacy actually mean? How can digital technology cause a privacy breach? How are citizens being protected by legislation?

Privacy is the ability of individuals and groups to determine for themselves when, how and to what extent information about themselves is shared with others.

There are three key aspects of privacy:

- **Freedom from intrusion** – an individual has the right to be left alone; for example, when at home, you have the right to not answer the door if someone calls, and you don't have the right to walk into someone else's house uninvited.
- **Control of information about oneself** – controlling information about yourself is a very important aspect of privacy. You are the one who decides what information is shared and where.
- **Freedom from surveillance** – if you have privacy, it means that you are not being watched.

What does it mean to have a breach of privacy?

Possible causes of data breaches include

- the unauthorized use of data by insiders – this could include the IT staff that maintain the data or the systems storing the data
- an accidental leak of data due to negligence or carelessness, which could result in access by hackers or third parties
- a series of errors that results in the exposure of information about an individual
- intentional use of data, such as used by marketing or for surveillance, that citizens may not approve of.

Data protection legislation

To protect individuals and groups of people from privacy breaches, different countries have their own set of data protection regulations and laws. In May 2018, the **General Data Protection Regulation (GDPR)** was introduced in Europe with the aim of harmonizing data privacy laws across Europe and providing greater rights and protection for European citizens. Designed to be more stringent and up to date than previous laws, many other countries are following suit and adapting their own laws accordingly.

There are seven key principles at the heart of GDPR:

- Lawfulness, fairness and transparency – outlines how the data being collected, used and stored may be treated.
- Purpose limitation – data collected should only be used for its original intended purpose.
- Data minimization – organizations should not collect more personal information than necessary.
- Accuracy – includes the responsibility of keeping data up to date and having processes to correct data.

- Storage limitation – covers the duration that data is kept; it should not be kept longer than necessary.
- Integrity and confidentiality – encourages organizations to adopt best practices for securing data.
- Accountability – a new principle to ensure that organizations can prove that they are working on compliance with the other principles.

The aims of data protection regulations are to provide individuals with more control over their data and to provide them with rights. For example, an individual has the right to be informed, they have the right to access their data, and they have the right to have it rectified. They also have the right to be forgotten.

ATL ACTIVITY

Thinking

Hold a discussion with a group of friends on the following questions:

- If someone says 'you are invading my privacy', what does this mean?
- What sorts of information do you think you should keep private?
- If you have been watching the news lately, how is social media being used to invade users' privacy?
- Should you expect privacy if you use social media?
- If someone says 'it was an anonymous post', what does that mean?
- How has digital technology helped people be anonymous on the internet?
- Distinguish between privacy and anonymity.

ATL ACTIVITY

Research

Research and apply the data protection regulations.

- Research the data protection regulations in one country of your choice.
- Apply these data protection principles/regulations to each stage of the data life cycle.
- Listen to the pizza order here **www.aclu.org/ordering-pizza** or here **www.youtube.com/watch?v=RNJl9EEcsoE**.
- Describe the breach of privacy of this scenario, including which data protection principles have been breached.
- Investigate one recent example of a data breach.
- Describe the cause of the data breach and the cost to the organization.

Inquiry

3.1 Data and data analysis (content) and 2.4 Power (concepts)

Starting point	Select a real-life example/news item with a digital society topic of interest • Does this source involve digital systems? • Does this digital system(s) clearly cause impacts and have implications for people and communities? • Is this a topic that provides opportunities for both secondary and primary research?
Determine inquiry focus	• Narrow the topic to a specific inquiry focus by using the digital society diagram and considering the 3Cs. • Find related real-world example(s).
Explore	**EXPLORE** • Find and evaluate sources. • Conduct research, collect data and record sources. • Check that there are adequate sources to address each aspect of the inquiry and the inquiry focus.

- Look back at the topics in this chapter. Select one that you would like to investigate further.
- Next, look at Chapter 2.4 Power and review the different prescribed areas. Conduct some initial research to help select a focus area.
- Can you link the inquiry to a personal experience?
- Find one or two examples of secondary research that will be the inspiration for this inquiry.
- Write a short summary to describe the topic of this inquiry, any link to a personal experience and the source that inspired you.

Creativity, activity, service (CAS)

Promote screen time awareness among the school community

Complete a short formal survey about screen time among a cross section of students in your school. Find out:

- what type of devices they use
- what activities students use their screens for
- how many hours they spend on-screen on school-related activities
- how many hours they spend on-screen on non-school-related activities.

Use a ready-made template online to create an infographic of your findings. Include suitable charts, images and text to describe student screen time habits.

Share this with the school community.

TOK

Knowledge and technology

In TOK lessons you may have discussed what is meant by the term 'knowledge'. How is the knowledge we have talked about in this chapter similar to your discussion in TOK? How is it different? Is there one 'right' definition of knowledge? One can also ask what is the difference between data, information and knowledge?

IT systems with artificial intelligence may be better at analysing patterns compared to humans but they rely on a vast amount of data. Many people are unaware that their digital footprint is allowing personal data to be collected, raising questions such as: What data is being collected? What methods are being used to get this data?

How has digital technology impacted how we filter data and information?

Does this data give a complete picture of what it is really like to be human?

It also raises ethical questions about information systems, how much data they should have about an individual, and how they are using the data.

Reflection

Now that you have read this chapter, reflect on these questions:

- How is data different from information, and what role does technology have in creating wisdom?
- Could you explain the different stages of the data life cycle?
- There are so many different types of data. Could you match up the types of data with the different contexts in the next section?
- Do you have the skills to present data in different ways? How might this be useful when working on the digital society internal assessment?
- Security is an important aspect of the data life cycle. What other chapters in this section might security be important for?
- What is the relationship between big data and artificial intelligence? How are these being used to improve the quality of life?
- Do the benefits of collecting, analysing and sharing data outweigh the ethical concerns that it raises?
- What is the relationship between data and power?
- How does your learning about data and knowledge in this chapter relate to your understanding of knowledge in TOK?

Extended essay (EE)

The data life cycle, big data and analytics, or the dilemmas of data may give you some initial ideas for an extended essay topic.

Learner profile

Thinker

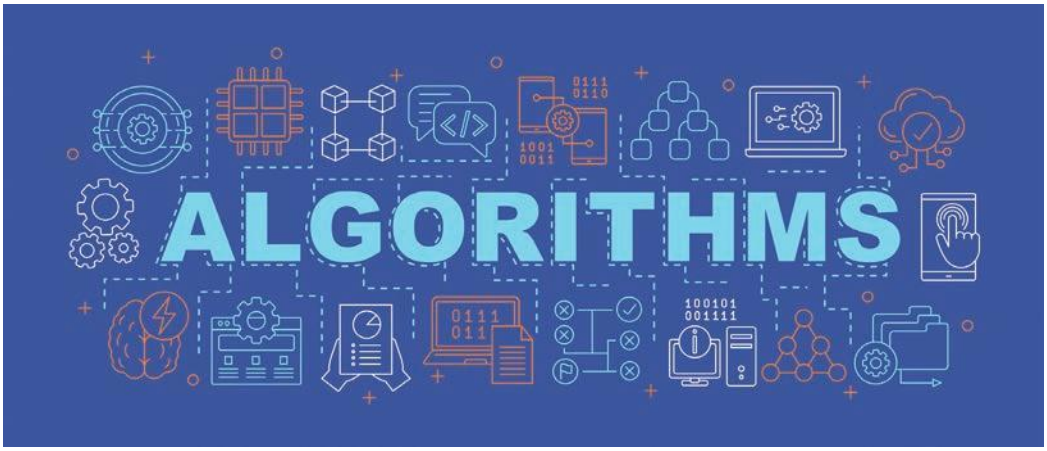
How has studying data made you think differently about your own personal data and how it is used?

3.2 Algorithms and code

UNDERSTANDINGS

By the end of this chapter, you should understand:

- algorithms are defined sequential steps or instructions to solve a specific problem or perform a task
- the effectiveness of an algorithm is often evaluated according to its efficiency
- the use of algorithms poses significant opportunities and dilemmas in digital society.



Algorithms have been around for thousands of years, but it's likely that you are hearing this term more frequently than ever before. Essentially, an algorithm is a step-by-step set of procedures used to solve a problem or perform a specific activity. The success of all computer systems is dependent on algorithms and how they are programmed.

◆ **Algorithm**: A procedure or formula for solving a problem that is based on a sequence of steps.

Whether we are conscious of it or not, algorithms are a ubiquitous part of today's society. For example, they are responsible for what we see on our social media feeds, and what movies are recommended on Netflix. The use of algorithms presents significant opportunities, but also poses new dilemmas for society.

3.2A Characteristics of an algorithm

Algorithms define a set of instructions that will be carried out in a specific order, to obtain an intended output. Consequently, algorithms should have the following characteristics:

- **Unambiguous**: Algorithms should be clear and concise; the inputs and outputs should be clear and all steps of the procedure explicit.
- **Finite**: Algorithms must have a finite number of steps that end once they have been completed. The algorithm must stop eventually with either the expected output or a response that indicates that there is no solution.
- **Well defined**: Each step of the procedure should be well defined, making very specific the steps to be taken and in what order. Details of each step must be explicit, including how to handle any errors.

- **Inputs**: The input is the data, which will be transformed by the procedure. An algorithm may have zero or more inputs.
- **Outputs**: The output is the data that has been transformed by the process; it should match the desired output. An algorithm should have one or more well-defined outputs.
- **Feasible**: For an algorithm to be effective, the procedure must be possible with the available resources and not contain any redundant unnecessary steps.
- **Independent**: The algorithm should have step-by-step instructions and be independent of any programming language.

ATL ACTIVITY

Social

Work in a small group to play this game. The purpose of the game is for one person to give instructions to their partner in sufficient detail to recreate a diagram. Each pair will need:

- copies of a printed diagram (this can be of anything as long as there is sufficient detail for person A to describe it)
- paper and pens
- chairs.

Setting up the game:

- Place the chairs back-to-back in a row.
- Get into pairs; each pair should sit down back-to-back.
- On one side (side A) give all the contestants a copy of the diagram (side B must not see it).
- On the other side (side B), each contestant should have paper and a pen.

Playing the game:

- Contestants on side A must give instructions to their partners (side B) on how to recreate the diagram.
- A time limit can be set to make this game harder.
- The winner of the game will be the team that has recreated the diagram most similar to the original diagram.

After playing the game, reflect on the characteristics of an algorithm. Which characteristics did the winning team display?

3.2B Components of an algorithm

The first computer algorithm was written in the 1840s by Ada Lovelace. It calculated a sequence of numbers called the Bernoulli numbers and was written for the 'Analytical Engine'. However, since the introduction of computers, algorithms have become more and more complex and sophisticated.

Despite the complexity of the more recent algorithms, many of the same components are commonly found. These include:

- **Instructions**: An algorithm consists of a series of sub-algorithms, each performing a small activity. Each set of steps for a small activity is called an instruction. One example would be digit addition.
- **Variables**: You may have come across variables in mathematical problem-solving or science experiments. They have the same function here in an algorithm, which is to temporarily store values while the steps of the algorithm are being executed. As the algorithm is being processed line by line, the variable will change value, hence its name. For example, an algorithm used to calculate profit will have the variable named 'profit' to store this data.

Ada Lovelace

- **Conditionals**: One of the steps in an algorithm could be to make a decision or choice. An example of this is when an algorithm is required to determine whether a profit has been made. This could be written as:

```
if Sales > Costs, then print 'We are profitable'
```

- **Loops**: Algorithms would be very limited if they could only run a sequence of steps once, which is why many algorithms contain loops. Loops allow a set of instructions to repeat when a certain condition is met. For example, an algorithm may repeat until there are no more customers.

3.2C Ways of representing algorithms

Algorithms are created independently of a programming language, which allows computer programmers to develop code in their preferred programming language. However, there are three main ways to represent an algorithm.

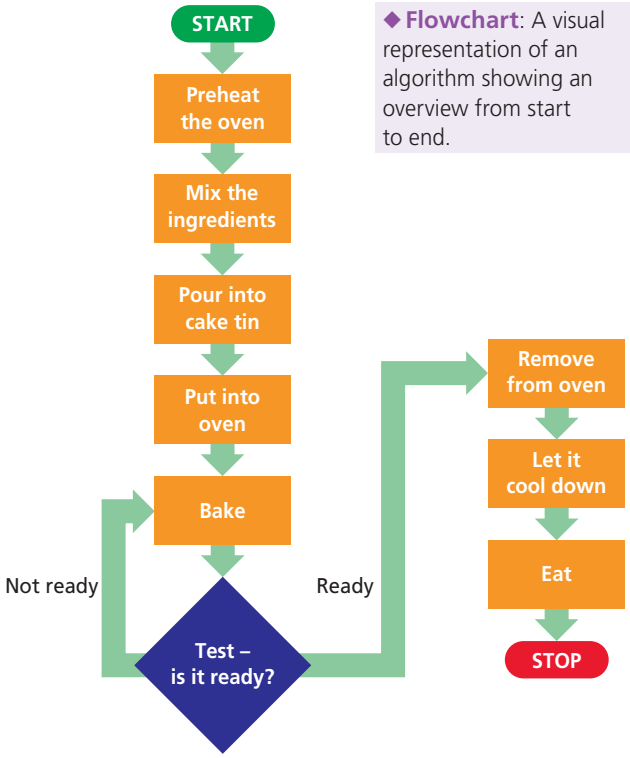
Natural language is a popular choice and may often be considered the first step of designing a computer program. Using everyday language allows developers to work with non-coders to write down the steps that the algorithm needs to follow, with the advantage that everyone involved is able to understand the process.

An example of a natural language algorithm would be a cooking recipe. To make a cake, you would follow the detailed steps of the recipe, such as get the ingredients from the cupboard through to take the cake out of the oven.

Although natural language is easy for everyone to understand, it has a tendency to be ambiguous and lack clarity. Consequently, an alternative method used to represent an algorithm is a **flowchart**.

Flowcharts use a standard set of symbols to represent the different components, and arrows are used to show the direction of the steps. For example, each rectangle represents an action, while diamonds represent a condition or a loop. Flowcharts help programmers visualize the steps of the algorithm and force them to think about sequence and selection. This makes them a useful planning tool.

Once an algorithm has been planned, it is time to start writing the **code** so that the program can be tested and implemented. There have been many **programming languages** created throughout history, with over one-third of these developed in a country that has English as the primary language. Despite the diversity of languages, many of the keywords, such as 'if' for conditions and 'while' for loops, are in English. It is not just the language used in the code that is important, however, but also the language of the community of programmers. According to the TIOBE Index 2022, Python is the most popular programming language, followed by C, Java and C++ https://www.tiobe.com/tiobe-index/



■ Flowchart to create a cake

◆ **Flowchart**: A visual representation of an algorithm showing an overview from start to end.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 a Outline two characteristics of an algorithm. *[4 marks]*

b Outline two common components found in an algorithm. *[4 marks]*

2 Explain why programmers may prefer to plan out the algorithm using a flowchart compared to natural language. *[6 marks]*

3.2D Uses of algorithms

Whether they are processed by mathematicians, scientists or computer scientists, algorithms often perform the same common tasks. Take, for example, the **bubble sort algorithm** learned by computer science students. This is one of the most basic sorting algorithms, which runs in a loop and swaps adjacent elements until they are in the correct order. Alternatively, sorting may be found as a built-in function in a spreadsheet or database.

Algorithms may also be used for **searching** (which may be referred to as a 'query' in a database), **filtering** (with the selection of cells based on certain criteria) and **counting**. For example, a scientist may use a spreadsheet to analyse the results of an experiment. To do this they may sort the results to find the highest or lowest values, or filter the spreadsheet for a specific variable to narrow down their results, or count how many instances a given value appears in their results. Alternatively, the scientist may use an open-access research database to **search** for results of similar laboratory investigations.

ATL ACTIVITY

Thinking

In the last chapter, there was an activity to download weather data. Use this data to practice using functions in a spreadsheet program.

- Search for online tutorials on how to sort, filter and count in a spreadsheet.
- Using the weather spreadsheet from before
  - select a column to sort the data in order
  - try using the filter features to narrow down the data
  - decide on a certain criterion and use the 'count' function.

REAL-WORLD EXAMPLE

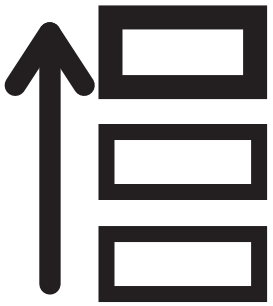
Search algorithms: PageRank

Google's search algorithm PageRank is one of the most frequently used search algorithms to find the most relevant web pages for a given search criteria. There are many sub-algorithms in this search algorithm that look at factors such as the words used in the query, expertise of sources, quality of content, location and useability of web pages.

An effective algorithm is one that makes an activity more efficient and solves the initial problem. So, naturally businesses are looking to algorithms to help them be more competitive. One such algorithm is the **prioritization algorithm**, which is a sorting algorithm used to prioritize customer orders, prioritize help desk requests or even decide which region to prioritize sales in. The first step in the algorithm is to count the frequency of requests from a customer, department or area. They are then sorted and classified into high, medium and low frequency, and then finally the customer, support, request or region would be ranked.

A second algorithm to improve efficiency is the **association rule**. Used in machine learning, association rules are algorithms being used in market basket analysis and medical diagnosis. Simply put, an association rule uncovers how items are associated with each other and reveals relationships between items in large databases. For example, analysing items in shopping baskets can determine how likely one item is to be bought with another. This information can then be used to determine product placement within a store, which will save customers time and remind them of things that they might be interested in buying.

Whether algorithms are in basic computer programs written by computer science students or by programmers from the top technology companies, the increase in the amount of data generated has steered companies towards artificial intelligence algorithms to help them make sense of the data.



■ Prioritization algorithms

◆ **Prioritization algorithm**: A sorting algorithm used to prioritize tasks.

◆ **Association rule**: Uncovers how items are associated with each other and reveals relationships between items in large databases.

■ Analysing items in shopping baskets can determine how likely one item is to be bought with another

ATL ACTIVITY

Research

Search for open-access databases using a search engine.

- Conduct a simple search to identify the most popular free, open-access databases.
- Search these databases to see if you can find out more information about prioritization and association algorithms.
- Read and make notes.

Links

We will learn more about machine learning and neural networks in Chapter 3.6 Artificial intelligence.

REAL-WORLD EXAMPLE

Machine learning algorithms and facial recognition

According to *American Scientist*, machine learning algorithms are being used to link physical appearance with other traits, many of which are reportedly making false claims. In one example, an algorithm was used to determine personality traits of job candidates based on their facial expressions. In another, machine learning was used to determine if a person was cheating in an online examination based on how their face changed as they answered the questions. One notorious misuse of facial recognition was an algorithm that claimed to identify a criminal based on the shape of their face with an accuracy of 89.5%!

www.americanscientist.org/article/the-dark-past-of-algorithms-that-associate-appearance-and-criminality

Inquiry

In this inquiry we will focus on only one of the stages of the inquiry process. If you need to refresh yourself on the Inquiry Process, revisit Section 1.4.

3.2 Algorithms and code (content) & 2.2 Expression (concepts)

Artificial intelligence models are being used to capture human expressions to make predictions. What impact is this having on people?

Determine inquiry focus

Formulate an inquiry question, find real-world example(s) and connect them to the 3Cs

- Is your question concise, thought-provoking and worth considering from different perspectives?
- Does your question support discoveries that move beyond recall, description and summary?
- Are the course concepts, content and contexts that you have identified connected to your inquiry question?

Use your research skills to narrow down this focus question to a particular context.

- Find one real-life example to support your choice of context.
- Rewrite your focus question to include the context and summarize the real-life example.

3.2E Algorithmic dilemmas

One goal of algorithms is to make people's lives easier, for organizations to operate with greater efficiency, and for governments to make better decisions. Algorithms are all around us, aiding us with online searching and shopping. Small businesses can gain new insights into trends when making sales forecasts without having to hire experts, which ultimately allows them to provide a better service for customers and employ the right staff. Governments can analyse health data to improve hospital services and use artificial intelligence in the courtroom.

However, algorithms created with good intentions in mind sometimes have negative consequences, albeit unintentional.

Algorithms replacing human judgements

Algorithms can be better decision-makers than humans: they don't get tired, and the decisions can be applied consistently and with precision as they are not emotional. On the other hand, however, even logical algorithms can give inappropriate results.

REAL-WORLD EXAMPLE

Algorithms used by the police and courts

In 2020 the *Harvard Gazette* reported on the use of algorithms by the US government. There were approximately 2.2 million adults in prison in the US in 2016. With increased pressure to reduce these numbers, police departments used predictive algorithms to help decide where to locate police personnel on the streets. At the same time, courtrooms were using criminal risk assessment algorithms to determine the length of prison sentences. This algorithm created a score for each defendant based on their profile and likelihood of reoffending. However, criminals from low-income and minority communities were at risk of having higher scores because historically they came from areas with a disproportionately higher number of court cases. This led to less-favourable sentencing. In a different case, one court sentenced a man to 18 months in jail because the algorithm placed a greater weighting on his age. If he had been older, he would have had a much shorter sentence.

https://news.harvard.edu/gazette/story/2020/10/ethical-concerns-mount-as-ai-takes-bigger-decision-making-role

As we can see from the example, there are real concerns about how much we should rely on algorithms for making judgements. The main problem is that many algorithms make judgements based on the bias that already exists in society. Since machine learning algorithms are learning from data sets using historical data, it is not surprising that these algorithms adopted the same level of bias that was present with previous human judgements.

ATL ACTIVITY

Thinking

Formulate a reasoned argument to support your opinion about the use of algorithms to replace human judgements.

- Conduct wider research to find two more examples of how algorithms are being used.
- Use this research to write a paragraph about algorithms replacing human judgements.
- The paragraph should include your opinion, which should be supported by clearly written arguments with real-life examples.

Algorithmic bias

There are two main reasons why artificial intelligence systems have built-in bias:

1. Human algorithm developers unknowingly introduce bias into their models.
2. The training data set includes biased data or is incomplete, so it is not a true representation of the population.

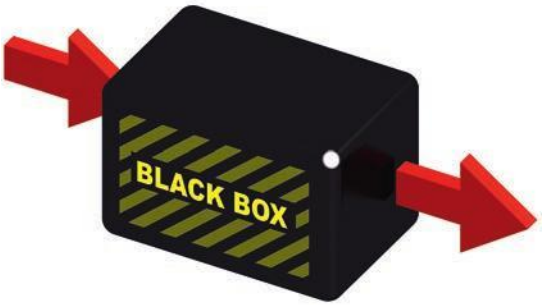
REAL-WORLD EXAMPLE

Bias in algorithms

A study published in 2020 found that the algorithm used to determine the health of a patient's kidney function used race as one of the factors. Of the 57,000 medical records reviewed in Massachusetts, one-third of the black patients would have had their disease classified as more severe if the formula used for white patients had been applied.

www.wired.com/story/new-formula-help-black-patients-access-kidney-care

Black box algorithms and the lack of transparency



Many of today's algorithms are often considered to be **black box algorithms**. In artificial intelligence this is when insights are made but it is not clear how the algorithm came to reach the conclusion from the data input. People are generally aware that algorithms are influencing the world they live in, yet don't know what they are or how they work.

Since artificial intelligence algorithms can learn from experience and improve over time, it is very difficult to know how they are making decisions. As artificial intelligence becomes increasingly sophisticated with developments in deep learning, programmers have less control over how artificial intelligence learning evolves. This creates issues around who is responsible when the algorithm does not perform as expected. Who is to blame? Is it the programmer or the data scientist?

With highly regulated industries such as health care and financial services, **transparency in algorithms** is important. People in these industries are held accountable for the decisions being made by artificial intelligence systems. This can be problematic, however, because:

- it is often difficult to explain how the algorithm reached its conclusion
- it is not always possible to know how the training data was selected
- the evolving nature of machine learning makes it difficult to keep up.

◆ **Black box algorithm**: An algorithm that provides insight without clarity on how the conclusions were reached from the data input.

◆ **Transparency in algorithms**: the ability to understand and be able to explain the inner workings of the algorithm.

REAL-WORLD EXAMPLE

Black box algorithms: Object detection systems in autonomous vehicles

'Predictive inequity in object detection', an academic paper written by a group of researchers at the Georgia Institute of Technology, highlighted that the deep learning computer vision model found it difficult to detect people with dark skin. If used in autonomous vehicles, it would unlikely detect a pedestrian crossing the road if they had darker skin. Due to the nature of the black box algorithms, it made it much harder for developers to go back and correct the algorithm.

REAL-WORLD EXAMPLE

Black box algorithms: Deep Patient software

In 2015, a research group trained their Deep Patient software to discover patterns hidden in hospital data to predict if a patient was likely to develop medical problems. It was particularly good at predicting psychiatric disorders, which were often difficult for human doctors to foresee. However, because of its black box nature and lack of transparency, doctors were very resistant to using it.

Top tips

The dilemmas found in this chapter are closely linked to many of the dilemmas in artificial intelligence, robotics and autonomous technologies.

Inquiry

In this inquiry we will focus on only two of the stages. After your initial research, use the guiding questions for each stage to help you complete the activity.

3.2E Algorithmic dilemmas (content) and 2.6 Systems (concepts)

Inquiry focus: How have the use of black box algorithms resulted in unintended consequences for a digital society?

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

- Use your research skills to find three sources to further your understanding of this question.
- Your final choice of sources must be able to help you gain a deeper understanding of this topic, provide a balance of claims and perspectives, and be embedded in the content (algorithms) and concept (systems).
- Write a short report to justify your chosen sources and their usefulness in this inquiry. Your report should include:
  - a discussion on the origin and purpose of each source, including any potential bias or limitations of using the source
  - a discussion of the main ideas being presented in each source and what features of the source were used to support the claim being made
  - a discussion on how the sources corroborate or contradict, and how it has helped you gain a deeper understanding of this question
  - a bibliography entry for each source at the end of the report.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

How has the use of black box algorithms in one real-life scenario resulted in unintended consequences for a digital society?

Analyse the inquiry focus using the perspective of systems by answering these questions:

- Describe the components of the digital system for the selected real-world scenario that uses a black box algorithm.
- Explain how the different components of the digital system interact with each other and the people and communities using it. Use a diagram to support your explanation.
- In what ways have black box algorithms changed the human/built/natural systems that are related to the real-life example. Are they evolutionary, adaptive, transformational or radical?
- Evaluate the intended and unintended consequences of the specific use of this black box algorithm?
- How has the use of black box algorithms made it possible for developers and users to fully understand the connections between the components of the digital system?
- In your opinion, are digital systems and devices becoming too big and complex to understand?

Activity: HL Extended Inquiry

Once you have studied Section 5.1, complete this inquiry activity.

3.2E Algorithmic dilemmas (content) and 5.1 Global well-being

Inquiry focus: How is algorithmic bias contributing to global inequality?

Research and describe the global challenge:

- Use effective research skills and identify one example where algorithmic bias is contributing to global inequality.
- Describe the challenge in detail.

Research and evaluate one intervention for this challenge:

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

Activity: HL Extended Inquiry

Once you have studied Section 5.2, complete this inquiry activity.

3.2E Algorithmic dilemmas (content) and 5.2 Governance and human rights

Challenge: An algorithm was developed to predict which patient would need extra medical care. The algorithm favoured white patients over black patients because they had used historic data on patient health care spending and made faulty assumptions based on the correlation between income and race.

Inquiry focus: To what extent is algorithmic bias reinforcing racial and ethnic discrimination?

Research and describe the global challenge:

- Use effective research skills to find out more about the global challenge of algorithmic bias and racial/ethnic discrimination.
- Describe the challenge in detail.

Research and evaluate one intervention for this challenge:

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

Creativity, activity, service (CAS)

User guide for CAS

As a service for the CAS coordinator, use the knowledge gained about algorithms in this unit to develop a step-by-step guide for IB students on how to document CAS at school.

- Use your knowledge about the characteristics of an algorithm and ways of representing algorithms to analyse the system in place at your school.
- Discuss the choice of digital media to use with the CAS coordinator.
- Select suitable software to create the guide and distribute it to students.

TOK

Knowledge and technology

Digital technology is changing the way we know things. Is it helping or hindering our cognition? One may start to question the ethical limits that should be put in place during the process of acquiring knowledge, especially the use of algorithms by IT systems. Can the use of algorithms to predict behavioural traits ever be free from human bias?

Reflection

Now that you have read this chapter, reflect on these questions:

- Could you explain the characteristics and different components of an algorithm?
- Compare the different ways algorithms can be represented? When is each of these ways used in real life?
- Could you explain the different types of algorithms and when they are used in a range of contexts?
- What is the relationship between data (3.1), algorithms (3.2) and artificial intelligence (3.6)?
- What are the main causes of bias in an algorithm, and what solutions are there to resolve this?
- To what extent should society allow algorithms to replace human decision-making?
- How have the dilemmas in algorithms created intentional and unintentional outcomes for society?
- How have algorithms created human rights challenges in society, and how are they becoming interventions for these challenges?
- How is bias in today's algorithms changing what we know about the world?

Extended essay (EE)

The uses of algorithms and the dilemmas that they raise may generate some initial ideas for an extended essay topic.

Learner profile

Inquirers

Inquirers conduct wider research into different claims and perspectives to check for possible algorithmic bias.

3.3 Computing devices

UNDERSTANDINGS

By the end of this chapter, you should understand:

- a computer is a machine that automatically executes sets of instructions to perform specific tasks
- computers have evolved over time and are increasingly ubiquitous in the everyday life of people and communities.

The term computer is widely understood and recognizable. Ask anyone and they will direct you to the personal computer sitting on an office desk or a mobile device in your school bag. However, what makes a computer a computer? Who is using computers and for what purpose? How has this changed over time? What is coming next in computing?

ATL ACTIVITY

Thinking

Complete this reflection activity:

- Look around the room – identify all the different computers, whether it is the laptop you are working on or the watch you are wearing.
- Think about all the different computers that you have interacted with over the last week. List them and write one sentence for each on how it has impacted your life.
- What do you know so far about the different components inside a computer? Have you ever opened a desktop computer or a tablet? What can you see inside? How many components can you list?

3.3A Types of computers

Computers come in all shapes and sizes so, to start off this unit, we will look at the different types of computers.

Embedded computers

Embedded computers can be found everywhere. Simply put, an **embedded computer** is a combination of hardware and software designed to perform a specific task and incorporated into an electronic or mechanical system. For example, computers are embedded into household appliances such as washing machines, microwave ovens, video consoles and digital cameras. Embedded computers are designed to withstand the specific environment that they are being used in. For example, an embedded computer in a car would be durable and able to cope with the heat of the engine.

Personal computers

Computers are all around us in one form or another, come in all shapes and sizes and for a wide range of purposes. You are probably most familiar with computers that you interact with daily. For example, a **personal computer (PC)** was designed for individual use and entered the home market in the early 1980s. The desktop computer – consisting of a system unit, monitor, keyboard and

◆ **Computer**: A machine or device that processes data, performs calculations and conducts operations based on algorithms provided by software and hardware programs; it can input data, process it, store it and produce an output.

◆ **Embedded computer**: A combination of hardware and software designed to perform a specific task and incorporated into an electronic or mechanical system.

◆ **Personal computer (PC)**: A general purpose computer designed for individual use.

mouse – was the first type of personal computer. Today, they are less common in the home but still popular in the corporate world as they are easier to customize and upgrade, and make it harder for corporate data to 'walk out of the door'.

In January 2003, Steve Jobs announced, 'This is going to be the year of the **notebook** for Apple.' By July 2005, laptop sales had exceeded those of desktop computers. Although laptops were still widely used in 2010, **tablets** began to increase in popularity. High-quality tablets, such as Apple's iPad, filled the gap between laptop and mobile phone. Although **smart/mobile devices** are the fourth device on our list, this is not based on when they were introduced but on their size. Many mobile devices have location services and use GPS, which adds additional functionality and mapping applications, however, they are limited by their lower processing power and battery life.

As **Moore's Law** has been applied to microprocessors, RAM and storage, laptops today are almost as powerful as desktop computers, and have the additional benefits of portability and convenience.

The smallest of device that we will discuss in this chapter is the **wearable computer**. Although wearables are not new, they have been transformed over time. For example, wearable technology was popular in 1975 with the introduction of the first calculator watch – but fast-forward nearly 40 years to the launch of Google Glass in 2013, Apple Watch in 2015 and the Oculus Rift VR Headset in 2016. Today health/fitness watches are widely used both to track fitness and monitor chronic diseases such as diabetes.

◆ **Moore's Law**: The number of transistors in a dense integrated circuit doubles every two years.

Links

This content links to ergonomic design in 4.4B The human body.

Inquiry

3.3A Types of computers (content) and 4.1 Cultural (contexts)

In this inquiry we will focus on the Analyse stage of the inquiry focus. Before attempting this inquiry make sure you have read Section 4.1 – Culture. Conduct research and use the guiding questions to help complete the activity.

Inquiry Focus: Wearable technology is making its way into the leisure industry.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

- Research one example of smart clothing being used in the leisure industry, for example, smart yoga pants.
- Describe the technology.
- Discuss the positive and negative impacts of this technology on two stakeholders.

Top tips

There are many different types of computers and they are used in a wide range of contexts. Although these computers may look very different, remember that they often have the same basic components and perform the same basic tasks: to input, process, store and output.

EXAM PRACTICE QUESTIONS

Paper 2

Source A

Analyse the following statistics which shows the trends in the use of the different types of computers to access the internet between 2019 and 2020.

	2019: 37.5 trillion visits			2020: 30.2 trillion visits		
	Desktop	**Mobile**	**Tablet**	**Desktop**	**Mobile**	**Tablet**
Visits	32%	63%	5%	29%	38%	3%
Bounce rate	43.11%	53.49%	46.64%	41.69%	52.11%	46.82%
Page views per visitor	3.75	2.68	3.40	3.95	2.67	3.21
Average time on site (seconds)	313.99	154.37	227.03	351.54	160.13	237.13

Source: **www.perficient.com/insights/research-hub/mobile-vs-desktop-usage**

1 Explain two trends in the use of desktop, mobile and tablet devices when used to access the internet. *[4 marks]*

Learner profile

Reflective

Reflect on the way that computers have evolved in your lifetime. How do these technologies influence your day-to-day living?

Mainframe computers and servers

When someone talks about a **mainframe** computer, it often creates visions of James Bond movies and rooms in government buildings filled floor-to-ceiling with technology. Nowadays the term mainframe computing generally refers to commercial **servers**, with the mainframe being the largest of these. Mainframes can serve thousands of users and support just as many applications and devices simultaneously.

Many medium-to-large-scale businesses use a collection of servers, each performing different functions on the network. For example, a business may have a print server, a database server, an email server, a web server and a file server. Very large collections of servers are called server farms and some data centres cover huge areas.

◆ **Mainframe**: A large computer used by businesses to host databases, servers used for transactions and business applications. Mainframe computers require high-level security measures.

◆ **Server**: A large computer dedicated to managing network resources. They can use specialized server hardware or can be a regular computer with a server-specific operating system capable of managing network resources.

Mainframe computer, National Museum of Computing, Bletchley

A server room

ATL ACTIVITY

Research

Conduct effective primary research by carrying out an interview with a member of the IT staff at your school.

- Before holding the interview, plan out the questions you would like to ask.
- Write at least five open-ended questions.
- Try finding out:
  - the different types of devices on the school network
  - what servers the school has and their functions
  - where the servers are hosted (for example, in the cloud or on the premises)
  - what operating systems are being used by the school servers
  - which applications are being used by the school.
- Record the interview as an audio file.
- Create a short podcast of the interview.

REAL-WORLD EXAMPLE

Microsoft's underwater data centre

In 2018, Microsoft launched Project Natick – a data centre 117-feet deep undersea data centre near the Orkney Islands in Scotland. Data centres positioned on the seabed benefit from the cool temperatures, which make them more energy efficient. Microsoft found that the data centre was eight times more reliable than those they had installed on land.

Activity: HL Extended Inquiry

Once you have studied Section 5.3B, try out this inquiry.

3.3A Types of computers (content) and 5.3B Responsible use of resources

Challenge: Capgemini reported that their data centres use approximately 200-terawatt hours (TWh) every year. This is higher than the annual consumption of energy of some countries. Data centres alone contribute to approximately 0.3% of overall carbon emissions. Information and communications technology (ICT) systems create more than 2% of carbon emissions worldwide.

Inquiry focus: How are companies addressing environmental factors and sustainability when designing data centres?

Research and evaluate one intervention for this challenge:

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.
- Present your work in the form of a written report.

3.3B Components of a computer

All modern computers function on the same model:

- A computer system needs to be able to input data. This is done using an **input device**. Common examples of input devices include keyboards, mice, touchscreens, microphones and sensors.
- Once data has been input, it needs to be processed. This takes place within the **central processing unit (CPU)**, which is sometimes referred to as the microprocessor.
- The output is the outcome once the processing is complete. For this to happen, there must be an **output device**. Common output devices include monitors, screens, printers, speakers and LED lights.

Hardware

If we look closer inside a computer, there are many common components, each performing a different role.

The **motherboard** is the circuit board that allows data to travel to the different components. The CPU is considered the main brains of the computer and carries out and controls the computer's instructions. Their performance can be affected by three main factors:

- **Clock speed**, measured in hertz, which represents the number of pulses the CPU clock generates per second.
- **Cache**, a small amount of memory built into the CPU; it stores data temporarily while it is being processed.
- The number of **cores** a CPU has: the more cores there are, the faster the CPU can process data; many processors have quad (four) core processors.

Data is not always immediately sent for output – often it is stored in the memory. **RAM (Random Access Memory)** is the short-term memory where data is stored temporarily while it is being processed or viewed on screen. It may be held more permanently in **secondary storage**, such as on a hard disk drive (HDD) or solid-state storage device (SSD).

Some motherboards come with built-in **sound and graphic cards**. Users who play games with high-quality graphics or use video editing software will want to take special note of these specifications and may upgrade their desktop computer with additional graphic and sound cards. The graphics processing unit (GPU) contains a circuit that will speed up the rendering of images and video, and thus free up the CPU to perform other tasks.

◆ **Central processing unit (CPU)**: The part of a computer that carries out and controls the computer's instructions.

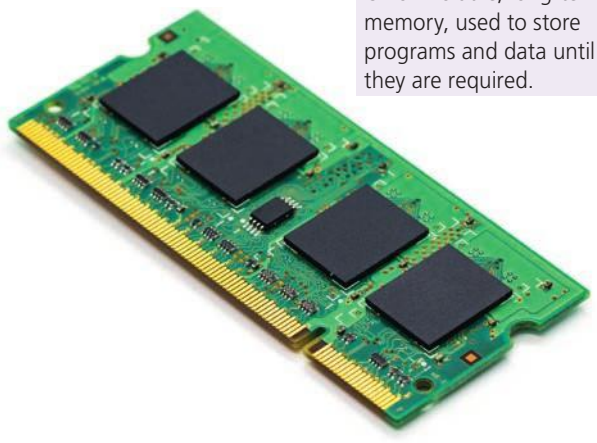
◆ **Motherboard**: A circuit board that allows data to travel to the different components in a computer.

◆ **Cache**: The small amount of memory built into the CPU that stores data while it is being processed.

◆ **RAM (Random Access Memory)**: Short-term memory where data is stored temporarily while it is being processed or viewed on screen.

CPU chip

◆ **Secondary storage**: is non-volatile, long-term memory, used to store programs and data until they are required.



RAM

Power is essential for any computer to work, whether the device is plugged directly into a power source or uses a battery. Personal computers have built-in power supplies. These convert AC (alternating current) to DC (direct current), which supplies the computer and its components with the right amount of voltage. Different countries use different voltages, so it is important to have the right power adapter when travelling with your computer.

Most laptops and phones use **lithium-ion batteries**, which are small containers of chemical energy. When a phone is plugged in to charge, the electricity is used to reset a chemical reaction within the battery. Lithium batteries contain a lot of power in a small size, which has made them suitable for portable devices.

ATL ACTIVITY

Communication

Create a video presentation to explain the different components of a computer.

- Investigate the role that the different components (motherboard, CPU, memory, storage, graphics and sound components, power supply) have when the computer is performing a task.
- Create a video to explain what the role of each of these components is and how they work together.
- Use the video you created to explain your understanding of these technologies to one of your classmates.

Software

Up until now we have only talked about the hardware (the different physical components) that a computer is made up of, however, these are only useful when used with software. There are different types of software including the operating system, utility software and application software.

The **operating system** is the software on a computer that manages the hardware, software and memory, as well as providing a user interface. Popular operating systems include Microsoft Windows, Linux, Apple MacOS, Google's Android OS and Apple iOS.

The **user interface** allows the user to interact with the device. This maybe via a **graphical user interface (GUI)**, which allows the user to select icons or click on links, such as those used on a tablet or phone; or it may be voice activated, such as those found in 'virtual assistants' such as Amazon's Alexa. It could also be a **haptic interface**, which allows the user to interact with a device through bodily sensations and movements. Commonly used in virtual reality, a haptic interface uses built-in sensors that send electrical signals to the computer. Once processed, it sends a signal back to the human. For example, in a virtual racing game a user may use a data glove and, while driving the car, receive vibrations similar to that experienced when driving a real car.

◆ **Operating system**: Software that manages the hardware, software and memory of a computer as well as providing a user interface.

◆ **User interface**: The means by which human users interact with a digital technology. The intent is to make the user's experience straight forward, intuitive, and requiring minimum effort to achieve the desired outcome.

One of the most important resources that an operating system must manage is the memory. It is responsible for moving data between RAM and virtual memory, and allows more than one application to run at the same time. Since computers have a finite amount of memory, it is important that this memory is managed efficiently. In addition to memory, the operating system must also manage the hardware. It does so by communicating with device drivers (a piece of software that informs the operating system how to communicate with the hardware).

Utility software is designed to perform specific useful tasks that either help to analyse, configure or maintain the computer. Utility programs may come as part of the operating system, for example, the features of the operating system that manage files, or may be installed separately, such as compression software or antivirus software.

Then there is **application software**. These are the computer programs that serve a specific purpose, such as a word processor or video editor. Think of a brand-new laptop or phone, first out of the box. It would have come with several system applications that are part of the operating system, but for the new device to be truly functional, it needs application software.

One way to classify software is through ownership and licensing. Two types are **open-source software** and **proprietary software**.

Malicious software

Not all software is written for ethical purposes. **Malicious software**, also known as malware, is software written with the specific purpose of stealing data or damaging computers/IT systems. Examples include viruses, worms, spyware, adware and ransomware. Malware appears as harmless files or links but is designed to trick users into downloading them. According to Statista.com, in 2020 there were 5.6 billion malware attacks worldwide with 678 million different types of malicious software.

REAL-WORLD EXAMPLE

Malicious apps on Google Play

Google removed 200 malicious apps from their app store in September 2021. At first glance these apps looked innocent, for example 'Handy Translator Pro' or 'Rate and Pulse Tracker'. However, after downloading these apps, the users would receive multiple notifications offering prize money in return for providing their mobile number. They would then be signed up for fraudulent SMS services that charged users while earning money for the malware operators.

www.wired.com/story/grifthorse-android-google-play-scam-campaign

- **Utility software**: Software designed to perform specific useful tasks that either help to analyse, configure or maintain the computer.
- **Application software**: Software that serves a specific purpose, such as a word processor or video editor.
- **Malicious software (malware)**: Software designed to steal data or damage computers/IT systems.
- **Open-source software** is free of charge and free of copyright, allowing the source code to be modified, often by an open-source community. However, there is no guarantee that the software will be bug free or support readily available.
- **Proprietary software** is often downloaded after paying for a license or subscription. In return for payment, users can expect updates and help from the company. Proprietary software is copyrighted which denies users access to the source code (so that it cannot be modified) and restricts the sharing of the software.

ATL ACTIVITY

Thinking

Analyse the software on your computer by completing the following tables.

Operating system

Name and version of system:		
Utilities (software to help manage the computer, e.g. maintenance utilities, security utilities)	**Pre-installed with the operating system (yes/no)**	**Installed separately (yes/no)**
e.g. Recycle Bin		
e.g. WinZip		

Details of application software

Type of application software	Name	Version
e.g. Word processor	Microsoft Word	V2106

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two input devices that would be used by a gamer. *[2 marks]*

2 Explain three components of a computer that would need to be optimized when playing a computer game. *[6 marks]*

3.3C Uses and forms of computer coding

In the last chapter you would have read about how algorithms are represented by code and how software applications are programmed. These are often called **high-level languages** because they are designed for programmers and are written in a language closer to the human language. However, this is not how computers understand code. Instead, they use low-level languages. At a hardware level, computers understand **machine code** or **assembly language** that needs to be translated into machine code.

◆ **Machine code**: Sometimes called object code, machine code is written in binary (0s and 1s) or hexadecimal instructions that the computer can respond to directly. Each type of computer has its own machine language.

◆ **Assembly language**: Used by programmers to write code for special hardware or so that a task can be performed very quickly.

It is very difficult for programmers to program in binary or assembly code, so they write in high-level languages that are then translated so that the computer can execute the code. A program called a **compiler** translates the code in the source language, for example Java, into the object code in binary and stores this in a program file. When the computer runs this program file, the operating system will open the file, read and execute the binary instructions.

ATL ACTIVITY

Research

Use effective online research skills to learn more about different forms of code.

- Conduct an online search to find out more about the different forms of code: machine code, assembly code and code written in a high-level language such as Java.
- Find an image of the code used in the different languages. How are they similar and how are they different?
- Outline the advantages and disadvantages of each form of coding for the programmer.

3.3D Evolution of computing

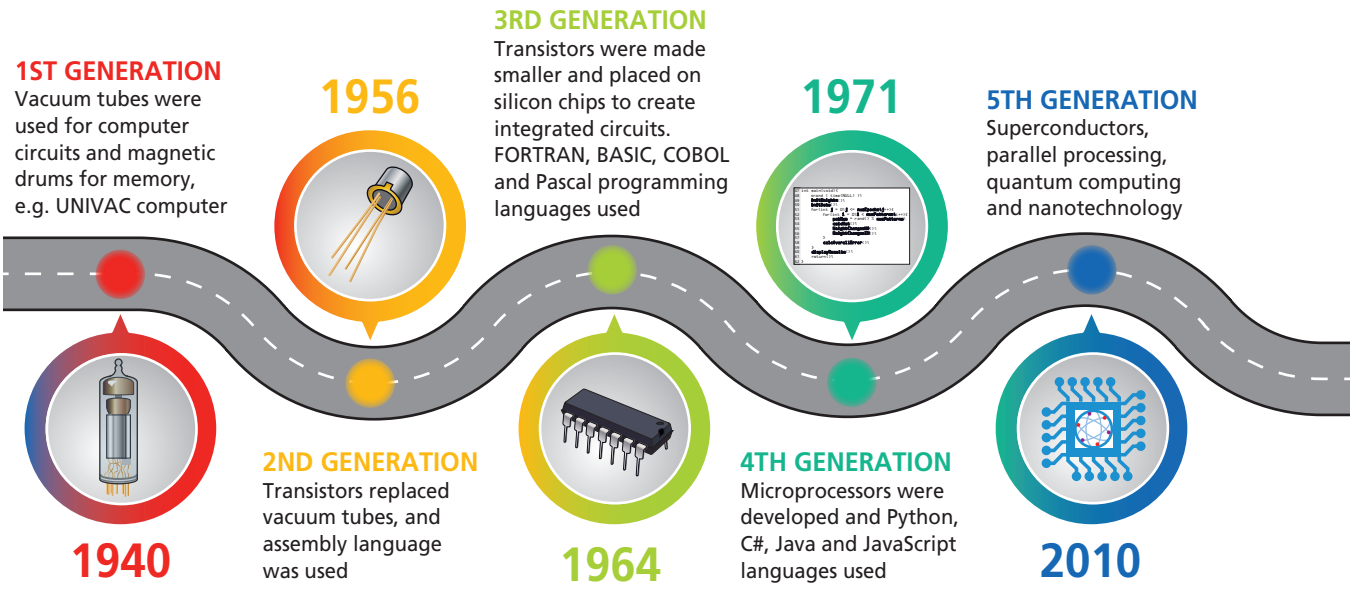
ATL ACTIVITY

Thinking

Even in your lifetime you will have seen changes in digital technology. Think back as far as you can remember.

- How old were you? What digital technology can you remember?
- Is that technology still in your life today? If so, is it the same or how is it different?
- What digital technology in your life today was not available then?

The history of computing is often defined by technological breakthroughs of the time. These are then categorized into what we call generations. To date there are five generations of computing that have influenced our lives today.



First generation: Vacuum tubes (1940–46)

During this period, vacuum tubes were used for computer circuits and magnetic drums for memory, which could only perform one activity at a time. They would take days to program in machine language and would frequently malfunction due to the heat they emitted.

Second generation: Transistors (1956–63)

Transistors were developed and used to replace vacuum tubes. Transistors allowed computers to become smaller and more reliable, with the benefit of being more energy efficient. Like the first generation of computers, they used punch cards and paper tapes, and produced printouts as output. Assembly language was introduced, making it easier for programmers, and high-level languages such as COBOL and FORTRAN were being developed.

UNIVAC computer from the 1940s

Third generation: Integrated circuits (1964–71)

Transistors were made smaller and placed on silicon chips (called semiconductors). These were even more efficient, reliable and faster than the previous generation, and were able to run multiple applications at the same time. This generation no longer used punch cards; instead, input devices such as a keyboard and mouse were installed with an operating system. The main programming languages of this generation were now high-level including FORTRAN, BASIC, COBOL and Pascal.

In 1965, Gordon E Moore made a statement based on what he noticed during the chip manufacturing at Intel – that the number of transistors in a dense integrated circuit would double every two years. This insight became the golden rule and Moore's Law has been driving the electronics industry until today.

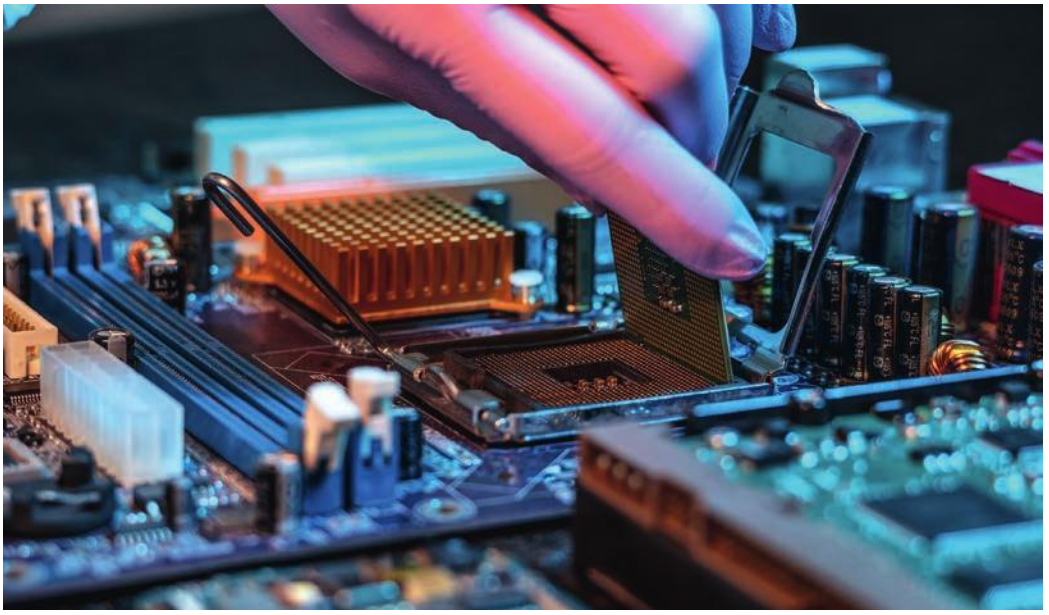
ATL ACTIVITY

Communication

Conduct an oral presentation to a group of friends about Moore's Law.

- Search for a video to further explain Moore's Law.
- Make notes and then orally present your understanding of Moore's Law.
- Practice presenting without using your notes.
- Present your findings to a friend.
- Ask for feedback on how well you presented.

Fourth generation: Microprocessors (1971–2010)



The introduction of the microprocessor saw thousands of the third-generation integrated circuits built on to a single silicon chip. Compare the size of a CPU today with those in the first generation. They have even more processing power. Many of the components that we looked at earlier were introduced in this generation, for example RAM, CPU and hard disk drives. The programming languages in this generation were all high-level, including Python, C#, Java and JavaScript.

Earlier in this chapter we looked at the introduction of the personal computer as a desktop computer with a GUI – this was in the fourth generation.

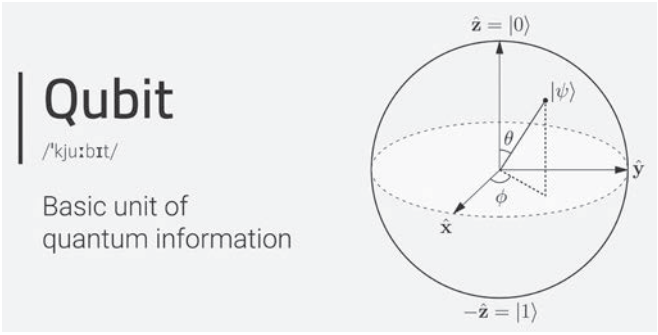
Fifth generation: Artificial intelligence (2010–present)

Although many of the computers used today are similar to the fourth generation, the development of technology that has made artificial intelligence possible is considered the fifth generation. From superconductors (with millions of transistors on a microchip) and parallel processing (using two or more microprocessors to run tasks at the same time) to quantum computing and nanotechnology, computing today is still changing radically. One of the goals of this generation is for computers to use natural language as input, such as voice recognition, and for computers to learn for themselves.

Quantum computing

Previously we talked about computers understanding binary, which consists of 1s and 0s (an on and off switch of the circuit), with each being one 'bit' of data. In **quantum computing**, computers use qubits, which follow the law of quantum mechanics. Instead of being on *or* off, they can be both on *and* off, or somewhere in between – this is called superposition.

Essentially quantum computing allows for uncertainty and the ability to analyse multiple options at the same time, making problem-solving much more efficient. Quantum computing is set to combat problems that would take current supercomputers hundreds of years to solve.



◆ **Quantum computing**: The technology that uses quantum mechanics to create powerful quantum hardware which can solve complex problems faster than existing supercomputers.

Quantum computing is currently being researched to make further developments in battery technology, cybersecurity, drug development, financial modelling, weather forecasting, artificial intelligence, traffic optimization and cleaner fertilizers.

REAL-WORLD EXAMPLE

Daimler's electric vehicles

Quantum computing is being used by Daimler to help design the next generation of lithium-sulfur batteries. Quantum computing has a greater ability to simulate the molecules and model the dipole moment of the lithium-containing molecules. Quantum simulations can be used to run through millions of chemical reactions and help narrow down which experiments should be tested in the laboratory.

https://group.mercedes-benz.com/magazine/technology-innovation/quantum-computing.html

ATL ACTIVITY

Research

Use effective online research skills to find other real-life uses of quantum computing.

- Using a search engine, find reliable sources to explain one other real-life use of quantum computing.
- Write a short paragraph to summarize the example
- Provide an opinion on the future impact of this digital technology from the example.

Links

The content on quantum computing links to 4.5B Science and technology innovation.

Inquiry

In this inquiry we will focus on only two of the stages. Ensure that you are familiar with the concept of 'Change' before attempting this task. After your initial research, use the guiding questions for each stage to help you complete the activity.

3.3D Evolution of computing (content) and 2.1 Change (concepts)

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

Change involves, understanding and evaluating people, ideas, objects and forces that shape the world: past present and future.

- Conduct some wider research and select one significant development in computers that is driving the change of computers in the present.
- Select three sources.
- Your final choice of sources must be able to help you gain a deeper understanding of this topic, provide a balance of claims and perspectives, and be embedded in the content (evolution of computing) and concept (change).
- Write a short report to justify your chosen sources and their usefulness in this inquiry. Your report should include
  - a discussion on the origin and purpose of each source, including any potential bias or limitations of using the source
  - a discussion of the main ideas being presented in each source and what features of the source were used to support the claim being made
  - a discussion on how the sources corroborate or contradict, and how it has helped you gain a deeper understanding of this question
  - a bibliography entry for each source at the end of the report.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

Using your research, answer the following questions:

- Why did the change take place? Was it due to needs or desires? Was it forced or optional? What were the main reasons for the change?
- When change happened, was progress made? Changes always bring a mixture of positive and negative impacts and implications – what were they at this time?
- To what extent was the change disruptive?
- Can change be predicted? Can we predict the outcomes of change? Can we force change?
- Overall has this change been beneficial?

Activity: HL Extended Inquiry

Once you have studied Section 5.3B, try out this activity.

3.3D Evolution of computing (content) and 5.3B Responsible use of resources

Challenge: The world is relying on the global distribution of oil and gas, which are often delivered by sea. Determining the most efficient route is important to reduce the carbon emissions. It is incredibly complex, however, as there are millions of options.

Research and describe the global challenge:

- Use effective research skills and describe this challenge in more depth.

Intervention

Research and evaluate this intervention: ExxonMobil is using IBM quantum computing to model the maritime inventory routing.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

Learner profile

Inquirers

In this unit you will have developed the skills to conduct several inquiries, whether it is the current prediction of Moore's Law or investigations into the uses of quantum computing.

Creativity, activity, service (CAS)

Run a coding club at school

Research the different clubs on offer at your school for the lower years. Is there a coding club?

If so, see the club coordinator and offer to support the students and help by creating activities each week.

If there is no coding club, see how many friends would like to join and set one up. This would make an ideal CAS project. You will need to seek approval and plan and design each session. Run the club for 8 to 10 weeks, and do not forget to reflect!

TOK

Knowledge and technology

The evolution of computers has changed the way that IT systems collect, process and present knowledge over time. These technologies have provided tools to do the job that may have promoted the availability of knowledge or restricted it. Questions to be asked could include:

- How have the developments in computing helped people process data and information to gain knowledge?
- How is digital technology going to shape our knowledge of the sciences?

The development of computer systems has also raised ethical questions, such as:

- Should we hold people in the IT community responsible for the digital technology they create?

Extended essay (EE)

Studying the evolution of computing may give you some initial ideas for an extended essay topic. If it does, put some of them down on paper and convert them into a mind map or spider diagram. What questions evolve as you put down your ideas? How has further research helped refine the topic?

Reflection

Now that you have read this chapter, reflect on these questions:

- What type of computers are you surrounded by day to day?
- How important are the different components of a computer for effective computer processing?
- Could you investigate how computers are used in a wide range of contexts?
- How can IT companies ensure that they are sustainable and use resources responsibly during the manufacturing and distribution of computers?
- How are computers being used as interventions for sustainable development?
- What significant developments are driving change in computers (computing) today?
- How are developments in computing changing the way that we process and share knowledge?

Links

Quantum computers use the properties of quantum physics to store data and perform calculations. This technology will be used by scientists in Physics research, and in the study of chemical reactions in Chemistry.

3.4 Networks and the internet

UNDERSTANDINGS

By the end of the chapter, you should understand that:

- networks connect computers, people and communities, allowing data and information to be created, accessed and shared in a distributed manner
- networks and the internet are defining features of digital society that have evolved over time
- networks and the internet involve significant opportunities and dilemmas for life in digital society.

From the minute we wake up to the time we put our phone on charge at the end of the day, our lives are being affected by networks, in particular the internet. Imagine you arrived at school and couldn't connect to the school Wi-Fi? How are you going to access the lesson resources if the school network is down? How can you upload your homework? How can you search for information that you need for an assignment? Our lives have become dependent on networks, whether it is the school network that you use to print out your work, or the internet to access online resources.

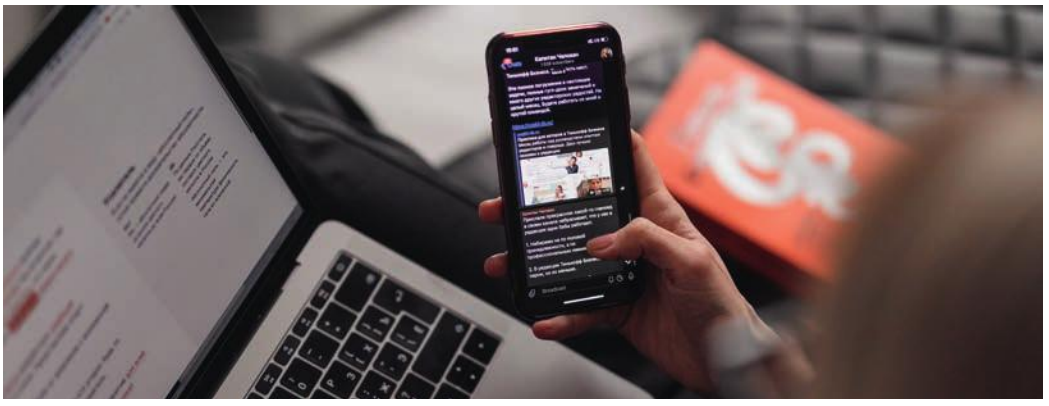
In this chapter we will look at network technologies and how they are configured to make-up the networks we use today; as well as the internet and the World Wide Web, and the services that are available to us. Is Sir Tim Berners-Lee's vision of the World Wide Web meeting his expectations? Or is the internet broken? Read on to find out more.

3.4A Types of computing networks

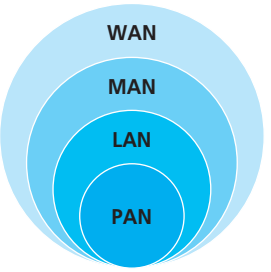
To understand **networks**, you need to appreciate that there are many types of networks, suitable for different purposes and situations. Types of networks can be categorized in several ways, whether it is by physical size, type of connectivity or how data is shared.

Networks by size

- **Personal area network (PAN)**: This is the smallest type of network and consists of the connected devices that are in close proximity to an individual. A typical PAN could be wirelessly connecting a phone and printer to one laptop. Another example is a health watch wirelessly syncing data to a phone.



A personal area network (PAN)



◆ **Network**: A series of interconnected nodes (connection points) that are able to transmit, receive and exchange data. The data may have various formats including text, sound, images and video. Examples of nodes include computers, servers and routers.

◆ **Personal area network (PAN)**: The smallest type of network, consisting of the connected devices that are in close proximity to an individual.

- **Local area network (LAN)**: This is a group of computers or devices that are connected on a single site. This could be on a small scale, such as a home with two or three users, or on a larger scale, such as an office or school that may have hundreds of users. A LAN is usually set up to help the sharing of resources, whether it is giving access to a centralized store of data in an office, sharing a printer at home or sharing internet access in school.
- **Metropolitan area network (MAN)**: This is a network that covers a larger geographical area. It will include two or more computers connecting together when they are not in the same building or campus, but they are in the same city. This type of network can cover an area of between 5 and 50 km. Examples of MANs include governments that provide free Wi-Fi access to residents in a city, or municipalities that connect traffic lights or parking meters to a single network. A future use of MANs will be the road infrastructure used by autonomous vehicles.

LAN in an office

REAL-WORLD EXAMPLE

Free Wi-Fi in New York

New York City provides free Wi-Fi to all residents as well as wirelessly connecting traffic lights and parking meters.

https://www.techtarget.com/searchnetworking/definition/metropolitan-area-network-MAN

- **Wide area network (WAN)**: The largest of networks is spread across a wider geographical area. WANs can be a collection of LANs connected by telecommunication technologies that are available to the public or may be limited to an organization that operates nationally or internationally. Typically, a company can have offices in different cities connected by public telecommunications networks in order to share applications and centrally held resources. This eliminates the need to have a server at each location, and all offices can access the same data. To secure the public connection a virtual private network (VPN) is often used. Alternatively, the organization may lease a dedicated line from their internet service provider (ISP), which they do not have to share with any other organization in the area. The largest WAN accessible to the public is the internet – a collection of networks and networking technologies that link billions of users worldwide.

ATL ACTIVITY

Thinking

Make a personal connection to this topic.

- Describe a scenario when you have used each type of network (PAN, LAN, MAN, WAN).

◆ **Local area network (LAN)**: A group of computers or devices that are connected on a single site.

◆ **Metropolitan area network (MAN)**: A network that covers a larger geographical area, such as a city.

◆ **Wide area network (WAN)**: A national or international network; the largest example is the internet.

Type of connectivity

- **Wired networks**: Traditionally, networks were wired – devices were connected on the network with copper ethernet cables using an ethernet port (either integrated on to the motherboard or installed as a separate network interface card) and a router or switch. Fibre-optic cables are now being used as they offer better connectivity over greater distances and a faster speed. Wired networks are still used by many businesses and governments because they are considered to be more reliable, operate at faster speeds and are able to transfer data more securely. However, developments in wireless technology mean that many of these advantages are slowly being eroded.

Fibre-optic cable

- **Wireless networks**: Wi-Fi technology allows devices embedded with wireless network interface cards to connect to a wireless network using either a wireless access point or wireless router. A wireless connection uses radio signals to send data across the network. It is widely used because it is easy to set up (there is no need for cables) and it offers flexibility because devices can connect anywhere within range. A wireless network still uses cables to connect the access points to a wired backbone, however, but it allows the devices (personal computer, laptop, tablet, printer and so on) to connect wirelessly.

- **Cloud networks**: Traditional wired and wireless networks are used to connect devices together to access shared resources and data with the networking technologies all on the physical site. Cloud networks have changed this. With a cloud-based wireless network, the organization can still install access points on site, but the management of the network or the data can be hosted off-site. Configurations to the network can be made by accessing the IP (internet protocol) address of the hardware controlling the wireless network, making it easier to deploy, saving costs and allowing for scalability.

◆ **Wireless networks**: Use of wireless technologies to connect the different nodes to form a network.

◆ **Cloud network:** Incorporate some or all of the network capabilities on a public or private cloud platform.

ATL ACTIVITY

Research

Use effective online research skills to investigate current networking technologies.

- Investigate which current wired and wireless technologies are being used in your home or school.
- Draw up a table to compare the speed, range of connectivity and cost of each of these.

Sharing data

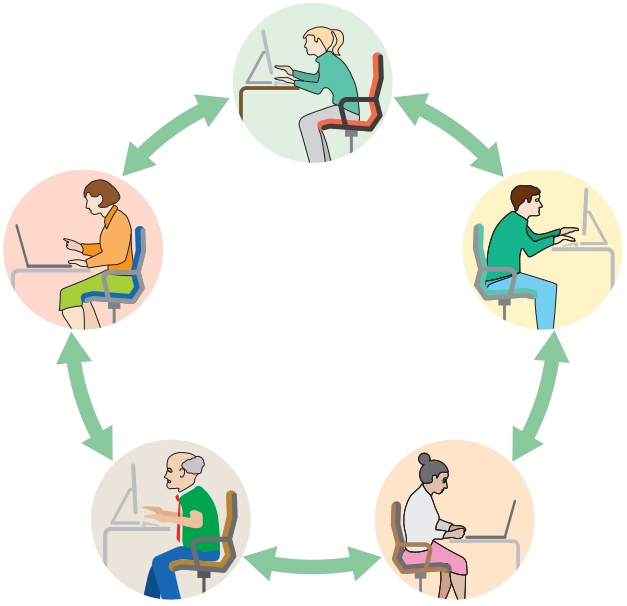
One of the main benefits of using a network is the ability to share resources and data, however, where the data is stored will depend on the type of network.

- **Client–server networks**: In this type of network, data is stored centrally on a server and access is given to the devices connected to the network (for example, a personal computer or mobile device). These devices are referred to as 'clients' and the server can either be hosted internally by the organization or externally in the cloud. Many organizations use this model so that organizations can prioritize IT resources that will secure and backup the data. This type of network does have disadvantages, however. Configuring and setting up a server can be costly and requires expert staff. There must be adequate bandwidth for all clients to request access to the server at the same time.

- **Peer-to-peer network (P2P)**: Alternatively, a network can be configured so that there is a decentralized method of storing data. In a P2P network, each computer is equally responsible for storing and sharing data. The main advantage is that the network is not dependent on one server. It is easy to set up, but it is much harder to manage and control the security of the data. P2P networks are very popular for sharing large files over the internet; for example, some online gaming platforms (such as Blizzard Entertainment and Wargaming) use P2P networks for downloading games between users. It is also the network model used for cryptocurrency. Unfortunately, P2P technologies can be used to illegally share copyright content such as movies and music. The decentralized nature of P2P networks makes it very difficult for authorities to shut them down.

◆ **Client–server network**: A type of network where data is stored centrally on a server and access is given to each device (client) connected to the network.

■ Client–server network



■ P2P network

ATL ACTIVITY

Thinking

Make a personal connection to this topic.

- Describe a scenario when you have used each type of network (client–server and P2P).

◆ **Peer-to-peer network (P2P)**: A decentralized network in which each computer is equally responsible for storing and sharing data.

◆ **Network interface card**: Device responsible for converting data into a digital signal and communicating this data to a network.

◆ **MAC address**: A unique identifier assigned to every piece of hardware.

3.4B Components of computing networks

Computers need specialist hardware to connect to each other on a network. As we mentioned earlier, the **client** can be a range of devices, from a personal computer to a laptop or tablet. Each of these will connect to the network provided that they have a network interface card. The **network interface card** (wired or wireless) is responsible for converting the data into a digital signal and communicating this data to the network. In a small network such as a home network, all that is needed is a router. Every piece of hardware on a network has a unique **MAC address**, which is allocated at the time of production. A MAC address is made up of 48 bits of data written in hexadecimal characters.

A **router** is networking technology that transfers data from one network to another. Its main role is to forward the data packets to their destination by the most efficient route available. A router allows you to connect to the internet from home as it forwards the data packet to the modem and then on to the ISP. A **modem** converts digital data into analogue data so that it can be transmitted over a telephone line using the telecommunications network. Many of today's ISPs offer a much faster connection using fibre optics, referred to as 'fibre to the home' (FTTH), and will install a fibre-optic router and modem to support this.

When it comes to larger networks, such as the network found in schools or an office, additional hardware is required so that the network can support the larger area. For a wireless network, **wireless access points (WAP)** are strategically placed around the building for the best coverage. This technology has a number of dedicated radio channels that the computers can connect to. Each WAP will be networked with a cable connected to either a switch or a hub – even a wireless network still has some wired components.

A **hub** is the least intelligent of the devices and will broadcast data to all of the devices on the network. This uses up a lot of bandwidth and sends unnecessary data, but it is easier to set up and can be useful when connecting only a few devices, for example, game consoles for a local multiplayer game. Instead of a hub, most local area networks use **switches**. These are more powerful and intelligent; they will forward the data packets more efficiently and give the network manager more control over how the data is shared across the network. Many larger organizations operate the **Client–server model** described earlier, which requires additional hardware – a server – which was discussed in the previous chapter.

Wireless internet router

◆ **Router**: A networking technology that transfers data from one network to another by the most efficient route available.

◆ **Modem**: A device that converts digital data into analogue data so that it can be transmitted over a telephone line.

◆ **Wireless access point (WAP)**: A device that creates a wireless local area network to improve coverage throughout a building.

ATL ACTIVITY

Communication

Explain in your own words how the network components work together.

- Use a drawing program to create a diagram of your home network.
- Check that you have included each of the components identified in this chapter.
- Label all of the components and write a brief explanation of what each one does.
- Write an explanation on how the components connect together.
- Use the network diagram you created to explain to your peers how the different components on a network work together to share data.

Network switch and ethernet cables

3.4C Characteristics of computing networks

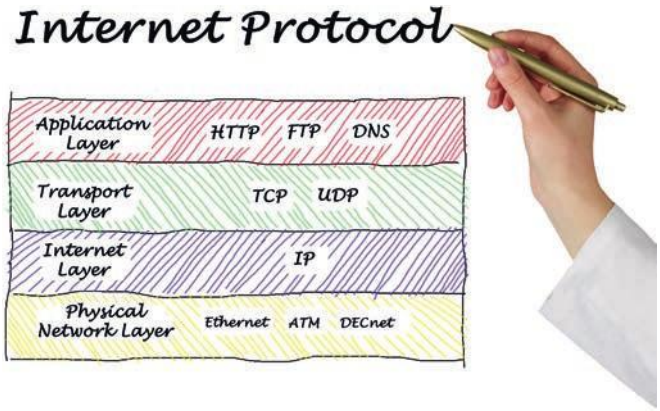
Earlier in this chapter, we discussed the different types of networks, their components and the fact that they have a common goal, which is to provide the **infrastructure** that allows people to communicate and share resources and data. It is no small feat that networking technologies allow data to travel globally using a wide range of technologies by different manufacturers. This **interoperability** can be attributed to the use of a common set of standards and network protocols.

◆ **Hub**: A networking device that broadcasts data to all devices on the network.

◆ **Switch**: A networking device that forwards data packets more efficiently than a hub.

◆ **Interoperability**: Allows different digital technologies or systems to connect and exchange data with one another without restrictions.

Network standards and protocols



A **network protocol** is a set of agreed rules that state how to format, send and receive data. To successfully transmit data, both sides of the communication must accept and follow these protocols.

In networking, different layers are identified to handle the different parts of a communication. This layering makes it easier for standards to be put in place. As shown in the diagram, there are four layers:

- **Application layer**: this includes the set of protocols that are used by applications, for example the web browser.
- **Transport layer**: this layer sets up the communication between hosts using protocols such as UDP and TCP. The **transmission control protocol/internet protocol (TCP/IP)** states how data is exchanged by providing end-to-end communication that identifies how the data is to be broken into packets (just like sending a large mosaic by post). The IP part of the protocol defines where the data has been sent to and from, while the TCP is responsible for breaking down the data into smaller sections before sending. Instructions would be included alongside the data on how to reassemble it back to its original form.
- **Internet layer**: this layer adds the sender and recipients' IP addresses and routes the packets across a network. An **IP (internet protocol) address** is a logical numeric address that is assigned to every node on a network. Every time a device connects to a network, an IP address will be assigned to it. This is different to a MAC address: MAC addresses are fixed by the manufacturer, whereas an IP address is assigned by the dynamic host configuration protocol (DHCP). Web servers typically have a fixed IP address.
- **Physical network layer**: this includes the protocols that allow the different networking technologies to work together, for example, ethernet.

To make our life easier, we do not need to remember the IP address of every web server that we visit. Instead, we type the website address into a web browser, which consists of a domain name, for example Twitter.com. This request is then sent to a **domain name server (DNS)**, which will look up the IP address in its database of public IP addresses. Once the IP address is known, the data packet will be forwarded to that address. For example, a request to visit Twitter.com would be sent to the IP address 104.244.42.1.

◆ **Network protocol**: A set of agreed rules that state how to format, send and receive data.

◆ **Transmission control protocol/internet protocol (TCP/IP)**: Protocol that defines where data is to be sent to and from (IP), and how the data is to be broken down into packets before sending (TCP).

◆ **IP (internet protocol) address**: A logical numeric address that is assigned to every node on a network.

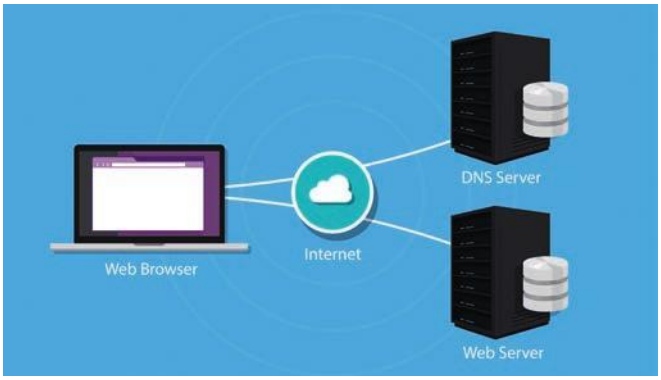
◆ **Domain name server (DNS)**: A server that translates domain names into IP addresses.

ATL ACTIVITY

Thinking

Make a personal connection to this topic with this activity.

- Look up the MAC address of your computer and write it down.
- Use a route tracing utility such as TRACERT to view the path that a data packet would take from your computer to a website request.
- What IP addresses were at the start and end destination?



Domain name server (DNS)

Network capacity

Earlier we looked at different technologies that could influence the speed that data can travel in a network. We also need to consider how much data can be transferred at any one time. Imagine you are getting ready to watch the World Cup football final using live streaming and all you see is a spinning wheel icon (this is called a throbber). How do content providers ensure that they meet the needs of the public? They must ensure that they have enough **bandwidth** to accommodate the needs of their audience. Although bandwidth and **speed** are talked about in the same conversation, they are different.

◆ **Bandwidth**: The maximum rate of data transfer at any one time, measured in hertz (Hz).

◆ **Speed**: The length of time it takes for data to be transferred, measured in megabits per second (Mbps).

REAL-WORLD EXAMPLE

Live streaming football

In June and July 2021, the UEFA Euro 2020 football competition was expected to live stream to 1.9 billion viewers, be available in 229 areas with 137 broadcasting partners. There was 3500 hours of content with 36 cameras per match.

www.svgeurope.org/blog/headlines/uefa-euro-2020-the-host-broadcast-facts-and-figures-for-the-tv-coverage-of-europes-biggest-football-show

As streaming videos and music have become commonplace, so has the use of file **data compression** to make the storing and streaming of data more efficient. Compression algorithms are used to reduce the amount of space needed to represent a file. There are two main types of compression algorithms:

- lossy compression, for example JPG and MP4, which reduces the file size by permanently removing unimportant, less noticeable data from the file
- lossless compression, which reduces the file size without losing data; this means that the data can be returned back to its original size after transmission, for example, PNG and BMP.

◆ **Data compression**: Is a process that reduces the size of a file by re-encoding it to use fewer bits of storage than the original file.

ATL ACTIVITY

Communication

Explain in your own words how compression works.

- Conduct more in-depth research about compression technologies and where they are used.
- Create an infographic that includes
  - an explanation of the difference between lossy and lossless compression
  - an explanation, with an example, of how the compression algorithm works
  - real-life examples of where the different technologies are being used.

All things are not equal on a network – sometimes priority can be given to a specific website. Imagine if your school's ISP allowed free access to your school's top 10 most-visited websites. This could give the school a tremendous advantage, with students and teachers being able to access learning materials much faster. This would be an example of **net partiality**.

Net neutrality, on the other hand, is the notion that the internet should be free and without restriction, so that all data requests made on the internet are treated equally. So, although the earlier example shows a clear benefit to the school, it is a slippery slope when telecommunication companies start to control who has access to which websites and at what speed. This could easily lead to ISPs charging companies to have preferential treatment and users having to pay extra to view specific content. This is not the internet that Sir Tim Berners-Lee had in mind when he created it.

◆ **Net neutrality**: The concept that all data requests on the internet should be treated equally by the internet service providers (ISPs).

ATL ACTIVITY

Thinking

Prepare for a debate on net neutrality. Not all country leaders have the same views on net neutrality; for example, Barack Obama was pro net neutrality while Donald Trump was against it.

- With friends, research two political leaders with opposing views on net neutrality.
- Hold a debate on the topic of net neutrality, with one group in favour and one group against.
- At the end of the debate, take a vote on which view of net neutrality you support.

Security

As soon as we start sharing data between different users on different devices in different locations, there is going to be a risk to the security of our data which may give rise to many of the dilemmas identified later in this chapter. It is therefore of paramount importance that all measures are taken to secure data.

Networking and security professionals have a very important role in keeping networks secure from both inside and outside threats. Likewise, individuals, whether they are using a mobile device, smart fridge (IoT) or desktop computer, also need to be educated and are responsible for having a certain level of security in place.

Controlling access from within

Network access controls can be set up to control how users access physical resources and data. The most basic of these is **authentication** using a unique username and strong password. When access rights are being configured, the network administrator determines which files and resources will be accessible and what type of access will be given, for example, read-only access or full control.

More common now is **multi-factor authentication**, which provides greater security as multiple methods of authentication are used to verify a user's identity for a log in or transaction. Two or more independent credentials are used to identify a user. This may be physical, through the use of a token, card or text message, or something that is part of the user, for example biometric measurements such as faceprint, or something known only to the user such as a PIN or phrase.

◆ **Multi-factor authentication**: The use of multiple methods of authentication to verify a user's identity.

Controlling access from outside threats

Three technologies that can protect a network from outside threats include firewalls, proxy servers and virtual private networks (VPNs), which we discussed earlier in this unit.

Links

This links to the content on biometric passports in Section 4.6B Governing bodies.

A **firewall** may be in the form of hardware (used by large organizations) or software (which can be turned on as part of the operating system) on a computer. The purpose of the firewall is to block unauthorized access to the network by inspecting packets trying to enter or leave the network. These requests are accepted or rejected depending on the set of rules defined by the firewall.

Additionally, a **proxy server** can be installed at the network's gateway for the purpose of accepting and forwarding connection requests. It uses the anonymous network ID instead of the actual IP address of the network address. It can also filter content requests from within the network and may be used to limit users from accessing certain undesirable or unproductive sites using keywords or by blacklisting web addresses.

Protecting the network gateway is one way of keeping data secure, but what if this fails? If the files are accessed, how can we ensure that they cannot be read? **Encryption** is used to help secure data on networks, whether this is encrypting data on the server storage device or encrypting the wireless connection using WPA (Wi-Fi protected access).

◆ **Firewall**: Hardware or software designed to block unauthorized access to a network by inspecting incoming and outgoing network traffic.

◆ **Proxy server**: Computer system that acts as an intermediary between the client on the network and the internet; providing an additional layer of security.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two hardware technologies used to form a LAN. *[2 marks]*

2 Describe two characteristics of a network. *[4 marks]*

3 Explain three measures that a network administrator should take to increase the performance of the network. *[6 marks]*

Inquiry

In this activity we will focus on the Explore stage of inquiry. Before attempting this task, re-read Section 2.6 systems.

3.4 Networks and the internet (content) and 2.6 Systems (concepts)

Inquiry focus: To what extent are humans involved in the effectiveness of a computer network?

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

- Select three sources that have different claims and perspectives on this topic.
- Evaluate and justify your choice of sources for this inquiry focus. Your report should include
  - a discussion on the origin and purpose of each source, including any potential bias or limitations of using the source
  - a discussion of the main ideas being presented in each source and what features of the source were used to support the claim being made
  - a discussion on how the sources corroborate or contradict, and how it has helped you gain a deeper understanding of this question
  - a bibliography entry for each source at the end of the report.

Inquiry

3.4 Networks and the internet (content) and 4.5A Learning and education (contexts)

Inquiry focus: How have the developments of networks in schools impacted the design and delivery of formal education?

Evaluate

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

- Conduct wider research for the inquiry focus to obtain the perspective of both the student and teacher.
- Create a spider diagram for each stakeholder showing the positive and negative impacts.

Analyse

Evaluate impacts and implications for relevant people and communities

- Is your evaluation based on your analysis?
- Does your evaluation focus on the impacts and implications for people and communities?
- Is your evaluation effective, sustained and well-supported by evidence?

- Write a detailed conclusion based on the notes made in the analysis stage to address the initial inquiry focus.

3.4D Computing network providers and services

Earlier in this section we talked about the different hardware and software that make up the internet, and the protocols for global interoperability. However, gaining access to global resources requires one other element: registration to a mobile service provider (MSP) or an internet service provider (ISP).

A **mobile service provider (MSP)**, also known as mobile carrier or mobile phone operator, is a company that offers cellular connection to mobile phone subscribers. An MSP purchases a license to transmit radio signals over a specific range within a particular frequency band, such as 1800 to 2100 MHz, which is used to provide high data speeds. These mobile phone networks are referred to as 4G or 5G networks (the G standing for 'generation'). Mobile phone customers use this service to make phone calls, send and receive text messages, and use their data to browse the web.

Users now have the choice to make calls directly using their mobile phone network or using **VoIP (voice over internet protocol)**. With a regular mobile phone call, a user can call a landline or another mobile phone and audio data is transferred wirelessly from cell tower to cell tower. With VoIP, audio data is transformed into digital packets that are sent via the internet between any two devices. Popular examples include Skype, WhatsApp and Facebook Messenger.

An **internet service provider (ISP)** refers to a company that provides internet access to its customers, making it possible for subscribers to use online services such as browsing the 'web', online shopping, file sharing and video conferencing. They also provide other services such as email, domain registrations and web hosting.

◆ **Mobile service provider (MSP)**: A company that offers cellular connection to mobile phone subscribers.

◆ **VoIP (voice over internet protocol)**: Allows users to make voice calls using a broadband Internet connection instead of an analogue phone line.

◆ **Internet service provider (ISP)**: A company that provides internet access and other related services to its customers.

Inquiry

3.4 Networks and the internet and (content) and 2.3 Identity (concepts)

Inquiry focus: What is the relationship between network and network services and our identity?

Analyse	Analyse impacts and implications for relevant people and communities • Is your inquiry question supported by additional questions to consider for analysis and evaluation? • Does your analysis focus on the impacts and implications for people and communities? • Is your analysis effective, sustained and well-supported by evidence?
Evaluate	Evaluate impacts and implications for relevant people and communities • Is your evaluation based on your analysis? • Does your evaluation focus on the impacts and implications for people and communities? • Is your evaluation effective, sustained and well-supported by evidence?

- Use secondary research to support your findings.
- Analyse and evaluate the use of networks (use two specific examples) and their relationship with our identity using the following questions:
  - How are networks used to help construct one's identity?
  - How are identities on these networks different from those in the real world?
  - Why there might be a difference?
  - To what extent do different aspects of one's identity appear on these networks?
  - How has one's identity on these networks changed over time?
  - How can networks be used to hide or distort one's identity?
  - Evaluate the potential harm and benefits that arise from the use of networks to develop one's identity.

ATL ACTIVITY

Communication

Create a promotional elevator pitch to present to your peers.

- Compare the packages of two local mobile service providers and two internet service providers.
- Make a list of what services they offer.
- Analyse and make a decision as to which one offers the best deal.
- Create an elevator pitch to a friend to persuade them to switch mobile phone providers.

3.4E The World Wide Web

In everyday language, you and your friends might talk about going on the 'net' or searching the 'web', and we might use these terms interchangeably, so how are they different? Simply put, the **internet** is the network of computers and networking technologies that we talked about earlier. A computer can connect to the internet through a router and connect with a web server to access resources or services. The **World Wide Web (WWW)**, on the other hand, is the collection of websites and web services that are hosted on these web servers and identified by their URL (uniform resource locator), for example **https://example.com**, and accessed through a web browser.

The three main technologies that have allowed for the interoperability between all of the technologies on the internet are URL, HTTP and HTML.

- A **URL** is the unique address of each resource on the web, which could be the address of a web page or the file hosted by a web server.
- From the application layer (mentioned earlier in this chapter), **HTTP (hypertext transfer protocol)** or **HTTPS (secure hypertext transfer protocol)** determines how web resources are transmitted between the web browser and the web server. The more secure HTTPS is now a requirement of many web browsers, which has forced web-hosting companies to add security certificates to their web servers so that when users transfer sensitive data it is encrypted.
- **HTML (hyper text markup language)** is the format of web pages that allows documents to be displayed as web pages as well as web pages to be linked together.

◆ **Internet**: The global collection of networks and networking technologies that link billions of users worldwide.

◆ **World Wide Web (WWW)**: The websites and web services that are hosted on web servers and identified by their URL (uniform resource locator).

3.4F Evolution of the internet and the web

The early days of the internet (1969–2000)

The internet started earlier than the World Wide Web. The first computer network was in 1965 when a computer at the University of California, Los Angeles, was used to send a message to a computer at Stanford University. Although the first attempt caused a system crash, the second attempt was more successful and led to the creation of the ARPANET (Advanced Research Projects Agency Network) in 1969. This network was expanded to include up to 30 academic, military and research institutions, connecting them from different locations including Hawaii, Norway and the UK. It saw the introduction of the TCP/IP protocol and was operational until 1990.

As the internet grew from 2000 nodes to 30,000, it became very apparent that it needed to be easier to use. The solution was found by Sir Tim Berners-Lee with the invention of the **WWW** in 1989. His proposal was for the information being shared to be structured and linked in a new way that made it quicker and easier to access. Alongside these protocols, the web browser was introduced, which made the WWW more accessible.

In 1993 there were only 130 websites, which grew to 100,000 by 1996.

With the exponentially growing internet and WWW, the **World Wide Web Consortium (W3C)** was formed in 1994 to promote its evolution and ensure interoperability. At the time of writing, Sir Tim Berners-Lee is the director of W3C. His main aim is to coordinate the developments of both web technology and standards. W3C uses processes that promote the development of these standards based on the agreement of a wide range of members who work for organizations all over the world.

Sir Tim Berners-Lee

The expansion of the web (2000–20)

As the web continued to grow and become a mainstream digital technology, it was still very much in the hands of the elite few that knew how to program in HTML. Websites were considered static and did not change frequently, because every change of content or formatting required a programmer. This version of the web was called Web 1.0.

By the year 2000, new technologies and protocols had been developed that changed this, and Web 2.0 was born. Web 2.0, also known as the 'social web', enabled users to generate their own content without needing to be coding experts. In this era, web developers would use XML and RSS to format and structure websites, allowing users to add their own content. This also allowed for more dynamic content as it was separated from the formatting. This period also saw the introduction of social media platforms, blogging, podcasting, social bookmarking and tagging, many of which are still popular today.

Links

This section links to Chapter 3.7.

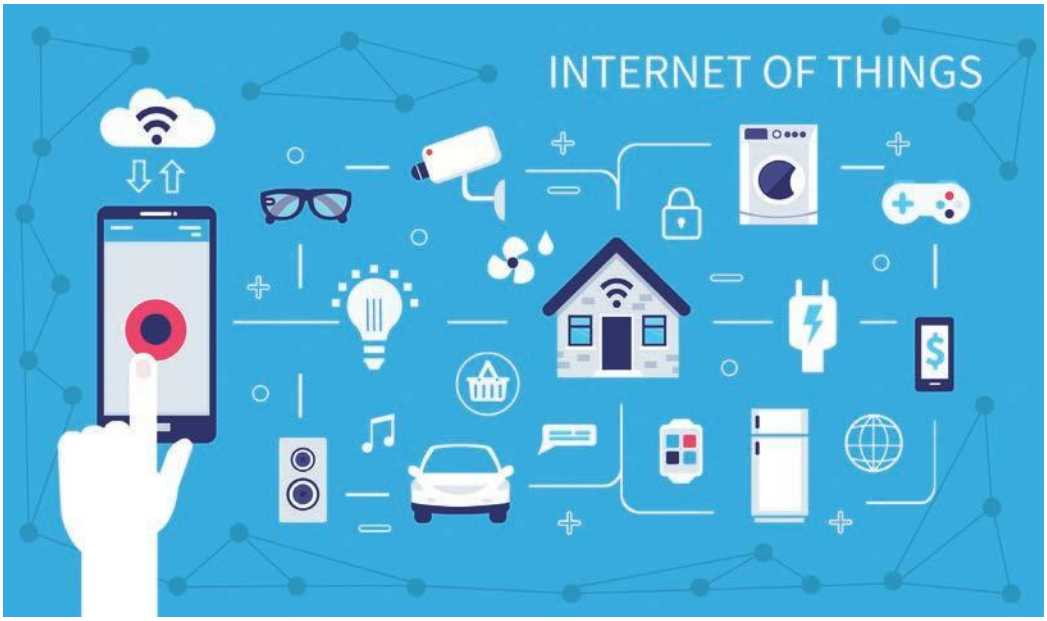
Web 3.0: the semantic web (2020–present)

Web 2.0 was mainly about innovating the user experience. In Web 3.0 the focus shifted to the back end, with the promise of being more intelligent. One development is the focus on generating a greater understanding of the meaning of the words being used when creating, sharing and searching content. A second feature of this generation is the utilization of artificial intelligence and natural language processing. Websites can now display interactive 3D graphics and the market for the internet of things (IoT) is growing.

The internet of things (IoT)

The **internet of things (IoT)** refers to all of the devices that are connected to the internet. Nowadays billions of devices are ubiquitously connecting and sharing data across the internet, and these are not just phones and laptops – it includes smart appliances and autonomous vehicles, and items as small as a smart lightbulb or as large as a jet engine.

◆ **Internet of things (IoT)**: Internet-connected devices that collect and share data.



IoT devices use sensors to collect data and communicate with each other over a network, often with the aim of providing assistance or increasing efficiency. In the home, individuals are investing in smart home technologies to increase efficiency, become more energy efficient or to control household appliances for greater convenience. For example, smart lightbulbs can be controlled with a phone, and smart door locks can let delivery drivers drop off packages.

While the IoT promises to make our homes and environment smarter, privacy and security remain real concerns that need to be addressed.

Inquiry

3.4F Evolution of the internet and the web (content) and 4.1B Home, leisure and tourism (contexts)

Inquiry focus: How is the introduction of smart home technologies having an impact on families and their friends?

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

- Conduct a survey among your family and friends to find out their opinions on the growth of smart home technologies.
- Develop your survey to find out which technologies they use, the positive experiences that they have had, and any concerns that they have regarding these technologies.
- Evaluate the effectiveness of your primary research.

Inquiry

3.4F Evolution of the internet and the web (content) and 2.1 Change (concepts)

Inquiry focus: Evaluate one technological development of Web 2.0 or Web 3.0 using the concept of change.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

Evaluate

Evaluate impacts and implications for relevant people and communities

- Is your evaluation based on your analysis?
- Does your evaluation focus on the impacts and implications for people and communities?
- Is your evaluation effective, sustained and well-supported by evidence?

Select one Web 2.0/3.0 technology and use secondary research to answer the following questions:

- Why did this change take place? Was it due to needs or desires? Was it forced or optional? Was it due to something being new?
- When the change happened, was progress made?
- Discuss the positive and negative impacts and implications due to the change of this technology.
- To what extent was this change disruptive?
- Was this change predicted? Was it possible to predict the outcomes of this change?
- To what extent was this change beneficial at a personal, local and global level?

3.4G Internet dilemmas

Understanding the risks to data

Networks at home or in the workplace must be secure. Users must take measures to protect their hardware and data from loss, damage and misuse, yet at the same time enable staff to carry out their jobs, which often involves the sharing of data or computer hardware. To keep a network secure it is important to understand the types of threats that may be encountered. Many of these are external to the network, and have increased exponentially due to the ease with which devices can be connected through the internet.

Specific risks include:

- **Spamming** refers to the sending of unsolicited emails, mainly for the purpose of advertising. With advances in email filtering, many spam emails are filtered out before they reach your inbox. According Statista.com, in March 2021 45% of email traffic was spam.
- **Hacking** can be defined as unauthorized access to a computer or network and can be accomplished in many ways. Hackers use a range of tools to gain access to their intended target, including:
  - **Social engineering** – tricking a user into sharing their username and password with a fraudster. For example, hackers have been known to impersonate IT staff, claim that they are conducting routine maintenance and make requests for credentials from the customers. With these details, hackers will have instant access to these accounts.

◆ **Spamming**: Sending unsolicited emails, mainly for the purpose of advertising.

◆ **Hacking**: Unauthorized access to a computer or network.

◆ **Social engineering**: In internet security, this means to manipulate a user into sharing confidential or personal information with a fraudster.

◆ **Phishing**: A type of social engineering that involves sending fraudulent emails designed to trick users into revealing sensitive information.

REAL-WORLD EXAMPLE

Phishing at Google and Facebook

Between 2013 and 2015, Lithuanian national Evaldas Rimasauskas set up a fake company pretending to be a computer manufacturer that worked with Google and Facebook. **Phishing** emails were sent to Google and Facebook employees that included invoices for goods and services that were fake. None the wiser, the employees processed the invoices and the money was paid to a fraudulent bank account. He cheated these companies out of US$100 million before being caught.

www.tessian.com/blog/examples-of-social-engineering-attacks

  - **Hacking a website or penetrating a network** includes gaining access to the back-end database of user information, or redirecting users to a different website.
  - **Exploiting a security flaw –** if a network does not have adequate malware and virus protection, or a firewall, hackers can take advantage of this to gain access to company servers.

REAL-WORLD EXAMPLE

Log4J attack

In December 2021, the BBC reported that a security flaw in the Java code 'Log4shell' had made many corporate networks running online services vulnerable to hackers. It gained public attention after it was found to affect some sites hosting Minecraft and was rated a serious vulnerability as Apache Software Foundation issued a fix to solve the problem.

www.bbc.com/news/technology-59638308

  - **Viruses** are a type of malicious software comprised of small pieces of code, often attached to legitimate programs or emails. When the program is executed or the email attachment is opened, the virus will be activated and spread throughout the computer.

◆ **Virus**: A type of malicious software comprised of small pieces of code, often attached to legitimate programs or emails.

REAL-WORLD EXAMPLE

Bangladesh Bank Hack

In 2016, the North Korean Lazarus group attacked Bangladesh's national bank with the aim of stealing US$1 billion. The elaborate plan consisted of a range of techniques including the social engineering of staff to gain access to the network through an email in which the hacker presented himself as a potential intern. The email included his CV as an attachment, which contained a virus. Once in the bank's system, the hackers patiently analysed the network, moving from computer to computer until they had access to the printer, which was used as a paper backup of all bank transactions. Once the printer was taken out of action, the hackers made steps to transfer the money out of the bank into their own bank accounts.

www.bbc.com/news/stories-57520169

- **Ransomware** is malware that infects a computer and effectively locks the user out of their own device and demands a payment to unlock it. Ransomware is typically activated by clicking on an email attachment, hidden in a software download, or through visiting a malicious website or link.

◆ **Ransomware**: Malware that infects a computer and effectively locks the user out of their own device and demands a payment to unlock it.

REAL-WORLD EXAMPLE

WannaCry Ransomware, May 2017

One of the most infamous of attacks was the WannaCry ransomware which spread globally and affected 230,000 computers, with users being held hostage until a ransom was paid in Bitcoin. The ransomware took advantage of a vulnerability in the Windows operating system, and although Microsoft had released a security patch, many organizations had not updated their computers. One-third of British hospitals were affected, resulting in the postponement of many life-saving operations. This ransomware is estimated to have caused US$4 billion in losses across the world.

www.kaspersky.com/resource-center/threats/ransomware-wannacry

- **Distributed denial of service (DDOS)** happens when a network of computers has been installed with malware designed to target a web server. When a hacker wishes to attack, they instruct their army of infected computers (bots) to make a connection to the target web server at the same time. The web server cannot cope with this spike in demand, which effectively prevents other users from being able to access the website.

◆ **Distributed denial of service (DDOS) attacks**: Overwhelming a site or service so that it is not available to its intended users.

REAL-WORLD EXAMPLE

DDOS at Amazon

Amazon web services were under attack in February 2020, which meant that many businesses using its hosting services lost revenue and reputation due to the unavailability of their site at this time.

https://securityboulevard.com/2020/09/top-five-most-infamous-ddos-attacks/

REAL-WORLD EXAMPLE

The Meris Botnet

In 2021, the security division of Rostelecom, the largest provider of digital services in Russia, took down part of the Meris Botnet, one of the largest available to cyber criminals, which consisted of 250,000 infected devices.

www.wired.com/story/security-roundup-even-cia-nsa-use-ad-blockers

ATL ACTIVITY

Research

Use effective online research skills and use correct citation and referencing.

- Conduct research on each type of attack (social engineering, hacking, virus, DDOS and ransomware).
- Create a short report that includes:
  - one real-life example for each type of attack
  - a short description of the scenario
  - a brief discussion of the impact of the attack on the victims
  - a summary of the consequences for the individuals/group who carried out the attack.

Consequences of the risks to data

Chapter 3.1 Data and data analysis addressed the concerns of privacy, which has led to other issues due to the widespread use of networks and the internet.

Anonymity is the most extreme form of privacy, to the extent that a user's name and identity are concealed when using applications and online services. Being anonymous online allows users to have the confidence to express themselves freely without fear of retribution. While this can make the internet a safe place to seek information and share opinions, it has also increased the confidence of those with malicious intent, such as cyberbullies and **internet trolls**. There are two types of trolls:

- people that target influencers with a large social media following – their aim is for their hateful messages to reach as wide an audience as possible
- people that just enjoy causing harm to others – the more one responds, the more hateful messages they send.

Trolling can cause significant harm and stress to those being affected, including disrupted sleep, low self-esteem and self-harm.

◆ **Anonymity**: The use of digital technology to conceal a person's true identity.

◆ **Internet trolls**: People who leave intentionally provocative or offensive messages online in order to get attention, cause trouble or upset someone.

REAL-WORLD EXAMPLE

Online harassment

Recent studies estimated that every one in three Australians have experienced some form of online harassment, and that it had cost the government A$3.7 billion (approximately US$2.6 billion) in 2019 in health costs and lost income.

https://theconversation.com/new-research-shows-trolls-dont-just-enjoy-hurting-others-they-also-feel-good-about-themselves-145931

◆ **Identity theft**: When someone steals your personal information with the intention of committing fraud. They may use your information to apply for a credit card or gain access to medical services.

Anonymity can help users to maintain their privacy as well as protect them from cybercrimes such as **identity theft**. Identity theft is when someone steals your personal information to commit fraud. Such information can be used to impersonate you when applying for bank cards, medical services or other financial benefits.

REAL-WORLD EXAMPLE

Identity theft

In 2020, identity theft cost Americans US$56 billion with over 49 million consumers being victims.

The most common ways for identity theft to occur included access to personal information through a data breach or by scammers emailing or calling to ask for your information by pretending to be from a government agency or a popular retailer.

www.cnbc.com/2021/03/23/consumers-lost-56-billion-dollars-to-identity-fraud-last-year.html

With the ever-increasing number of websites requesting users to sign up, there is no surprise that our personal information ends up in many web servers on the internet. But what happens when we stop using these services? What happens to our data? Is it still being kept securely? These are the sorts of questions we should be asking.

With many countries tightening up their data protection regulations, **the right to be forgotten** is now being enforced by governments. For example, the GDPR governs how data is being protected in Europe and states that citizens have the right to request to have their data erased from an organization should the right circumstances apply. These include:

- the personal data is no longer needed by the organization
- the individual's consent has been withdrawn
- there is no longer a legitimate reason to keep the data, or data was obtained unlawfully
- the individual objects to having their data used for direct marketing purposes.

Top tips

There are many similarities between the dilemmas in this chapter and those found in Chapter 3.1 Data and data analysis.

ATL ACTIVITY

Thinking

Look for a personal connection to one of the internet dilemmas and reflect on each question:

- Which internet dilemmas have you or someone you know been affected by?
- How did you manage it?
- What advice would you give to someone going through the same experience?

Inquiry

3.4G Internet dilemmas (content) and 4.2C Goods, services and currencies (contexts)

Using the inquiry process presented in Section 1.4, complete a full inquiry, including all stages of this process. Research and investigate one internet dilemma and the impact it has had on e-commerce. Select how you will communicate your findings.

Activity: HL Extended Inquiry

3.4E The World Wide Web (content) and 5.1A Local and global inequalities (contexts)

Challenge

During the second wave of COVID-19 in India, the country was faced with a huge challenge: there was no efficient way to match up available oxygen tanks with patients.

Intervention

Listen to this Digital Human podcast from 21 June 2021:
www.bbc.co.uk/programmes/m000x6pq

Social media was used to send out 'SOS tweets' during the second wave of COVID-19 in India. The communications platform was used to help source oxygen needed for friends and family, empowering ordinary people to participate in the relief work.

Research and evaluate this intervention using the HL extended inquiry framework.

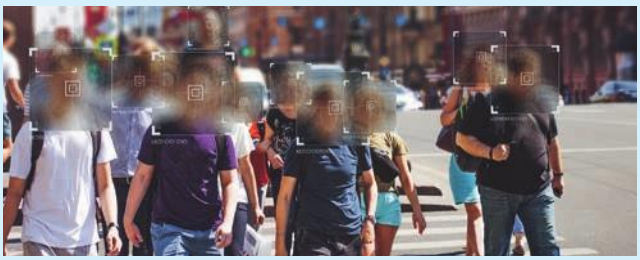
- How was social media being used as an intervention to solve the problem of a shortage of oxygen in India?

Make a recommendation for steps for future action.

Present your work in the form of a written report.

Deeper thinking

Surveillance



Simply put, surveillance is the close monitoring of a person or group of people. However, there is an ever-increasing range of technologies that can be used in surveillance, both directly or indirectly. Obvious surveillance technologies include CCTV (closed circuit television) or network cameras. Strategically placed inside and outside of buildings, at traffic junctions and on highways, video footage is being captured 24-7. As these technologies are being combined with facial recognition and artificial intelligence technologies, privacy concerns are rising.

According to a 2020 study by Comparitech, 16 out of the top 20 most surveilled cities are in China based on the number of cameras per 1000 people. The cities outside of China in the top 20 were London, Indore, Hyderabad and Delhi.

Some forms of surveillance may not be as obvious and may be a direct or indirect result of using an IT system or service. These include:

- **Government monitoring of communications**: In some countries, governments monitor internet use and communication technologies. Although it is often used for national security, it can result in the monitoring of ordinary citizens.
- **Drones**: These have multiple uses but one common use is to capture aerial video footage. Drones can be controlled remotely and are a very effective way to monitor an area.
- **Wearable cameras**: Whether it is a policeman's body camera or a skateboarder's GoPro, cameras may be capturing where you are and what you are doing without your knowledge or consent.
- **Location services**: Enabling location services on mobile phones improves app performance and allows users access to the full features of the app, however, the app is also collecting your location in real time.
- **Smart home technologies**: Intelligent devices, which are increasingly used in the home, need to monitor their environment to perform their function efficiently, which includes those who are at home.
- **Trace and track apps**: With nationwide restrictions being imposed due to COVID-19, users in many countries have had no choice but to adopt trace and track apps in return for being able to visit places outside of their home.

Inquiry

3.1I Data dilemmas (content) and 4.6D Laws, regulations and policies (context)

Determine inquiry focus

Formulate an inquiry question, find real-world example(s) and connect them to the 3Cs

- Is your question concise, thought-provoking and worth considering from different perspectives?
- Does your question support discoveries that move beyond recall, description and summary?
- Are the course concepts, content and contexts that you have identified connected to your inquiry question?

- Conduct research into one of digital technology that is being used for surveillance, for example police body cameras or drones, and the laws regulating its use.
- From your initial research, find one real-life example.
- Using the steps above, create a statement for the inquiry focus.
- Justify your choice of inquiry focus.

TOK

Knowledge and technology

The evolution of networking technologies and the internet has given people access to a tremendous amount of knowledge. But how do we know how much of this knowledge is true? In today's world, are we able to use terms such as 'fact' and 'truth'? How is the internet changing what it means to 'know' something? This could raise ethical questions such as:

- What role have networks had in exacerbating unequal access to knowledge?

Alternatively, networks have given rise to questions related to perspectives such as:

- How are the different communities created by digital technology changing the communities of knowers?

Reflection

Now that you have read this chapter, reflect on these questions:

- How are networks impacting your day-to-day life?
- How do the different networking technologies work together?
- How do the network protocols support the interoperability required for a global network?
- Could you identify the types of networks used in a range of contexts?
- Could you match suitable security solutions to the different security threats on a network?
- To what extent do the concerns from the internet dilemmas outweigh the benefits from using networks?
- Through the lens of change, how has the internet evolved?
- How can networks be used as interventions for global inequalities?
- How instrumental are networks in influencing how we know things?

Extended essay (EE)

Network technologies, the evolution of the internet and network dilemmas may give rise to some interesting topics for an extended essay. Perhaps you could look at one of these technologies with one of the concepts, such as combining the evolution of the internet with the concept of expression, for example: To what extent are social media platforms influencing our identity?

Learner profile

Principled

In this unit you will be researching technologies that are impacting many lives. Are you a principled internet user? How can you ensure that your own use of the internet respects others around you?

3.5 Media

UNDERSTANDINGS

By the end of the chapter, you should understand that:

- digital media are defined by the convergence of computing, communication and content
- digital media are created and distributed through multiple channels and platforms
- digital media are associated with significant opportunities and dilemmas in digital society.

The world has been exposed to media for a very long time, whether it was the hand-drawn images found in printed newspapers archived in libraries or the paintings found in art galleries. So, when we talk about the media, what do we mean?

Media can be referred to as any communication channel that serves as a medium to enable information to reach a large group of people.

There are several types of media, including print media, which consists of published newspapers, magazines and books; mass media, such as the news channels on TV and radio; and **digital media**, which is the information consumed online.

Anytime you access a website or app, you will be either consuming or creating media. As both computing (3.3D) and the World Wide Web (3.4F) have evolved over time, so has digital media. In this chapter we will investigate the different types of media in more detail and the new dilemmas that have emerged due to their prolific availability.

◆ **Digital media**: Video, audio, images and other content that is created, encoded and stored before sharing to the user(s). Encoding is the process of converting the media into a computer-readable format.

ATL ACTIVITY

Thinking

Make a personal connection to this topic by inspecting your favourite websites and how they have changed over time.

- Navigate to the 'Internet Archive WayBackMachine' – https://web.archive.org – and type in the URL of a website.
- Select the year it was created and then compare this to a recent date.
- Reflect on how the website was different back then, compared to now.
- Reflect on how the use of media has changed? Why do you think this took place?

3.5A Types of digital media

ATL ACTIVITY

Thinking

Reflect on how digital media has influenced your day.

- Did you check your phone to find out what your friends have been doing on social media?
- Did you listen to a music app on the way to school?
- How did digital media provide you with information you needed for the day?
- How else have you been a consumer of media?
- Have you been a creator of media?

Media and Web 1.0

Digital technology may have changed the speed and volume of media; but digital media still fulfils the same basic roles in society that it has always done, which is to entertain, educate and be a channel for public discussion. In the early days of the World Wide Web, web pages contained text and images and, as bandwidth increased, so did the ability to host video, animations and audio recordings.

Media and Web 2.0

The introduction of Web 2.0 technologies, such as blogs, podcasts, wikis and social media, were instrumental in increasing the volume of user-generated content, which has changed the way that the public receives both local and global news.

REAL-WORLD EXAMPLE

News from social media

In 2010, CNN reported that 75% of those surveyed were getting their news from email or social media platforms such as Facebook and Twitter. Traditional media companies were experiencing massive changes to their industry and were required to adapt in order to stay on trend and in business. By 2014, the terms, **trending** and **hashtag** were commonplace and, in 2015, the industry was producing more content targeted at social media such as **live video streaming**.

YouTube launched in 2005 and, at the time of writing, had over 2 billion monthly users and was the platform of choice for many internet influencers.

www.forbes.com/sites/petersuciu/2019/10/11/more-americans-are-getting-their-news-from-social-media/?sh=283112063e17

◆ **Trending**: A topic that experiences a sudden surge in popularity on social media platforms for a limited period of time.

◆ **Hashtag**: A word or phrase preceded by the symbol # to classify or categorize the accompanying text.

Links

The rise of social media links to social media addiction in Section 3.5D Digital media dilemmas and Section 4.4C Mental health.

REAL-WORLD EXAMPLE

The first viral meme

The first viral **meme** was an animation of a baby dancing the cha-cha, designed by graphic designer Michael Girard in 1996. The animation was originally created to demonstrate the capabilities of software but, once shared, was converted into a gif and spread via communication technologies such as email.

With the widespread use of social media, it has become easier for memes to gain popularity and go viral. Memes have developed over time from political or cultural topics to anything that is funny and relatable, with more cultural references and sarcastic life observations.

ATL ACTIVITY

Social

Make a personal connection and find your favourite meme.

- Search for one of your favourite memes.
- Show it to a friend.
- Discuss why it is your favourite meme.
- Describe the genre of the meme and explain what message it is trying to show.

◆ **Meme**: An image, video, piece of text – typically humorous in nature – that is copied and spread rapidly by internet users, often with slight variations.

Links

The content on memes links to Section 4.1A Arts, entertainment and popular culture.

Media and Web 3.0

Developments in artificial intelligence have influenced the media industry, from content creation to the consumer experience.

Content creation

Advancements in artificial intelligence, cloud computing and graphics technology have led to a rapid development in techniques that manipulate images, audio and video.

Artificial intelligence-generated synthetic media is referred to as a **deepfake**. Deepfakes consist of synthetic (*fake*) media created using *deep* learning.

◆ **Deepfake**: Synthetic media created with the use of deep learning/ artificial intelligence.

Many of these new tools are readily available online and are being used to manipulate media, whether it is superimposing one person's face on to another (face-swapping) or manipulating a voice to change the audio and lip movement at the same time (lip-syncing).

Face-swapping technology was made popular in 2014 by Snapchat with the use of filters. The face-detecting lens technology was fun to use and entertaining, allowing people to share selfies with a choice of accessories, for example cat ears.

While the innocent use of deepfakes can be entertaining, more sinister uses of deepfakes have contributed to **fake news**. They can be used to damage reputations, fabricate evidence and defraud the public.

◆ **Fake news**: False or misleading information presented as news.

REAL-WORLD EXAMPLE

Positive use of artificial intelligence for content creation

In 2021, Duran Duran created a music video for their song 'INVISIBLE' using artificial intelligence. The band teamed up with Nested Minds to generate the video. The artificial intelligence (called Huxley) used the lyrics, pictures, music and other information provided by the band to create the video using deep learning.

www.itv.com/news/2021-05-19/duran-duran-how-the-band-made-a-new-music-video-untouched-by-human-hands

REAL-WORLD EXAMPLE

Negative use of deepfakes

In March 2019, a UK-based energy firm was tricked into transferring around £200,000 (approximately US$260,000) to a Hungarian bank account. An individual had used deepfake audio technology to impersonate the voice of the firm's CEO to authorize the payment.

REAL-WORLD EXAMPLE

Deepfakes for educational purposes

In 2018, Buzzfeed worked together with the actor Jordan Peele to create a deepfake video of the former US president Barack Obama. The aim of this video was to raise awareness about the potential harm of deepfakes and the role that these realistic-looking videos could have in spreading fake news.

www.trendmicro.com/vinfo/ph/security/news/cybercrime-and-digital-threats/exploiting-ai-how-cybercriminals-misuse-abuse-ai-and-ml

ATL ACTIVITY

Thinking

Formulate a reasoned argument to support your opinion after completing this task.

- Research what free deepfake apps and software are available online.
- Select one to try out.
- Make a short deepfake video.
- Share this with a friend and see their response.
- Discuss how you created the video with your friend, including which aspects were easy and which were difficult.
- Ask your friend their opinion on your deepfake, for example, how realistic it was, or how obvious it was that it was fake.
- Form your own opinion about the use of deepfakes and potential concerns based on the outcomes of this task.

Artificial intelligence and the consumer's media experience

Artificial intelligence can be used by media companies to predict demand and adjust their media production, accordingly. Used alongside content recommendations (such as Netflix recommendations), media companies can offer a more personalized experience.

However, one challenge for the media industry is how to effectively manage the data needed to train the artificial intelligence algorithm so that it can be more reliable. To improve the user experience, the media industry needs to collect data about the audience, such as their choice of device, when they watch and the routines they have, as well as what they are watching (content data).

ATL ACTIVITY

Research

The health industry is investigating the use of recommendation systems to help design effective health messages for the public. Research this topic in more depth.

- Search for sources using the digital resources provided by your school library.
- Find at least three articles on this topic.
- Discuss your findings with a friend.
- What is the potential benefit to society from using recommendation engines for this purpose?

Electronic games

E-sport arena

Social media is not the only digital technology that has changed over time – the **electronic games** industry has also developed. The development of internet-enabled gaming consoles and personal computers has enabled more social aspects to video gaming and opened up gaming to new audiences. For example, senior citizens can now play bowling games in their retirement homes, and busy parents can play games on their phone while waiting for their children to finish after-school activities.

Previously, computer gamers did not make enough money from playing video games to make a career out of it, but this has slowly changed. Platforms such as YouTube and Twitch have allowed gaming influencers to grow their fanbase and tournaments now offer large cash prizes. E-sports (electronic sports) have been gathering momentum since 2000, with a variety of types of tournaments, from first-person shooter events (for example, Call of Duty), to multiplayer games (Dota 2) and fighter events (Mortal Kombat). In 2019, US$100 million was made available for the Fortnite World Cup.

Like all sports, in order to succeed a player must select a game, develop their skills, find a community to practice with and climb the ladder. The window of opportunity for professional gamers is a small one, with the average age being 24 to 27. However, today many professional teams are turning to data analytics and machine learning to optimize their chances of success.

Links

The content on gaming links to Section 4.1B Home, leisure and tourism.

Inquiry

3.5A Types of digital media (content) and 2.4 Power (concepts)

Determine inquiry focus

Formulate an inquiry question, find real-world example(s) and connect them to the 3Cs

- Is your question concise, thought-provoking and worth considering from different perspectives?
- Does your question support discoveries that move beyond recall, description and summary?
- Are the course concepts, content and contexts that you have identified connected to your inquiry question?

- Conduct initial research on how the different types of media are contributing to the unequal distribution of power.
- From your initial research, find one real-world example.
- Use the steps above to create a statement for the inquiry focus.
- Justify your choice of inquiry focus.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

Evaluate

Evaluate impacts and implications for relevant people and communities

- Is your evaluation based on your analysis?
- Does your evaluation focus on the impacts and implications for people and communities?
- Is your evaluation effective, sustained and well-supported by evidence?

Conduct research for the real-world example chosen, and analyse and evaluate of the use of digital media and power:

- What form does power have through the use of the media and its platform?
- Has the media and its platform been used to constrain power?
- To what extent has the use of the media and its platform impacted the balance of power on a personal, local and global level?
- Evaluate the use of the media and its platform. Does it have too much power? Is it possible to limit this power?

Inquiry

3.5A Types of digital media (content) and 4.6A Political processes (contexts)

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

- Conduct secondary research into the uses of digital media for one real world example of a political movement or activism.

Reflect

Reflect on new ideas and understandings, and discuss future developments

- Does your conclusion include a reflection based on new ideas and understandings that are a result of the analysis and evaluation?
- Does your conclusion include a discussion of possible new trends and future developments?
- Does your conclusion answer the inquiry question?

- Consider emerging trends and future developments of the use of digital media in this context.

3.5B Characteristics of digital media

Digital media generally serves the same purpose as traditional media, which is to entertain, educate and provide a forum for expression. However, digital media does have some unique characteristics:

- **Rapid sharing**: Compared to the past, it is now easy to share any kind of content, whether it is uploading a video to YouTube or reposting a Tweet.
- **Efficient storage**: Developments in storage technologies mean that huge amounts of data can be stored in one place. Mobile phones with cloud computing can store all data while people are using social media.
- **Interactivity**: Traditional media used to be 'one way' – audiences could receive the media but were not able to respond or interact. With interactive media in web design, media now has the potential to be more engaging for consumers and to motivate them to revisit web pages, post comments and make recommendations to friends.
- **Non-linear content or hypertextual**: In contrast to traditional media, which was linear, the use of hyperlinks on web pages allows people to click and visit pages in any order. This gives them the option to navigate media how they want to, not how a media company has decided they should.
- **Global networks**: Digital media has allowed people to interact more globally, which means that they can pool resources together more easily and have access to a wider range of sources of information than before.
- **Virtual**: Digital media allows people to communicate virtually through a wide range of technologies. They can now communicate very differently compared to how they used to face-to-face, which gives individuals more choices on how they present themselves.
- **Convergence of digital media**: People are frequently communicating using more than one form of digital media at a time. People no longer just call someone using voice – they can include voice and live video. When messaging, people do not just write in text – they can include a voice message, an emoji or an image. All of these demonstrate the convergence of media.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two types of digital media. *[2 marks]*

2 Explain three characteristics of digital media that have contributed to the growth in consumption of digital media. *[6 marks]*

3 Using the concept 'expression', discuss how digital media is changing the way history is being recorded. *[8 marks]*

3.5C Immersive digital media

◆ **Virtual reality (VR)**: A simulation that provides a completely immersive environment for the user.

Earlier we discussed the fact that digital media allows for user interactivity. Go one step further and digital media becomes an immersive experience for people in a virtual life, based on simulations.

Virtual reality (VR) is a simulation that provides a completely immersive environment for the user. This is typically used with virtual reality headsets, from the cheaper option of using a phone in a cardboard mask to more expensive custom-made virtual reality goggles.

Virtual reality involves programming 3D objects to perform actions depending on how the user interacts with them. This involves the use of spatial computing. Spatial computing is when physical actions are used as inputs to receive outputs in a 3D space. This could be in three degrees of freedom (3DoF) such as a 360° video, or six degrees of freedom (6DoF), which allows a user to move backwards and forwards in a virtual space.

As businesses are looking for a competitive advantage, they are turning to virtual reality for a variety of uses:

- **Employee safety training**: Oil companies BP and ExxonMobil use virtual reality to train their employees in everyday work scenarios, such as emergency procedures. This allows employees to make mistakes in a controlled environment without causing themselves any harm.
- **Sales and marketing presentations**: Virtual reality allows sales teams to let potential customers experience products by interacting with them in an immersive environment. Zimmer Biomet, a dental technology provider, has created a virtual dental lab that lets dentists experience how the new technologies impact routine dental procedures.
- **Design decisions**: Virtual reality can be used to see the effects of various design decisions, allowing decision-makers to visualise different options before making their final choice.
- **Virtual workspaces**: Companies are investing in virtual office experiences to provide an office-like experience for employees working from home. Companies anticipate that this type of environment will provide a space for more casual work discussions, which may promote problem-solving and creative solutions.

ATL ACTIVITY

Self-management

Make a personal connection with this topic by exploring virtual reality videos on YouTube.

- Using a phone and a cardboard mask, such as Google Cardboard, search for virtual reality videos on YouTube.
- Watch several videos of different genres.
- Reflect on how this experience makes you feel.
- Did you feel immersed in the environment?
- What advantages and disadvantages do you think there are from using this type of digital technology?
- How many degrees of freedom did you experience?

■ Augmented reality

◆ **Augmented reality (AR)**: Digital content overlaid on to a real-world experience.

Augmented reality (AR) is when digital content is overlaid on to a real-world experience; it is commonly used with mobile devices, for example, the filter in Snapchat. Before taking a photo, individuals can see themselves (the real world) and then select from a range of digital items to enhance the picture.

Many industries are adopting augmented reality:

- The manufacturing, mining and maritime industries are using augmented reality as part of the inspection process of machinery for remote support to minimize interruptions to operations.
- In education, augmented reality is being used to allow teachers to present real situations through 3D modelling and providing a fun and engaging way to learn.

ATL ACTIVITY

Research

Use effective research skills to find augmented reality apps.

- Search online for the top 10 augmented reality apps.
- Download one and try it out.
- Reflect on these questions:
  - What was your experience like?
  - What was the main purpose of the app?
  - Did the augmented reality aspect of the app enhance your experience?
  - Were there any disadvantages to this experience?

Mixed reality (MR) is the blending of the real world and the digital world to create a new experience.

◆ **Mixed reality (MR)**: Blending the real world and digital world to create new experiences.

Sometimes the simulation of a real-world system is called a **digital twin**. This technology is used by industries that are looking for ways to visualize, analyse, maintain and control their valuable assets. The dynamic nature of digital twins offers professionals more tools and information than static 3D data models.

REAL-WORLD EXAMPLE

Royal Dutch Shell's digital twin initiative

Shell has created digital twins of their oil rigs that are out at sea. These detailed structural simulations of the oil rigs, developed using big data analytics and artificial intelligence, incorporate sensors to collect real-time data. The digital twins are being used to help manage the oil rigs, improve the safety of the workers and develop predictive maintenance by providing real-time data that they can act on.

https://internetofbusiness.com/shell-digital-twin-oil-gas

Virtual, augmented and mixed reality are already being used in a wide range of industries today. In the automotive industry, potential buyers can try out different options before choosing their car specifications; doctors can train in virtual 3D environments before performing surgery on real humans; and tourists can take virtual tours before finalizing their bookings.

So, why are businesses choosing this digital technology? From personal experiences it is possible to see how virtual reality is both engaging and entertaining. This is particularly useful when encouraging consumers to buy a product. Being able to visualize what it would look like, or how one can interact with it, can help consumers make up their minds.

It can also provide a cheaper and safer way of training. Immersive experiences can have a genuine physiological effect on their users, which is important in training. Training for doctors and military staff needs to be as close to reality as possible, so that their bodies are prepared for what is to come when they operate in the real world.

Inquiry

3.5C Immersive digital media (content) and 4.5A Learning and education (contexts)

Inquiry focus: How are augmented reality and virtual reality being used by companies to support training?

Communicate	Presentation • Is your presentation organized in a logical manner and is the media used to communicate effectively? • Does your presentation lead towards answering the inquiry question? • Does your presentation include findings, emerging trends, future developments and further insights?

A range of augmented and virtual reality technologies are being used in education today to enhance teaching and learning. You are a salesman for one of these technologies and have been asked to set up an exhibition to promote it. Your job is to persuade teachers to buy/use it.

Select one augmented/virtual reality technology for one subject and set up a display to include:

- a demonstration of the technology being used – in real life or via a video clip
- a description of the app, including its features and price.

You should also:

- discuss the impacts this technology will have on the students' learning
- discuss the impact that this technology will have on teachers
- cite your sources and include a bibliography.

Remember to be persuasive yet honest. If there are any disadvantages, include them, but also possible solutions.

Inquiry

3.5C Immersive digital media (content) and 2.2 Expression (concepts)

Inquiry focus: What different kinds of stories are possible through the immersive digital world?

Analyse	Analyse impacts and implications for relevant people and communities • Is your inquiry question supported by additional questions to consider for analysis and evaluation? • Does your analysis focus on the impacts and implications for people and communities? • Is your analysis effective, sustained and well-supported by evidence?
Evaluate	Evaluate impacts and implications for relevant people and communities • Is your evaluation based on your analysis? • Does your evaluation focus on the impacts and implications for people and communities? • Is your evaluation effective, sustained and well-supported by evidence?

Explore sources to be able to effectively address the inquiry focus.

Investigate the different types of stories that are possible with an immersive digital world and select 'one or two' real-world examples.

Analyse and evaluate the effectiveness of this form of media in storytelling by answering the questions:

- What different kinds of stories are possible through the use augmented/virtual/mixed reality?
- What type of change has been brought about by the use of augmented/virtual/mixed reality in storytelling? Was it evolutionary, adaptive, transformational or radical?
- What are the positive and negative impacts of using augmented/virtual/mixed reality for storytelling?
- Should these stories be censored or controlled?
- If so, who should control these stories, and how, for example governments creating laws on censorship?
- How does this inquiry focus relate to the concepts of power, values and ethics?

Activity: HL Extended Inquiry

3.5C Immersive digital media (content) and 5.1C The future of work

Challenge: Once you have studied Section 5.1C, research and describe the global challenge.

- Use effective research skills to identify one global challenge related to a current employment issue that is impacting global well-being that has virtual reality or augmented reality as an intervention.
- Describe the challenge in detail.

Research and evaluate one intervention using augmented/virtual reality for this challenge.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

Links

Content on augmented reality links to Section 4.4B The human body.

3.5D Digital media dilemmas

Developments in the media industry have come with many advantages:

- Digital media has made news, information and entertainment more readily available and almost instant.
- Much of the online content is free or of minimal cost.
- Digital media is now widely more accessible around the world.

However, it has also introduced many new issues and dilemmas, which will be discussed briefly here.

Media addiction and other psychological concerns

For many individuals, the consumption and creation of content on social media is a source of entertainment and a way of connecting with friends. However, there are more and more reports in the news of addiction and other well-being related concerns.

Social media addiction is an example of behavioural addiction. It is an uncontrollable urge to use social media for extended periods of time. Using social media can influence the way the brain functions. When using social media, individuals experience dopamine hits, which makes them feel rewarded temporarily. This might be due to the number of likes from a post or the fun content they have interacted with. However, due to the short-term nature of a dopamine hit, the brain 'encourages' individuals to stay on social media in order to get more dopamine, and so the addiction begins.

So, although moderate use of social media is unlikely to be harmful, the overuse of social media can lead to:

- low self-esteem
- anxiety and depression
- disrupted sleep patterns, especially if used before bedtime
- a fear of missing out (FOMO)
- decreased physical activity and engagement in real-life activities.

Impact on journalism

Digital media has contributed to the breaking down of cultural barriers, which has allowed people to have more control over the media they consume: they can now see, experience and understand more, as well as interact with the content.

The characteristics of digital media discussed in Section 3.5B are transforming journalism. Traditional forms of journalism have now shifted to online, real-time reporting, multimedia content, access to global information and the personalization of news, which has challenged the monopoly previously held by the mass media.

Today's journalists must develop new skills – in addition to writing and reporting, they also need technical and digital literacy skills. Journalists are expected to complete their articles with shorter deadlines and for more than one type of media. It has always been important for journalists to get their story out first but, in the rush to break news stories online, there is a higher chance that the information has not been checked adequately to stop the flow of **misinformation**.

◆ **Misinformation**: False or inaccurate information that is mistakenly or inadvertently created or spread; the intent is not to deceive.

Web 2.0 technologies have enabled users to generate their own content and share it with ease. Social media has become an essential tool for journalists as they can write breaking news stories and post within seconds to their thousands of followers. Social media has the additional advantage that journalists can allow readers to get to know them on a personal level through their profile and online conversations. The ability to allow journalists to create their own 'brand' can bring about loyalty in their followers.

However, the same digital technology has enabled many amateur journalists who have not undergone the same training and who are not under the same editorial control. Fake news and 'alternative facts' damage the reputation of journalists and make it harder for people to determine what is true and what isn't. One potential solution is the formation of a peer-review network, whereby journalists review and fact check each other's work.

REAL-WORLD EXAMPLE

QAnon

QAnon is an American conspiracy theory movement centred around an anonymous individual called Q who made unsubstantiated claims allegedly from within the US government administration. In 2017, Q posted a series of messages (Q drops) on the website 4chan, claiming to have security clearance (Q clearance). Since then, thousands of followers have been using social media to share the conspiracy theories and coordinate abusive messages on the perceived enemies, including politicians, celebrities and journalists, who they believe are covering up the stories. Social media companies have taken down many of the Q-supporting accounts, but there are still millions of believers online.

www.bbc.com/news/53498434

QAnon Rally in London

Media authenticity

Technological developments in the creation and distribution of media are making it increasingly more difficult to check the authenticity of the media. Social media sites have become a one-stop shop for entertainment and a way to keep up to date with friends and the news.

A study by George Pearson from Ohio State University found that when people use the same source for both news and entertainment, they pay less attention to the source of the content, making it more difficult for them to evaluate sources and therefore are more vulnerable to fake news.

Broadly speaking, fake news is deliberately made up with the intent to disinform and is usually political or criminal in nature. One of the main goals is for articles to go viral so that creators can make money or promote a political agenda.

Fake news!

REAL-WORLD EXAMPLE

Fake news spreads faster than real news

An MIT researcher investigated how and why stories spread differently through social media using data from 126,000 stories that had been tweeted by 3 million people from 2006 to 2017. The study concluded that fake news spreads faster on social media than real news, mainly because false news stimulates emotions, such as surprise, fear and disgust, while real news is met with sadness, joy, anticipation and trust. The study was considered particularly important at the time as it was established that fake news had distorted the 2016 US presidential election.

www.theguardian.com/commentisfree/2018/mar/19/fake-news-social-media-twitter-mit-journalism

Deepfake technology, such as lip-syncing and face swapping, were introduced earlier in this unit. A 2019 report by start-up company Deeptrace found 7964 deepfake videos online and predicted this will increase in the future, largely due to the fact that the tools are widely available and easy to use. It is still currently possible to notice if a video is fake but, as technology improves, it will become harder to distinguish between real and fake. It does not require much imagination to see the potential harm that deepfakes can have on journalism.

ATL ACTIVITY

Research

Satirical news sites such as the *Onion* contain a range of fake stories with the intention of entertaining their readers by mocking people's habits and stereotypes.

- Find three stories online, two of which are fake news and one that is real news.
- Present them to your friends to see if they can guess which one is real.
- Explain the dangers of fake news to your friends.

Top tips

Can you distinguish between misinformation and **disinformation**? How are they different? Make sure you have revised these key terms so that you can use them correctly in your exam answers.

◆ **Disinformation**: False information that is deliberately created and spread with the intent of influencing public opinion or obscuring the truth.

Ownership of media

The evolution of the internet has made it easier than ever to share and distribute digital media. With the right social media presence, artists can instantly reach out to millions of viewers and listeners to get their work known. But this can come at a price, forcing artists to rethink their business models if they wish to survive. As an IB student, you should be aware of academic honesty when it comes to citing sources and using someone else's **intellectual property**.

Intellectual property is the outcome of thought or intellectual effort. It gives protection to creators of new inventions, designs, brand names and other original creations. Legal rights, such as patents, trademarks and **copyright**, give the creator the rights over their work and can protect them from unauthorized use of their work for a specified period of time. The aim of intellectual property is to reward the creativity of the owners of the work and encourage inventors to share their innovations.

Copyright refers to literary and artistic works including books, music, paintings, films and computer programs, which may also be digital. It is important that all consumers of digital media and creators of digital media are aware of the copyright laws operating in their country because unauthorized use is a criminal offence and is considered theft.

Copyright laws outline the rights of users to be able to use, modify or distribute the work included in this category. To use copyrighted work, one must first identify the owner of the work and then obtain permission to use it. This can be a time-consuming process and ultimately restricts creativity. There are two circumstances in which work can be used without gaining permission, however. This includes work in the **public domain** (work that is available to the public and not subject to copyright) and **fair use** (which can include using the work for study or research, commentary or criticism). Should there be a dispute over whether the use of copyrighted work comes under 'fair use', the following would be considered:

- Is it being used to create something new, or is it just straight-forward copying?
- Will it impact the market value of the original work?
- How much of the original work is being used?

◆ **Intellectual property**: The outcome of thought or intellectual effort, for example a new invention or an original design. It also refers to the legal protection of that work.

◆ **Copyright**: Legal protection for the creators of literary and artistic works including books, music, paintings, films and computer programs, which may also be digital.

Copyright

REAL-WORLD EXAMPLE

Blurred lines

Robin Thicke, Pharrell Williams, and TI's song 'Blurred lines' was released in 2013. After five years in court, however, it was ruled that it infringed the copyright (was too similar to) of Marvin Gaye's 1977 song 'Got to give it up'. Thicke and Williams had to pay a fine of over US$5 million to the Gaye estate.

www.rollingstone.com/pro/features/music-copyright-lawsuits-chilling-effect-935310

ATL ACTIVITY

Research

Use effective online research skills to:

- Research the copyright laws in your country. Write a brief summary of the laws.
- Research the meaning of 'public domain'. What type of works can be found in the public domain?
- Research fair use and outline some examples that are usually considered to be fair use, such as news reporting.
- Find one example in your local news where copyright has been infringed. Write a summary of the scenario and details of the fine awarded.
- Use the bullets above to plan a quiz for your friends.
- Use online quiz tools to create a self-marking quiz.
- Test out the quiz and then share it with your friends.

As we said earlier, obtaining permission can be time-consuming, for both the person wanting to use the work and the owner of the work. A solution can be found in **copyleft** licensing.

Copyleft is when owners of work will allow others to use their copyrighted property freely under specific conditions. For example, copyleft software allows users to copy, modify and share their code provided that the source code remains open and publicly available. The aim of this type of licensing is to help build communities so that they can collaborate to improve the creative works.

An example of copyleft licensing is **creative commons licensing**. Creative commons can be used by anyone and helps to standardize the way that copyright permissions are granted to others who wish to use their work.

CC BY is the least restrictive and allows others to distribute, remix, adapt and build on work as long as they credit the original creator.

CC BY NC ND (non-commercial and no derivatives) is the most restrictive. This only allows others to download and share the work as long as the owner is credited. It cannot be changed or used commercially.

◆ **Copyleft**: When owners of original work allow others to use their copyrighted property freely under specific conditions.

■ Copyleft

■ CC BY creative commons licence

■ CC BY NC ND creative commons licence

ATL ACTIVITY

Social

Work in a small group to complete this task.

- Research the different types of creative commons licensing in more depth.
- Create a set of cards that includes images of the different licences, an explanation of the licences and scenarios for each one.
- Write up the rules of the game.
- Print out the cards and invite your friends to play.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two works of art that are covered by copyright. *[2 marks]*

2 Explain two limitations of copyright laws. *[6 marks]*

3 The evolution of the internet and computing has made it easier for people to illegally copy and distribute works of art. Discuss the impact this is having on the music industry. *[8 marks]*

Paper 1 (HL extended)

4 Evaluate one **intervention** used in the music industry to advocate for better conditions for new music artists. *[12 marks]*

Links

This content links 4.1A Arts, entertainment and popular culture.

Censorship and control of media

The protocols and standards used by the internet have supported the global sharing of digital media. However, not everyone has access to the same digital media, with many governments employing sophisticated digital censorship for reasons in four main categories:

1 **Political content**: Content that is of a political nature may be blocked by governments when the opinions of minority groups conflict with that of the government.

REAL-WORLD EXAMPLE

Cambodia

In July 2018, Cambodia blocked several independent news sites two days before a general election.

www.reuters.com/article/us-cambodia-election-censorship/cambodia-blocks-some-independent-news-media-sites-rights-group-idUSKBN1KH29Q

2 **Social content**: Content that is socially sensitive or perceived to be offensive is often blocked by governments to protect their citizens from exposure to undesirable media. This can include content related to sexuality, gambling, alcohol and illegal drugs.

REAL-WORLD EXAMPLE

Uganda

In July 2018, Ugandan communication regulators directed internet service providers to block access to pornographic websites.

https://qz.com/africa/1340505/uganda-is-making-isps-block-pornography-from-its-citizens

3 **Conflict and security**: Content that is related to conflicts, militant groups and border conflicts may be blocked so that local citizens do not contribute to the conflict in question.

REAL-WORLD EXAMPLE

Sri Lanka

Following a series of bombings in 2019, Sri Lanka shut down access to social media to prevent the spread of misinformation in an attempt to reduce the acts of further violence that followed.

www.theguardian.com/world/2019/apr/21/social-media-shut-down-in-sri-lanka-in-bid-to-stem-misinformation

4 **Internet tools**: Some countries may monitor communications within a country, looking for keywords in conversations in emails or messages, or internet searches.

ATL ACTIVITY

Research

Practice effective online searching skills on digital censorship.

- Research the different reasons for digital censorship. Find an example of each of the above and include which country and what sort of media is censored.
- Find one recent article in the news in which the internet has been 'switched off' or monitored during times of conflict or security. Discuss with your friend how this action may have impacted the country at the time.

Learner profile

Open-minded

Be open to the perspectives, values and traditions of others when you are researching and discussing the use of content filtering.

Digital media preservation

The evolution of computing and the internet has brought on the development of digital media formats and storage. Such changes have led to **obsolescence** of both storage media and data formats.

Take, for example, home video footage recorded in the 1990s using a video camera and stored on a magnetic tape. Once recorded, it would have been be played back by connecting the video camera to the television. As years went by, the camera has become obsolete, and so the family would have had to upgrade to a new camera. Faced with the issue of how to view the footage stored on the tapes, the family would have used a company to convert them to a DVD format, so that it could be played on a DVD player. Fast forward another ten years and the family disposes of the DVD player and now the footage needs to be transferred to another storage device, and so the story continues.

Also, It is not just the hardware that becomes obsolete over time, but as digital technology evolves, so do the file formats being used and the software required to read the files. So, what is the solution to this never-ending story of obsolescence?

Digital preservation is essential for modern history and includes practices to ensure that information is safe from media failure and hardware/software obsolescence in the future. To preserve data, it must be transferred on to fresh media. In the case of obsolete software, emulators are used to simulate the old software so that the data can be retrieved. For example, when computers simulate an older operating system, they can then run the older software, open the file and save it in a new format.

Activity: HL Extended Inquiry

5.2A Conflict, peace and digital media

Challenge: Digital media is being used around the world to spread misinformation and spread propaganda. Select one example of real world conflict and research how media has been used in a negative way.

Intervention: Research and develop your understanding of one intervention that could be used to address this challenge.

Evaluate the intervention and make recommendations for future action.

TOK

Knowledge and technology

Developments in digital media, and the software that is used to create digital media, provide different methods and tools to support the acquisition of knowledge.

- How has increased access to digital media impacted what we know and how we know?
- How does the choice of digital media change the way that knowledge is produced, shared and understood?

Creativity, activity, service (CAS)

Copyright and academic honesty awareness campaign

Using a range of digital media, create an awareness campaign for students new to the IB Diploma course about copyright and compliance with academic honesty.

Extended essay (EE)

The evolution of digital media and how it is being used may give rise to some interesting topics for an extended essay.

Perhaps you could look at one of these technologies with one of the contexts as a focus for the essay. The technologies used for augmented reality could be investigated in a context such as e-commerce, for example: How is augmented reality impacting the shopping experience in a market of your choice (computer games, clothing, furnishings, and so on)?

Document the process of converting your initial ideas into a research question.

Reflection

Now that you have read this chapter, reflect on these questions:

- Which types of media do you consume or create on a daily basis?
- To what extent has media changed in your lifetime?
- How is digital media different from traditional media?
- In which contexts are the different media formats having an impact?
- How can media be used as an intervention to improve global well-being?
- To what extent are the dilemmas in the use of media impacting individuals and society?
- Discuss the relationship between media and power?
- How is the media influencing the way that we know things?

Learner profile

Principled

Use your honesty and integrity to reflect on the dilemmas created by the evolution of the digital media.

Links

Links to DP Business management, The use of digital media in marketing.

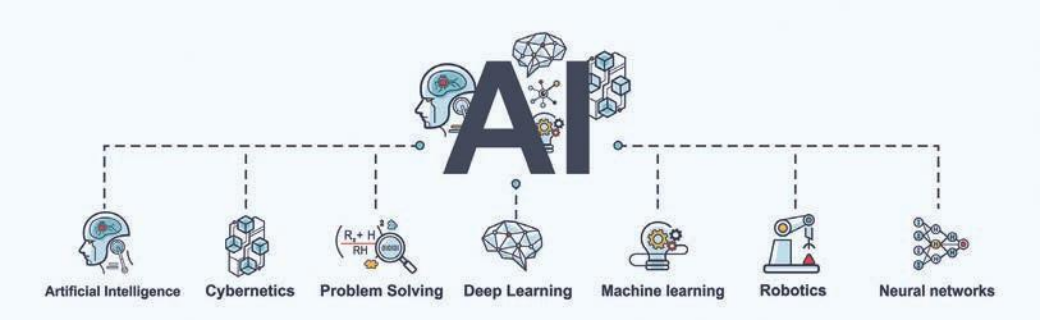
3.6 Artificial intelligence

UNDERSTANDINGS

By the end of the chapter, you should understand:

- artificial intelligence (AI) involves agents, devices or systems that adapt to perform tasks (or appear to do so) that once required the cognitive and creative processes of human beings
- there are several types of existing, emerging or proposed AI; these categories frequently overlap or are contested
- AI has evolved over time and introduces significant opportunities and dilemmas in digital society.

We have entered a fifth generation in computing, artificial intelligence (AI). Although stemming from science fiction and the earlier work of Alan Turing, a mathematician and cryptographer, artificial intelligence is emerging and becoming more prevalent in today's news headlines. As well as beating humans in games such as the AlphaGo challenge, it is becoming ubiquitous in our everyday lives. In this chapter we will investigate the technologies being developed in artificial intelligence, where they are being implemented and the dilemmas that are arising from their use.



ATL ACTIVITY

Thinking

Reflect on the following questions before starting this chapter:

- What is easy for a human to do but not a computer?
- What is easier for a computer to do than a human?
- What is meant by the term 'human intelligence'?
- What is meant by the term 'artificial intelligence'?

3.6A Types of AI

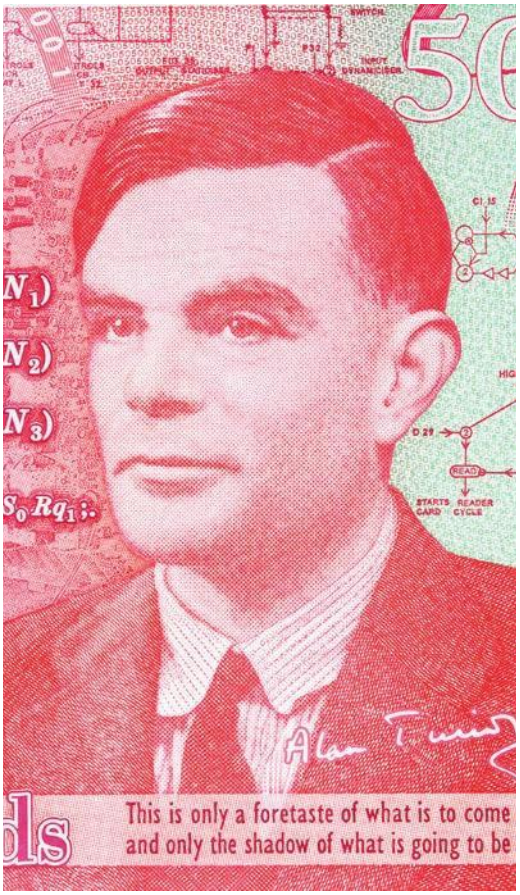
When looking up the word 'intelligence', one will be presented with a wide range of terms including abstract reasoning, mental representation, problem-solving, decision-making, emotional knowledge, creativity and adaptation.

Given the complexity of our brains and the way that we think, it is no surprise that it is difficult to develop artificial intelligence. It comes with other inherent problems, as well, for example:

- most people cannot describe how they do things
- there is a difference between the way a human brain is structured and human capabilities compared to that of a computer
- the best way for a machine is often different to that of a human.

How can we determine whether a computer system has true intelligence? In 1950, Alan Turing wrote an academic paper titled 'Computing machinery and intelligence', from which he developed a test of artificial intelligence called the Turing Test. Based on a party game called 'The Imitation Game', an interrogator is on one side of a screen and asks questions to different players on the other side of the screen. One of the players would be a computer (chatbot). The game would continue with the interrogator chatting (with typed text) for up to five minutes. If the interrogator mistakes the computer for a human more than 30% of the time, then the computer has passed the artificial intelligence test.

The Turing Test was used on early chatbots, such as ELIZA in the 1960s, but it took over 60 years before a chatbot passed the test. The Loebner Prize, an artificial intelligence competition, was held annually with the aim of evaluating the status of conversational machines aspiring to pass the Turing Test. In 2012, a chatbot posing as a 13-year-old Ukrainian boy (named Eugene Goostman) convinced the interrogator that it was human. This was controversial, however, as it was considered that the chatbot had tricked the humans by behaving like a teenager.



Alan Turing

Although the Turing Test can only test natural language processing; it is still popular because it provides a simple test that can be applied to a complex situation. You can read more about the history of the test here: **www.thinkautomation.com/bots-and-ai/the-history-of-the-turing-test**.

CAPTCHA (Completely Automated Public Turing Test to tell Computers and Humans Apart) is a form of modern-day Turing Test. CAPTCHA questions are frequently used when registering on a new website. It was created so that a user can prove at the time of registration to the website that they are human and not a bot.

ATL ACTIVITY

Thinking

Hold a discussion about the development of CAPTCHA.

- Research and collate a selection of CAPTCHA images to show how they have changed over time.
- Hold a group discussion about how CAPTCHA has evolved.
- Discuss possible reasons why CAPTCHA has changed.
- Use your knowledge of machine learning to support this discussion.

ATL ACTIVITY

Social

Complete this activity with a group of friends.

- Research for an unplugged activity to recreate the Turing Test.
- Download the activity, follow the instructions to set it up, and play.

CAPTCHA

It is important to recognize that there are different types of artificial intelligence. The artificial intelligence that we encounter day to day is referred to as **weak or narrow AI**. It is called weak because it only has a limited function or can only perform a specific task. Take, for example, the artificial intelligence in Netflix – it can only perform one task, which is to recommend what we watch next. Other examples of weak artificial intelligence include chess programs, Google searching, Siri and Alexa, self-driving vehicles, recommendation engines and facial recognition. Many weak artificial intelligence systems are changing the world we live in as they can complete tasks much quicker than humans and can discover patterns in big data.

◆ **Weak/narrow AI**: Artificial intelligence that has a limited function or can only perform a specific task.

◆ **Domain-specific AI**: Artificial intelligence that perform tasks better than humans in certain domains.

◆ **Strong AI**: Artificial intelligence that can develop consciousness and make decisions better than humans.

In certain domains, artificial intelligence can perform tasks better than humans. This is known as **domain-specific AI**. Examples include artificial intelligence that can detect cancer better than human doctors, and artificial intelligence such AlphaGo, developed by DeepMind to beat the world champion at the board game Go. However, this is not enough to be classed as **strong AI**, also known as **full AI** or **artificial general intelligence (AGI)**. Strong artificial intelligence will be when machines get to the point that they can develop consciousness and make decisions better than humans. Additionally, strong artificial intelligence will be able to demonstrate self-awareness and emotions, and have full human cognitive abilities.

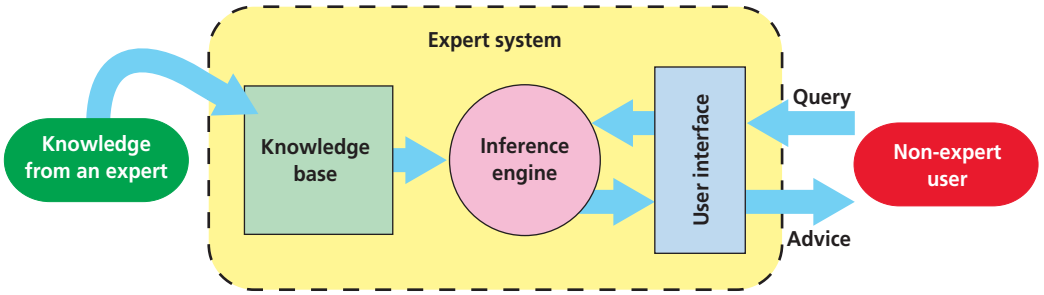
Once strong artificial intelligence is achieved, the next milestone will be **super AI**, which is when machines surpass human intelligence. When artificial intelligence gets to this point, there are concerns (such as those found in science fiction) that machines will overthrow the human race. In technology, **singularity** describes the hypothetical future where AI becomes so advanced that it is superior to human intelligence. Nanotechnology is perceived as one of the key technologies that will make this a reality.

◆ **Super AI:** Artificial intelligence that surpasses human intelligence.

◆ **Singularity**: The hypothetical future where artificial intelligence becomes so advanced that it is superior to human intelligence.

◆ **Expert system**: A computer system that acts like a human expert in a specific subject area.

In artificial intelligence, an **expert system** is a computer system that acts like a human expert in a specific subject area. Expert systems are often used to advise non-experts when a human expert is not available.



Components of an expert system

An expert system has three main components: the user interface, inference engine and the knowledge base.

◆ **Knowledge base**: Facts and rules in an expert system.

◆ **Inference engine**: The part of an expert systems that uses programmed rules to interpret and evaluate the facts in the knowledge base.

- The **knowledge base** represents facts and rules and is created by a knowledge engineer who collects the information provided by human experts.
- The **inference engine** uses programmed rules to interpret and evaluate the facts in the knowledge base. Logic is applied in the inference engine using if/then statements, Boolean logic and fuzzy logic. To provide a solution or answer, the inference engine uses forward or backward chaining.
- The user interface (see definition on page 97) is the part of the system that allows a non-expert to ask questions of the expert system and receive advice.

An expert system is an example of domain-specific AI and is frequently used in medical or car diagnosis, petroleum engineering, financial advising and identifying unknown items.

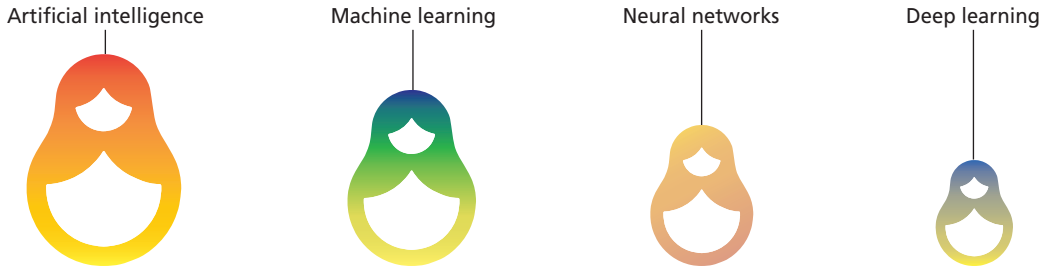
ATL ACTIVITY

Self-management

Become an independent learner and try something new.

- Search online for a web-based expert system, for example medical system checkers, car diagnostics or plant recognition.
- Interact with the different online expert systems that you have found.
- Reflect on how this experience is different from a human expert.
- Reflect on the pros and cons of using such a system.

So far you have been learning about artificial intelligence, but how is this different to machine learning, neural networks and deep learning? Neural networks are then the backbone of deep learning. Over the next two sections, we will be discussing each of these in more detail.

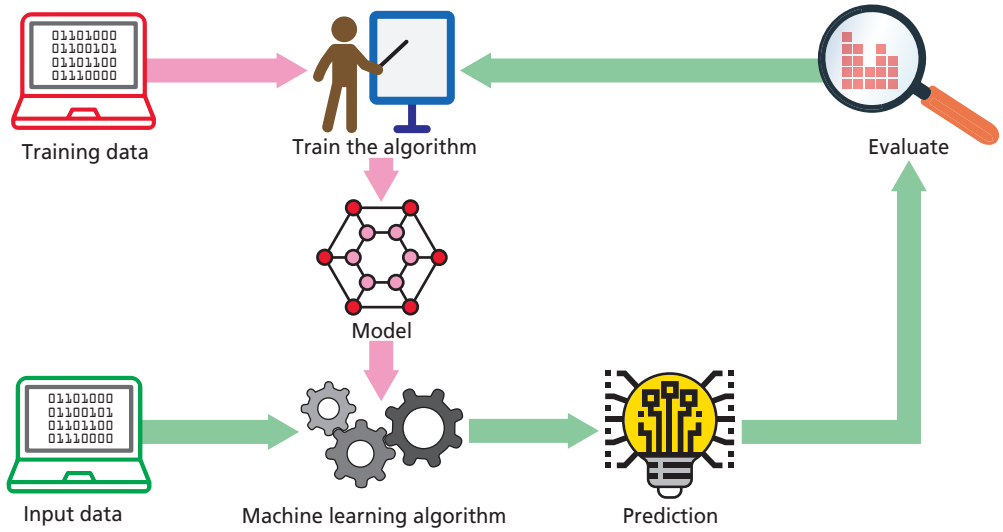


Overview of different AI terms

3.6B Types and uses of machine learning

Before discussing the different types of machine learning, let's briefly look at the key elements of machine learning.

- It needs a set of good data (often called training data).
- It uses algorithms (based on a computer model) to look at the data and understand it.
- Data is input into the algorithm to make a prediction.
- The prediction is then evaluated and, if inaccurate, this data is fed back into the system to update the model/algorithm.



How does machine learning work?

ATL ACTIVITY

Thinking

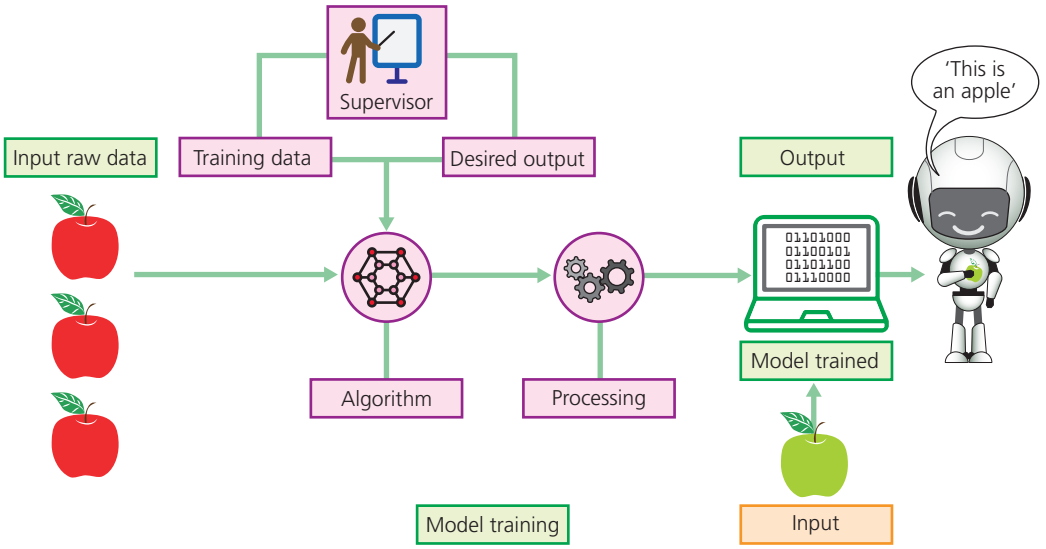
Become an independent learner and teach yourself something new.

- Search online for a web-based tool in machine learning modelling, for example Google's 'Teachable Machine'.
- Try creating different data sets and teach the model to recognize simple tasks.

Types of machine learning

Supervised learning

Supervised learning is the simplest form of machine learning, with algorithms learning by example. The training data consists of a set of inputs, each paired with a set of correct outputs. During the training process, the algorithm will search for patterns in the data that correlate to the desired output. Once the system has been trained, it will be fed new, unseen inputs and determine which label to give the new input. It is considered 'supervised' because the system is trained with known outputs and the algorithm is adjusted until it can produce the correct output for unseen inputs.



Supervised learning

Supervised learning can have different algorithms for different purposes. A **classification algorithm** will take input data and assign it to a category that is based on the training data. A **regression algorithm** is different in that it is used for predictions and looks at the relationship between variables. This algorithm is commonly used to make predictions, such as sales or test scores, based on the analysis of the data set.

Applications that use supervised learning include spam filters, fraud detection and handwriting character recognition.

REAL-WORLD EXAMPLE

Supervised learning

In June 2020, the UK government published a report with recommendations to help fight the increase in online misinformation. The report concluded that many online platforms were using black box algorithms to select which content their users were shown. The investigation found that Google was using supervised learning.

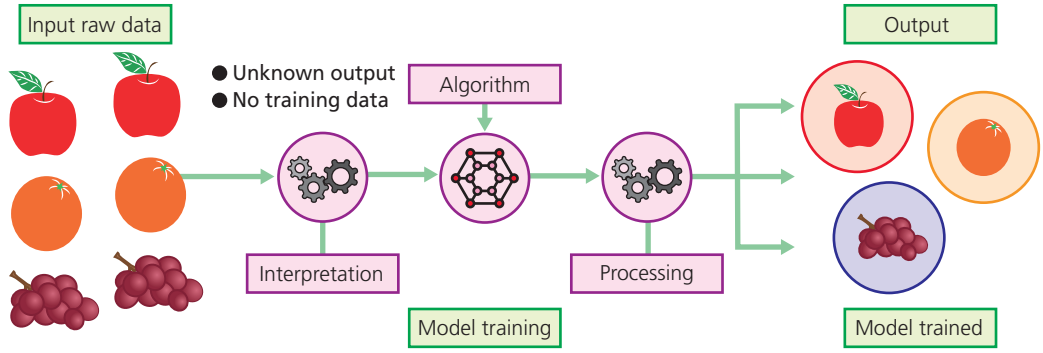
Human content evaluators were used to creating good-quality training sets for the machine learning system. They were given guidelines on how to rate content and were asked to use their own judgement to rate the quality, reputation and usefulness of web pages. The investigation found that rather than editing the code of the algorithms, evaluators were manually rating sites and search rankings for the training sets as a way of influencing the algorithm.

Google's algorithm is relied on by millions of users when searching for information. It uses a combination of human judgement and constant modifying of the algorithm coding (it was reported that Google modified its algorithm 3200 times in 2018).

www.fastcompany.com/90663621/vint-cerf-google-misinformation?

Unsupervised learning

Unsupervised learning is used to find underlying patterns in data. It uses data sets that do not have any labels but instead uses the data's features. The goal of unsupervised learning is to analyse data to find hidden patterns that cannot be noticed by a human observer. The algorithms use cluster analysis, which looks for ways to group the data.

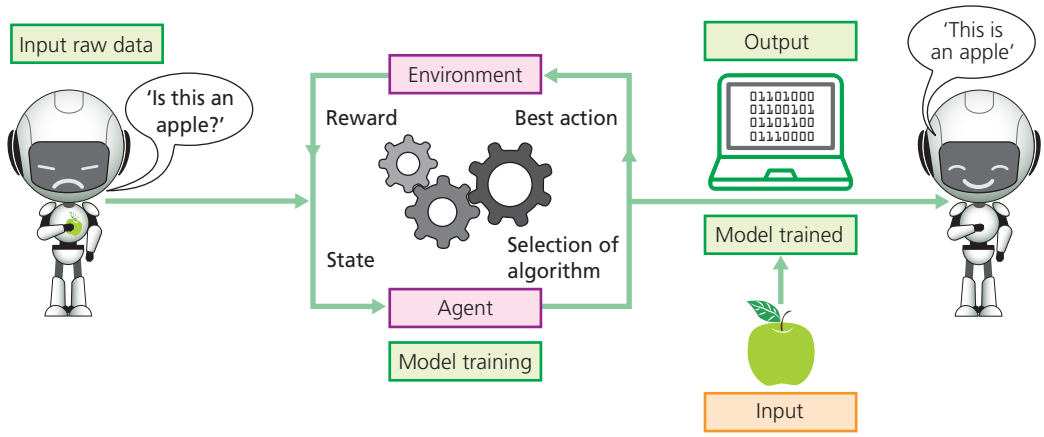


Unsupervised learning

Applications that use unsupervised learning include social networking analysis and market segmentation.

Reinforced learning

This type of machine learning is based on rewarding positive behaviour. The algorithm is trained by rewarding the system if it performs correctly and gives a penalty if it performs incorrectly. The software agent makes decisions to maximize its reward and keep adapting to the environment. This form of machine learning requires a lot of data, which is why some of the first applications were based on how readily available the data was.



Reinforced learning

Applications that use reinforced learning include autonomous vehicles, predictive maintenance, games and robotics.

ATL ACTIVITY

Research

Use research skills to further your knowledge on the different types of machine learning.

- Use effective online search skills and digital resources from the school library to find out more about machine learning.
- Find one real-life example for each type of machine learning.
- Write a report to include:
  - an explanation on how machine learning is being used in this context
  - a discussion on the impact the machine learning is having in this context.
- Correctly cite the sources used and create a bibliography at the end of the report.

Deep learning

Deep learning is a type of machine learning that is used for more complex problems. It does not require structured data, but instead uses artificial neural networks. A neural network that consists of more than three layers is considered to be a deep-learning algorithm. We will look at neural networks in the next section.

Applications of deep learning include facial recognition, image recognition, natural language processing and speech recognition.

Pattern recognition

Pattern recognition uses machine learning algorithms to recognize patterns; these can be either observed physical patterns or mathematical patterns. Pattern recognition is used for many different purposes.

Data analytics

Data analytics is used in stock market forecasting and audience research. In stock market forecasting, pattern recognition is used to analyse the changing values in the stock exchange in order to make predictions. Audience research, such as Google Analytics, uses pattern recognition to analyse user data for market segmentation.

Natural language processing

Natural language processing uses machine learning to teach a computer to understand human language. It has multiple uses today including:

- text analysis, which is used to convert unstructured data into structured data ready for analysis; examples include analysing surveys or customer call notes
- plagiarism detection, which is used to analyse text and compare to sources on the web, for example, Turnitin
- text generation for chatbots, such as customer service chatbots on websites
- text translation, which uses text analysis, word substitution and sentiment analysis to recreate messages in different languages, for example, Google Translate
- text correction, used in grammar correcting apps, for example, Grammarly.

Image recognition

Image recognition is used to understand what is in a picture so that it can describe the picture and the image can become more searchable. Two uses of image recognition include:

- image search – Google's image search uses both pattern recognition and meta data in its search algorithms

- facial recognition – recognizing someone from using their faceprint is used in numerous applications, for example, to unlock a phone or spot someone in a crowd.

Facial recognition for identification

Voice and sound recognition

Voice and sound recognition works by analysing patterns of sound that can be converted into text and applied to natural language processing. This can be used in:

- AI assistants, so that users can interact using voice commands
- speech-to-text and text-to-speech translation, which allow users to convert spoken words into text on the screen and vice versa; one example is the use of automatic caption creation on video websites such as YouTube.

Sentiment analysis

Sentiment analysis can interpret someone's mood or intent using pattern recognition. This is commonly used in audience research or customer relationship platforms to gain more information about a customer's response to a product or service.

REAL-WORLD EXAMPLE

Sentiment analysis at KFC

The fast-food chain Kentucky Fried Chicken (KFC) used sentiment analysis to monitor their brand and manage their reputation. They used this analysis to review the success of different aspects of their marketing campaign, for example the use of RoboCop in their advertisements. Sentiment analysis was used to make decisions about the campaign based on insights from posts and comments made by consumers reacting to the campaign on social media.

https://theappsolutions.com/blog/development/sentiment-analysis-for-business/

ATL ACTIVITY

Research

Use research skills to further your knowledge on deep learning.

- Use effective online search skills and digital resources from the school library to find out more about the applications of deep learning.
- Find one real-life example for facial recognition, image recognition, natural language processing and speech recognition.
- Write a report to include:
  - an explanation on how it is being used in the real-life example
  - a discussion on the impact it is having in this context.
- Correctly cite the sources used and create a bibliography at the end of the report.

Activity: HL Extended Inquiry

3.6 Artificial intelligence (content) and 5.1B Changing populations

Challenge: The UK government has the challenge of an aging population.

Investigate the challenge in more depth.

- Who is being impacted by this challenge?
- To what extent is an aging population a problem for the UK government?

Intervention: A three-month trial to monitor elderly people in one region of the UK was initiated in August 2021. Sensors were installed in the homes of elderly people and were used to monitor their movement, temperature and the use of appliances. The system, powered by artificial intelligence, was able to monitor the behaviour of elderly people and determine if a potential health problem needed human attention.

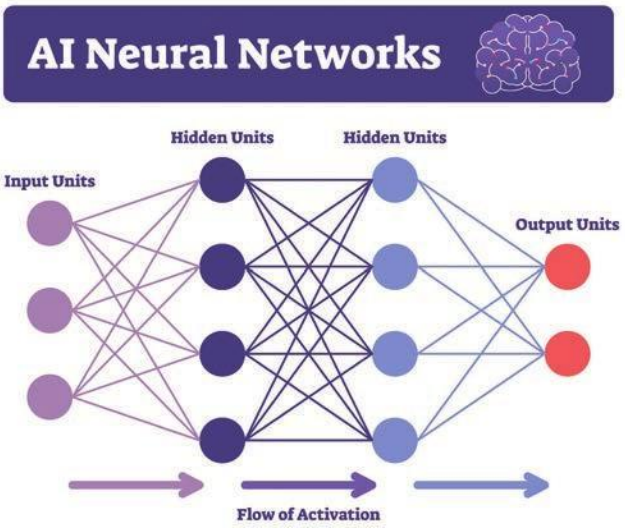
Research and evaluate this intervention using the HL extended inquiry framework.

Make a recommendation for steps for future action.

Present your work in the form of a written report.

3.6C Uses of artificial neural networks

Neural networks are systems with interconnected nodes that work in a similar way to the neurons in the human brain. Nodes are activated when there is sufficient input, which in turn provides input for the next series of nodes, and so on (depending on how many levels there are) until it produces an output. The connections between these artificial neurons act in a similar manner to real synapses, enabling signals to be transmitted from one node to another. The signals move from one hidden layer to another, being processed on the way as they travel from the first input to the last output layer. When given input stimulus, the neurons run mathematical calculations to figure out if there is enough information to pass the information on to the next neuron. For example, data inputs received are added up and, if the sum is more than a certain threshold value, the neuron 'fires' and activates the neurons it is connected to.



A simple neural network with three input neurons and two outputs

Description of steps

- Data is fed into a neural network through the input layer, which communicates with hidden layers.
- Processing takes place in the hidden layers through a system of weighted connections.
- Nodes in the hidden layer combine data from the input layer with a set of coefficients and assign appropriate weights to inputs.
- These input-weight products are then summed up.
- The sum is passed through a node's activation function, which determines the extent that a signal must progress further through the network to affect the final output.
- Finally, the hidden layers link to the output layer, where the outputs are retrieved.

The key advantages of neural networks are:

1. They can learn and model non-linear and complex relationships. This is really important as many scenarios in real life are non-linear.
2. They can generalise and infer relationships from unseen data.
3. They do not impose a restriction on the input variable.

Neural networks and deep learning are currently used in image processing and forecasting.

REAL-WORLD EXAMPLE

GitHub

The GitHub coding program uses a model called Codex, which uses a large artificial neural network to predict text and computer code. It uses billions of lines of code stored on GitHub to learn how to write code, not all of which is bug free.

www.wired.com/story/ai-write-code-like-humans-bugs

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1. Identify two types of artificial intelligence. *[2 marks]*
2. Describe two uses of machine learning. *[4 marks]*
3. Distinguish between two types of machine learning. *[6 marks]*
4. For one context of your choice, to what extent has artificial intelligence been making a positive impact? *[8 marks]*

Activity: HL Extended Inquiry

3.6B Types and uses of machine learning, 3.6C Uses of artificial neural networks (content) and 5.3C Managing pollution and waste

Once you have studied Section 5.3C, try this inquiry activity.

Challenge: Research and describe the global challenge.

- Use effective research skills to identify one global challenge related to the management of pollution and waste.
- Describe the challenge in detail.

Intervention: Research and evaluate one intervention for this challenge.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

3.6D Evolution of AI

Artificial intelligence features strongly in the imagination of many famous science fiction writers, who offer a futuristic look at our lives to come. One of the most violent depictions of an AI-dominated world was *I have no mouth and I must scream*, written by Harlan Ellison in 1967 in which artificial intelligence killed all but five of the human race.

Ellison was one of the first writers to understand that a machine with consciousness and emotions (a sentient machine) would face the same horrors as a sentient human.

But how has artificial intelligence moved from science fiction to reality?

Although the fifth generation in computing is said to have started in 2010, the roots of artificial intelligence started much earlier than this. In the period between the 1940s and 1960s, there was a strong desire to bring together the functionality of machines and organic beings. Research into artificial intelligence officially began in 1956 at the Dartmouth Conference, which aimed to unify research in **cybernetics**, automation and complex processing, thus allowing machines to 'think'. Key researchers include Norbert Wiener, a pioneer in cybernetics, John McCarthy, Marvin Minsky and Claude Shannon.

◆ **Cybernetics**: The study of communication and control in both living things and machines, especially automatic control systems such as the human nervous system, and mechanical–electrical communication systems.

In the 1950s Alan Turing was credited with being one of the first people to come up with the idea that machines could think. We talked about him earlier in this unit. While the technology remained promising, the popularity of artificial intelligence developments has had its peaks and troughs. An **AI winter** is a period in which funding and interest in research and development of artificial intelligence is reduced. The first AI winter occurred between 1974 and 1980. Researchers at the time had made promises about artificial intelligence developments that did not materialize. Consequently, many agencies cut their funding.

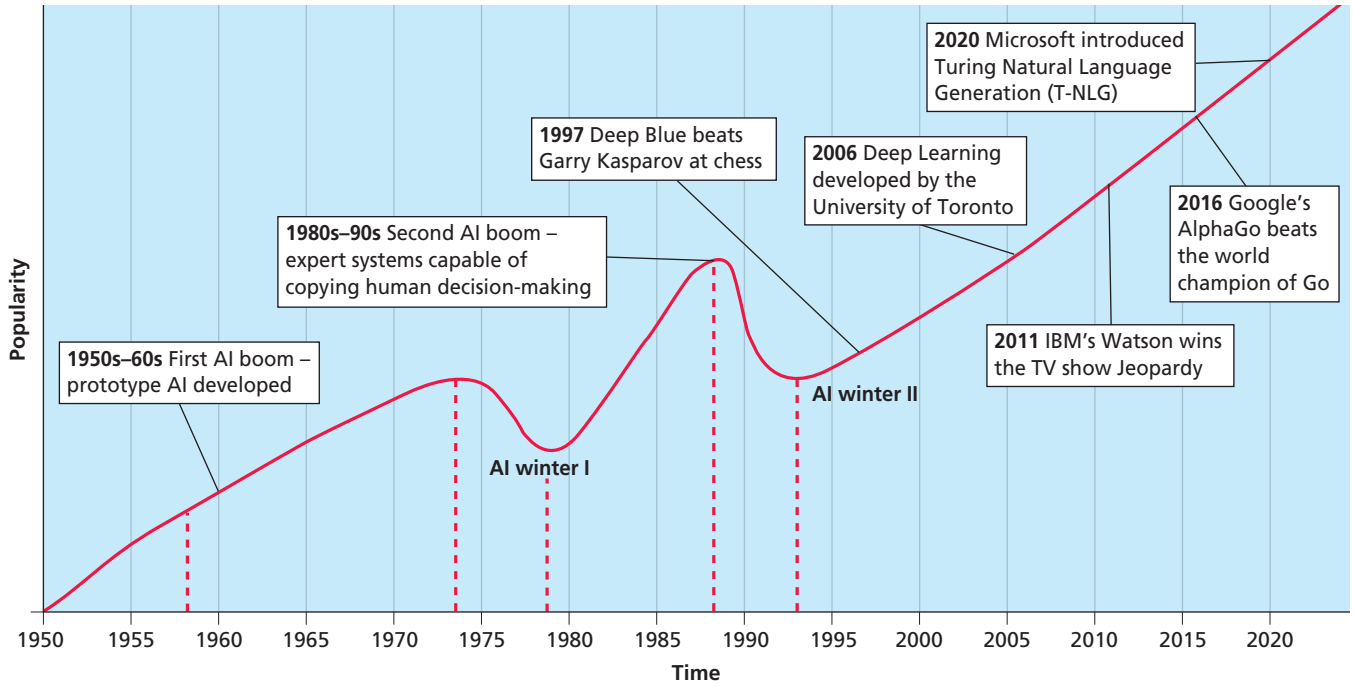
The next peak in artificial intelligence was the development of **expert systems**. They were considered a move in the right direction and focused on very specific problems. The first expert system, named Dendral, was developed to analyse chemical compounds by Edward Feigenbaum and Joshua Lederberg at Stanford University in 1965. Expert systems became very popular in the 1980s. They attracted funding from technology companies and the government. However, the market for expert systems collapsed and brought with it a second AI winter.

In technology, as artificial intelligence has evolved, so has the concern for the future of civilization. Two key thinkers of the time predicted a future where technology growth would be out of control and be irreversible, with the boundary between humanity and computers being removed. This concept and the term **singularity** were popularised by Vernor Vinge in 1993. Ray Kurzweil published his book *The singularity is near* in 2005, in which he predicted that singularity would be achieved by the year 2045 using super-human artificial intelligence.

There was another boom in the late 2000s and early 2010s, this time with the advances in machine learning and deep learning. Two factors can explain the new boom in this area. The first was the availability and access to massive amounts of data (big data) and the second was the developments in computer graphic cards and microprocessors, making the increased processing capabilities needed for artificial intelligence possible. These developments became the focus of many large tech companies and triggered an **AI summer**.

With AI summers leading to an increase in artificial intelligence development, the public have become concerned about what artificial intelligence might mean for future jobs. Alongside the predictions of singularity came the concern that many human jobs would be replaced by artificial intelligence. This has been seen in the manufacturing industry, with many robot-driven factories. However, Ken Goldberg, a roboticist at the University of California, Berkeley, believes that instead of artificial intelligence and robots replacing all jobs in the future, they will instead be developed to work alongside people. He called this **multiplicity**.

◆ **Multiplicity**: A future in which artificial intelligence and robots are developed to work alongside people, rather than to replace them.



Timeline of AI winters

EXAM PRACTICE QUESTIONS

Paper 2

Source A: Article View on Artificial General Intelligence is overhyped

At the start of the 2010s, one of the world leaders in AI, DeepMind, referred to artificial general intelligence (AGI) being developed at some point in the future. Deep Mind believes that machines possessing AGI would be just as smart as humans across the board.

However, AI researchers (who wish to remain anonymous) say that statements like these were overhyped by certain companies and believe that society is entering a period where they are especially sceptical about AGI, and that we are about to enter another AI winter. The AI researchers state that 'there is a general feeling of plateau' and that 'AI is entering a new phase [in which] the public perception of AI is increasingly dark: the public believes AI is a sinister technology.'

When the reporters requested a response to the claim, DeepMind took a more optimistic view of AI's potential, suggesting that as yet 'we're only just scratching the surface of what might be possible'. While AGI isn't going to be created any time soon, machines have learned how to master complex activities such as:

- playing the board game Go
- identifying human faces, plant and animals
- translating text into practically every language
- driving cars.

Adapted from **www.bbc.com/news/technology-51064369**

Source B

Find a current article written by AI researchers on the 'Success of Artificial General Intelligence'.

1 a **Identify** two characteristics of an 'AI winter'. *[2 marks]*

b **Explain** the difference between artificial general intelligence (AGI) and domain-specific AI. *[4 marks]*

c Use the source above, your additional source and your knowledge of the uses of AI to, **compare** the claims and perspectives made by the artificial intelligence researchers and the companies creating artificial intelligence solutions, and the impacts that artificial intelligence will have on society. *[6 marks]*

d With reference to the two sources and your knowledge of artificial intelligence, **discuss** whether **changes** in artificial intelligence have been incremental or radical. *[12 marks]*

Top tips

When working on Paper 2 there will always be more than one source to analyse. Practice gathering sources with different perspectives so that you can read similar or opposing viewpoints.

Inquiry

3.6D Evolution of AI (content) and 2.1 Change (concepts)

Research how past events, patterns or trends in artificial intelligence will help forecast the future developments in artificial intelligence.

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

Use your research skills to find three sources to further your understanding of this inquiry.

Your final choice of sources must be able to help you gain a deeper understanding of this topic, provide a balance of claims and perspective, and be embedded in the content (artificial intelligence) and concept (change).

Write a short report to justify your chosen sources and their usefulness in this inquiry. Your report should include:

- a discussion on the origin and purpose of each source, including any potential bias or limitations of using the source
- a discussion of the main ideas being presented in each source and what features of the source were used to support the claim being made
- a discussion on how the sources corroborate or contradict, and how it has helped you gain a deeper understanding of this question
- a bibliography entry for each source at the end of the report.

3.6E AI dilemmas

Earlier in this unit we discussed the different algorithms and uses of artificial intelligence, and how they have evolved. The development of artificial intelligence is important for many reasons. Firstly, it allows for the **automation of the discovery of data** and can automate certain computerized tasks more reliably and without getting tired. For example, when detecting fraudulent transactions, artificial intelligence can operate 24-7 and send alerts for human intervention. Artificial intelligence can also **add intelligence to existing products**, such as our home appliances or security intelligence in the workplace.

Since artificial intelligence is **adapting through learning** and can **analyse data** more deeply, it can be more reliable in classifying and making predictions. Developments in deep learning have made artificial intelligence systems more accurate and are consequently being widely used in the medical field, for example analysing MRIs for cancer.

Data is now more important than ever before. With the right data and sophisticated artificial intelligence, more and more answers are being provided. However, the design and use of artificial intelligence is creating a number of global dilemmas.

Fairness and bias

One limitation of artificial intelligence is that it learns from the data sets that are fed into the system. This means that any inaccuracies in the data will be reflected in the results. This has been particularly evident with systems designed on biased data sets or algorithms. It is the role of artificial intelligence designers and developers to minimize algorithmic bias through research and data collection that represents the whole population.

REAL-WORLD EXAMPLE

Twitter

In May 2021, a study of 10,000 images found bias in what Twitter's photo crop algorithm chose to highlight. The algorithm was more reliable in selecting lighter-skinned faces compared to those with darker skin. Twitter has stopped using the tool on its mobile app following the discovery.

www.wired.com/story/twitter-photo-crop-algorithm-favors-white-faces-women

Accountability in design and use

In the development of artificial intelligence, developers are responsible for the designs, developments, outcomes and impact that the system has on the world. This becomes increasingly difficult when one considers the range of uses and different types of artificial intelligence that are being developed.

When discussing accountability, several questions should be asked:

1 How does accountability change if the end-user has more influence over an artificial intelligence system?

REAL-WORLD EXAMPLE

Tay

Microsoft's AI chatbot Tay made inappropriate statements on Twitter and was taken offline after only 16 hours. Tay was programmed to imitate the language of 18–24-year-old millennials and to talk and engage with people, learning from the users' conversations. However, the users purposefully provoked Tay with inappropriate discussions, which Tay then repeated.

www.analyticsinsight.net/famous-ai-gone-wrong-examples-in-the-real-world-we-need-to-know

2 How does accountability change if the artificial intelligence is being used to support decision-making or make decisions on its own?

REAL-WORLD EXAMPLE

Uber's autonomous vehicles

Uber's real-world testing of autonomous cars in San Francisco in 2016 reported that the autonomous vehicle had made the decision to not stop at six red traffic lights when being tested. The testing included the use of vehicle sensors, networked mapping software and a driver in case the autonomous vehicle went out of control. This example shows how it is difficult to determine who is accountable when technology goes wrong. At the time of testing, Uber reported that it was the fault of the driver.

www.analyticsinsight.net/famous-ai-gone-wrong-examples-in-the-real-world-we-need-to-know

www.ibm.com/design/ai/ethics/accountability

ATL ACTIVITY

Thinking

In a group, conduct some wider research on the topic of accountability in the design and use of artificial intelligence. Hold a discussion to address each question.

1 How does accountability change if the end-user has more influence over an artificial intelligence system?
2 How does accountability change if the artificial intelligence is being used to support decision-making or make decisions on its own?

Transparency in design and use

Artificial intelligence should be designed so that humans can understand its decision-making process easily. The solution to this is **transparency**. As artificial intelligence's capabilities increase, so does the impact it has on society. Consequently, it should be possible to explain its decision-making to people clearly, and for people to see how its conclusions and recommendations have been formed. This is essential if developers want end-users to trust the systems. People should be aware that they are interacting with an artificial intelligence system at all times, even if the designers would like a flawless experience.

However, as deep learning algorithms evolve over time, it is very possible that developers will not be able to explain the 'black box' nature of the artificial intelligence system. Unlike traditional programs, developers cannot just examine the code to test it for bugs to make them more reliable or to see the decision-making process clearly. As users of artificial intelligence technology, if it is not performing as expected we would want to know why.

There are four main problems:

1. **Unexplainable algorithms**: When artificial intelligence is drawing a conclusion, whether during classification or regression, there is no visible understanding of how it was reached.
2. **Lack of visibility in training data sets**: It is not always clear where the training data has come from, whether it has been cleaned, or even if it is accessible.
3. **Lack of visibility in methods of data selection**: Even if developers were given access to training data, this could be petabytes of data. However, they may not know which aspects of the data was actually used. For transparency, one would want to know how the training data was used.
4. **Poor management of model versioning**: As models are continuously developed, it is sometimes difficult to keep track of which version is being used.

As society strives for greater transparency, it can come with its weaknesses as well. If people can understand how an artificial intelligence is reaching its decisions, it poses two threats:

- it is easier for hackers to try to work around the system
- it is easier for competitors to steal the artificial intelligence algorithms.

REAL-WORLD EXAMPLE

Apple's credit card service

In November 2019, the US financial regulator set up an investigation into claims that Apple's credit card service was offering different credit limits to men and women. The cause of this discrimination was unclear but it was speculated that it was due to biased data sets or a lack of transparency in how the algorithms were determining what the final credit limit should be.

www.bbc.com/news/business-50365609

ATL ACTIVITY

Thinking

Prepare for a debate about the transparency of artificial intelligence algorithms.

- Divide your group of friends into two: one side are pro-transparency, the other against.
- Research in more depth about the transparency of artificial intelligence.
- Conduct the debate.
- At the end of the debate, as a group take a vote on whether artificial intelligence should be more transparent.

AI's carbon footprint

The University of Massachusetts Amherst completed a research paper that estimated that the carbon emissions when training a neural network are the same as that of a car. Factors that influence the carbon footprint include:

- the algorithm and its training time
- the processing unit
- the energy efficiency of the data centre
- the type of energy used in the data centres.

CodeCarbon, an open-source project, is being developed to estimate the carbon footprint of computing. The aim of the project is to help data scientists make more environmentally friendly decisions.

Uneven and underdeveloped laws, regulations and governance

The rapid pace of artificial intelligence adoption has created a strain on existing regulations, with laws struggling to keep up. In the early 2020s, Cognilytica released a report based on an investigation into the actions taken by countries around the world. It concluded that many countries were not rushing into developing laws and regulations on artificial intelligence, instead they were waiting to see how the technology was being used before they came up with a meaningful law. Another area researched was the level of discussion regarding the restrictions of lethal autonomous weapons systems (LAWS). At the time of the report, only one country, Belgium, had passed legislation on this, with 13 countries engaged in discussions.

In the meantime, this leaves the technology companies in a dilemma, because without the laws, their technology may not be legal to operate. For example, for autonomous vehicles to be allowed on the roads, laws must be written to permit them. In this report, only 24 countries had laws allowing for the operation of autonomous vehicles.

Another aspect of artificial intelligence that is gaining regulatory attention is user data rights. Since developments in artificial intelligence require large data sets to train with, it is no surprise that these data sets may include data from people, collected by the IT systems they have signed up for. This makes it all the more important that organizations comply with data protection laws.

ATL ACTIVITY

Research

Conduct effective online research on artificial intelligence legislation.

- Research existing artificial intelligence legislation in two countries (where you live and one other country).
- Focus on legislation in one of these artificial intelligence technologies:
  - facial recognition
  - autonomous vehicles
  - conversational artificial intelligence, such as chatbots
  - LAWS.
- Compare and contrast the legislation between each country.
- Suggest reasons for any differences.

Automation and displacement of humans in multiple contexts and roles

Alongside the rapid development of artificial intelligence comes concern about how the widespread use of artificial intelligence will impact employment. Will it replace jobs, will it support existing jobs, or will it create new jobs?

One limitation of artificial intelligence is that it is only capable of narrow tasks or intelligence; humans possess a more generalized intelligence that will continue to be important.

The World Economic Forum concluded that advances in artificial intelligence could potentially replace a large proportion of jobs. Artificial intelligence used to automate tasks is predicted to replace 75 million jobs by 2025. In 2020, 2.7 million industrial robots were found in manufacturing, completing heavy-duty work or completing tasks with high precision. Food preparation was another area where jobs have been lost to **automation**, as well as construction and driving jobs.

◆ **Automation**: The increased use of technology in a process, which reduces the need for human involvement.

The most vulnerable group of people likely to lose jobs to artificial intelligence are those with lower-level qualifications. More-educated employees will be required to adapt to the technological changes or will be in senior management roles that still require human judgement.

The same World Economic Forum report predicted that artificial intelligence will also create 133 million new jobs. Jobs in sectors such as health, education, scientific and technical services will be least affected, and employment opportunities will be based on what artificial intelligence and robots are not capable of. Jobs that require care and understanding, for example caring for elderly people, will still be in demand, especially in countries with an aging population.

REAL-WORLD EXAMPLE

Alibaba's FlyZoo Hotel

Developed by Alibaba, a 290-room hotel in Hangzhou, China, promises to be the hotel of the future. It utilizes many technologies that have already been established in other hotels, including self-service kiosks for checking in, artificial intelligence-driven apps to allow travellers to book their stay, and facial recognition to gain access to rooms and elevators. Each room has a voice-activated smart assistant that can help the guests customize their room temperature, lighting and entertainment, and robots can deliver room service or perform other concierge services.

The main aim of this level of automation is to provide a better service for guests, reduce staffing costs and free up employed staff to give a more individualized service.

https://hoteltechnologynews.com/2019/03/flyzoo-hotel-the-hotel-of-the-future-or-just-more-technology-hype

ATL ACTIVITY

Research

Look for personal relevance in this research activity.

- Research the industry that you are planning to have a career in.
- How is artificial intelligence being used in this industry?
- What jobs are being replaced by artificial intelligence?
- What jobs have been created by artificial intelligence?

Inquiry

3.6E AI dilemmas (content) and 4.4A Medicine and health (contexts)

Analyse	Analyse impacts and implications for relevant people and communities • Is your inquiry question supported by additional questions to consider for analysis and evaluation? • Does your analysis focus on the impacts and implications for people and communities? • Is your analysis effective, sustained and well-supported by evidence?
Evaluate	Evaluate impacts and implications for relevant people and communities • Is your evaluation based on your analysis? • Does your evaluation focus on the impacts and implications for people and communities? • Is your evaluation effective, sustained and well-supported by evidence?

Select one artificial intelligence dilemma and research how it is impacting either the delivery of medical diagnostics, medical research, or monitoring of health and well-being.

- Discuss how the artificial intelligence is causing the dilemma.
- Discuss the impact this dilemma is having on two stakeholders, for example patients and health care workers.
- Evaluate the significance of the dilemma.

Communicate	Presentation • Is your presentation organized in a logical manner and is the media used to communicate effectively? • Does your presentation lead towards answering the inquiry question? • Does your presentation include findings, emerging trends, future developments and further insights?

- Present your findings in a multimedia presentation.

Activity: HL Extended Inquiry

3.6 Artificial intelligence (content) and 5.1C The future of work

Once you have studied Section 5.1C, try this inquiry activity.

Challenge: Research and describe the global challenge.

- Use effective research skills to identify one global challenge regarding the future of work.
- Describe the challenge in detail.

Intervention: Research and evaluate one intervention for this challenge.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

TOK

Knowledge and technology

Developments in artificial intelligence raise many questions about knowledge.

- What do the developments in artificial intelligence mean for knowledge?
- Should we redefine our human concept of knowledge because of developments in artificial intelligence?

The kind of knowledge produced by technology empowered by artificial intelligence is not always ethical. Because this field of technology is relatively new, with varying legislation in different countries, there is potential for unethical uses to arise. As we saw in this chapter, claims made by artificial intelligence systems to be able to determine a person's behaviour using facial recognition could potentially lead to discrimination. So, how can one ethically define the limits of progress in knowledge that has been created by an artificial intelligence system?

Extended essay (EE)

The evolution of artificial intelligence, its uses and its intended and unintended consequences may give rise to some interesting topics for an extended essay.

One possible focus for the essay could be how a specific artificial intelligence technology is impacting a particular context, such as human knowledge and the design and delivery of formal education.

Creativity, activity, service (CAS)

Complete an online AI course

Teach yourself more about artificial intelligence by completing an online course. This may be an introductory course that will teach more theory related to artificial intelligence, or a technical course to develop skills in creating artificial intelligence. Before starting, conduct some initial research into which online platforms provide IT courses. Perhaps your school is already registered with one that can be used, or see what free courses are available.

Select the platform and the course to register for. Work through the required activities and don't forget to document the journey for CAS.

Reflection

Now that you have read this chapter, reflect on these questions:

- What type of artificial intelligence are you surrounded by day to day?
- Are traditional tests for artificial intelligence effective for the current developments in artificial intelligence?
- How are machine learning and neural networks making IT systems more intelligent?
- In which contexts is artificial intelligence having a significant impact?
- To what extent should expert systems be used to replace or support human experts?
- Is it possible to develop artificial intelligence algorithms without bias?
- Should limits be imposed on the development of artificial intelligence?
- To what extent is current artificial intelligence legislation a barrier for artificial intelligence development and adoption?
- How can analysing past trends in AI winters and summers help predict the future of artificial intelligence?
- How is artificial intelligence being used as an intervention to solve global environmental and employment issues?
- How is artificial intelligence changing how we know things?

Learner profile

Inquirer

Develop skills in inquiry to research the topics in this unit in more depth, for example the artificial intelligence legislation where you live, the use of artificial intelligence in the world around you, and the dilemmas that artificial intelligence is creating.

3.7 Robotics and autonomous technologies

UNDERSTANDINGS

By the end of the chapter, you should understand that:

- robots and autonomous technologies demonstrate a capacity to sense, think and/or act with some degree of independence
- robots and autonomous technologies have evolved over time and are increasingly ubiquitous, pervasive and woven into the everyday lives of people and communities
- robots and autonomous technologies introduce significant opportunities and dilemmas in digital society.

Robot – a word that was first introduced to society in a science fiction play in 1921 – is now a reality and becoming more prevalent in our lives. Robots have transformed manufacturing by increasing efficiency, safety and accuracy, but at the cost of replacing jobs on the production line. Robot designers are now turning their attention to the development of service and social robots, aimed at working alongside humans. In this chapter we will investigate different types of robots and autonomous technologies and where they are being used, alongside the dilemmas that these developments have brought about.

◆ **Robot**: A programmable machine that can complete a set task with little or no human intervention.

3.7A Types of robots and autonomous technologies

It is important to establish what we mean by the term 'robot'. Essentially a robot is a programmable machine that can complete a set task with little or no human intervention.

It has taken decades to develop the robots that are integrated into today's society. Later in this chapter we will discuss how they have evolved over time but, to get started, it is important to look at the wide range of robots that are in use today. Robots have evolved over time in two distinct categories: robots used in manufacturing, and robots designed for human interaction. In this section we will also look at other autonomous technologies, in particular autonomous vehicles and drones.

Industrial robots

The demand for robots in manufacturing has been one of the driving forces in robotics from the 1960s to the present day. Robots used in manufacturing complete tasks such as drilling, painting, welding, assembly and material handling. Industrial robots are different from those used for professional service robots based on their purpose. Industrial robots completing tasks in manufacturing have replaced many human workers on the production line, while service robots often perform tasks by assisting workers or customers, for example, in agriculture or the construction industry.

Advances in robotics used in manufacturing are ongoing with organizations always looking for greater efficiency and accuracy on their production lines.

REAL-WORLD EXAMPLE

Automation in car production

In 2014, Great Wall Motors, a Chinese automotive manufacturer, increased automation in their plant with robots collaborating on different parts of the production line. For example, one robot would position the panel while a second robot would do the welding.

According to the American Society of Mechanical Engineers, the Taiwanese electronics company Foxconn announced plans to increase automation by 30% in their Chinese plants by 2020, which would ultimately replace 60,000 jobs.

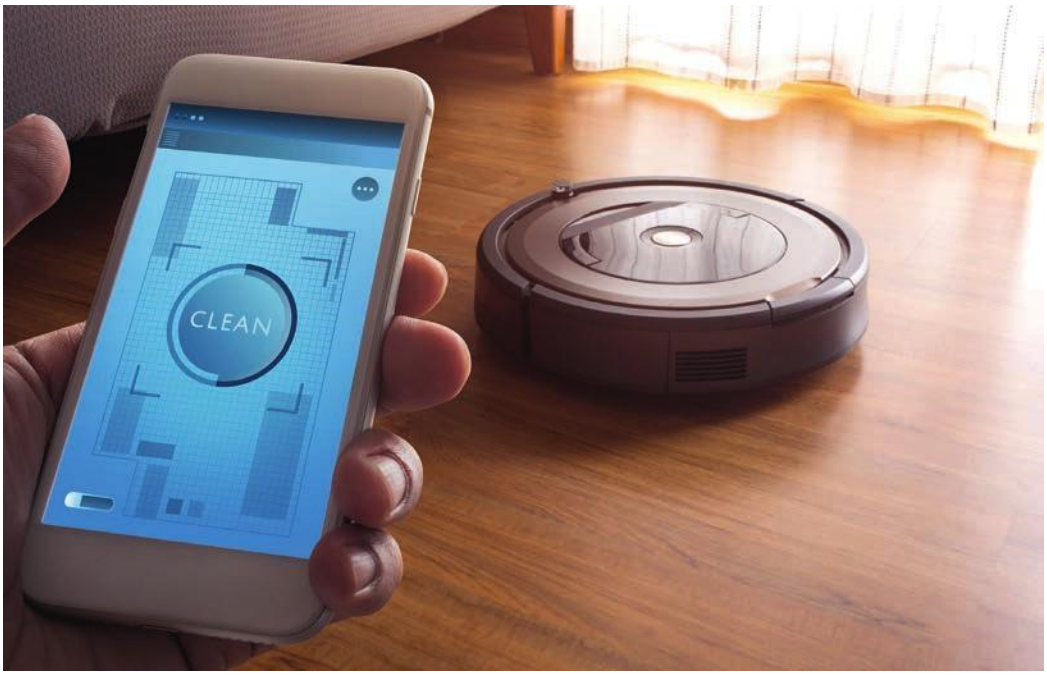
www.asme.org/topics-resources/content/top-5-robot-jobs-manufacturing

Service robots

Service robots have been developed to assist humans in completing tasks that are less desirable, such as dull, dirty or dangerous jobs. This category of robot may be for domestic or professional use and is growing in demand because it frees up humans to do other things, which could include more challenging tasks or allowing individuals to have more leisure time.

◆ **Service robots**: Robots developed to assist humans in completing tasks that are less desirable, such as dull, dirty or dangerous jobs.

Personal service robots used in the home include robots that can vacuum, clean the pool, mow the lawn and even robotized wheelchairs for elderly people. These robots can be programmed to complete the task and work autonomously. For example, robot vacuum cleaners are becoming more common in homes: they are affordable, can vacuum your house while you are out and have features such as self-emptying bins.



Robot vacuum

Virtual personal assistants

Virtual personal assistants, such as Google Home, Amazon Echo or Apple HomePod, are voice-controlled helpers mainly found in smart speakers or mobile phones. Once connected to the home network, a user can use voice commands to prompt different activities, such as providing a weather update, setting a timer or reading out the latest news.

◆ **Virtual personal assistant**: Voice-controlled helpers mainly found in smart speakers or mobile phones.

REAL-WORLD EXAMPLE

Virtual assistants

In 2018, Hampshire County Council, UK, trialled the use of virtual assistants to support elderly people and people with disabilities. Users with limited mobility benefited from being able to use the voice-activated devices to complete tasks such as turning on smart home devices, searching for information and activating entertainment, which then allowed carers to focus on other tasks in the home.

www.bbc.com/news/av/uk-politics-43869120

A **professional service robot**, on the other hand, is for commercial use. These service robots may clean public places (windows and floors), make deliveries, complete inspections for maintenance and even assist in surgery. There are a wide range of professional service robots in operation today – too many to list in this book. Most professional service robots are semi-autonomous or fully autonomous, they have some mobility and can interact with people, and can be found in the retail, hospitality and health care industries. Others may be used in more challenging environments, such as space, defence or agriculture.

◆ **Professional service robot**: Semi-autonomous or fully autonomous robots developed to assist humans in commercial settings.

Safety is an important consideration for companies when introducing robots because they can handle dangerous jobs or jobs that are repetitive and unpleasant for people. Another benefit of service robots is that they can work efficiently, accurately and with very little downtime.

REAL-WORLD EXAMPLE

Flippy 2, the grill chef robot

In 2017, Tech Crunch reported on Flippy, a 'grill chef' robot that was introduced in an American fast-food chain, CaliBurger, to overcome the staffing problem experienced by the chain of restaurants. Preparing foods over a hot grill all day long is an unpleasant, repetitive task, making it ideal for a service robot. The next generation, Flippy 2, is integrated with the kitchen ticket system and uses sensors and machine learning to fry foods to perfection.

https://techcrunch.com/tag/flippy/, https://misorobotics.com/flippy-2/

Social robots

Social robots differ from service robots because they have a different purpose. Where service robots are used for dirty, unpleasant jobs, social robots are designed to interact and communicate with humans in a socially acceptable manner. Social robots are increasing in demand in the workplace, for example, customer service robots or home companion robots for elderly people. Social robots can be programmed to perform many routine tasks, but they may lack empathy or emotion and do not always respond appropriately to unknown situations. Such limitations raise dilemmas, especially if these types of robots become fully autonomous.

REAL-WORLD EXAMPLE

Jibo

Jibo, a social robot for the home with a face like a cartoon, no legs and curvy body, was designed to provide friendship and companionship. It uses facial and voice recognition. It was designed to be a voice assistant and can answer questions, read the news and provide weather updates along with being compatible with many smart home devices.

https://medicalfuturist.com/the-top-12-social-companion-robots

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two examples of autonomous technologies. *[2 marks]*

2 Outline one use a social robot may have in a health care environment. *[2 marks]*

3 Distinguish between social robots and service robots. *[4 marks]*

4 With reference to a real-world example, discuss whether social robots should be used as 'companion robots' for elderly people. *[8 marks]*

REAL-WORLD EXAMPLE

Aerobot

Aerobot is a robot assistant at Istanbul Sabiha Gökçen International Airport. It communicates in more than 20 international languages and uses AI technology to profile approaching passengers in order to customise conversations. Aerobot also reminds passengers about airport health policies, reads barcodes, answers flight inquiries, and guides passengers to their boarding gates.

www.malaysiaairports.com.my/media-centre/news/social-robots-introduced-part-airports-40-initiative

ATL ACTIVITY

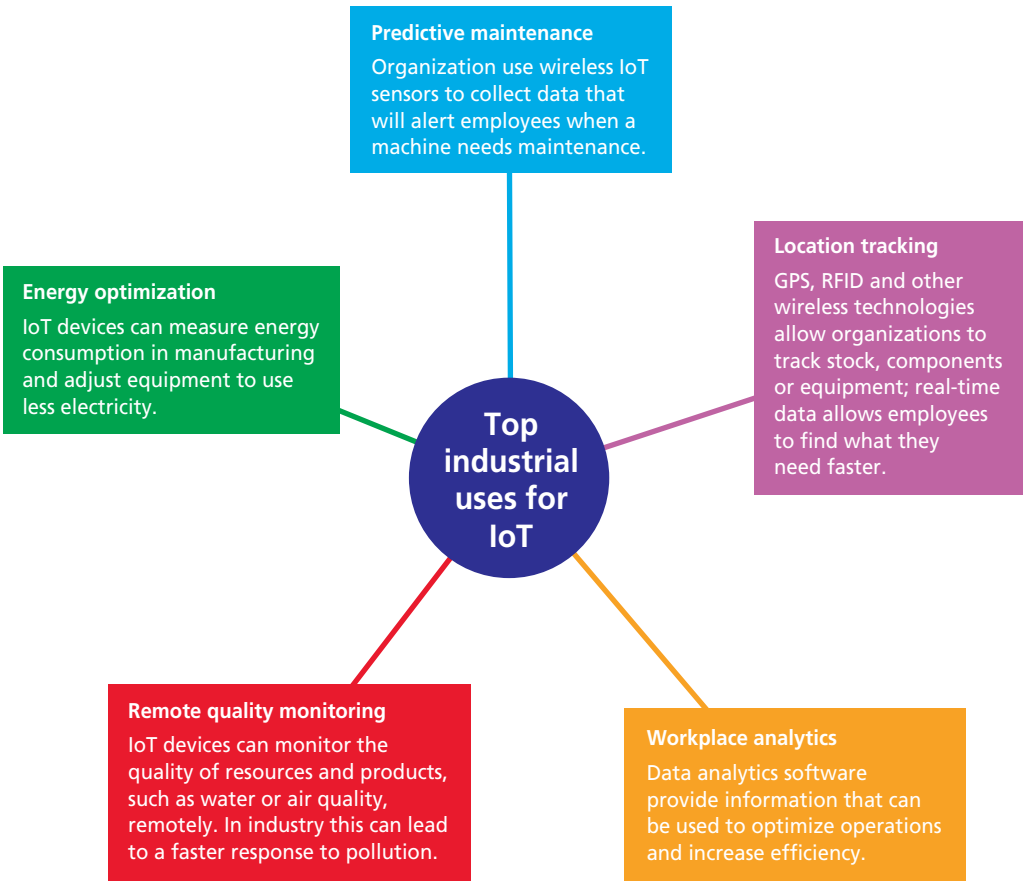
Research

Research the use of service robots in a context of your choice.

- Select one of the contexts from 4.1 Cultural to 4.7 Social.
- Research service robots in this context using the digital resources provided by the school library and effective online search skills.
- Design a poster to communicate your findings to your parents.
- Your poster should include details about several robots being used in this context.
- For each robot include:
  - a title, image, and description of the task the robot performs
  - an outline of the impact this robot is having on the user
  - a statement to support why you selected this robot
  - a prediction of the future of the robot, for example, will it still be in use in the next 10 years or will it become obsolete?

Internet of things (IoT)

Earlier forms of IoT used by businesses included RFID (radio-frequency identification) tags to track the location of assets or deliveries. Now, businesses can add sensors to their components to collect even more data that can be analysed to increase the efficiency of their production lines or services. In industry these autonomous technologies are also having similar benefits to those found in the home (see Chapter 3.4) but on a much larger scale.



Top five industrial uses for IoT

ATL ACTIVITY

Research

Research the growth of IoT in different markets.

- Use the internet to research statistics about IoT adoption.
- Identify the trends of adoption in one of the following segments: utilities, security, manufacturing, transportation and retail.
- Present your findings in a suitable chart.

Links

This content links to Section 4.3C Cities, infrastructures and built environments.

Autonomous vehicles (AV)

Many of today's traditional car manufacturers are in a race to dominate the autonomous or semi-autonomous car industry in the face of increased competition from technology companies such as Waymo or AutoZ. An **autonomous vehicle** has the ability to operate without human intervention and can drive itself.

◆ **Autonomous vehicle**: A vehicle with the ability to drive itself and operate without human intervention.

You may have experienced autonomous vehicles at the airport, transporting you from one terminal to another, or in a city with driverless taxis. There are different levels of autonomy as categorized by the Society of Automotive Engineers (SAE). Levels 0 to 3 include low levels of autonomy designed to augment a driver. Levels 4 and 5 do not require a driver.

Different levels of autonomy

- **Level 0**: A traditional car with zero automation. It may include cruise control, which can be turned on for long distances, or warning signs, for example when reversing or warnings for blind spots.
- **Level 1**: Driver assistance – provides features such as adaptive cruise control, which keeps the vehicle a safe distance from the vehicle in front, and lane keep assistance, to prevent the vehicle from veering out of its lane. Many newer models of cars include these features.
- **Level 2**: Partial automation – assists drivers by controlling steering and speed. It is similar to autopilot but requires the driver to have their hands on the wheel, ready to take back control should they be needed.

REAL-WORLD EXAMPLE

Mercedes-Benz' self-parking car

The Active Parking Assist system PARKTRONIC uses a range of sensors to determine if a car can fit into a parking spot and automatically steer the car while the human controls the brakes and gears.

www.waltersmercedesbenzofriverside.com/what-is-park-assist-in-corona-ca

- **Level 3**: Conditional automation – vehicles that can drive themselves but only under certain conditions. The driver does not need to have their hands on the wheel but must be seated in the driver's seat. For example, the car could drive automatically in a traffic jam.
- **Level 4**: High automation – vehicles that can drive themselves without human interaction and are available on public roads subject to a country's regulation. Vehicles of Level 4 or 5 do not require a steering wheel or pedals, as there is no human driver. Trialled uses of Level 4 autonomous vehicles include driverless taxis and public transport services, where vehicles can be programmed to travel between two geographical points. However, Level 4 vehicles will only operate if certain conditions are met; for example, they may only function under certain weather conditions.

REAL-WORLD EXAMPLE

Singapore's driverless taxis

In August 2016 Singapore became the first country to trial a driverless taxi on public roads using a Mitsubishi i-MiEV electric vehicle. The service was limited to 10 people who were able to use a smartphone app to call the taxi to one of 12 locations in Singapore. The service was limited to non-peak hours and was planned to be rolled out to the public in 2018.

To what extent are driverless taxis are used now in Singapore?

www.straitstimes.com/singapore/transport/worlds-first-driverless-taxi-trial-kicks-off-in-singapore

- **Level 5**: Full automation is the highest level of automation, has no restrictions and, to date, has yet to be achieved. It is intended to be fully responsive to the road conditions and other vehicles on the road, so will not be restricted by the weather and can travel to any geographical location.

The prospect of widespread use of autonomous vehicles promises benefits such as fewer traffic accidents, reduced traffic congestion and energy savings.

Although many car manufacturers are striving to develop the technology for Level 4 and 5 automation, there are many obstacles to overcome, including:

1. **Sensors**: Autonomous vehicles use a wide range of sensors to 'see' the environment around them and feed this data back to the control system. Bad weather, heavy traffic and road signs with graffiti provide a challenge for these vehicles.
2. **Machine learning**: Is is being used by autonomous vehicles to detect and classify objects within the path of the car. The system then uses this information to decide how to act, for example, brake or swerve to avoid the obstacle. At the time of writing, industry agreement on standards for training and testing the artificial intelligence is a challenge.
3. **Deep learning**: As autonomous cars are continuously learning on the road; the industry must determine how to ensure that the vehicle continues to be safe as it learns.
4. **Regulations and standards**: Governments need to work with manufacturers to develop the regulations and standards required to allow autonomous vehicles to operate on public roads. Governments also need to consider international standards so that autonomous vehicles can operate across borders.
5. **Social acceptability**: There have been several high-profile accidents involving autonomous vehicles in the news. Trust needs to be built up in the community in order for them to become more socially acceptable.

ATL ACTIVITY

Thinking

Conduct wider research and discuss these questions with your peers.

- What will the future of our world look like if we achieve Level 5 automation?
- Will there be any unintended consequences?
- How will autonomous vehicles change car ownership?
- How will the demand for space in our cities change?

Inquiry

3.7A Types of robots and autonomous technologies (content) and 2.5 Space (concepts)

Inquiry focus: How will developments in autonomous vehicles affect the future use of space within urban areas?

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

Use your research skills to find three sources to further your understanding of this question.

Your final choice of sources must be able to help you gain a deeper understanding of this topic, provide a balance of claims and perspective, and be embedded in the content (autonomous technologies) and concept (space).

Write a short report to justify your chosen sources and their usefulness in this inquiry. Your report should include:

- a discussion on the origin and purpose of each source, including any potential bias or limitations of using the source
- a discussion of the main ideas being presented in each source and what features of the source were used to support the claim being made
- a discussion on how the sources corroborate or contradict, and how it has helped you gain a deeper understanding of this question
- a bibliography entry for each source at the end of the report.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

Analyse the inquiry focus by answering the following questions about spaces and the use of autonomous vehicles using your research.

- How is information transferred between digital objects, autonomous vehicles and the road infrastructure in a digital society?
- How is this different from the non-autonomous vehicles being used on the roads?
- How will the use of autonomous vehicles change the use of space in urban areas?
- How will autonomous vehicles affect how people experience specific spaces and locations?
- Spaces usually have laws connected to them – how is this changing with the use of autonomous vehicles?

EXAM PRACTICE QUESTIONS

Paper 2

Source A

Sensors used in autonomous vehicles

1 Define the term 'autonomous vehicle'. *[2 marks]*

2 Explain how sensors would be used by autonomous vehicles to avoid obstacles in the road. *[4 marks]*

Drones

A **drone**, also known as an unmanned aerial vehicle (UAV), is a flying robot that can either be remote controlled or autonomous. In the past, drones were commonly associated with the military and had three main purposes: they were used for anti-aircraft practice, to gather data from the sensors attached, or used with weapons to make military attacks. Nowadays drones have both commercial and private uses, with businesses using drones for delivery, surveillance, search and rescue operations, and personal use to capture video footage.

◆ **Drone**: A remote controlled or autonomous flying robot.

Drones have two main functions: flight and navigation. For flight, the drone needs to be lightweight, include propellers and have enough power to last the duration of the journey. For navigation, built-in systems such as GPS are used so that they can communicate their exact location to the user. Fully automated drones require a wide range of sensors to be able to function, as well as hosting sensors for data collection.

REAL-WORLD EXAMPLE

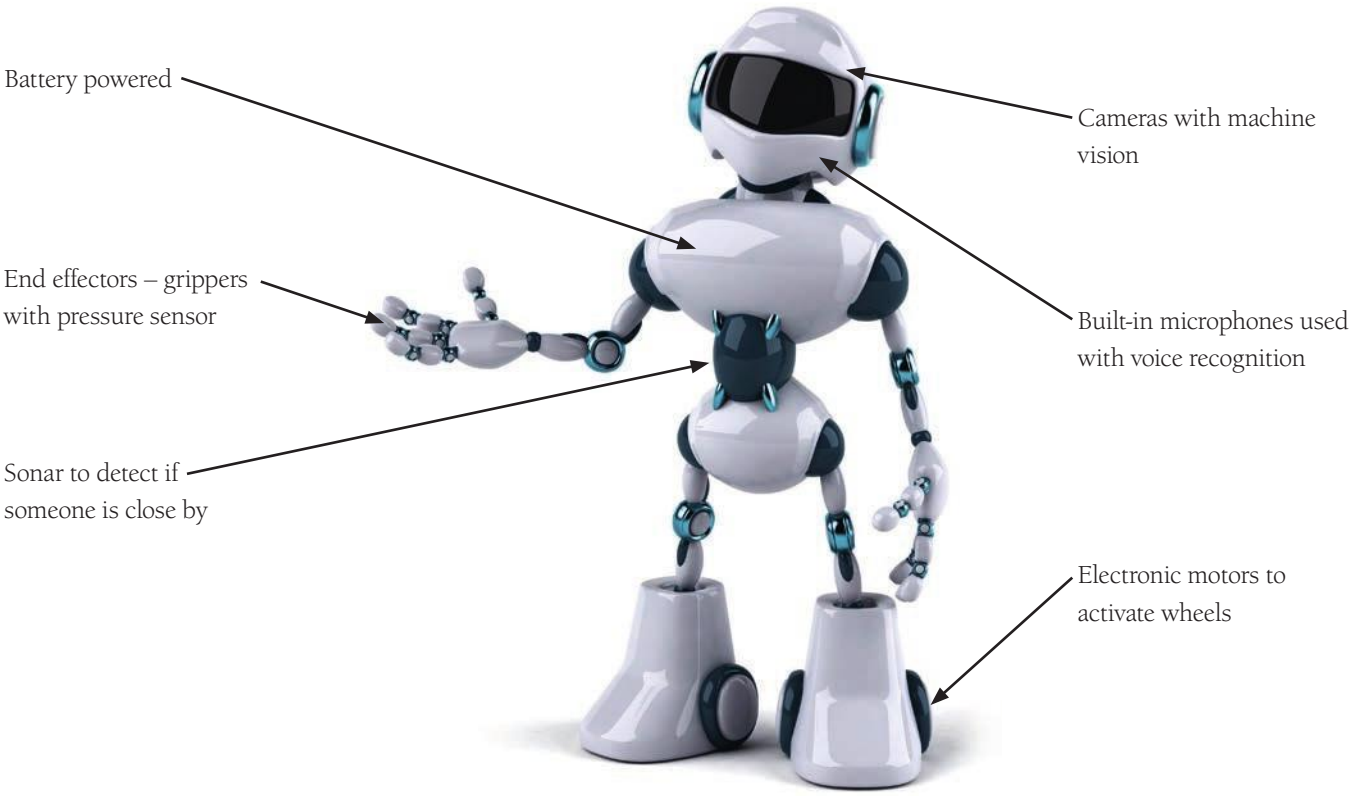
Commercial use of drones

Drones may be used for making deliveries to remote locations, completing everyday tasks such as fertilizing crops, or monitoring traffic. In Ghana, a company called Zipline uses drones to deliver medical supplies to approximately 2000 medical centres.

www.freightwaves.com/news/six-drone-delivery-use-cases-and-lessons-for-companies-to-use

3.7B Characteristics of robots and autonomous technologies

We have already looked at the amazing array of robots being used today. Developments in artificial intelligence mean that data collected by sensors is better perceived and understood by robots, while improvements in agility and mobility have allowed them to move more fluidly around their physical environment.



Characteristics of a robot

Sensory inputs for spatial, environmental and operational awareness

With the help of a number of technologies, robots are able to perceive their environment in a similar way to which humans perceive the world with their five senses:

- **Vision**: Firstly, a robot needs to see its surroundings; in the same way that people use their eyes, robots use **digital cameras** to capture images within range. Two cameras (stereo vision) are needed for image recognition, which allows the robot to have depth perception. However, understanding what a camera can see is more complex, so other technologies are used to help perceive the environment.

  Light sensors can be used to detect changes in light levels and inform the robot if it is night or day so that it can perform different functions accordingly. Simpler robots can use **infrared or ultrasound sensors** to 'see' objects. Essentially, the robot emits beams of infrared light or sound signals to determine how far away an object is based on how long it takes for the signal to bounce back. **GPS satellite navigation** can inform a robot of its exact geographical location in a physical space.

  More sophisticated robots, such as autonomous vehicles, use other sensors to detect their environment, including **lidar** (light detection and ranging), **sonar** (sound navigation and ranging) and **radar** (radio detection and ranging). Like the infrared sensor earlier, they measure the time it takes for the light, sound or radio waves to bounce off an object. Lidar can measure the shape and contour of the ground, including the height of objects; sonar can measure the depth of water; and radar can detect moving objects and map the shape of the environment.
- **Hearing**: Robots can use a microphone to collect sounds, which are then converted into electrical signals used for processing. Combined with voice recognition (discussed in the previous chapter), the robot can 'understand' what is being said.

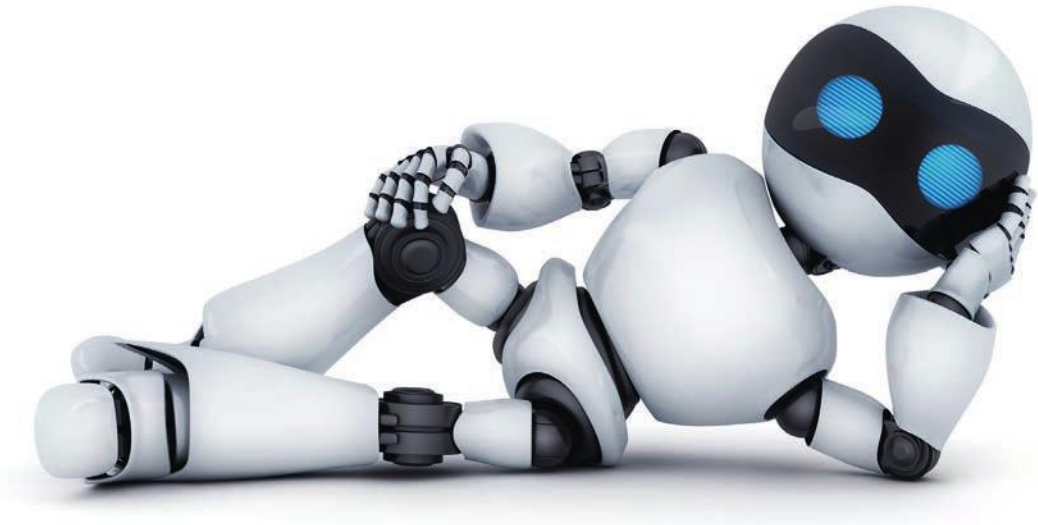
- **Smell and taste**: For a robot to be able to smell, it needs the right kind of **chemical sensor**, which collects data, converts into an electrical signal and uses pattern recognition to identify the origin of the smell. Likewise, taste also requires appropriate chemical sensors; for example, a food-tasting robot may use a pH sensor.
- **Touch**: Depending on the type of end effector, **pressure sensors or resistive touch sensors** are used to determine how strong a hold a robot has on an object so that it does not drop it or break it. Alternatively, a **capacitive touch sensor** can be used where the robot detects an object, including the human touch, that conducts electricity. Temperature sensors can also be built into robots; a robot may be required to perform a certain function when a particular temperature is reached, for example, a firefighting robot may navigate to the hottest part of a room.

The ability to logically reason with inputs, often using machine vision and/or machine learning

The robot's computerized control system is used for decision-making and will take the data collected by the sensors, process it and send a command to the actuators and end effectors. The robots that we talked about earlier would have varying degrees of artificial intelligence. Robots with basic artificial intelligence can be used to **solve problems in limited domains**. For example, a robot will collect data through its sensors, compare this data to its stored data, run through possible scenarios and select the optimum action. Simple robots on a production line may use this level of artificial intelligence, for example an inspection robot could determine if a particular product was within the approved limits.

More recent robots use machine learning to learn within a limited capacity. For example, developing a robot that can walk like ASIMO (see next section) demonstrates how the robot's skills in walking have been developed. Machine learning is being used to make robots intelligent and, ultimately, more useful. For example, let us review some of the developments we discussed in the last chapter. Supervised learning could be used by the most basic of industrial robots, such as a robot on a production line that needs to select different part types – it would be able to do so with the parts that it was trained with. Alternatively, reinforcement learning enables robots to learn, improve and adapt to their environment, as happens in autonomous vehicles. **Machine vision** has made great progress due to deep learning. It has improved depth and image recognition, which makes robots even more useful on a production line as they can work with greater accuracy.

The ability to interact and move in physical environments



Almost all robots have some parts that can move. This may be moving parts in a robotic arm on a production line, or motorized wheels that allow a service robot to roam around a hotel lobby. All moving parts will use an **actuator**, which may include an electric motor, a hydraulic system (driven by incompressible fluid) or a pneumatic system (driven by compressed gas). Each of these actuators needs power to operate. A mobile robot, for example, would use a battery, while a static robot would be powered by the main electricity supply.

While actuators will control the 'joints' of the robot, a peripheral device is usually attached to make these actuators useful. These devices are called **end effectors**. End effectors are either mechanical or electromechanical and can be used to grip objects and attach tools or sensors.

◆ **Actuator**: A device that moves or controls some form of mechanism.

◆ **End effector**: A mechanical or electromechanical peripheral device that can be used to grip objects and attach tools or sensors.

- **Grippers**: The most common of end effectors allow robots to pick up and manipulate objects. This is particularly useful on an assembly line.
- **Process tools**: These are tools for completing a specific task, for example tools for welding, spray painting and drilling.
- **Sensors**: We talked about sensors earlier; they are especially useful for applications such as robot inspections.

The demonstration of some degree of autonomy

Strictly speaking, robots that are remotely controlled by humans are not actually robots. The level of autonomy defines how independently the robot can operate without a controller.

Semi-autonomous robots are robots that have some level of intelligence. They will be able to react to certain conditions without needing to be directed all the time. For example, a basic robotic vacuum can work autonomously with sensors that will stop the vacuum from hitting objects in its path and sensors to detect the level of debris. However, it is only semi-autonomous because, if you want to change its settings, it requires human interaction.

Fully autonomous robots operate independently, can accomplish more complex tasks and are generally more mobile. Currently they may be restricted to one working environment, for example a factory floor or shopping mall but, as digital technology advances, they will become more adaptable and more autonomous.

ATL ACTIVITY

Research

Research and produce an infographic about social robots.

- Select one of the contexts from 4.1 Cultural to 4.7 Social.
- Research using digital resources from the school library and effective online search skills.
- Select one social robot.
- Design an infographic to explain how this robot works.
- Your infographic should include:
  - an image of the robot
  - an explanation of how the robots 'sees', 'hears' and 'touches'
  - an explanation of how it processes the data
  - an explanation of its ability to move in and interact with its environment.
- Publish the infographic and request feedback from your peers.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two characteristics of a robot. *[2 marks]*

2 Explain three different ways a robot can perceive its environment. *[6 marks]*

Top tips

It is important to know the relationship between artificial intelligence and robots. For example, if you were to read about robot journalists online, are they referring to physical robots that are writing news articles or are they talking about artificial intelligence algorithms. Revise your definition of a robot to answer this question.

3.7C Evolution of robots and autonomous technologies

Early forms of robots and autonomous technology

The history of robots and autonomous vehicles is intertwined with developments in science, technology and artificial intelligence. There have been numerous developments in robots and autonomous technologies over time – too many to write about – so only a selection of important milestones are given here.

The idea of robots goes as far back as 1500BC with Egyptian water clocks using human figurines to strike the bell, or the period of around 400BC when Greek mathematician Archytas built a steam-powered mechanical bird.

Fast forward to the twentieth century and, in 1948, William Grey Walter created two autonomous robots, Elmer and Elsie. Both were shaped like tortoises and used three wheels for mobility. They could navigate themselves to a recharging station when needed.

In 1958, Charles Rosen led a research team at the Stanford Research Institute in developing a robot called 'Shakey'. Shakey could wheel around the room, observe the scene with its television 'eyes'. move across unfamiliar surroundings and make simple responses to its environment.

Robots in science fiction and philosophy

Before modern robots came to be in existence, they were found in science fiction stories. Czech writer Karel Capek introduced the term 'robot' in his 1921 play *Rossum's Universal Robots*, which was the first time that the word robot was formally used. The play was based on a man who created a robot but who was then killed by it – a common theme in many science fiction novels and movies.

In 1941, science fiction writer Isaac Asimov, wrote the three laws of robotics:

1 A robot must not injure a human being.

2 A robot must obey orders given by human beings, except if it conflicts with Law 1.

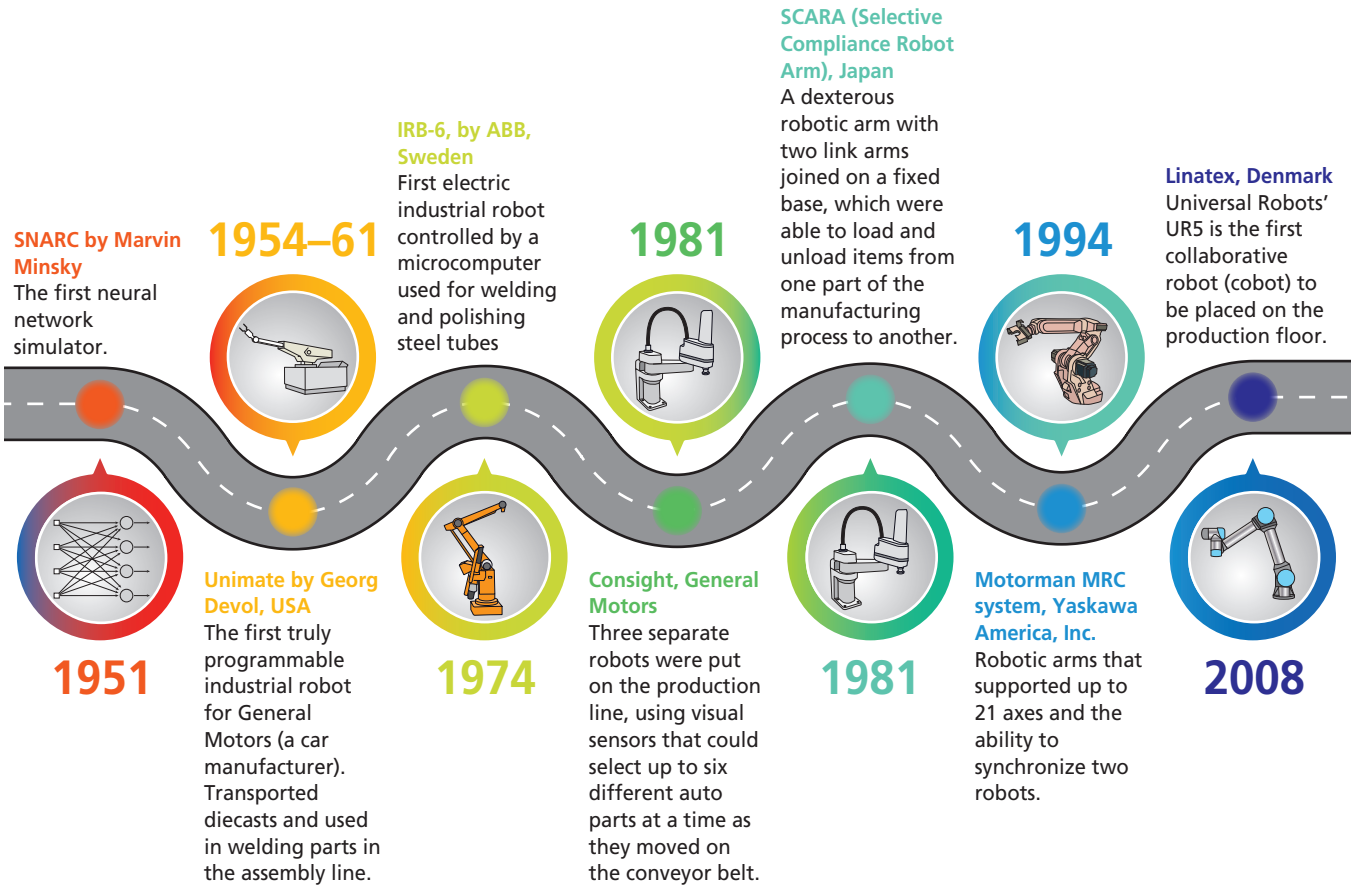
3 A robot must protect its own existence as long as it does not conflict with Laws 1 and 2.

The writer wrote numerous short stories about robots during the 1940s and 1950s. Later on, a 'zeroth' law was added:

0 A robot may not injure a human being or, through inaction, allow a human being to come to harm, unless this would violate a higher order law.

Robots designed for industry and manufacturing

Industry was a good place to start in the development of robotics as there was an obvious purpose – they were able to perform repetitive tasks and were capable of lifting heavy objects, making them ideal on a production line.



The development of robots

As developments in robots in industry have improved over time, they have been able to move faster, carry heavier loads, 'see' better, and handle more decisions. It is commonplace to see a robot assembly line in manufacturing today.

Robots designed to interact with humans

Many robotics researchers were developing more lifelike robots, called humanoids, and robot pets.

Wabot-1, Waseda University, Japan
First humanoid robot with machine intelligence that could walk, grip and carry objects, 'see' by measuring distances and communicate in Japanese.

ASIMO (Advanced Step in Innovative Mobility) Honda
A robot that could run, walk and climb stairs, kick a ball, sing and respond to voice commands

AIBO Sony, Japan
Robot pet that imitated dog-like behaviour. It used actuators for life-like movement in its head, neck and tail, and sensors to enable touch and sight.

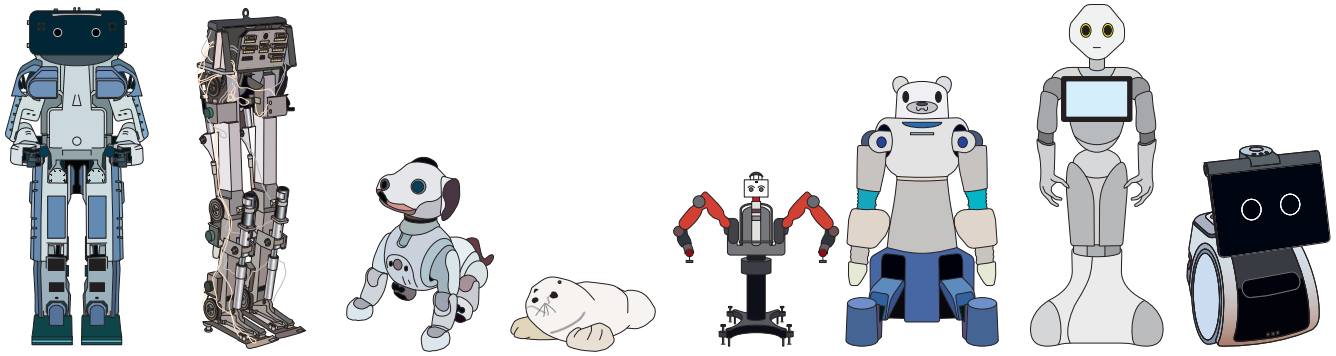
PARO, National Institute of Advanced Industrial Science & Technology, Japan
A therapeutic robotic baby seal used to reduce stress for patients.

Baxter by Rethink Robotics, Germany
First humanoid industrial robot developed for general use.

Robear, RIKEN-SRK Collaboration Center for Human-Interactive Robot Research and Sumitomo Riko Co.
A giant bear robot used as a hospital aid.

Pepper, Softbank Group, Japan
Child-size robot that can dance, make jokes and navigate around a room.

Astro, Amazon Lab126, USA
A home assistant robot referred to as Alexa on Wheels, which combines robotics, AI, home monitoring and cloud services.



[1973] [1986] [1998] [2004] [2013] [2015] [2018] [2021]

Robot evolution

Inquiry

3.7C Evolution of robots and autonomous technologies (content) and 4.4B The human body (contexts)

Inquiry focus: How are developments in robots being used to augment human abilities?

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

- Conduct research into one digital technology that is being used to improve quality of life, for example exoskeletons designed for war veterans, robot prosthetics or digital technology implants.
- Analyse the impact that this digital technology is having on the user.

Machine consciousness, cognitive robotics and robot rights

While weak artificial intelligence would have played a role in earlier robots designed to interact with humans, it is assumed that these robots did not have consciousness and could only simulate intelligence. For a robot to have machine consciousness, it requires the development of strong artificial intelligence.

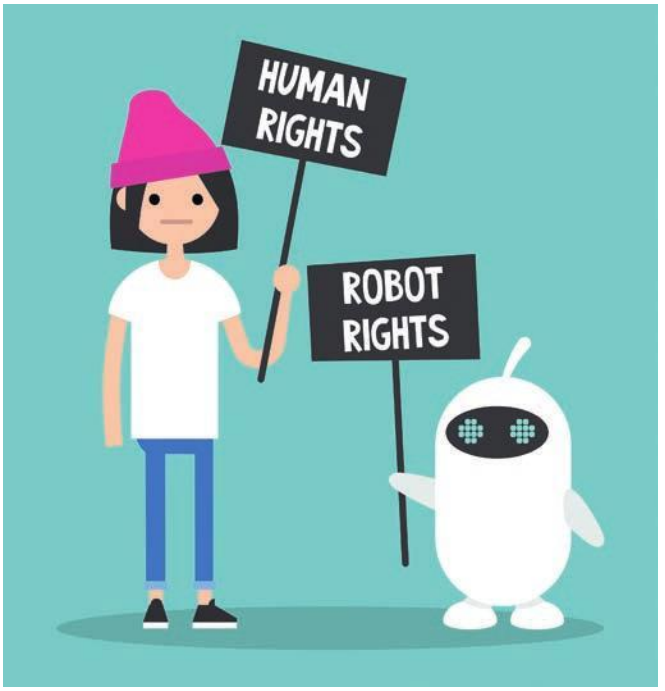
Cognitive robotics is an emerging field aimed at designing robots with human-like intelligence. The goal is to create robots that can perceive their environment, plan what they will do and deal with the uncertainty of the real world by continuous learning. An important aspect of cognitive robotics is the development of predictive capabilities and the ability to view the world from different perspectives.

REAL-WORLD EXAMPLE

Sophia

Sophia was a robot celebrity in 2016 thanks to her human-like features. The use of artificial intelligence, visual data processing and facial recognition enabled her to imitate human gestures and facial expressions; she could answer questions on predefined topics using speech-to-text technology and was designed to learn. Originally designed to help elderly people in care homes, Sophia became a celebrity when she was granted citizenship by Saudi Arabia. She became the first non-human to have a nationality. Although this was considered a publicity stunt at the time, it did raise some important questions. Should robots be granted rights?

https://delta2020.com/blog/224-rise-of-the-robots-should-we-give-robots-rights



As robots become more sophisticated with developments in artificial intelligence, the rights of robots are becoming a matter of serious policy debate. Although present-day robots may not yet have high-level cognitive abilities, what will happen when they do? How prepared are we? Most claims for rights (human or animal) are centred around the question of consciousness. Although it is hard to define consciousness, we know that it exists because we experience it. We are entitled to rights because we can feel pain or pleasure. Rights were introduced to protect us from anything that causes us pain and, as humans, we have been programmed to learn if something is fair or unfair.

ATL ACTIVITY

Thinking

Hold a discussion on the issue and questions regarding robot rights.

- If a robot became self-aware, would it deserve rights?
- Can robots feel pain or pleasure? What if they were programmed to do so?
- What if robots were programmed to recognize justice over injustice?
- What if robots develop these traits through deep learning?
- Do robots deserve rights?
- What happens if machines become conscious?

Inquiry

3.7C Evolution of robots and autonomous technologies (content) and 2.7 Values and ethics (concepts)

Inquiry topic: Is it possible to program values and ethics into a robot?

Complete all inquiry stages to address the focus question.

When analysing and evaluating the focus question, use the following questions:

- Do the designers of robots have an ethical obligation to their users?
- What happens when different ethical frameworks are applied to the issues of using robots in digital society?
- Can developers program values and ethics into robots that make decisions?
- Who decides what ethical framework robots should use?
- Does responsibility carry accountability as well?

Select the most suitable format to communicate your inquiry.

Top tips

Visit Section 1.4 to refresh yourself on all of the stages of the inquiry process.

3.7D Robots and autonomous technology dilemmas

Alongside the advances in artificial intelligence, parallel developments in robotics have had positive impacts on society. For example, robotic solutions are being developed to help people with disabilities, and manufacturing efficiency has increased. However, with benefits, come challenges and some unintended consequences. One such challenge is the uncanny valley.

Anthropomorphism and the uncanny valley

Human-like characteristics are frequently given to animals in movies, for example Paddington Bear and Winnie the Pooh, as well as non-human beings such as robots. This is called **anthropomorphism**.

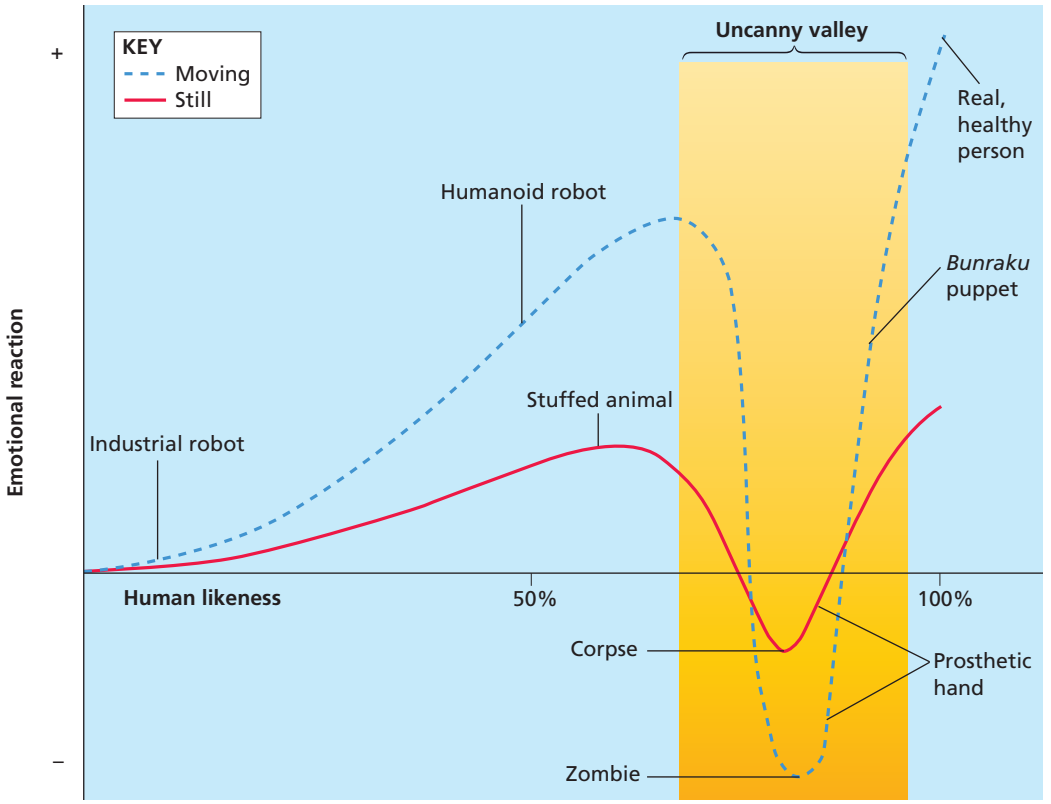
Let's look at two examples of robots: Pepper, with his adorable expressions, and Sophia, the lifelike robot that has been given residency in Saudi Arabia, and her uncannily lifelike expressions.

◆ **Anthropomorphism**: Attributing human characteristics to non-human entities.

■ Pepper

■ Sophia

The term **uncanny valley** describes the phenomenon of the eerie, unsettling feeling that people get when they interact with lifelike humanoid robots or lifelike computer-generated characters. The concept was introduced by Masahiro Mori in 1970, a professor at the Tokyo Institute of Technology. He observed that robots become more appealing as they become more human-like, but only up to a certain point. This point is called the uncanny valley. After this, there is a sense of unease and a negative reaction.



Masahiro Mori's 'uncanny valley'

This creates a dilemma for robot designers that design machines to operate in the human world that push the boundaries of biology, cognitive science and engineering. On one hand, the more lifelike a robot is, the more they are accepted in certain situations – for example, autistic children respond better to more lifelike robots, and they are more effective in training situations. On the other hand, if they are too lifelike, they will be less accepted by society.

ATL ACTIVITY

Thinking

Conduct a survey to investigate the uncanny valley.

- Create a survey that includes images of a range of robots, from non-lifelike to lifelike.
- Ask people to rate how appealing they find them and how creepy they are.
- Ask as many people as you can to complete the survey.
- Analyse the results.
- Write a conclusion to determine whether the results support the uncanny valley theory.

Complexity of human and environmental interactions

One of the main aims of robotic research is to create robots that can work effectively alongside humans, either doing the tasks that they do not want to do because they are too unpleasant or dangerous, or to augment human abilities. However, developing a robot to work alongside unpredictable humans in environments that are constantly changing is extremely challenging.

Cobots (robots designed to work alongside humans and augment their capabilities) are currently being developed to work cohesively with humans. For example, a cobot needs to understand human emotions, language and behaviour. Developing robots that can respond to human emotions may be considered a more desirable end goal, as these cobots will end up in the workplace or shop floor and will ultimately be more accepted if they can make eye contact, smile or behave in a more human-like way.

◆ **Cobots**: Robots designed to work alongside humans and augment their capabilities.

The aim may not be to develop an emotional robot, however, but one that can develop an emotional attachment from the human to the robot. In the 1990s, Cynthia Breazeal developed an 'emotional robot' called Kismet. Although the robot itself did not have emotional intelligence, it did provoke authentic emotional reactions in humans.

Similarly, developing a robot to interact with the environment is also challenging. Something as simple for humans as walking has required intense focus from developers to be able to mimic both animal and human's mobility across different terrain. Developments in machine learning and robot vision technologies are being used to overcome the challenge of navigating along a path with obstacles. Even if a robot is trained in a particular environment, the slightest alteration, such as a fallen tree or ice on the road, requires the robot to relearn and adapt to the environment. There will always be new situations for which a robot has not been prepared. Robots need to develop further to be able to operate in environments that are not already mapped out or that are unfamiliar to the robot. For example, there have already been cases in the news of accidents caused by autonomous vehicles.

REAL-WORLD EXAMPLE

Autonomous vehicles

In 2018, Elaine Herzberg was killed by an autonomous car in Tempe, Arizona, as she wheeled her bicycle across the road. Dashcam footage revealed that the car's safety driver was not paying attention to the road at the time, and therefore did not take over the steering wheel to prevent the accident.

www.bbc.com/news/technology-54175359

ATL ACTIVITY

Thinking

Prepare for a debate on emotional robots.

- Conduct wider research into the development of emotional robots.
- Divide the group into two: one group will support the idea that robots need to be designed to be emotional, while the other group will support the idea that robots need to be designed so that humans have emotional responses to them.
- Conduct the debate and, at the end of the session, take a vote.

Uneven and underdeveloped laws, regulations and governance

Minimizing privacy and security risks is a challenge not only for robot developers but for governments too. For example, the data used to train robots could be misused, ultimately causing the robot to malfunction, or the robot could be hacked for malicious purposes, putting not only personal data at risk but also the human lives interacting with the robot. There are always questions about how much we can depend on robots. There are also discussions about the ownership of data, for example who owns the data – the end-user, the robot manufacturer or the robot developer? Creating guidelines and legislation related to the use of robots is essential.

If we refer back to Asimov in the 1940s, his three laws (plus Law 0) have stood the test of time and are still used as guiding principles. However, with significant developments in technology, should new laws be considered?

One issue is that robots today are far more varied than envisioned by Asimov. Therefore, one must ask, should there be a level of complexity before the rules apply? Is there an agreed definition of what a robot is before the law can be applied?

Secondly, applying the laws as a blanket approach to all types of robots may be difficult. For example, military robots could be deployed on the battlefield and ultimately save the lives of civilians and soldiers alike, yet not comply with the first law (not allowing a human to come to harm). Laws on drones and autonomous vehicles may be developed by different authorities compared to robots used in manufacturing. Therefore, the laws may need to be adapted according to the context they are being used in.

ATL ACTIVITY

Thinking

Research each of these principles in more detail and hold a discussion about each one.

According to Professor Frank Pasquale, an expert on the law of artificial intelligence, four more principles should be introduced:

1. Artificial intelligence should complement professionals, not replace them. This is particularly important where a task requires judgement or decisions that are better done by humans
2. Artificial intelligence and robotics should not counterfeit humanity. For example, devices should not be developed to mimic human emotions.
3. Robotic systems should not intensify arms races. Developments in smart robotic weapons could easily spiral out of control and turn into an arms race.
4. Robotic systems must always indicate the identity of their creator, controller and owner. Greater levels of transparency and accountability are important, and necessary to deter illegal activities using robots.

Governments with advanced developments in robotics are prioritizing developments in legislation. For example, Asimov's laws inspired the South Korean government to work on the Robot Ethics Charter in 2007, with the intention of writing an ethical guide on the development and use of robots. This charter was designed to mitigate the problems associated with an aging population and the growth of service and social robots.

In 2016, the UK published a set of standards to guide the ethical design and application of robots. Although not legally binding, the aim of the publication was to make recommendations and raise awareness of the ethical issues associated with the use of robots and any potential negative impacts.

The EU funded a project to develop RoboLaw, which concluded in 2014. The outcome of the project was guidelines on the regulation of robotics. In 2017, the European Parliament launched a draft report urging governments to start discussing the issues related to the development of robots.

For robots to operate legally in the real world, robot designers need to comply with each country's regulations. If something should go wrong while being used, existing legislation would be applied in a court of law, with judges using the laws to make the final decision in a trial. For example, robot applications are considered to be products, and are therefore covered under laws such as the European Product Liability Directive or the US Restatement of Torts, Third. While this might be OK for a rogue robot vacuum cleaner that damages a carpet, the outcome may be more controversial in the case of autonomous vehicles and robot prostheses.

While product liability rules are there to promote high quality and safety in products, when it comes to more complex robots, legislation could ultimately deter developments in robotics, so a fine balance is needed.

Inquiry

3.7D Robots and autonomous technology dilemmas and 3.7A Types of robots and autonomous technologies (content)

Reflect

Reflect on new ideas and understandings, and discuss future developments

- Does your conclusion include a reflection based on new ideas and understandings that are a result of the analysis and evaluation?
- Does your conclusion include a discussion of possible new trends and future developments?
- Does your conclusion answer the inquiry question?

- Select a country of your choice and research how the development of regulations and laws is impacting one type of robot or autonomous technology, for example the regulation of autonomous vehicles in Singapore, or the regulation of service robots in South Korea.
- Reflect on the implications that these technologies are having on your chosen scenario.
- Provide a supported opinion about the future of legislation and the use of this technology.

Activity: HL Extended Inquiry

3.7D Robots and autonomous technology dilemmas, 3.7A Types of robots and autonomous technologies (content) and 5.1B Changing populations

Once you have studied Section 5.1B, complete this inquiry activity.

Challenge: Research and describe the global challenge.

Many developing countries have aging populations, which are predicted to create issues in the future.

- Use effective research skills to describe the challenge of an aging population in detail.

Intervention: Research and evaluate the use of social robots as one intervention for this challenge.

- Research and evaluate this intervention using the HL extended inquiry framework.
- Make a recommendation for steps for future action.

Present your work in the form of a written report.

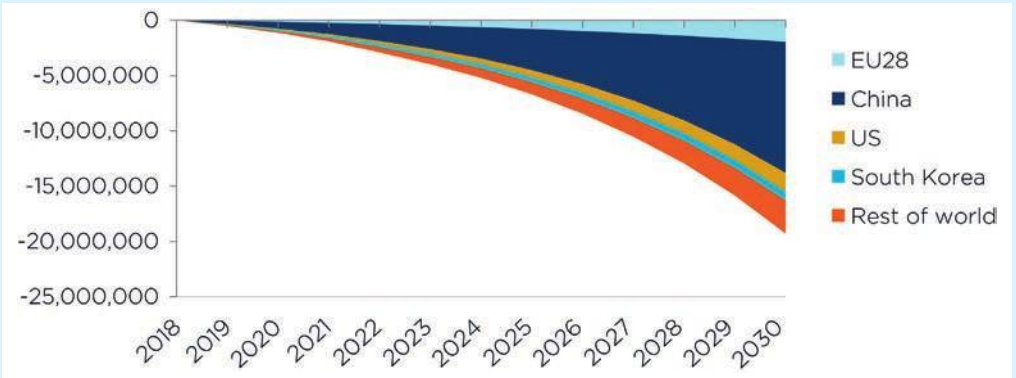
Displacement of humans in multiple contexts and roles

Earlier in this chapter we discussed the use of robots in manufacturing as well as the development of service and social robots. So, there is no doubt that these robots will impact the workplace – whether it is replacing jobs on a production line, or working alongside humans in the service industry.

REAL-WORLD EXAMPLE

Automation and job losses

In June 2019, Oxford Economics predicted that up to 20 million manufacturing jobs around the world could be replaced by robots by 2030. Automation is replacing lower-skilled jobs, with workers moving out of manufacturing into jobs in the transport, construction and administration industries, which are also likely to undergo a certain level of automation. This is a challenge for governments, which promote innovation on one hand but also need to address the issues of unemployment.



Projected cumulative jobs losses by automation, up to 2030

www.bbc.com/news/business-48760799

Links

This content links to 4.2B Employment and labour.

So, which industries will be susceptible to automation next?

Workers in the food industry spend a lot of their time performing physical tasks that are repetitive and in a predictable environment, therefore their jobs are more susceptible to being automated. Meanwhile, industries such as education and health care, which involve interpersonal work, are more likely to be an area for the cobots. Cobots can be medical assistants and monitor health conditions to alert human nurses when needed. They can also be used by law enforcement agencies or security companies for patrolling. In this instance, any suspicious activities would be referred to a human officer. However, despite cobots operating with humans, robots performing these routine tasks will still effectively replace some, if not all, of the lower-skilled jobs.

So, we may be looking at a future where we do not need taxi drivers, or car sales people (as we may no longer be car owners), but new jobs will also be created: jobs that assist robots in their learning, robot engineers, robotic technicians, robotic sales people, software developers and robotic operators to name just a few.

Inquiry

3.7D Robots and autonomous technology dilemmas (content) and 4.3D Agriculture (contexts)

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

Conduct research and then analyse your findings to address the following questions:

- How are robots being used in agriculture? In which areas are they replacing workers or working alongside humans?
- How is this affecting the industry?

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Define the term 'uncanny valley'. *[2 marks]*

2 Outline two reasons why robot developers would want humans to develop an emotional relationship with robots. *[4 marks]*

3 Explain two reasons why there are underdeveloped laws about the use of robots in some countries. *[6 marks]*

4 For one industry of your choice, evaluate the use of robots in the industry, using real-life examples to support your answer. *[8 marks]*

TOK

Knowledge and technology

The impact robots have had on knowledge has given rise to new ethical debates. When looking at the new knowledge being created by these machines, one may ask the following questions:

- Who is the owner of this knowledge?
- When an autonomous robot is required to make ethical decisions, who is responsible?
- What criteria should we use as a foundation for the ethical programming of these machines?
- Is it possible to have a global agreement?
- Is the absence of an emotional human an improvement on ethical decision-making by a robot?
- How can a robot be programmed when two ethical principles contradict each other?
- When looking at the scope of robots, what does it mean when a robot is said to 'know' something?
- Is it possible for robots to acquire knowledge?

Creativity, activity, service (CAS)

Robotics club

Research different clubs on offer at your school. Is there a robotics club? If so, see the club coordinator and offer to support the students and help by creating activities each week.

If there is no existing robotics club, see how many friends would like to join and set one up. This would make an ideal CAS project. You will need to find out what robot kits the school has, and seek approval, plan and design each session. Run the club for 8 to 10 weeks, and do not forget to reflect!

Extended essay (EE)

The evolution of robotics, its uses and the intended and unintended consequences may give rise to some interesting topics for an extended essay.

Look at one of these topics as a focus for the essay, for example, how a specific use of robots is impacting a particular context, such as health and the provision of health care.

Reflection

Now that you have read this chapter, reflect on these questions:

- What type of robots have you personally encountered?
- In which contexts are robots having a significant impact?
- To what extent are robots replacing humans in the workplace?
- To what extent is the community that you live in ready for autonomous vehicles?
- Should limits be imposed on robot developments?
- To what extent are current robot legislations a barrier for development and adoption?
- How are robots being used as an intervention for changing populations?
- To what extent is it possible to agree on the ethical decision-making by robots?

Learner profile

Principled

When discussing the many ethical debates surrounding the use of robots, consider your viewpoint on these moral dilemmas.

Section 4
Contexts

4.0 Overview of real-world contexts

UNDERSTANDINGS

By the end of the section, you should be able to:

- demonstrate knowledge of a range of real-world examples in different contexts
- understand the content and digital systems that are used in each real-world example
- relate each real-world example to relevant concepts
- understand how real-world examples will be used as a basis for Paper 1 and Paper 2
- extend some of the real-world examples to include challenges and interventions for higher-level topics.

When studying digital society, it is important to have an understanding of a range of real-world contexts and how they relate to the content and contribute to our overall understanding of the major concepts.

This section consists of seven chapters highlighting real world contexts with examples:

- cultural
- economic
- environmental
- health
- human knowledge
- political
- social.

The importance of the contexts section

The first chapter in this section starts with an exploration of **culture**. Culture encompasses all the 'ways we live' in a digital society, including traditions, customs, arts and creativity. Just as physical locations have their own unique cultural norms and expectations, digital spaces have their own sets of norms and cultures. Culture is also impacted by how we integrate digital technologies into our daily life and activities.

This is followed by an exploration of the **economic** context: the areas where digital tools impact business, employment, market and international activities. This chapter explores a diverse range of areas in which the nature of work has shifted due to our digital society, as well as the changes in markets, trade and commerce.

The **environmental** context encompasses how the creation and disposal of digital goods are impacting the environment, how technologies are being used to monitor the natural world, and how innovations are used to make our existing activities more efficient and sustainable.

The **health** chapter discusses the ways the medical profession is integrating digital tools for patient care as well as developing and refining their best practices and treatments. Additionally, this chapter explores how digital technology can impact the human body – both the risks and benefits of augmentation of the body with digital systems. Finally, the chapter concludes with an examination of the mental health concerns of life in a digital society, now that we are constantly connected and interacting in ways that were not possible just a few decades ago.

The impact of digital technologies on learning and education in both academic and professional settings are discussed in the **human knowledge** chapter. This includes formal and informal access to knowledge, as well as how the internet has made information and knowledge more accessible. This chapter also explores how discovery and innovation have evolved with the integration of digital technologies.

The **political** chapter looks at a wide range of topics including government use of technologies, such as the integration of digital technology in political campaigning. It also discusses the issues and challenges that arise in regulating digital technologies, including the emergence of cybercrime and digital warfare.

Finally, the **social** chapter explores how our demographics, class, family, location and other identity markers are impacted by technology. This section shines a light on digital divides, encouraging you to reflect on your own experiences and identities, and how your reality may differ from those with a different social background from you.

How to use this section

Each chapter contains an overview of the context as well as a sample of real-world examples and activities. You are encouraged to use these examples or to conduct your own inquiry activities. It is recommended to follow the inquiry process and consider:

1. Other examples where digital technologies or phenomena are relevant to the context or information from this section.
2. Multiple sources about the topic or digital technology you are investigating, especially those with differing perspectives and backgrounds.
3. Individuals and communities (stakeholders):
   - **a** at the local, regional and global level
   - **b** with various involvement such as end-users and creators of digital technology.

4 Brainstorm the positive and negative impacts of the technology on the stakeholders.

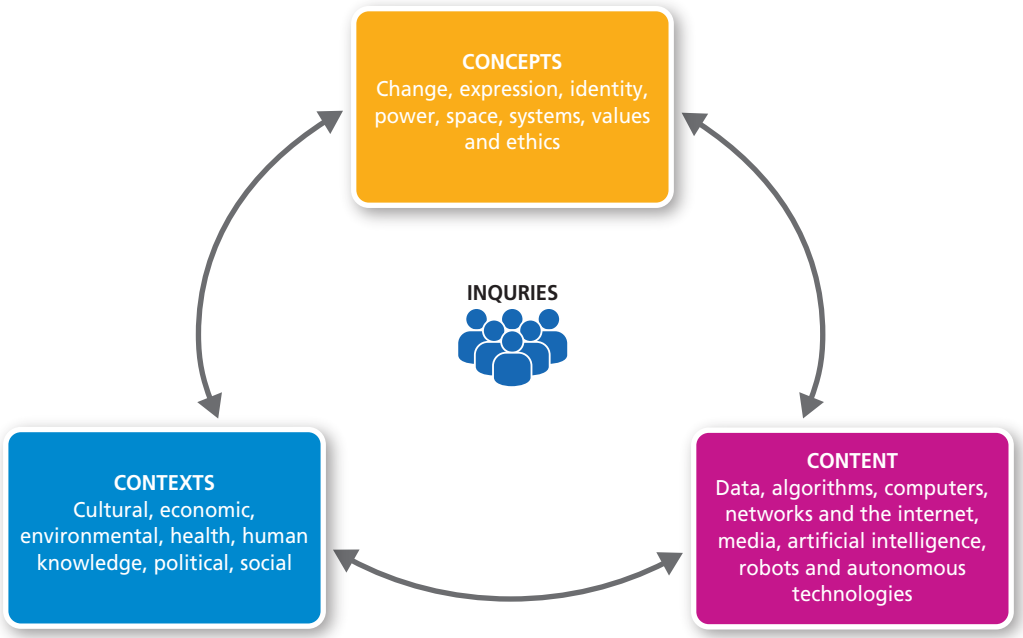
5 **Connection to concepts**: What concepts are most significant in the real-world example that enable you to look at it in different ways?

6 **Connection to content**: Ensure you can articulate the step-by-step process of how the digital technologies work and what relevant content will help you to understand that process.

7 Respond to the activities provided.

Context and the 3Cs

By completing inquiries in the context chapters, you will be able to apply all parts of the 3Cs diagram to each real-world example.



Digital society: Contexts

For the core syllabus for higher-level and standard-level students:

- Context: The specific real-world example as it relates to individuals or people and communities at a local or global level.
- Content: Digital systems and technologies used in the specific real-world example.
- Concepts: Relevant to the specific real-world example.
- Stakeholders: Consideration of the impacts and implications of the use of digital technologies.

Higher-level students may also extend the real-world examples from Section 4 to the HL extension challenges and interventions in Sections 5 and 6.

4.1 Cultural

UNDERSTANDINGS

By the end of this chapter, you should understand:

- innovations in digital technologies have changed the definition, creation process and sharing of cultural artifacts and traditions
- digital technology tools are integrated into our daily lives and activities, causing the evolution of both what people do and how they do it
- digital technology is both an asset and a threat to existing traditions and ways of being
- technologies have connected groups and subcultures, as well as created new spaces for youth engagement and connection.

This chapter examines our way of life in a digital society. It includes creative expression, as well as the tools, methods and approaches that are used to both generate and share media and other cultural artifacts.

Culture is also defined by how we live, work and engage in leisure activities. Families and communities often have their own traditions, practices and customs that they share from generation to generation. Within cultures, smaller subcultures also have their own practices and customs.

4.1A Arts, entertainment and popular culture

Art and entertainment have been part of cultures and cultural expression for thousands of years. **Popular culture** encompasses the music, dances, movies, performances, art and other forms of expressive media enjoyed by a society. Even food is part of pop culture.

◆ **Popular culture**: The music, dances, movies, performances, art and other forms of expressive media enjoyed by a society.

The interaction between digital technologies and culture is intricately balanced, with each informing and influencing the other's development. For over 200 years, artists, authors and (more recently) filmmakers have described future settings with flying cars, interactive advertisements and humanoid robotic assistants.

As digital technology integrates into all aspects of society, it also shapes and provides bridges between modern cultures. The internet gives people access to new, virtual experiences all over the world, often overcoming distance, wealth and resources divides.

Access to the arts has also evolved significantly due to advances in digital technologies – this includes access to performances, art galleries and museums, as well as new approaches to artistic creation.

Overall, arts organizations believe that the internet and social media have increased engagement and made art more accessible to a diverse audience base. This access reduces the digital divide and provides more opportunities for expression. Others argue that digital technology dilutes the aesthetics of traditional arts by opening new pathways for artistic expression and creation. In addition, developments such as cell phones can disrupt live performances, and contribute to the expectation that all digital content should be free.

Genres, techniques and forms

Digital technology has transformed art, music, performing arts and other **genres**, or categories, of artistic expression. While different **forms** and manifestations of culture continue to develop, common forms of cultural expression include painting, graphic design, sculpture, literature, film, music, theatre and fashion; even architecture can be considered a form of cultural expression.

The **techniques** used to create, edit and publish art have evolved and adapted to advances in digital technology. New tools, in combination with advancing software, have shifted the landscape for photography, including the scanning, storage and restoration of classic photos. Digital photography and cameras are now so commonplace and affordable that the world now captures more photos every two minutes than were taken during the entire 1800s.

Although the use of smartphones has made it easy to capture moments in our lives and memories to look back on, there is growing concern that we have become too busy trying to capture a photo that we no longer fully enjoy the moment.

- **Genre**: A category of art.
- **Form**: The physical natures of a work of art, for example painting, graphic design, sculpture, literature, film, music, theatre, fashion and architecture.
- **Technique**: The way an artist uses their technical skills to create their art.

Inquiry

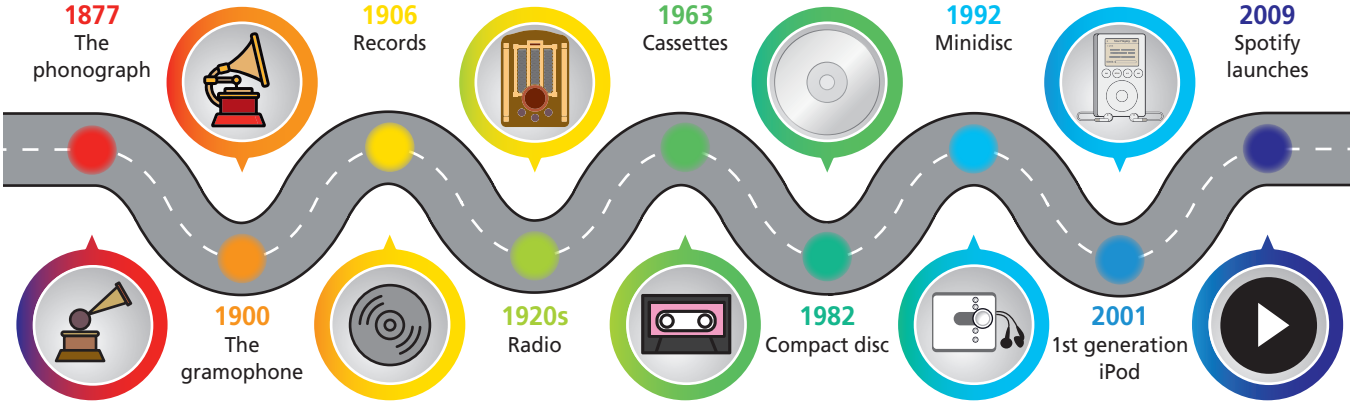
Linda Henkel, a professor of psychology at Fairfield University, USA, conducted a study in 2013 on how taking photos impacts our experience and memory.

Use this research to evaluate the impact that taking photos has on our memory and experience of an event.

- Conduct research into Linda Henkel's study, and on how taking photos impacts the experience and memory. Use at least three different sources.
- Describe the details of the study.
- Discuss the impact this has on both an individual's experience and their memory of the event.
- Evaluate the claim that the camera on a smartphone undermines the appreciation of art.
- Reflect on at least one occasion where you or a friend has used the camera on your smartphone in this way. Do you agree with the outcomes of this study?

Ways to experience art and entertainment

Prior to the 1900s, music could only be heard in live performances. Over the past 100 or so years, the way music is produced, experienced and stored has evolved to the point where people can access and listen to high-quality recordings instantly anywhere in the world.



Evolution of technology in music

It is not only the music industry that is shifting dramatically with emerging digital technologies. Modern cinema has captured the acting and drama that was once reserved for playhouse stages, and now video **streaming** platforms bring this content directly into homes. Art galleries are digitizing their collections and many are hosting online galleries and **online exhibitions** – some interactive and immersive – where one can take a virtual tour to see timeless pieces without leaving the comfort of home. Advances in technology have made cultural experiences more readily accessible, affordable and instantaneous.

◆ **Streaming**: Multimedia (especially video and audio) that is delivered digitally with little or no intermediate storage.

◆ **Online exhibition**: An exhibition in a virtual venue (cyberspace).

ATL ACTIVITY

Research

Research online museum tours or exhibitions and try one out.

- Conduct research to find a list of free online museum or exhibition tours, such as Google Arts & Culture, Musée du Louvre or the Met 360° Project.
- Create a shortlist of those that interest you.
- Select two on your shortlist to try out and spend at least 15 minutes on each site.
- Compare and contrast the experience of the online tour with a recent visit to a physical museum/exhibition.

Links

This content links to Chapter 2.1 Change.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Discuss the decision for an owner of an art gallery to develop a virtual tour that is accessible online. *[8 marks]*

Memes, online forums, internet celebrities and influencers

The internet has built and developed its own culture. **Memes** can take a range of forms but often use images combined with text. Modern memes are often silly, diverse and cater to a wide range of audiences. Internet memes have even been mobilized to advance the causes of social issues. For example, in 2014 the ALS (amyotrophic lateral sclerosis) ice bucket challenge raised over US$220 million in funds for ALS when it went **viral**. Participants were challenged to post a video of themselves pouring a bucket of ice water on their head while promoting awareness of ALS and encouraging donations.

Links

Memes are also discussed in Chapter 3.5 Media.

ATL ACTIVITY

Research

Research the origin of the 'Pepe the Frog' internet meme.

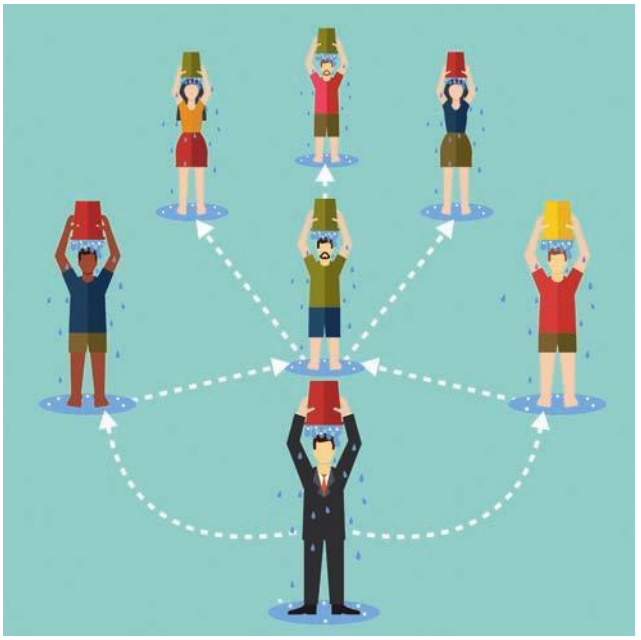
- Conduct research to find an image of Pepe the Frog.
- Can you find its original source?
- How has it been used and repurposed?

ATL ACTIVITY

Communication

Create your own meme.

- Research and find a free online meme generator or online image editing software.
- Try out the different tools in the software.
- Create your own meme to raise awareness of an issue or to communicate a message.
- Share your meme with your peers.



The ice bucket challenge

Online forums are any platform where people can post and discuss messages. They can be anonymous, use display/user names or actually (attempt to) identify the true authors. Reddit is one popular forum that hosts anything from Photoshop battles (such as 'People with Bird Heads') and fan-fiction threads (where amateur authors create their own stories, sequels and spinoffs to their favourite books, movies and stories) to personal finance threads, where users can ask practical questions about money matters.

As social media has become more prevalent, internet celebrities, also called social media **influencers**, have gathered large numbers of followers to their profiles. Thanks to the ease with which content can be created and shared, influencers have been able to build their own brands and pave their own paths to success, regardless of their age, gender identity, religion or social class. Many have been rewarded with record labels, advertising deals, promotional sponsorship and more.

◆ **Online forum**: Any platform where people can post and discuss messages.

◆ **Influencer**: Social media celebrity with large numbers of followers.

ATL ACTIVITY

Research and thinking

Research real-life examples where social media influencers have been criticised. Suggest ethical criteria that social media influencers should adhere to. You may address promoting sponsored products, respecting local cultures, and standards for fact checking/accuracy.

Links

This content links to Chapter 2.7 Values and ethics.

REAL-WORLD EXAMPLE

The Monkey Selfie

In 2011, photographer David Slater set up camera equipment in an Indonesian jungle. While the camera was unattended, a monkey (named Naruto) took a selfie using the photographer's equipment. As the photo became famous on the internet and began to generate global interest, David Slater started to earn revenue from the photo.

People for the Ethical Treatment of Animals (PETA) engaged Slater in a lawsuit claiming that since the photographer was the monkey, revenues from the photo should go toward preserving habitats for monkeys like Naruto. The two parties eventually settled and Slater agreed to donate 25% of the revenue from the photos to groups that protect monkeys in Indonesia.

The American courts involved in the case argued that there is 'no indication' that American copyright laws extend to animals. This raises an ethically debatable question over what protection animals and non-humans should have, not just in matters of copyright but in many legal processes.

Inquiry

Explore

Explore and collect information from relevant sources

- Do these other sources provide claims and perspectives that will be useful in the inquiry?
- Have you gathered a range of content from secondary and primary research and investigations?
- Can you provide clear justification for three main sources for their usefulness in the inquiry?

Research how the internet is being used to raise awareness and funds for an issue or cause. Make sure that you have enough sources to be able to:

- describe how the internet was being used
- have at least two example of awareness campaigns to support your inquiry
- have different perspectives from two stakeholders.

Analyse

Analyse impacts and implications for relevant people and communities

- Is your inquiry question supported by additional questions to consider for analysis and evaluation?
- Does your analysis focus on the impacts and implications for people and communities?
- Is your analysis effective, sustained and well-supported by evidence?

- Analyse the impacts that this technology is having on the campaigners and the public.

Links

This content links to Chapter 3.5 Media.

Concept connections

- **Identity**: Selfies and social media have become part of our identity and are often the first place people and organizations investigate to find out about people.
- **Systems**: A monkey taking a selfie in the jungle of Indonesia invoked a lawsuit from an animal rights organization that centred around extending copyright laws to non-humans – this has implications for both the judicial and economic sectors.
- **Power**: The original US Copyright Law only protected artwork for 14 years. In 1976, however (possibly due to lobbyists from Disney, as Mickey Mouse's copyright was about to expire), the law was changed to cover the author's life plus 50 years (or 75 years for business copyrights). How does longer copyright protect and/or hinder artists, creativity and progress?
- **Space**: Selfies and social media have extended the reach of our identities and expression to many people; we now live in extended social spaces.
- **Change**: Selfies and social media can be permanent records of ourselves. While we may change much about ourselves over time, including our interests and our relationships, social media does not change with us and can act against us.
- **Expression**: Selfies and social media have changed the way we document our lives and experiences. Do you think the monkey was emulating human behaviour, or just curious and pressing buttons that happened to result in a selfie photo?
- **Values and ethics**: What values and ethics considerations apply in the real-world example, The Monkey Selfie?

4.1B Home, leisure and tourism

Digital technologies are embedded into our daily lives. Modern conveniences have transformed the ways we live, travel and relax. In 1905, the first electrical appliance revolutionized the way bread was toasted. In just over a century, the convenience this first toaster offered has expanded into automated vacuums, phone-controlled thermostats and fridges that can automatically order more milk when you start running low.

Kitchen appliances have come a long way!

Leisure has also evolved, whether you are indoors glued to a screen watching an endless stream of content or playing video games, or outdoors with your smartwatch keeping track of your steps as you hike through the wilderness (and your GPS keeps you from getting lost). While we are not yet entering *The Matrix* or *Ready Player One* levels of virtual reality, digital technology has become an integral part of the way that humanity enjoys itself.

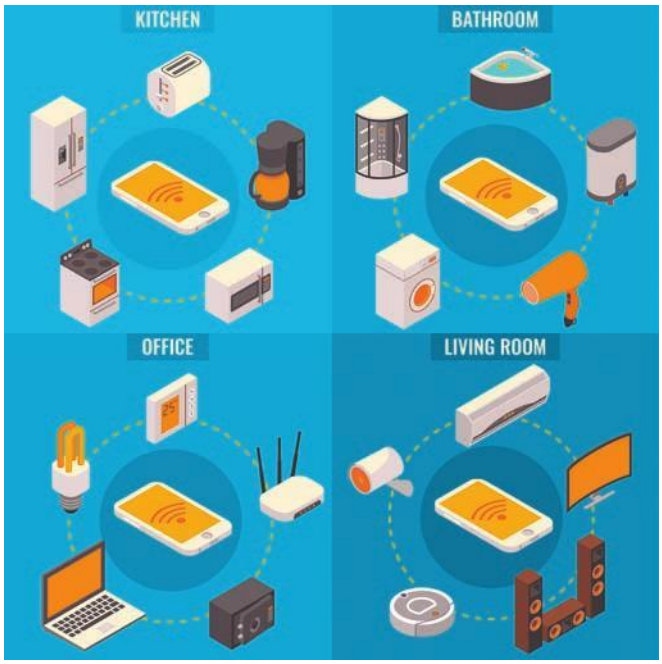
Travel has never been easier, with translation apps, peer-reviewed forums, online booking systems and an endless stream of bloggers sharing tips and recommendations to ensure you have the most unique experience, just like they did.

Links

This content links to Chapters 3.4 Networks and the internet, and 3.7 Robots and autonomous technologies.

Home appliances, services and technologies

The **internet of things (IoT)**, introduced in Chapter 3.4, encompasses the billions of network-connected devices found in homes, ranging from vacuums and toasters, to thermostats and lightbulbs. By connecting objects to the internet, they can be controlled remotely from anywhere in the world. **Smart homes** are equipped with internet-connected lighting, heating and other electronic devices. Waking up in a smart home could mean that your window blinds open automatically, as your thermostat heats up your room, while your coffee pot starts, as your virtual home assistant turns on your favourite news channel, while your vacuum starts cleaning, and your dog food dish dispenses another ration of food, while your … you get the idea!



◆ **Smart homes**: Homes equipped with internet-connected lighting, heating and other electronic devices.

ATL ACTIVITY

Social

With a group of friends, research and present on the different digital technologies used in a smart home.

- In your group, assign one person to each of the areas:
  - security and door access
  - smart entertainment systems
  - lighting and heating controls
  - kitchen and laundry appliances
  - bathroom applications.
- Research the digital technologies available for your given area.
- Describe each technology, including its purpose and how it functions, with suitable images.

REAL-WORLD EXAMPLE

Hacked home security cameras

In 2018, an elderly couple in Leeds, England, installed remote-access cameras in their home after someone broke into their tool shed. Due to limited security features in the camera software, during the three years that the cameras were installed, their security footage was accessed over 5000 times in 70 different countries. This meant that they unintentionally allowed access to their private lives.

www.bbc.com/news/av/uk-44117337

Concept connections

- **Identity**: Early adopters are quick to incorporate new technologies into their homes and lives. Having the newest gadget or feature can become part of a person's identity, just as much as technological resistance can become an identity marker to those who prefer to limit the integration of digital tools into their lives.
- **Systems**: Security is only as effective as its weakest point. By introducing a wider range of devices into the network ecosystem, potential vulnerability points are made available to hackers and malicious users.
- **Change**: How does increased connectivity of the IoT change the way we approach our household appliances, chores and everyday activities?

IoT security tips

While security cameras can be password protected, there are other steps that many smart device users can take to improve the security and limit access to their devices:

- Using more complex passwords and checking the administration settings can allow users to limit unwanted access to their devices.
- Check the data permissions when installing a device or app and only share data that is essential to device functionality.
- Routine software updates will help address any known bugs or security risks that the company has identified and addressed.
- Finally, setting up a separate network for your IoT devices will ensure that any security breaches do not give hackers access to your computers, phones and other sensitive data.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 To what extent are IoT smart home devices improving the quality of living for their users? *[8 marks]*

It is not only homes that are going digital. Digital society provides access to an endless array of online services. Food can be ordered and delivered from our phones; you can even interview and hire dog sitters, cleaners, florists, gardeners and other services using applications. Greater connectedness has evolved into the **gig economy**, where individuals and organizations exchange short-term/task-based services using digital platforms.

◆ **Gig economy**: Labour market in which individuals and organizations exchange short-term/task-based services using digital platforms.

ATL ACTIVITY

Research

Research local examples of the gig economy.

- Interview family members to find out how they currently use the gig economy.
- Find out the details of the goods or services being used, for example transportation or food delivery, the frequency with which they are used, and the reasons why they prefer to use them.
- Reflect on the different responses from your family members.
- What conclusions can you draw?

Sports, gaming and hobbies

Digital systems have been integrated into sports in a range of ways. Professional sports use cameras and sensors to help refine the accuracy of events, for example to confirm goals, penalties and more.

ATL ACTIVITY

Thinking

Prepare for a debate: Should referees rely on digital sensors to ensure more unbiased calls in sports, or is the human perspective an essential part of the sports tradition/game?

- Conduct wider research into the use of sensors in sports events.
- Divide the group into two – one group will support the idea that sensors are an important technology, while the other group will research why they are not.
- Conduct the debate and, at the end of the session, take a vote.

Athletes are often equipped with wearable technology devices that have sensors to monitor their health and vitals to maximize their performance and minimize the risk of injuries. It is also common for phones, watches and other devices to track steps and activity, so that all users can have data and statistics about their health progress and work toward goals such as 10,000 steps, or elevating their heart rate for at least 30 minutes a day. In Chapter 3.1 you may have completed the ATL activity to investigate the data collected by a smartwatch. Now we will evaluate the impact that sports watches may have on the wearer.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Evaluate the decision of professional sports teams to require athletes to use wearable technology during competitions. *[8 marks]*

Links

Revisit Section 3.3A Types of computers, to see how wearables are making their way into the leisure industry.

In 2020, the average consumption of online content doubled from about three hours a day in previous years to six hours a day. Whether it was scrolling through social media, streaming video content, chatting with friends or playing games, 2020 saw a dramatic growth in the time spent consuming digital content as well as major shifts in how the content is delivered, most likely due to the COVID-19 pandemic.

Streaming services were able to bypass movie theatres and 'premier' blockbuster movies in people's homes (for a fee, of course) and many social interactions moved into **virtual conferencing platforms**, such as Zoom or Google Meet, that allow multiple users to video chat at the same time. While these were used significantly in schools and workplaces during the pandemic, families and friends also used these tools to celebrate holidays 'together', host game nights or just catch up.

Video games have continued to evolve since the release of *Pong* by Atari in 1972. **Augmented reality** bridges the real world with fantasy in games such as Pokémon GO, which uses GPS location and cameras to get people out and walking in real life as they progress through the game. **Virtual reality** platforms and headsets also allow for immersive experiences where you move and interact in a fully simulated environment.

ATL ACTIVITY

Research

Meta (previously Facebook) has been investing heavily in virtual reality and augmented reality research and development, and the creation of metaverses.

Research which industries are investing in virtual/augmented reality. Summarize two real life examples.

Gaming consoles continue to evolve. Instead of a large upgrade every seven years or so, we now see yearly updates to platforms and a marked shift toward streaming and downloading content. Game designers are increasingly prioritizing the 'feeling' they want players to have while gaming, then building story and gameplay around that. Additionally, there is a shift in gaming towards more inclusiveness and diversity, both in terms of the players and the content of the games.

REAL-WORLD EXAMPLE

Snapchat's augmented reality selfie games

In 2018, Snapchat launched a series of augmented reality games called Snappables. These were among the options of special effects 'lenses' on the social media's camera features. Using augmented reality technology, these games allow users on 'selfie mode' to interact with a digital environment to play games. They can send these to friends, who can join in and play along.

https://techcrunch.com/2018/04/25/snappables-snapchat-games

Concept connections

- **Expression**: Augmented reality tools are creating new ways for people to communicate and interact, even asynchronously or over large distances.

Links

In Section 4.4A Medicine and health, you will continue to explore how medical professionals and patients use wearable technologies in the health context.

◆ **Virtual conferencing platform**: Digital platform that allows multiple users to video chat at the same time, for example Zoom or Google Meet.

Links

This content links to Chapter 3.5 Media.

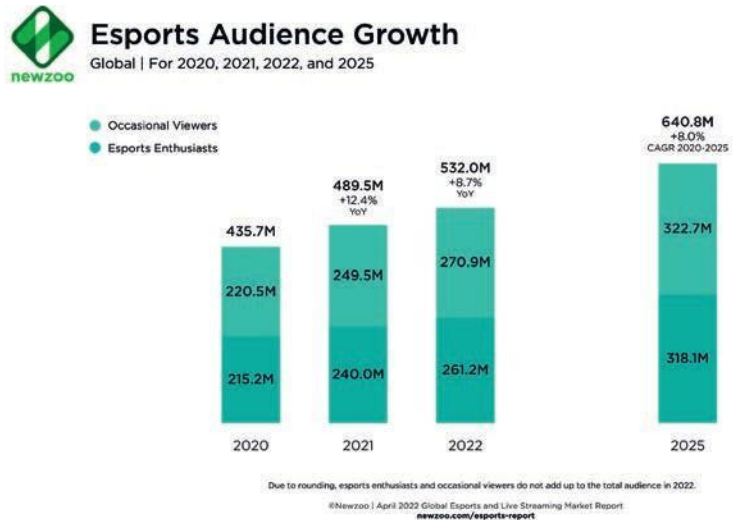
ATL ACTIVITY

Communication

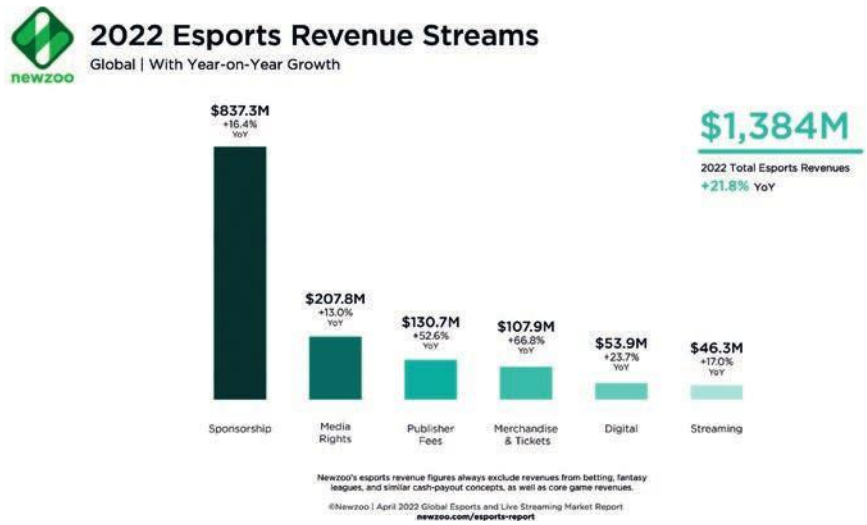
- What new ways of communicating and keeping in touch with your friends are popular?
- How have these evolved throughout your own experiences?
- What augmented-reality experiences have you encountered?
- Share examples and findings with your classmates.
- Try out a new method for interacting digitally with your peers. For example, you could play new types of online games with your friends or experiment with new features in communication/social media tools that you are already using.

EXAM PRACTICE QUESTIONS

Paper 2



Source A: E-sports audience growth in 2019



Source B: E-sports revenue in 2019

1 **Identify** two trends from Source A. *[2 marks]*

2 With reference to Source B, **explain** two possible reasons for the changes in the revenue streams compared to the previous year. *[6 marks]*

Travel, sharing platforms and tourism

Travel has evolved to become more affordable and accessible in digital society. Forums and blogs allow travellers to share tips and tricks, and leave insights about their experiences so that others can learn and follow in their tracks. They also offer **ranking systems** for companies and organizations that cater to tourists, collecting data from **customer reviews** to guide and identify the best experiences for future travellers.

ATL ACTIVITY

Thinking

Evaluate the use of travel platforms to rate travel activities in your local area.

- Visit a travel forum, such as Yelp or Tripadvisor, for your home town or a nearby destination and browse through the entries.
- Evaluate how suitable the comments and rankings provided are.
- To what extent do you agree with the ratings and comments?
- Draft a review of one of your favourite businesses.

Another useful development for travel are **translation apps**, which use artificial intelligence to bridge language barriers by converting one language into another. They can translate in real time, allowing two people to communicate through an app that translates the language back and forth, or by translating text in a photo to allow travellers to quickly understand signs and menus.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 **Outline** the step-by-step process that is started in the digital technology hardware and software when you give a voice command to ask your virtual assistant (Alexa, Siri or Google, for example) to play your favourite song using a specific app (for example iTunes, Spotify or YouTube). *[4 marks]*

- **Ranking system**: The assignment of a number or short description to data to indicate first to the last in a data set.
- **Customer review**: Is the evaluation of particular items posted by previous customers or users.
- **Translation apps**: An app that translates one language into another allowing communication in real time.
- **Heritage**: The objects and qualities that are passed down from generation to generation.
- **Customs**: Traditional ways of behaving or doing things.
- **Celebrations**: Important events and milestones that are honoured and observed within a culture.

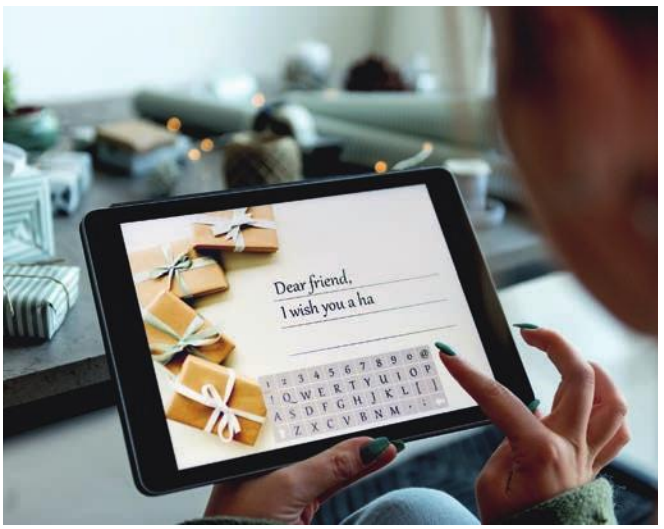
Links

This content links to Section 3.1G Data security.

4.1C Heritage, customs and celebrations

Ideas and traditions are passed down from one generation to the next in all cultures. Some of these rituals are preserved in their original forms, others have been adapted and assimilated into the digital society environment, while others grow obsolete and fade out of existence.

Heritage refers to the objects and qualities that are passed down from generation to generation; these could include traditions, rituals, natural resources, significant buildings or other valuable items and concepts. Among these are **customs** – traditional ways of behaving or doing things, linked to a specific place, time or culture. Finally, **celebrations** refer to the important events and milestones that are honoured and observed within a culture. This could include holidays, birthdays, historical events, harvest rituals and more. Heritage, customs and celebrations continue to exist and evolve in digital society.



Holiday e-cards

Many countries celebrate special days, some of which are religious, while other mark a point in history. Many of these holidays include a tradition of exchanging gifts, sending cards or sharing a meal together. Gifts that were originally home and handmade evolved to be store bought, and now many purchases are executed online from home. Mailing individual holiday cards, possibly containing family photos and personalized notes, has evolved into mass email lists, where hundred can be sent the same card with one click. Video calling brings families together even when members are scattered around the globe, and with just a few clicks, social media allows us to publish, share and comment on the highlights of our holiday and compare our posts (and number of likes) with our friends.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

On 23 December 2011, an e-card with the subject 'Merry Christmas!' was supposedly sent by the US President's office (from 'jeff.jones@whitehouse.org') to a massive number of recipients. Recipients who clicked to download and open the card (a .zip file) saw an animated Christmas tree while a trojan virus accessed their saved documents and passwords, and uploaded them to a server in Belarus.

1 a Identify two common file types for animated images. *[2 marks]*

b Outline two precautions to prevent falling victim to an email-based scam. *[2 marks]*

c Outline two characteristics of a '.zip file'. *[2 marks]*

2 Outline four steps in the process of how victims opening the e-card resulted in their files being uploaded to servers in Belarus. *[4 marks]*

3 In response to the news about the e-card trojan virus, some employees decided to search for, download and install FREE email protection software for their work computers instead of waiting for instructions from their employer. Evaluate this decision. *[8 marks]*

Rites of passage

A **rite of passage** is a ceremony or tradition to mark when an individual leaves one group and enters another. Traditionally these could include ceremonies to acknowledge events such as births, marriage, death. Many cultures have a rite of passage that marks the transition from childhood into adulthood; for example, in Mexican, Caribbean and other Latino cultures, when a girl turns 15 she celebrates her *quinceañera*, which marks the passage from girlhood to womanhood.

◆ **Rite of passage**: A ceremony or tradition that marks when an individual leaves one group and enters another, for example a birth, marriage or death.

Digital societies have evolved new rites of passage to mark milestones in the virtual and physical world. This could be a child's first smartphone, their first social media account, the removal of parental controls/monitoring tools from their devices, being allowed a TV/computer in their bedroom, reaching 1000 followers, and more. While these may not have traditional and cultural ceremonies attached, these milestones can often be as significant to the individual as traditional milestones and rites of passage.

ATL ACTIVITY

Research and communication

Prepare for a debate: Should children below the age of 11 own a smartphone?

- Conduct wider research into the use of smartphones by children.
- Divide the group into two – one group will support the idea that young children should be able to own a smartphone, while the other group will research why they shouldn't.
- Conduct the debate and, at the end of the session, take a vote.

Expression and preservation of cultural heritage, customs and tourism

As digital technology continues to evolve and more time passes, there is a risk that historical traditions and customs will be eroded or disappear altogether. Heritage sites and museums make significant efforts to protect and preserve significant artifacts. UNESCO, a sub-organization of the UN, is involved in the preservation of over 1000 World Heritage Sites across the globe. For each one, their website provides visitors with descriptions, photos and conservation strategies. This both documents these valuable sites and creates a space for people to learn more about these institutions.

Digitization of cultural heritage creates a digital equivalent of cultural artifacts that can be accessed by a larger public, while also allowing the safe storage and preservation of the original artifact. Digital alternatives offer greater accessibility to students, teachers and researchers, who can now use tools to study these items online. This also reduces the risk of damage to the original item.

REAL-WORLD EXAMPLE

An Amish approach to technology

The Amish are a subset of Christianity in the USA and are usually portrayed as living simple lives in plain clothes and as rejecting of new technologies. While they do choose to use horse-pulled buggies instead of cars, and do not use zippers on their clothing, they do not reject all technology outright. Instead of quickly adopting new technologies like most of American culture, they are more cautious and discerning, taking time to examine whether the tool will be helpful or detrimental to their community before deciding whether to embrace a new technology and, ultimately, a new way of living.

There are more than 40 different subcultures within the Amish umbrella, and their decisions on integrating technology varies from community to community. For example, in one community a farmer may choose to have a phone with voicemail in his professional life, but it will be kept outside the house to prevent disruptions to family life. They may use battery-powered lights for turning signals on their horse-drawn buggies, and may also have solar panels to generate energy without having to join the nation's electricity grid.

As the world evolves, so does the Amish community. While many still live off the land as farmers as in previous generations, the youngest generation of Amish workers are often in entrepreneurial positions. When faced with adopting new technology, they ask themselves 'Will this technology hurt the Amish way of life?' While this may be a lengthy and slow process, this reflection, investigation and inquiry helps the Amish to navigate the balance between progress and tradition. As a result, they are able to protect their traditions and culture while also enjoying the benefits of technology.

www.npr.org/sections/alltechconsidered/2013/09/02/217287028/amish-community-not-anti-technology-just-more-thoughful

ATL ACTIVITY

Thinking

Look for personal relevance by evaluating a digital technology in your home and how it is impacting your family life.

- Select one digital technology used by your family that is relatively new in your home, for example a new gaming console or smart TV.
- Complete the table to compare how this digital technology is impacting your family members.

Positive impacts	Negative impacts

- Evaluate how disruptive the new digital technology has been on your family life and whether it was a good decision to bring it into your home.
- Reflect on what family life was like before digital technology was introduced and whether it was better then.

Concept connections

- **Identity**: How does the adoption of (or decision not to adopt) new digital technologies influence our sense of identity?
- **Systems**: Bringing a smartphone into a place that has never had one before has cultural implications. Suddenly, people must learn how to respond when they receive messages and develop norms for communicating and responding on the phone. What other impacts might the integration of digital technology into new locations have on the existing culture? Does rejecting digital technology ensure the protection of existing heritage?
- **Space**: As digital technology brings the world closer together, does it also drive communities farther apart? Many Amish people reject cars and smartphones because they believe they erode the strength of the family. Many families across the globe set limitations on smartphone use, for example at the dining table because it detracts from the family meal. Some schools implement smartphone-free zones where students disconnect from screens to play games such as chess, read books, make art or just talk to their friends face to face. Do we need to protect spaces from the negative impacts of digital technology?
- **Values and ethics**: Think about your own values and beliefs, then look at how you use digital technology. Which apps are in alignment with your beliefs and values? Which challenge them?

ATL ACTIVITY

Self-management

Can you go for a day without any digital technology? Select a day (probably a day on a weekend) and make a list of the digital technologies you use or come in to contact with. Keep a pen and paper close to make notes and reflect on the experience.

4.1D Subcultures

Subcultures are cultural groups that exist within a larger culture. They often have beliefs or interests that vary from the dominant culture. Digital systems create opportunities for these subcultures to meet and connect in virtual and physical spaces. In its early stages, being an internet user was its own subculture, as early adopters could chat online and connect with others who shared their passion and interest for technology.

◆ **Subculture**: Smaller cultural groups that exist within a larger culture.

Youth cultures

The internet creates a space for more unique and multi-layered identities. Young people can gather and connect with a community of people who share their interests and passions, have common challenges or family structures, and more. The apps that young people use are often different from those of adults, and these apps tend to move/change rapidly. Viral content in youth communities may seem different or nonsensical to adult users, for example, the user who gained 10,000 followers on TikTok for posting a video of herself clapping along to a song.

Within a digital society, research has shown that users aged 13–24 often prefer social media applications. They check these apps frequently but only stay on them for a short period of time. On an average day, they may check their smartphones 150–300 times, while older users average closer to 100 times a day (the numbers vary depending on the source). Young users are less likely to be on email or productivity sites by choice when compared with older users.

The ease with which youth subcultures can form and proliferate through the use of digital technology can have serious implications. The disconnect between adults and teens/young adults can be made worse, as **youth culture** in digital society is very different from the youth culture of earlier generations. The digital worlds young people live in are outside the experience of older generations and are difficult for them to understand. Also, people with bad intentions can infiltrate and use these subcultures for their own purposes. Groups around the world often have a youth branch that works through social media to attract them to their causes.

◆ **Youth culture**: The culture and social norms of teenagers and young adults.

Youth subcultures can also divert young people away from their own cultures, locally and nationally. This is known as **soft power** – where the cultural values of one society are spread through the use of digital technology to the detriment of the native culture. This was originally seen with the spread of Western ideas, initially through the world wide viewing of Western movies. Some countries have tried to counter this by promoting their own movie industries, such as India with Bollywood and Nigeria with Nollywood. Some countries have also developed their own national social media platforms that use their national language(s), such as WeChat in China.

Links

This content links to Chapters 2.2 Expression, 2.3 Identity, 2.4 Power and 2.7 Values and ethics.

ATL ACTIVITY

Research and Thinking

Compare and contrast applications used by adults and teenagers in your community. Use specific examples and findings from your research to support your claims. You may focus on what apps they use, or if they use them differently than adult users. Applications you could look at include Twitter, Facebook and Snapchat.

ATL ACTIVITY

Research

Research the impact of digital technology by two different types of youth subcultures. Research real-world examples from at least two distinct communities. Possible examples include those based around music, fashion, sports or hobbies; they can be local or national.

Online communities and forums

Online communities (or internet communities) are groups of people united by a shared interest or purpose who use online tools to communicate with each other. Like all communities, they often have a set of norms or **guidelines** for membership and participation. Communication and interactions are often conducted on **forums** – or message boards – which are online discussion sites that allow users to post and reply to messages. Some forums are **moderated**, meaning that content must be approved before it goes public.

◆ **Online community**: A group of people united by a shared interest or purpose who use digital tools to communicate with each other.

◆ **Guidelines**: Norms and rules for membership and participation.

◆ **Forum**: Online discussion sites that allow users to post and reply to messages.

◆ **Moderation**: A system designed to ensure messages posted online comply with the rules set by the online community.

The proliferation of online communities and forums creates subcultures that have both benefits and issues, from a personal level up to societal level. Users can become members of a wide range of different groups, and there is more **fluidity** in digital groups, allowing people to join and leave groups with greater ease than in-person groups.

Radicalization through the internet is now a major issue for governments around the world. Using social media, people can form online communities to share ideas and resources that are radically different from those in society. The internet has been shown to be very effective for the spread of radical ideas as it is so vast, diverse and easy to use. Keeping track of those who are radicalized, and stopping radicalization, is very difficult. These radical ideas are often violent and include groups that are extremist or have political, social, economic or religious interests.

◆ **Fluidity**: The ease with which people can join/leave digital subcultures.

◆ **Radicalization**: The use of the internet to share ideas and resources that are radically different from those in mainstream society.

Inquiry

The dark web is a part of the internet where groups can meet in secret to conduct business, communicate and share ideas. Much of the activity on the dark web is illegal.

- Research the technology used by the dark web and the range of activities that it is used for.
- Research how law enforcement and state authorities deal with the issues raised by the dark web.

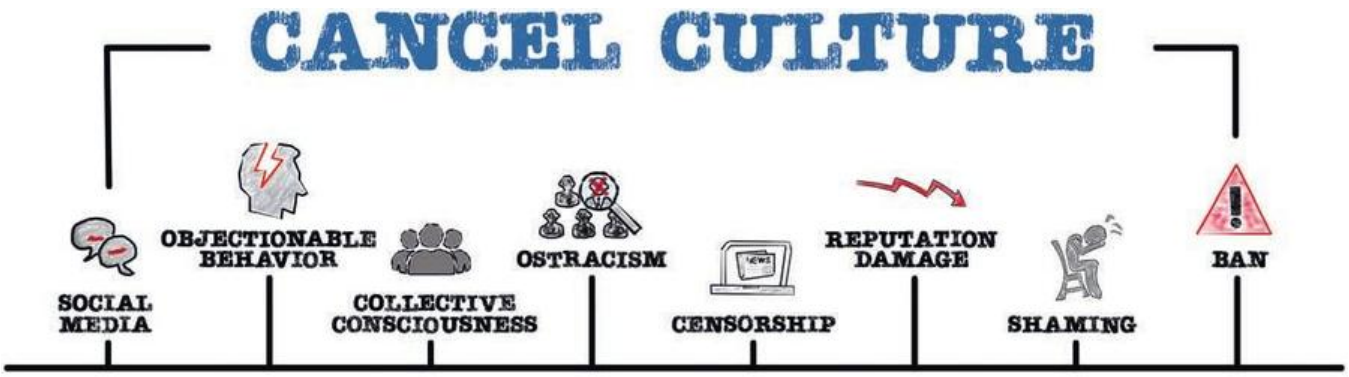
ATL ACTIVITY

Thinking

Look for personal relevance in this topic and the groups you belong to.

- List all of the groups you belong to in two columns – the ones in the physical world and then the virtual one,
- Select which of these groups brings you the most happiness and reflect why.
- Select which of these groups brings negativity into your life. Reflect why you are a member of these groups.
- Reflect on how many of the groups selected in the previous two points are physical or virtual.

Cancel culture



Cancel culture has been enabled by the use of social media. It describes the public backlash that results online when a person or organization says or does something that is considered objectionable or offensive. Cancel culture often takes steps towards ending the career of the person who initiated the offensive action. While social media can be used to highlight questionable comments and spark debate in a society, it can be taken too far and becomes destructive rather than constructive criticism.

Proponents argue that cancel culture promotes accountability and can be used to further social justice efforts through collective actions. Critics, on the other hand, argue that it has evolved into social media mob rule that actually mutes the voices of citizens and violates their access to the free exchange of ideas, thoughts and speech. It can be regarded as a form of vigilante justice, targeting any celebrities or influencers that push the moral boundaries of society.

◆ **Cancel culture**: Public backlash on social media when a person or organization says or does something that is considered objectionable or offensive.

REAL-WORLD EXAMPLE

Cancel culture

A high-profile case of cancel culture happened when author JK Rowling voiced concerns that the push for transgender rights could endanger women's rights. Critics and social media campaigns called for a boycott of her books. It remains difficult to truly end someone's career through cancel culture. However, despite the negative attention, JK Rowling's book sales continued to increase in the UK.

www.washingtontimes.com/news/2021/feb/16/top-10-recent-examples-cancel-culture

www.vox.com/culture/2019/12/30/20879720/what-is-cancel-culture-explained-history-debate

Concept connections

- **Identity**: How can cancel culture be used to advocate for traditionally marginalized groups and be a voice for oppressed or targeted communities?
- **Power**: Many argue that cancel culture offsets the power dynamic and expensive influence of public figures and celebrities.
- **Expression**: How does cancel culture limit the expression of dissenting thoughts?
- **Values and ethics**: Does cancel culture violate celebrities' rights to free speech? Does their larger audience and platform justify a higher sense of accountability? Who determines the moral code that must be adhered to?

Creativity, activity, service (CAS)

E-sports tournament

Set up an e-sports tournament at school. To start this initiative off, write a proposal and obtain approval from your school. Include details such as when it will be, who it is for, where it will be held, which e-sports it will include and how the tournament will run. Do not forget to include details of the educational value of this tournament – it will help you get approval.

Reflection

Now that you have read this chapter, reflect on these questions:

- What are your personal, family and local cultures, values and traditions?
- How do digital tools shape the way you live and experience day-to-day life?
- How do IoT and smart home devices impact your daily life experience?
- What rites of passage are valued in your community/school/family? Explore both physical/traditional passages and virtual milestones.
- How do you connect with others over digital platforms? Are you a part of any virtual communities?
- To what extent do you engage virtually with people who come from different backgrounds or identities as yourself?

Extended essay (EE)

- Investigate the impacts of digital tools on a specific genre or medium of art. For example, the development of holographic concerts on the live music industry or how immersive art experiences impact how people experience art.
- Investigate the impacts (advantages and disadvantages) of the use of social media of a group you are associated with or that operates in your local area or country.

TOK

- How do cultural values and identities shape our approaches to learning, knowledge and value?
- What cultural conflicts can arise as digital tools create global communities?
- How valuable is the contribution of various cultures to society, considering the different perspectives of each culture?

4.2 Economic

UNDERSTANDINGS

By the end of this chapter, you should understand:

- business and commercial organizations have evolved to integrate, build and rely on digital systems in a digital society
- digital innovations offer new and alternative approaches to work and employment; they create new jobs while making others obsolete
- digital tools have created new and virtual markets to supplement or replace traditional methods of exchanging goods, services and financial instruments
- digital communication tools have connected global markets for the production and selling of goods, and many commercial organizations operate across borders.

As the world becomes more interconnected, economics, business and financial institutions have adjusted and evolved to meet the demands of an ever-changing marketplace. New tools and digital technologies made old jobs obsolete, created new jobs and even changed the workday experience. Offices, businesses and managers have shifted in how they engage their employees productively, and capitalist values have shifted from maximizing profits to better meeting the needs of customers. Online marketplaces, digital payment methods and new production processes have shifted the selling and buying experience, and globalization has created a world market for production, labour and sales of goods and services.

4.2A Business

Operation and organization of businesses

As technology and society have evolved in the twenty-first century, business practices and values have also adapted and changed. The goal of maximizing profits and revenues has also shifted towards maximizing value for customers, knowing that profits will follow if customers are satisfied. Additionally, short-term profits may be sacrificed to invest in improving the customer experience and retaining long-term, loyal customers.

Businesses used to rely on a vertical hierarchy, where a boss or manager develops roles and hires employees to complete specific tasks. Every employee reports to a supervisor above them, with decisions made at the top trickling down through managers to staff. Now teams are more dynamic and work in shorter cycles, which is facilitated by the use of a variety of digital technologies including email, video communications, shared calendars and collaborative access to files and resources. While employees still have specific roles or duties, many companies have created spaces and opportunities for employees to branch out from their defined responsibilities and incorporate their passions and talents. Executives at the top will often solicit ideas and feedback from the bottom, and foster leadership and collaboration across the entire organization.

Digital tools facilitate common practices in the day-to-day business operations today. These may include **transaction processing systems**, which incorporate all of the resources, software and hardware needed to manage sales, purchases and other transactions. **Office automation systems** help to centralize and organize data, improve communication between workers and departments, manage calendars and facilitate collaboration. Other systems exist to develop and manage corporate

◆ **Transaction processing system**: A system designed to incorporate all of the resources, software and hardware needed to manage sales, purchases and other transactions.

◆ **Office automation system**: A system designed to centralize and organize data, improve communication between workers and departments, manage calendars and facilitate collaboration in businesses.

databases, as well as to facilitate data analysis to optimize decision-making and monitor performance. The IoT has also been adopted by many businesses to facilitate efficiency.

ATL ACTIVITY

Research

Research the impacts of customer sales tracking tools. Possible examples include loyalty programmes.

ATL ACTIVITY

Research

Visit a local supermarket or other store and ask them to explain how their transaction processing systems work and how they benefit the store.

EXAM PRACTICE QUESTIONS

Paper 2

■ Research how the adoption of IoT in various market segments varies greatly over time and location in billions of units or in the amount of expenditure. Record findings for some of the market segments over a range of years (i.e. 2018 and onwards) and for particular country and/or worldwide. Cite sources.

Market segment	2018	2020	2022
Utilities			
Government			
Banking and financial services			
Physical security			
Manufacturing			
Agriculture			
Health care			
Retail			
Information and IT			
Transportation			
Other			
Total			

1 Analyse the statistics collected and identify two trends in IoT. *[2 marks]*

2 For one of the market segments, explain two ways IoT is being used. *[4 marks]*

Diversity in business and corporations

Diversification, when a company enters into a new market or industry, is also a growth strategy used by businesses. There are four main types of diversification:

- **Horizontal diversification** is when a business adds on products or services that are complementary to their core business. An example would be a social media platform building a direct messaging platform or a marketplace for buying and selling.
- **Conglomerate diversification** is when a company adds new products that are completely separate from their existing operations. This could be a search engine investing in self-driving car technology.
- **Vertical diversification** involves taking over a new part the product's supply or production chain. Examples include online stores purchasing their own delivery fleet to ship purchases to the consumer, or when a computer company begins producing its own microprocessors instead of purchasing them.
- **Concentric diversification** involves adjusting the existing product lines to meet a wider customer audience. For example, a social media platform could adapt its content for younger users, or for business/corporate accounts.

◆ **Diversification**: When a business enters into a new market or industry.

◆ **Horizontal diversification**: When a business adds on products/services that are complementary to their core business.

◆ **Conglomerate diversification**: When a business adds new products that are completely separate from their existing operations.

◆ **Vertical diversification**: When a business takes over a new part of their supply or production chain.

◆ **Concentric diversification**: When a business adjusts their existing product lines to meet a wider customer audience.

Inquiry

Analyse the diversification strategies used by a large digital technology company.

- Identify a large technology company.
- What is their primary market/industry? What was the original product or service they provided?
- How have they diversified their business?
  - Horizontal diversification: What complementary products/services do they offer in addition to their main product line?
  - Conglomerate diversification: What unrelated products/services have they branched out into or begun working on?
  - Vertical diversification: How have they taken over parts of their supply/production/delivery chain?
  - Conglomerate diversification: How have they adapted their existing products to reach a broader audience?
- To what extent have these strategies been effective in reaching more customers and growing their business?
- Suggest other potential diversification strategies and explain how those will reach more customers and grow the company.

Diversity in business also refers to the hiring and incorporation of people from a range of demographic indicators. This can include the integration of employees from various ethnicities, social spheres, genders and sexual orientation. In many countries it is illegal to **discriminate** or make biased decisions based on social identity, women and non-white employees remain underrepresented in executive roles.

◆ **Diversity**: In business, this refers to the inclusion of people with a range of demographic indicators.

◆ **Inclusive**: In business, this refers to an environment in which people of all backgrounds feel valued, safe and respected.

◆ **Discriminate**: The unjust treatment of people based on gender, social identity, race or disability.

Links

For more on demographic indicators see Chapter 4.7 Social.

REAL-WORLD EXAMPLE

Bias in an AI algorithm

In 2014, Amazon developed software that used artificial intelligence algorithms to review job applicant resumes and rank them. By 2015, Amazon realized that the ranking was not fair and showed bias against women. The reason for this bias in the data sets used to train the algorithm, which were based on historical data that was 60% male.

Inquiry

With reference to two real-world examples, research the approaches taken by Silicon Valley tech companies to increase diversity in the workplace. Possible examples are Twitter and Google.

REAL-WORLD EXAMPLE

Psychometric surveys

When applying for jobs, many companies require **psychometric surveys**, a computer-based test to measure an individual's mental capabilities and behavioural style. These tests are used to screen out applicants who may not be a good fit with the company culture or may not have the communication skills necessary to work well with their colleagues. While some tests are research based and use known measures, other tests ask questions that might have an adverse impact on the hireability of people with disabilities.

◆ **Psychometric survey**: A survey designed to measure an individual's mental capabilities and behavioural style.

In the US, the American with Disabilities Act bans employers from asking questions about one's health status, but some of the psychometric survey assessment items are based on mental health evaluations. One assessment company, Unicru, was involved in a legal case because their automated personality testing system was suspected to discriminate against people living with bipolar disorder. The questions were similar to medical assessment questionnaires, which had prevented jobseekers from getting interviews for minimum-wage jobs in the past – digitizing discrimination based on mental health that would otherwise be illegal.

Another company, HireVue, has integrated web-camera analysis and artificial intelligence in order to analyse candidates' facial movement, speaking voice and other traits as they respond to a 30-minute interview to automatically generate an employability (likelihood of success) score based on over 500,000 data points. HireVue claims that it streamlines the most time-consuming parts of the interview process and identifies skills, such as problem-solving and teamwork, that might not be readily apparent from a resume or transcript.

Critics argue that these undisclosed **black box algorithms** (introduced in Chapter 3.2) are unfair, deceptive, biased, unproven and cannot be trusted. They say it is not possible to use voice tone or mannerisms to automatically determine someone's employability, and that it create a new method of discrimination that is a major threat to workers' privacy and lives. Proponents maintain that it creates a more balanced and quantitative approach to a subjective process.

Critics fear that it will undermine diversity, while proponents view these tests as a useful tool for improving diversity and overcoming the existing bias in hiring practices.

www.washingtonpost.com/technology/2019/10/22/ai-hiring-face-scanning-algorithm-increasingly-decides-whether-you-deserve-job

www.recruiter.com/i/what-hbos-persona-gets-right-and-mostly-wrong-about-personality-tests

https://medium.com/@ianhierl/cathy-oneil-weapons-of-math-destruction-chapter-6-7131535f1bc7

ATL ACTIVITY

Thinking

Look for a personal relevance in the following task.

- Take an online psychometric test, for example the Myers–Briggs personality profile: **www.16personalities.com/free-personality-test**
- Evaluate how accurate, complete and reliable the results are for you.

Concept connections

- **Change**: As the internet makes job applications more accessible, resulting in more candidates are applying for the same jobs, is the use of artificial intelligence necessary and/or justified to screen applicants quickly and focus human resources only on the best candidates determined by the algorithms?
- **Expression**: The use of web-camera analysis interview tools quantifies the way people respond and interact with virtual interviews. What characteristics do they value? Is it possible to cheat the system?
- **Power**: The processes of black box algorithms are not transparent. They often provide scores with minimal indication of how those scores were generated. How do these processes empower/disempower employees and employers?
- **Systems**: How does artificial intelligence replicate and improve on existing bias in the hiring process?
- **Values and ethics**: Considering the limitations, should companies use artificial intelligence to analyse personality traits in order to be able to build and hire the team that they feel will be most successful?

4.2B Employment and labour

The workforce in a digital society overlays traditional employment opportunities with new and evolving opportunities for entrepreneurship and work. Nearly every job has some connection or involvement with digital technologies. Postal workers scan package details into databases, office managers coordinate online calendars and schedules, and nearly every professional must spend at least part of their day responding to e-mail or other messages.

The internet also facilitates networking for the exchange of goods and services on a task-by-task basis. This has resulted in short-term employment opportunities, or 'gigs', where people can request or offer services online with platforms helping to match supply with demand.

Links

Chapters 3.6 and 3.7 discuss how automation through artificial intelligence and robotics is displacing many workers.

Working practices

Start-ups are companies in their initial stages of business. Many digital technology companies are in this category, and it can create a stressful environment as they rely on new product releases, grants and investments to satisfy investors and build their market reputation. To offset these challenges, many start-ups have been redesigning the workplace and work experience, encouraging working from home and incorporating game rooms or meditation spaces into their offices.

Office design incorporates all of the functional and decorative components of the working environment. Many modern offices include open floor plans, flexible furniture and glass walls that allow employees to transform spaces to meet their needs in any given situation. Even established tech companies want to offer spaces for their developers to recharge in and get off screen. For example, Twitter's office in San Francisco includes a rooftop garden, an arcade room and a musical 'jamming' space to give employees a space to unwind in if they need breaks during their work day.

◆ **Office design**: The functional and decorative components of the working environment.

◆ **Remote working**: Conducting business and completing tasks from anywhere that employees are able to connect to the essential networks, for example, working from home.

Because many jobs are serving online and digital tasks, some employees are able to work from home almost permanently. During the COVID-19 pandemic, many industries found that employees could work from home effectively using video-conferencing platforms and other digital tools. **Remote working** allows employees to conduct business and complete tasks from anywhere that they are able to connect to the essential networks.

ATL ACTIVITY

Thinking

Imagine you are working for the IT department of a company that requires their staff to work remotely. At the next team meeting you are required to research and present:

- technologies that employees would need to be able to access company servers, and to be able to attend company meetings and to handle customers remotely
- recommendations for the measures you would put in place to ensure the security of all company and customer data.

Links

Use your knowledge from Chapter 3.4 Networks and the internet, and 3.1G Data security in this activity.

Digital nomads work remotely and do not tie themselves down permanently to any particular location. For example, a website developer could travel the world while logging in daily to complete tasks anywhere that they can get online. This can help create a good work–life balance, and also boost tourism revenues for the countries where digital nomads work. In some regions, special hostels and hotels market themselves to digital nomads by promising great internet connectivity, comfortable workspaces, affordable accommodation and also the ability to network with other digital nomads around the globe.

◆ **Digital nomad**: A person who works remotely and is not tied down to any particular location.

There are often legal challenges to working outside of your home country, and many companies and digital nomads may violate immigration policies if appropriate permissions and visas are not obtained. Additionally, there is an added security risk to the data and information that the employees are working with if they are tempted to use public Wi-Fi facilities.

ATL ACTIVITY

Research

Research the type of jobs that are available for digital nomads.

- Reflect on how this may impact where you choose to live.
- Does this lifestyle appeal to you?
- If yes, what makes it attractive?
- If no, why not?

Crowd work, microwork and gig economies

Crowdsourcing allows companies to save time and money by collecting information, ideas or work from a group of people, usually over the internet. Instead of hiring a single person to complete a task, the task may be open to the public or a group. This can improve the speed, flexibility, diversity and scalability of projects, however someone usually still has to review and curate the crowdsourced work and, depending on the 'crowd', the work could be biased or potentially fall short of the intended goal.

◆ **Crowdsourcing**: Collecting information/ideas/work from a large group of people, usually over the internet.

REAL-WORLD EXAMPLE

Crowdsourcing

Artist Aaron Koblin paid 10,000 people US$0.02 to draw sheep. He curated a gallery of sheep where visitors could watch the sheep being drawn, or zoom out to see the entire herd.

While crowdsourcing seeks information or work, **crowdfunding** solicits people for money to support start-ups, charities and other causes. Many creative projects, charities and entrepreneurial initiatives use crowdfunding as an alternative approach for securing the capital or resources they need to realise their projects.

◆ **Crowdfunding**: Collecting money over the internet to support start-ups, charities and other causes.

ATL ACTIVITY

Thinking

Look for a personal relevance in the following task.

- Sign up for Amazon Mechanical Turk – **www.mturk.com** – and think about how you could participate in crowdsourcing projects (terms and conditions may apply).

Small tasks like the ones in the activity above are a form of **microwork**, where short-term projects can be completed quickly for payment. The growing demand for microwork has led to the **gig economy**, where online platforms facilitate matching between short-term service providers and customers on a payment-by-task basis. The gig economy offers a range of services including customized crafts, pet-sitting, ride-sharing, and more. The **sharing economy** overlaps with the gig economy and includes assets or services that can be shared between individuals, often using an online booking system. For example, many cities have installed electric scooters or bikes that can be rented for short-term use.

◆ **Microwork**: Short-term projects completed quickly for payment.

◆ **Sharing economy**: Assets or services that are shared between individuals, often using an online booking system.

Examples of gig and sharing economies

Sector	Description	Examples
Transportation	Digital platforms that enable freelance drivers to provide transport services, for example taxis, ride sharing and restaurant food delivery	Uber, Lyft, Careem, Bla Bla Car, DoorDash, Grubhub
Asset sharing	Digital platforms that enable person-to-person sharing of property, such as holiday homes, parking spaces and equipment	Airbnb, VRBO, Turo, Zipcar
Professional services	Digital platforms that connect freelancers with businesses for microwork, administrative assistance, writing/translation	Upwork, Fiverr, PeoplePerHour, Catalant, Guru
Handmade goods and individual services	Digital platforms that enable people to sell homemade goods and services such as dog walking and tutoring	Etsy, Airtasker, Rover, GoPeer

Employee organizations may include labour unions or any agency where employees gather for the purpose of improving relationships between employees and employers. Employee organizations advocate for workers' rights through tools such as collective bargaining, where improved benefits and working conditions are negotiated on behalf of a group of employees. Collective bargaining has resulted in higher wages, better benefits and safer workplaces. However, non-traditional employment opportunities have developed based on digital technologies that bypass some of the rights and progress that has been made. For example, companies like Uber may have different legally required benefits for their full-time employees than for their contracted workers (drivers), even if they work the same number of hours.

ATL ACTIVITY

Research

Many companies in the gig economy consider their 'short-term task providers' to be contract workers rather than full-time employees. In some countries, this allows them to limit the benefits they provide, such as health insurance, parental leave and so on.

Research the impacts on companies and gig workers if these workers are classified as contract workers instead of full-time employees. Use real-world examples from at least two different companies to support your claims. Possible examples include Uber and Lyft in various countries around the world.

Automation and employment

With software and machines automating more work, companies no longer need to hire as many employees, and some people may find themselves out of a job if a computer program is able to do their work. As of 2021, one in three workers are at risk of at least part of their job being automated in the next 10 years. However very few jobs will be fully automated. In these jobs, it is expected that tasks will evolve, and workers will have to adapt to the new environment. Jobs in unpredictable environments, such as caregivers, gardeners and plumbers, have some protection as they are very difficult to automate and less financially lucrative to developers.

Inquiry

For an industry of your choice, research how automation, through artificial intelligence and robotics, have had an impact on both the companies and employees.

Links

This content links to Chapters 3.6 Artificial intelligence and 3.7 Robots and autonomous technologies.

Links

This content links to Section 5.1B Changing populations.

REAL-WORLD EXAMPLE

Amazon's smart warehouses

Amazon's dominance of the online retail industry evolved in large part due to its rapid delivery times. One tool that enabled them to offer one-day deliveries is the use of a range of robots and artificial intelligence. Amazon uses deep learning and artificial intelligence to make inferences about what people will buy to ensure that local warehouses are ready to distribute items, even before shoppers have made purchases. After the purchase is made, a team of humans working alongside machines prepare the products for delivery. Since 2012, when a purchase is made, an army of Roomba-like robots brings entire shelves to human workers, allowing the warehouses to hold 50% more stock and retrieve it three-times faster, saving the cost of shipping goods by 40%. Each robot can lift shelves weighing over 500 kg.

Amazon diversified by buying out the company that supplies the robots, and then stopped selling them to competitors such as Gap and Walmart.

With up to 800 robots moving around the factory at once, a centralized optimization algorithm helps to direct their traffic to maximize efficiency without causing crashes between the robots. To accommodate the robot army, Amazon's warehouses have installed charging stations, ceiling lighting has been blocked out to improve the efficacy of sensors, and QR codes are embedded in the floor. Additional robots help with moving heavier items and labelling packages.

Robots working in a warehouse

While complete automation remains at least a decade away, Amazon still employs human warehouse workers. However, it is estimated that their labour force is 50% lower due to the integration of robots in their warehouses. Humans working alongside the robots complete jobs such as shelving new goods and picking items off the shelves when the robots arrive at their workstation. Productivity levels of the humans are monitored to ensure that they keep up efficient rates, and they risk discipline or even termination if their pace slows. Depending on how long they have been at the company, they have anywhere between 15 and 30 seconds to load or unload a specific item from the shelf, and an error rate of more than 0.01% will result in disciplinary action.

Amazon uses **gamification** to incentivise speed and accuracy in human workers – their efficiency enables them to 'compete' against other workers, for example in a race-car simulation, where each moved package helps speed their car along a track. Winners can earn 'swag bucks' that can be used to purchase Amazon-brand merchandise.

Amazon's warehouses are frequently under scrutiny, however, for their harsh and intense working conditions. Their warehouse injury rate is nearly double that of their competitors, particularly during high frequency times such as 'Prime Day'.

www.youtube.com/watch?v=IMPbKVb8y8s

www.theverge.com/2019/5/22/18635272/amazon-warehouse-working-conditions-gamification-video-games

Concept connections

- **Identity**: The personal identity of workers is often linked to the type of work they do. How has automation impacted workers' identity?
- **Power**: Power is embedded and exercised through digital systems. How has automation impacted the power relationship between companies and their employees?
- **Space**: How does the warehouse environment change when humans and robots work side by side? Is it more or less human orientated?
- **Systems**: Automation involves complex technologies, both digital and other types. Are human elements considered in the design of these systems?
- **Values and ethics**: Is it acceptable for companies to prioritize decreases in product costs and delivery times if they correlate with an increase in safety risks for employees?

◆ **Gamification**: Applying elements of game playing to other activities to encourage participation or efficiency.

4.2C Goods, services and currencies

E-commerce, e-trading and online marketplaces

E-commerce is the buying and selling of goods and services online. In today's world, nearly anything can be ordered or purchased online. **Brick and mortar stores**, or those with a physical building, usually offer online purchasing options also through their apps or websites. E-commerce can be classified into three main categories:

- business-to-business
- business-to-consumer
- consumer-to-consumer.

For example, an online bookstore is business-to-consumer because the company is selling the product directly to the end-user. A variety of **online marketplaces**, such as Etsy, Amazon and eBay, allow individual sellers and buyers to post advertisements, photos and products for new and used goods that they hope to sell. **E-trading**, or online trading, is a subsection of e-commerce centred on buying and selling financial products, such as stocks, bonds or other assets, on online trading platforms.

◆ **E-commerce**: The buying and selling of goods and services online.

◆ **Brick and mortar store**: A retail outlet with a physical building.

◆ **Online marketplace**: A digital platform that allows individual sellers and buyers to trade.

◆ **E-trading**: The trading of financial products, such as stocks, bonds or other assets, online.

ATL ACTIVITY

Research

Compare your online shopping experience of two e-commerce platforms.

- You are required to go through the steps of shopping online (without completing the payment step, unless you really wish to purchase a product).
- Choose a product that you wish to buy, for example a book, item of clothing or some IT hardware, and identify two online stores that you could use to buy it, for example, Amazon and Waterstones for books.
- Complete the following table to compare the sites.

Feature	Store 1	Store 2	Note down any differences, which store you prefer and why
Describe the shopping aspect of the store, e.g. how you could browse the products			
Outline the payment methods available			
Were there any additional features of the shopping experience?			
What personal details do you have to provide?			
Find and read the privacy and security policy. Was it present – yes/no?			

Personalized and targeted marketing

Many free services online are funded through advertising. Advertising becomes more valuable if it can be personalized to the viewer. **Microtargeting** is the strategy of using consumer data and information to create personalized content and advertisements. When people browse the internet, cookies, location and device information provide advertising services with key information that enables them to show advertisements that will increase the likelihood of people becoming aware of products and services and provide access to the related website.

◆ **Microtargeting**: The strategy of using consumer data and information to create personalized content and advertisements.

Links

Flip forward to Section 4.6A Political processes to see how microtargeting strategies are being used in political campaigns.

Cryptocurrency, non-fungible tokens (NFTs), cashless society, micro-transactions

Traditional currencies are centralized and controlled, usually by the government, which sets the rates and makes printing decisions about the money. **Cryptocurrencies** are digital currencies that use blockchain technology to create a decentralized encrypted ledger that facilitates online transactions, sometimes allowing for anonymous exchanges. Currency values are more volatile as they are unregulated, and a speculative market can drive their worth up and down with few safeguards in place.

◆ **Cryptocurrency**: A digital currency that use blockchain technology to create a decentralized encrypted ledger.

ATL ACTIVITY

Research

With reference to two real-life examples, research how cryptocurrencies are being used, for example, used to pay for things (the first transaction with Bitcoin was to purchase a pizza) and the impact that they are having in countries that have adopted them.

A **non-fungible token (NFT)** is a unique, one-of-a-kind digital artifact – usually drawings, music or art – that is combined with blockchain technology to allow a unique identification of the artifact. NFTs allow artists/creators to retain some ownership of their work, while collectors can verify that they own an authentic digital creation. The blockchain technology enables the authentication of the digital object. It is currently unclear if NFTs will bring digital art sales up to the same level as classical art, or if this will be more comparable to trading cards, where hundreds of similar cards exist but a few valuable ones in circulation may make them worth money to interested collectors.

◆ **Non-fungible token (NFT)**: A unique digital artifact (usually drawings, music or art) combined with blockchain technology to allow a unique identification and authentication of the artifact.

REAL-WORLD EXAMPLE

Nyan Cat

An animated gif of Nyan Cat, a 2011 meme of a flying cat, was linked to an NFT and sold for more than US$500,000 in February 2021.

www.bbc.com/news/technology-56371912

ATL ACTIVITY

Research

How are NFTs being used in e-commerce? Reference at least two real-world examples in your response.

A **cashless society** is one in which all transactions are carried out electronically. This could be facilitated through online transactions, bank transfers, credit cards, cryptocurrencies or other technologies. By 2017, in Sweden, only 20% of all transactions were made in cash. As society moves toward digitization, and phones are equipped with wallets, a cashless society seems like it could become a reality. China is already broadening and implementing mobile payments using apps such as AliPay and WeChat. However, 25% of the world does not have a bank account, which means that a cashless society would limit their ability to purchase and exchange goods and services.

Micro-transactions (mtx) refer to purchases of virtual goods for small sums of money. These are common in free-to-play games and apps where you can purchase player skins/outfits, extra lives/playtime or bypass challenging rules to make the game more enjoyable and easier. Somewhere between 5 and 20% of gamers make micro-transactions, but these in-game purchases can add up over time, especially when there is a large player base.

◆ **Cashless society**: A society in which all transactions are carried out electronically.

◆ **Micro-transactions (mtx)**: The purchase of virtual goods for small sums of money in games/apps.

One controversial example of micro-transactions are in-game **loot boxes**, where players pay real money to purchase a mystery item. Critics claim that these in-game purchases by gamers, particularly younger ones, are a form of gambling, and video games are far less regulated than casinos.

◆ **Loot box**: A virtual consumable that contains a random/mystery item. These can be purchased or won in games/apps.

Inquiry

Some countries have banned loot boxes in video games and apps. With reference to real-world examples, evaluate the impacts and implications of this decision on the affected stakeholders, such as the video game manufacturers and the game players.

Additive manufacturing

Additive manufacturing, also known as 3D printing, adds raw materials layer by layer to build an object or product. This process is less wasteful than **subtractive manufacturing**, which creates an object by cutting or carving a larger material into the desired shape. Additive manufacturing can also save costs for specialized projects. 3D printing usually begins with the creation of a CAD file containing a 3D rendering or model of the desired object. Usually, a plastic spool is heated up and 3D printers build the product from bottom to top using the model. Other applications of 3D printing include printing food, body organs and even houses!

◆ **Additive manufacturing**: Adds raw materials layer by layer to build an object or product, as in 3D printing.

◆ **Subtractive manufacturing**: Creating an object by cutting or carving a larger material into the desired shape.

ATL ACTIVITY

Communication

Design (and print) a 3D model using CAD software such as Blendr, Tinkercad or SketchUp.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Describe the components and steps involved in the process of developing a 3D printed artifact from a 3D model. *[4 marks]*

2 Distinguish between additive and subtractive manufacturing in product development refer to a real-world example in your response. *[6 marks]*

3 In 2014, NASA sent 3D printing hardware to the International Space Station. Discuss the impact and implications of providing astronauts with access to 3D printing technology. *[8 marks]*

REAL-WORLD EXAMPLE

Reddit manipulates the stock market

GameStop is a video game store that has been in steady decline as malls have lost popularity and e-commerce has become more common, exacerbated by the COVID-19 pandemic. Professional hedge fund traders decided to short the stock – a risky investment strategy that pays off if the stock price goes down, which many indicators and data points made it seem likely.

In January 2021, a group of individual traders on Reddit noticed this heavy shorting of the stock and decided to work together to build demand for the stock. They gathered enough demand to move the price from US$20 to US$350, earning them money while also exploiting the risks taken by the professional hedge fund managers. To minimize their losses, funds that had 'shorted the stock' were trapped – they either had to continue losing money or purchase GameStop stock, which would alleviate their risk but further increase the stock price. Basically, once the GameStop stock price started going up, due to the large number of 'shorts' it created a snowball effect that drove the price up even higher and created a feedback loop.

While this was in part a profitable prank executed by a group of individual day traders, it demonstrated the power of social media to manipulate the stock market, which could potentially be replicated by monitoring what stocks are being shorted by large investment firms.

Online e-trading platforms have implemented limitations on trades of volatile stocks, but individual investors, some with large social media followings, are arguing that they are being unfairly banned from the markets and opportunities that are available to large investment firms and corporations.

While the GameStop stock price surge may have been a reckless collaboration of a small social media group, it showed that a small collection of individuals could challenge the large banks and firms, and shift the rules of the investment world.

www.vox.com/the-goods/22249458/gamestop-stock-wallstreetbets-reddit-citron

Concept connections

- **Change**: The trading of shares has changed significantly with the use of digital technologies. How has this change been both evolutionary and transformative?
- **Power**: Should individual investors have access to the same trading tools, platforms and equipment as professional traders and hedge fund managers?
- **Space**: Digital technologies have made it easy to participate in share trading from around the world, with both positive and negative impacts.
- **Systems**: How have digital technologies impacted the trading of shares?
- **Values and ethics**: While it was not illegal to surge the GameStop stock price, it was a risky move that exposed volatility in a financial market. Some say it was like David attacking Goliath, while others accused the group of being a reckless mob, treating financial trading like a game.

4.2D Globalization

Borderless selling and global sourcing

Borderless selling (or borderless marketing) is the process of selling goods across national borders. Through the global reach of the internet, large and small businesses are able to reach clients across the world and widen their exposure and sales potential. Some countries have tax laws that benefit borderless selling, making it possible for international businesses to offer products and services at prices competitive with local providers. Borderless selling has been effective in the gig economy, music distribution, telemarketing and phone support, e-commerce and other fields where the goods and services can be purchased outside of the country they are created in.

◆ **Borderless selling**: The process of selling goods across national borders.

Global sourcing is the supply side equivalent of global selling. Companies buy the materials, goods and services they need to produce or maintain their business from countries all over the world. This can help corporations to access cheaper labour, more specialized workers or specialized materials.

While global sourcing allows for more competitive pricing and creates jobs across the globe, critics argue that corporations often bypass labour and environmental regulations when seeking out the most cost-effective sources and labour for their operations.

◆ **Global sourcing**: Buying materials, goods and services from all over the world; the supply-side equivalent of borderless selling.

ATL ACTIVITY

Research

Research your own, and your family and friends, participation in the globalization of business and commerce (buying and selling across borders). To what extent has it been a positive or negative experience?

Offshoring, outsourcing, reshoring, inshoring and insourcing

As more tasks and work can be completed remotely, and the convenience and speeds of international shipping are improving, companies are looking to the global labour market when deciding how to operate most efficiently.

Offshoring, or **outsourcing** to another company, is the practice of moving corporate operations overseas, usually to areas with lower costs of labour or more favourable tax and environmental regulations. Low-skilled jobs are often outsourced to areas with a lower cost of living where companies can pay employees a fraction of what it would cost for the same work to be completed in their country.

Reshoring (or inshoring) is the practice of bringing previously outsourced jobs back from overseas. As the costs of offshoring increase, due to rising labour and shipping costs and shifting regulations, as well as political and consumer pressure, the trend towards outsourcing is starting to shift.

Nearsourcing is the practice of establishing operations as close to where the end-products are sold as possible. This reduces transportation costs and lowers the environmental impact. As companies are reshoring some services, many are deciding if nearsourcing is a good method for determining the most efficient places to establish operations.

Insourcing is the labour practice of finding existing in-house employees to complete a task that would normally be given to workers outside of the organization.

◆ **Offshoring**: The practice of moving corporate operations overseas.

◆ **Outsourcing**: The practice of moving corporate operations to another company, usually overseas.

◆ **Reshoring**: The practice of bringing previously outsourced jobs back from overseas, also called 'inshoring'.

◆ **Nearsourcing**: The practice of establishing operations as close to where the end-products are sold as possible.

◆ **Insourcing**: The practice of finding existing employees to complete a task rather than outsourcing it.

Inquiry

Research businesses in your local area to see how and why they use, or have considered using, each of the following labour practices: insourcing, outsourcing, nearsourcing and offshoring.

Research how digital technologies are used in each type of sourcing for the businesses and how they facilitate insourcing, outsourcing, nearsourcing and offshoring.

Reflection

Now that you have read this chapter, reflect on these questions:

- How can businesses leverage digital technologies to improve their products, marketing and operations?
- How is the use of digital technologies addressing inequalities in the workplace and furthering issues of inequality?
- How does remote working and video conferencing shift the nature of work in a digital society?
- What apps and products are you using that rely on the gig economy? Do you know anyone earning money from these companies as contracted workers?
- How do digital technologies change the labour market?
- What percentage of your shopping do you do physically versus online? What about your parents?
- Where do you encounter targeted advertising? Do you find it useful or invasive?
- How do cryptocurrencies work and can they be a viable alternative to centralized currencies?
- How do technologies such as 3D printing change manufacturing processes and impact workers?
- What global corporations do you interact with? What websites/tools would allow you to engage in commercial activity outside of the country you reside in?
- What issues and concerns arise when companies engage in offshoring and outsourcing practices?

Creativity, activity, service (CAS)

Get involved with a small business in your community. See how they are using technology (including social media) and look for ways to optimize or improve their digital platforms.

Extended essay (EE)

The use of digital technologies in large and small businesses, especially the impacts on local people and society, can be a focus for an extended essay.

4.3 Environmental

UNDERSTANDINGS

By the end of this chapter, you should understand:

- the creation and use of digital tools impacts natural resources and ecosystems; these same tools are also used to make processes more efficient, with the potential for both a reduction in natural resource use or an accelerated consumption of them
- digital tools and other consumable products contribute to various types of pollution and there are actions in the development and disposal of products that individuals and corporations can take to minimize their negative environmental impact
- technology and data are being used to optimize spaces, infrastructure and communities; technologies also help individuals and organizations plan and navigate these spaces more effectively
- the agricultural industry has evolved to incorporate digital technology to improve efficiency and lower costs in the production, distribution and management of agricultural goods.

A digital society has both positive and negative impacts on the environment. Digital tools are used to make processes more efficient, reducing pollution and waste from existing systems. However, these tools also use scarce natural resources such as cobalt. Running digital systems requires energy, which can come from 'renewable' or 'clean' sources, such as solar or wind, from non-renewable sources such as coal, oil and natural gas.

As devices become obsolete, or are replaced by newer and better products, the physical waste that accumulates – known as **e-waste** – takes up lots of space and can leak chemicals and other hazardous materials into the environment. While there are ways to **recycle** e-waste, many of those processes are expensive, or result in the burning of non-reusable materials.

Many cities are using digital technologies to create a healthier, safer and more efficient environment for their citizens. As populations increase, digital tools help to optimize the systems and structures to meet the needs of their citizens effectively and efficiently. **Smart cities** integrate sensors, voice recognition and other new technologies to better manage transportation, energy distribution and other services.

◆ **E-waste**: Discarded electronic and electrical devices.

◆ **Recycle**: The process of converting waste into reusable materials.

◆ **Smart city**: A city that integrates sensors, voice recognition and other new technologies to better manage transportation, energy distribution and other services.

4.3A Natural resources and ecosystems

The natural environment provides many tools and energy sources to support life and activity on the planet. Natural resources range from water, solar and wind to the animals and trees that populate the planet. Natural resources can be **renewable** or clean if they are constantly being replenished. In contrast, there is a limited supply of other resources, such as crude oil, which will eventually be depleted – this makes them **non-renewable**. Digital technology developments consume resources in their production but can also make existing systems more energy efficient or help us to move towards more renewable energy solutions.

Biodiversity is the variety in animal and plant life in a particular community or **ecosystem**. Rapid population growth and economic expansion are threatening biodiversity and changing existing ecosystems. While digital technologies offset some of these impacts by increasing the efficiency of agriculture (farming) and forestry methods, it cannot compete with the increases in demand for the

◆ **Biodiversity**: The variety in animal and plant life in a particular community or ecosystem.

◆ **Ecosystem**: A community of living organisms and the physical environment that they live in.

use of land and consumption of natural resources. As a result, more animals are endangered as environments such as rainforests are being cut down and repurposed for more lucrative endeavours, such as farming cattle or harvesting palm oil.

Use and distribution of natural resources, including in digital systems and devices

REAL-WORLD EXAMPLE

Cobalt mining in the DRC

Cobalt is a chemical element that is essential in the rechargeable batteries found in smartphones and laptops. Over half of the world's supply is found in the Democratic Republic of the Congo (DRC). Many major corporations, including Apple, Sony and Samsung, purchase cobalt from artisanal mines – small-scale mining sites with limited tools.

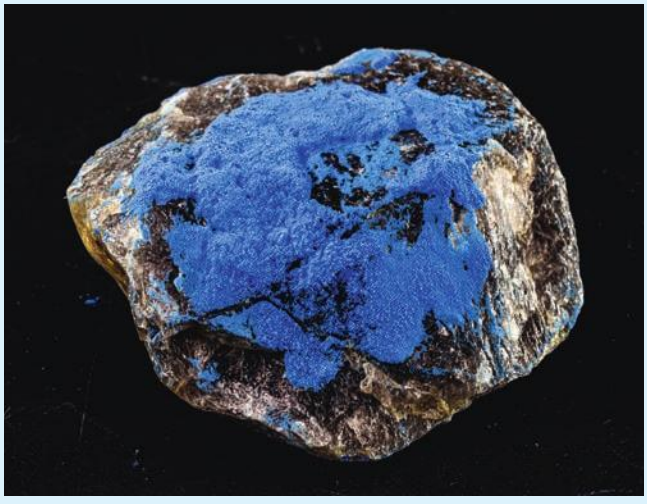
Cobalt mining for an extended period of time is dangerous. Workers can inhale metal dust, which can lead to serious lung disease, while direct skin contact with cobalt can cause itchy rashes. In many artisanal mines (as of 2016), workers rarely have face masks, gloves or protective clothing, and 90% of miners complained of coughing and breathing problems. Limited labour laws and regulations mean that mining accidents and collapses are common. Additionally, some artisanal mines employ children as young as four years old. Miners continue to work despite the risks, however, as there are limited economic opportunities in the region. It provides access to income and can help some workers afford to attend school.

Many tech companies claim to be exploring regulations and policies to ensure that they are not supporting suppliers that take advantage of their workers. The companies say that boycotting these mines would not help to improve conditions for those working and living in the region. However, critics argue that they are not doing enough as they are profiting from human rights abuse and child labour.

www.vox.com/world/2017/3/7/14828272/apple-congo-cobalt

www.cbsnews.com/news/the-toll-of-the-cobalt-mining-industry-congo

www.washingtonpost.com/news/the-switch/wp/2017/03/03/apple-cracks-down-further-on-cobalt-supplier-in-congo-as-child-labor-persists



Concept connections

- **Systems**: When we buy digital technologies, are we saving money at the expense of the miners and manufacturers who supply the materials to make them?
- **Values and ethics**: What obligations do consumers, companies and businesses have to ensure safe and sustainable conditions for workers in the supply chain when using and manufacturing digital technologies?

Inquiry

To what extent should corporations be accountable for improving labour conditions in their supply chains for the production of digital technology devices?

- Conduct research into the collection of natural resources to build consumer electronic goods. This could be an investigation of cobalt mining in the DRC, niobium in Brazil, tungsten in China, or many other possibilities.
- Explore at least three different sources – be mindful of bias.
- Discuss the labour conditions of the natural resource mines and collection sites that supply materials to digital technology companies. What safety conditions are in place? Are children working? What are the hours and wages?
- Evaluate steps taken to protect workers and ensure ethical business practices in digital technology supply chains.
- Look into policies from digital technology brands that you use. Do you agree with the values and ethics of their business practices?

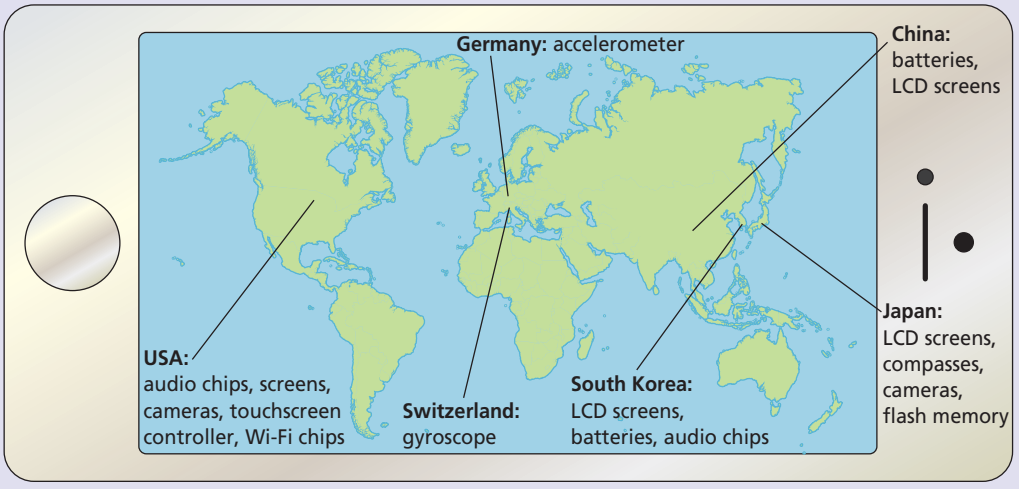
Digital tools and systems are produced and operated using resources. For example, cobalt is a non-renewable magnetic metal that is mined and processed to develop batteries. The scratch-resistant glass used to make many smartphone touch screens contains a range of materials such as silicon dioxide, aluminium, magnesium and sodium. These resources must be processed and manufactured from their natural state into the parts, components and end products you are able to purchase in stores.

ATL ACTIVITY

Research

Where are the components of your smartphone made?

- Conduct research to find out where all the components of one brand of mobile phone come from.
- What impact do you think this has on the environment?



Operating electronic devices also requires a significant amount of energy. Google operates its own fleet of electricity generators, which helps to ensure that its computers, storage servers and other products remain ready at all times, even if there is an interruption to the local electricity grid. This is how its search engine is ready and able to respond to the 75,000 queries it handles per second. In 2019, the amount of electricity used by Google (about 12.4 terawatt hours) exceeded the use of the entire country of Sri Lanka.

A global **digital divide** exists, as wealthier nations often have greater access to digital tools, services and resources. They are also responsible for a larger portion of the waste and environmental damage. Wealthier countries and corporations often harvest resources and dispose of waste in places where it is less expensive to conduct businesses. As a result, digital artifacts (such as a cell phone, computer or video game system) might be designed in the USA but manufactured in China using resources collected in the DRC, before being shipped globally to retailers in over 70 countries.

Protection and threats to ecosystems and biodiversity

Radio, GPS and satellite technology enable those who work with endangered species to track and monitor their locations on the planet. They can even send notifications if the animals' usual movements are interrupted, which can help emergency response teams save the lives of endangered animals.

REAL-WORLD EXAMPLE

Rainforest Connection

Rainforest Connection is a non-profit that uses digital technology to mitigate and prevent biodiversity loss. They retrofit old smartphones with solar power and place them in forests, using their sensors and microphones to detect and report the sounds and vibrations of illegal deforestation and poaching. In addition to helping protect wildlife, their smartphones collect real-time audio data from forests that can be used by scientists and policymakers to further protect and understand forest ecosystems.

https://rfcx.org/our_work

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline four digital technologies used by Rainforest Connection to collect, store and analyse data collected in the forests to detect illegal activity. *[4 marks]*

Scientists use climate models to collect and analyse data, to better understand how the Earth's climate has changed in the past and to predict future climate trends. Climate models are an extension of weather forecasting, which uses historical patterns to predict the weather, but it examines changes in decades instead of hours. The models rely on **supercomputers** to process thousands of calculations per second, analysing data from the Earth's atmosphere, oceans, land and ice-covered regions. The models allow scientists to run simulations and see how various components in Earth's climate system relate to one another. They are also used to investigate the degree to which any changes are the result of natural causes, human activities or a combination of both.

◆ **Supercomputers**: Refers to high-performance computers capable of high-speed calculations that are required in scientific and engineering fields.

Inquiry

With reference to real-world examples, research how climate models are produced and then evaluate the decision to rely on these climate models when making global policies and decisions. Possible models include the energy balance model, global temperature model and greenhouse effect model.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Identify two inputs that might be tracked and used by climate models. *[2 marks]*

Natural events and disasters

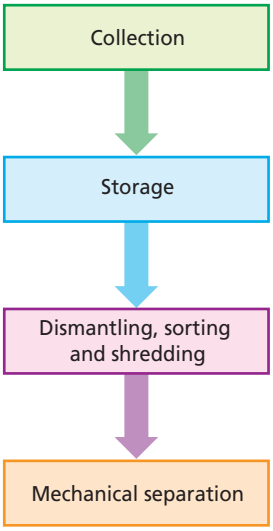
While natural disasters such as earthquakes, floods, fires and disease outbreaks remain difficult to prevent, digital technologies and data analysis are helping to make them more predictable so that communities can prepare and plan accordingly. Robots and drones are used to deliver aid as well as investigate damage sites and transmit information to rescue workers. Social media is used to raise awareness about events and allow those living near a disaster to inform their loved ones that they are safe. There are even technologies that allow phones to communicate directly with one another even when the network is compromised or inaccessible.

In 2018, natural disasters cost the world over US$130 billion in damages, affected over 68 million people and caused nearly 12,000 deaths. Digital tools increase the human capacity to predict, prevent and respond to natural disasters. Artificial intelligence and machine learning are being used to analyse vast amounts of data to identify patterns in tectonic motion that can help to track earthquakes (while prediction remains very difficult in this field). New forecasting models are being developed that will be able to predict the onset, duration and severity of heat waves. Natural flooding, such as that caused by increased rainfall or storms, can be better predicted and used to identify areas that are susceptible to flash flooding. Data analysis is even being used to forecast and mitigate the spread of diseases, for example, using satellite imagery to monitor the migration of insects that transmit certain diseases.

4.3B Pollution and waste

As digital technology continues to develop faster and faster, buyers upgrade and replace their technology with the newest and latest trends. The obsolete technology is often thrown away or recycled. Over 40 million tons of electronic materials are disposed of globally each year, including approximately 150 million cell phones. While electronic waste makes up only 2% of the waste in landfills, it accounts for 70% of toxic waste.

Recycling and waste management



E-waste process

When garbage is thrown away, it is often taken to landfills, where piles of trash accumulate over time. Because electronic parts are manufactured with potentially harmful chemicals, such as lead or mercury, they harm the environment if they end up in landfills. When exposed to heat, these chemicals contribute to air pollution and, when it rains, they can pollute nearby water sources.

E-waste services claim to 'properly dispose' of your electronics. Often this begins with collecting obsolete electronic devices and storing them until they can be transported to a facility where parts are sorted, dismantled and shredded. Magnets are then used to separate metallic components that can be processed for further use or resale. E-waste services are often outsourced to developing countries to save financially or to keep up with the demand as more electronics are disposed of. In some cases, e-waste ends up being dismantled 'in backyards' in developing countries, where non-salvageable parts are burnt as trash, adding to air pollution and health risks to anyone in the vicinity. While e-waste recycling allows some of the product to be salvaged or repurposed, it still contributes to pollution and global inequality.

◆ **E-waste service**: A business that collects obsolete electronic devices and sorts them into recyclable and non-recyclable elements.

ATL ACTIVITY

Research

With reference to real-world examples, research the drawbacks and concerns of e-waste recycling.

Possible research topics include e-waste chemicals (for example mercury, lead and beryllium), e-waste working conditions in Ghana and e-waste combustion.

ATL ACTIVITY

Communication

Create your own e-waste flyer.

- Research local solutions for properly disposing of e-waste.
- Create a post, poster or map to inform your peers of how to access these sites and properly dispose of electronic waste.
- Share it with your peers.

Types of pollution

Digital technologies often contribute to various forms of **pollution**.

The accumulation of waste materials contributes to **solid pollution**. The packaging and plastics used in consumer electronics contribute to solid waste, which can lead to overcrowded landfills or end up in waterways.

When e-waste is exposed to heat, either in landfill or when burned, chemicals, gases and particles are released into the air, causing **air pollution**. This can contribute to global warming, acid rain, respiratory illness, heart disease, cancer risks and wildlife degradation. When those same chemicals are connected with water (resulting in **water pollution**), either through rain or contact with a stream, river or ocean, it can increase the risk of waterborne illness as well as damage the ecosystems that rely on that water (marine life or agriculture).

Noise and **light pollution** refer to excessive noise or light in the environment. Cars, loudspeakers, floodlights, screens and dense populations contribute to these. Light pollution makes it hard to see the stars and disrupts nocturnal wildlife, migratory patterns and human sleep cycles. Noise pollution also disrupts sleep cycles and can also be linked to higher blood pressure and communication problems.

- **Pollution**: The introduction of substances or energy into the natural environment that cause a negative impact.
- **Solid pollution**: Solid waste material.
- **Air pollution**: Pollution released into the air either through exposure to heat or burning.
- **Water pollution**: Pollution released into water.
- **Noise pollution**: Excessive noise in the environment.
- **Light pollution**: Excessive light in the environment.

ATL ACTIVITY

Thinking

- Download a stargazing app and look out at your night sky.
- How many of the stars on the app can you actually see? Does light pollution interfere with your ability to see the stars?

Inquiry

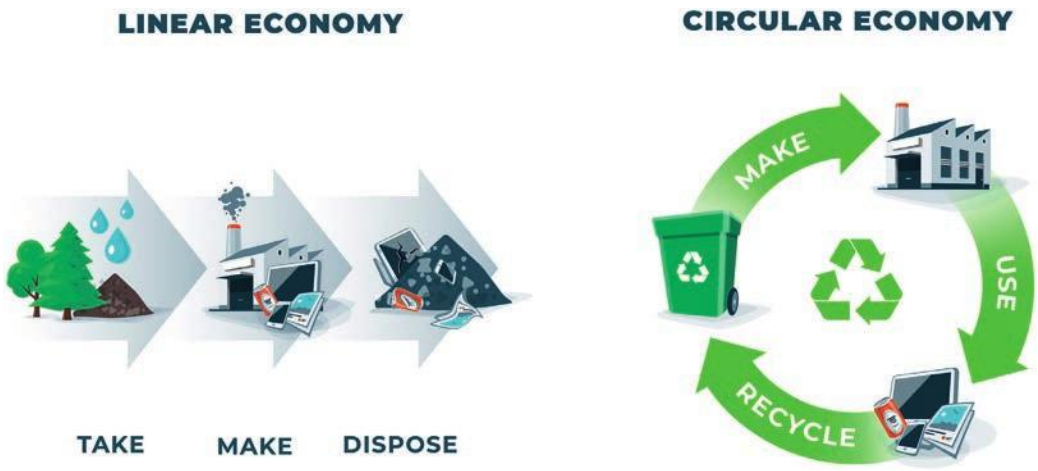
Research the world's most polluted cities and the actions (or inaction) taken to mitigate the environmental impacts of digital technologies.

Green computing, e-waste, planned obsolescence

Planned obsolescence is the development of products with intentionally short lifespans so that companies can get repeat sales as devices are replaced or upgraded. While some perceive this as a strategy of corporate greed, enabling businesses to sacrifice the environment as they capitalize on consumer markets, proponents argue that the rapid turnover of digital technology products fuels innovations and creates more jobs. While it is largely responsible for significant waste accumulation, it does enable digital technology to continue to develop and improve.

◆ **Planned obsolescence**: The development of products with intentionally short lifespans so that companies can get repeat sales as devices are replaced or upgraded.

Corporate take-back policies (or buy-back policies) are when a company will repurchase old digital devices when they become obsolete. This encourages companies to build in a more sustainable manner so that old parts can be integrated into future products. It also creates an incentive for more durable or long-lasting parts. This is one way for companies to shift from a linear production model, where materials are mined and used for a single item that is eventually disposed, toward a **circular economy** where existing resources are reused and repurposed to minimize waste and reduce the demand for new materials.



REAL-WORLD EXAMPLE

ecoATM

ecoATM has over 4500 kiosks across the USA that purchase used cell phones. Users provide information about their phones, such as the model and condition, and the automated kiosk will buy the phone on the spot. Most of the phones they purchase are resold to keep them out of landfills, while the others are recycled. Users are directed to erase all personal data from their devices prior to submitting them into the kiosk. The company claims that it has helped to keep over 28 million phones out of landfills since 2009.

www.ecoatm.com/pages/how-it-works

Inquiry

To what extent are electronic buy-back programs, such as ecoATM, effective in reducing the environmental impact of outdated devices?

ATL ACTIVITY

Research

Research how e-waste recycling programs and corporate take-back programs work in your region for the digital technologies that you use regularly.

Green computing is the study and adaptation of computer design, engineering, manufacturing, use and disposal to reduce their negative environmental impact. Green computing prioritizes energy-efficiency and proper e-waste disposal to reduce the **carbon footprint** or the total amount of greenhouse gases generated.

◆ **Green computing**: The study and adaptation of computer design, engineering, manufacturing, use and disposal to reduce their negative environmental impact.

◆ **Carbon footprint**: The total greenhouse gas emissions caused by a person, place or product.

ATL ACTIVITY

Thinking

You are concerned about the environmental harm that computers and computer manufacturers are causing. Investigate this at an individual, organizational and governmental level.

1 **Individual**: Research and describe some of the environmental factors that you could consider when purchasing or using a computer (for example, energy/paper saving).
2 **Organization**: select two computer manufacturers and research their initiatives to be environmentally responsible with regard to:
   a the use of non-renewable natural resources in manufacturing
   b the global transportation of manufactured components.
   Evaluate which company is acting more ethically.
3 **Government**: Identify ways in which governments can encourage local citizens and organizations to be more environmentally responsible computer users. What role should governments play in this?

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Outline three ways that individuals can be environmentally friendly when using their digital devices. *[3 marks]*
2 Explain three ways that the disposal of digital technologies can harm the environment. *[6 marks]*
3 Discuss the decision by companies to donate obsolete digital technologies to schools in developing countries instead of disposing of them. *[8 marks]*

REAL-WORLD EXAMPLE

Planned obsolescence in printer cartridges

Modern printer cartridges are a prime example of planned obsolescence. Microchips on the cartridge or printer use sensors to disable a cartridge before it is fully used up. Owners often must replace the entire cartridge as very few printer ink cartridges are refillable. In North America, 350 million printer ink cartridges end up in landfills each year. The impact of producing these items is also harmful for the environment.

In 2017, a French lawsuit accused printer companies Epson, HP, Canon and Brother of showing components 'at the end of their life' prematurely. This would be a violation of France's Hamon Law, which requires transparency about the product lifespan and prohibits 'deliberately reducing a product's lifetime in order to increase replacement rates'. The complaint by consumer group Halte à l'Obsolescence Programmée (End Planned Obsolescence) resulted in an investigation into Epson's business practices. Apple received a similar complaint for slowing down older iPhone devices to enhance the battery performance.

While some see planned obsolescence as corporate greed, others describe it as a natural phenomenon in a consumer-driven market that is always seeking the newest and best things. Where products in the past were developed to last decades (sometimes even centuries), most modern technological developments naturally become outdated within a few years.

www.forbes.com/sites/davidschrieberg1/2017/09/26/landmark-french-lawsuit-attacks-epson-hp-canon-and-brother-for-planned-obsolescence/?sh=4c0c0bc91b36

Concept connections

- **Change**: How do the continual changes and progress in digital technology make products obsolete earlier?
- **Power**: How much power do concerned individuals have to force digital technology companies implement an effective end-of-life programme for their products?
- **Systems:** Digital technologies have a complex life cycle involving many different systems that are often unseen and unknown that have an impact on our environment.
- **Values and ethics**: When does it become unethical for companies to make consumers replace outdated products?

ATL ACTIVITY

Communication

This would make a good CAS activity.

How can you take action to dispose of e-waste ethically in your school?

- Visit a local dump or e-waste service centre and learn more about their systems.
- Make a guide for your school telling students where they can take their batteries, old devices and other e-waste for proper recycling.

4.3C Cities, infrastructures and built environments

As populations grow, cities and communities are looking for new and innovative ways to create healthy, safe and sustainable living environments for their residents. Many towns are working to incorporate more green spaces and gardens to ensure access to fresh air and to offset the carbon emissions from traffic in congested areas. New technologies are making these spaces more efficient, sustainable and healthy for the communities that can afford to invest in these upgrades.

REAL-WORLD EXAMPLE

Tengah – Singapore's next smart city

In 2021, Singapore began construction on their 'forest town', Tengah, a new eco-friendly town of 42,000 homes enhanced with abundant greenery and public gardens. The city will integrate a 328-foot wide eco-corridor (or park) running through the centre, to protect wildlife and water systems, and as space for a nature reserve.

City planners aim to keep cars, traffic and parking underground so that the ground level is safer for pedestrians and to promote cycling and walking. Tengah will also host electric vehicle charging stations, and the roads are being built to be compatible with a future of autonomous cars and self-driving vehicles. Shifts such as these will not only make the city a more pleasant place to live, but it will also reduce the pollution and carbon emissions of the city.

Tengah, Singapore, is just one example of a growing movement to incorporate sustainability and greenery into city living. Envisioning and planning a new town gives city officials a blank slate to devise a more sustainable way of living that can both accommodate large populations and integrate technology to improve environmental access and sustainability.

Other digital technologies being implemented in cities include those for waste management, gunshot detection, smart traffic control systems, smart air quality and smart street lighting.

◆ **Infrastructure**: The structures and facilities, such as roads, buildings or power supply, that allow a place to operate effectively.

Local and regional infrastructures

Cities are using IoT technologies to improve the quality of life for their residents. **Infrastructure** includes any of the structures and facilities, such as roads, buildings or power supply, that allow a place to operate effectively. **Smart cities** are combining their infrastructure with information technologies to create more sustainable and efficient living environments.

Elements of a smart city

REAL-WORLD EXAMPLE

Smart cities

Pittsburgh, a city in the USA, upgraded their traffic lights with sensors to analyse and respond to traffic patterns in real time, reducing traffic by 41% and emissions (pollution) by 21% on the road.

Seoul, South Korea, reduced garbage collection costs by 83% with smart trash cans and recycling bins that auto-schedule pick-ups when they are full, rather than relying on pre-planned schedules.

The Japanese government is experimenting with different robots that can navigate crosswalks and avoid plants and pedestrians to make contactless deliveries throughout the country.

www.thalesgroup.com/en/markets/digital-identity-and-security/iot/inspired/smart-cities

www.iotacommunications.com/blog/smart-city-solutions-examples

Links

This content links to Chapters 3.7 Robots and autonomous vehicles and 2.5 Space and Sections 5.3A Climate change and action, and 5.3C Managing pollution and waste.

Inquiry

Research real-world examples to analyse the impacts of smart city technologies on the communities they serve. Possible examples include Virtual Singapore, the DubaiNow app and Oslo's investment in electronic vehicle-charging technology.

Transportation and wayfinding, maps, global positioning systems (GPS) and geographic information systems (GIS)

Wayfinding refers to the technologies and systems that give directions to people as they navigate a physical space, such as trying to find the closest ice cream store on the way home from school. Wayfinding is possible due to the **global positioning system (GPS)**, which uses satellite **trilateration** to locate GPS-enabled devices.

- **Wayfinding**: The technologies and systems that give directions to people as they navigate a physical space.
- **Global positioning system (GPS)**: A satellite-based navigation system.
- **Trilateration**: Technology that uses three satellites to pinpoint our device's location.

ATL ACTIVITY

Communication

Create an interactive community resource map.

- Investigate software that can create an interactive map for a smartphone.
- Create an interactive map of your local community on a topic of your choice. For example, you could create a map identifying the best restaurants in your city, or the most fun places to shop.

When combined with a mapping platform, users can interact with data displayed on a geographic map using data collected from **geographic information systems (GIS)**.

These three technologies also make it possible for cell phones to provide step-by-step directions from one location to another, monitor a taxi route, or display the exact number of minutes until a bus arrives at a specific stop.

◆ **Geographic information system (GIS)**: A system that connects data to a map.

ATL ACTIVITY

Research

Investigate how GPS satellites and the map on your smartphone work together to provide you with your location on a map.

REAL-WORLD EXAMPLE

Waze

Waze is a community-driven mapping app that aggregates data from users in real time to provide the fastest navigation routes, as well as notify drivers about hazards, police, accidents, traffic and other things that could impact their journey. Like most navigation apps, mapping platforms are combined with GPS location services to both locate users and guide them towards their destination. The app collects data automatically to monitor traffic and determine optimal routes based on drivers currently on the road. Users can also manually enter data and information about their trip (such as police car locations and road hazards).

The app uses **gamification** – users can go up levels the more they use and engage with the app. It also incorporates social interactions by allowing groups of friends to share their routes, and shows their icons on the screen if a friend happens to drive nearby.

The large number of icons and data points can crowd the screen, however, and make it difficult for users to access their routes. In addition, ads, pop-ups and reroutes can be distracting to drivers, encouraging them to look at application notifications instead of the road. While the app argues that displaying police data encourages safer driving, particularly where police are present, police officers argue that alerting drivers to police presence can make them a target or undermine their traffic control efforts. Finally, with all of the data and updates being transferred while the app is in use, the app causes a significant drain on batteries.

www.investopedia.com/articles/investing/060415/pros-cons-waze.asp

Concept connections

- **Power**: How does Waze empower users? At whose expense?
- **Space**: GPS allows users to navigate new spaces more strategically and with greater information.
- **Systems**: Live traffic updates and recommendations allow people to avoid congested areas. This has the potential to create a feedback cycle that helps to improve the congestion as fewer drivers will navigate through crowded areas.
- **Values and ethics**: The data collected by apps that use GPS to determine and use your location can be sensitive as it allows for your movements to be tracked. What policies should be implemented by governments to minimize the negative impacts and implications?

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Describe two sensors that could be used in a smart city. *[4 marks]*

2 Explain how GPS would be used to help an autonomous vehicle navigate from point A to point B. *[6 marks]*

3 Discuss how citizens could be impacted through the use of smart city digital technologies. *[8 marks]*

4.3D Agriculture

Agriculture, like other industries, can benefit from the use of digital technologies. Whether it is the use of the internet and mobile technologies to connect farmers to new markets, the use of robots and artificial intelligence to help automate processes, or the use of digital satellite imagery to reduce the cost of monitoring, digital technology is being introduced at a local and countrywide level.

Agricultural production and distribution

Agricultural production refers to the farming of crops and animals to create food, fuel, fibres and raw materials. While agriculture is often thought of as part of the food industry, it is also significant in production of materials used to make clothing, cleaning products, energy and more. In a digital society, agricultural operations incorporate sensors, robots, GPS and other technologies to yield more crops using less labour and resources. Digital tools allow farmers to monitor individual plants and exactly how much water, fertilizer and other materials each plant receives, reducing the costs and environmental impact of their operations, while also making farms safer places to work.

Distribution of agriculture is how the products get from the farmers and growers to the customers. For example, a banana picked in Costa Rica to be sold in the US will be transported by truck to a refrigerated shipping container, where it will travel by boat for 48 hours (often in air-conditioned containers) before it arrives in Miami, Florida, for distribution in the US. The bananas in the stores in Florida have already travelled over 1100 miles (1700 km).

Transporting large amounts of food requires substantial resources to both fuel the trucks and boats used for transports and maintain appropriate temperature controls in the shipping containers and storage areas so that the produce does not rot. Digital technologies are often used in this chain of activities, mostly having large efficiency benefits.

As people become more aware of the costs of transporting food over long distances (financially and environmentally), many are turning to local alternatives such as farmers markets or subscribing to local farm delivery services. While some farmers host their own websites and online stores to distribute directly to customers, many start-ups are building platforms and services to partner with farms and connect them with local customers.

ATL ACTIVITY

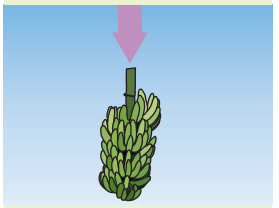
Research

Research how food arrives at your table.

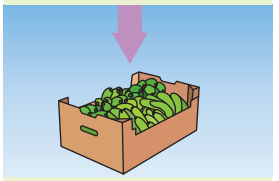
- Choose an imported food product that is available in local stores in your community.
- Research the details of the production process. Where is it farmed, and how it is transported, stored and processed?
- How is digital technology currently being used along the journey?

◆ **Distribution**: The movement of products from farmers and growers to customers.

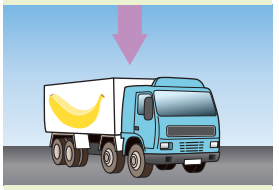
1. Bananas are harvested from plantations.



2. The bananas are cleaned and inspected.

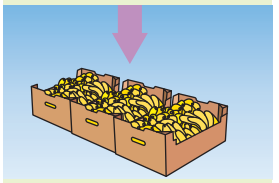


3. The bananas are split into smaller bunches and boxed for transport.



4. The bananas are transported to a port by truck.

5. The bananas are loaded on to a container ship and sail to their destination.



6. After another inspection, the bananas are sent on to supermarkets to be sold.

REAL-WORLD EXAMPLE

FarmBot

FarmBot is a farming robot, based on open source technologies, that can help to plant, water and monitor seeds automatically. It uses microcomputers, computer vision, an onboard camera, motors and interchangeable drill bits to automate the process. There is an application that includes a graphical interface for growers to plan their garden without coding. FarmBot moves in a similar way to a 3D printer, with motors that move its position along the *x*- and *y*-axis, as well as a third motor that allows it to move vertically as it plants seeds or water plants.

FarmBot

While the FarmBot machinery costs over US$2500, the software and design specs are freely available for manufacturers or hobbyists to create their own if they have access to the right materials. Additionally, because it is an open-source platform, programmers can customize it for their own gardens. FarmBot makes it possible for amateur farmers to start their own gardens indoors or in their backyards, making it accessible for anyone who wishes to automate their gardening and grow their own produce.

https://farm.bot

Concept connections

- **Change**: The change from manual and old technologies in agriculture to now include digital technologies is an example of evolutionary change as the fundamentals have not changed.
- **Space**: FarmBot allows for more precise planning and use of limited space to maximize yields in small zones.
- **Values and ethics**: The decision to make their software open source means that others can recreate and build FarmBot without purchasing anything from the company. What company values might this decision indicate?

Links

Revisit Chapter 3.7 Robots and autonomous technologies.

Inquiry

Discuss the impacts and implications for the environment of using robots in agricultural production. Make reference to real-world examples in your response. Possible examples include Harvest CROO, Harvest Automation and Abundant Robotics.

Extended essay (EE)

You could investigate the questionable manufacturing decisions of large digital technology companies. Choose a specific component or resource and evaluate the environmental impacts of its collection, use and disposal.

Creativity activity service (CAS)

- **Save the planet**: Start a social media campaign for an environmental cause, educating your peers on how to properly dispose of their e-waste.
- **E-waste project**: With the evolution of computing comes the increase of e-waste. Initiate a project in school for the collection of e-waste.
  You may need to start this project by researching which organizations are available locally to receive this waste and what they are willing to receive.
  Following on from this, initiate a collection campaign that will raise awareness about e-waste and provide a collection service for the school community.

Reflection

Now that you have read this chapter, reflect on these questions:

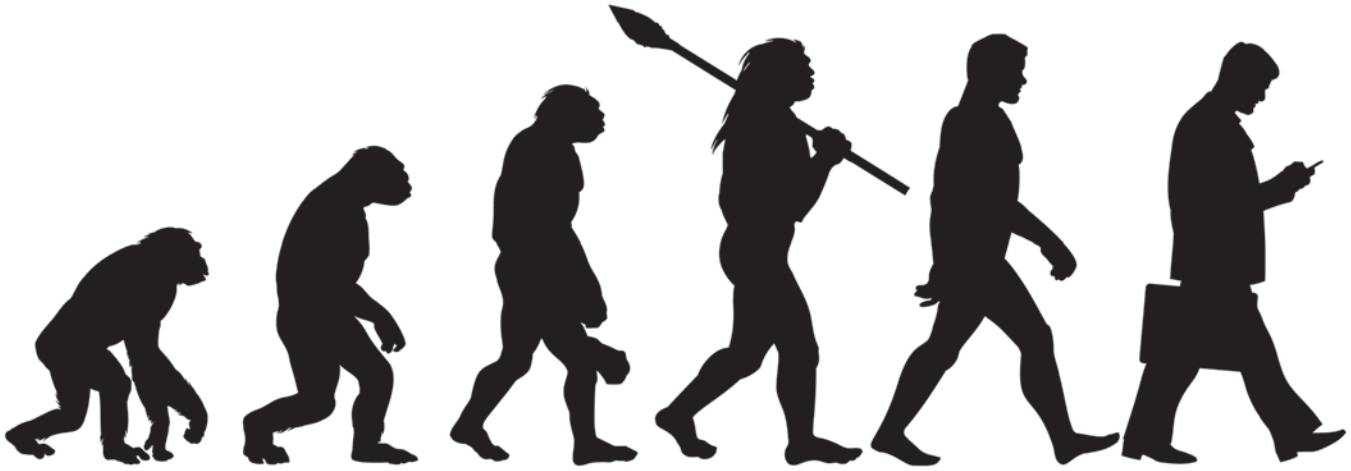
- What natural resources are used in the production of digital technologies? What social and ethical concerns arise from the harvesting and use of these resources?
- How can digital technology help to diminish the negative impacts of human activity on the environment?
- What are the different options for disposing of obsolete digital systems? What are the impacts and implications of each option? What are the viable recommendations for getting rid of hardware components ethically?
- What is the potential for smart city technologies to improve the quality of life for citizens? What are the risks and concerns of these technologies?
- How do GPS and transportation apps help us navigate the world around us more efficiently?
- How do digital technologies impact the agricultural processes of production and distribution?

4.4 Health

UNDERSTANDINGS

By the end of this chapter, you should understand:

- innovations in digital technology have evolved in the health and medical systems including the treatment of patients and the systems used to manage hospitals and other health care facilities
- digital technology tools can be used to overcome the limitations of the human body, which range from augmenting our existing capabilities to developing accessibility tools to create a level playing field for those living with disabilities
- the use of digital technologies has physical and mental health impacts.



Digital technology tools are changing the way our bodies function. The time spent on devices has impacts on our physical body, and the emotional impacts of social media use can be devastating. However, other innovations have given doctors and health care providers more tools and resources for monitoring health indicators and interacting with patients in remote areas. When examining the impacts and implications of health developments on individuals and communities, it is important to explore the trade-offs for various stakeholders.

4.4A Medicine and health

The medical field is adapting rapidly as technology evolves. New robotic and diagnostic technologies equip health care providers with new tools and data. Paper charts are moving on to cloud-based databases, and video conferencing makes doctor visits possible when hospital and home visits are not. Wearable technology can be used to monitor patients as well as athletes, and a range of software applications and tools exist to help individuals track their meals, activities and other health-related habits.

Approaches to the design and delivery of medical diagnostics and care

Medical diagnostics includes the equipment, tools and processes that allow professional medical personnel to observe a patient's health in order to determine what treatment to provide. This can range from listening to heart and lung activity using stethoscopes to monitoring blood pressure and other physical indicators of vital health signs.

Artificial intelligence is being used to analyse and monitor images, scans and data, while machine learning tools are being trained to recognize cancerous cells in tissue samples better than humans can, as well as suggest diagnoses in other areas. **False positives** are a common issue in many of these tools. Their recommendations and diagnoses often need to be re-evaluated by human medical professionals once an irregularity is identified.

◆ **Medical diagnostics**: The equipment, tools and processes that professional medical personnel use to make a diagnosis.

◆ **False positive**: A test result that incorrectly suggests a condition is present.

REAL-WORLD EXAMPLE

AI in predictive medicine

The US Department of Justice spent millions of dollars to maintain prescription drug databases to track the prescriptions of certain controlled substances in real time. This was contracted out to a company called Appriss, which used machine learning algorithms to generate data insights. NarxCare, one of Appriss' databases, identified patients at risk of misusing opioids by analysing the patients' drug shopping behaviour, along with medical claims data, electronic health records and criminal justice data, and used this to assign the patients an overdose risk score.

Appriss stated that NarxCare's score was not designed to replace a doctor's diagnosis, but many busy physicians –accountable to the police and federal law on how they handle patients with high scores – were pressured to act on the score.

In one case, the algorithm was responsible for a patient being denied medical treatment prescribed by their doctor and the cancelling of the opioids that were being used to alleviate pain while the hospital was monitoring their condition.

www.wired.com/story/opioid-drug-addiction-algorithm-chronic-pain

Links

This content links to 3.6E AI dilemmas.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 To what extent should artificial intelligence systems be relied upon when making decisions about patient health? *[8 marks]*

Patient care is also evolving as technology develops. IoT devices, including **wearable medical devices**, offer continuous, real-time data to improve treatment, diagnosis and monitoring of patients by medical professionals. These tools, combined with video-conferencing technology, enable **telemedicine** – the remote treatment of patients – reducing the costs and making the process more efficient for both providers and patients. Additionally, **robotic surgeries**, and robot-assisted surgeries increase precision, flexibility and control for doctors compared with conventional approaches. Often these procedures can be performed through smaller incisions, reducing the risk and healing time for the patient.

◆ **Wearable medical device**: A device that can be worn to provide continuous, real-time data to improve the treatment, diagnosis and monitoring of patients.

◆ **Telemedicine**: The remote treatment of patients.

◆ **Robotic surgery**: Surgery carried out using robotic systems, for example mechanical arms controlled by a surgeon.

Inquiry

With reference to two real-world examples, research and evaluate the impacts and implications of robotic surgery on the work of medical professionals. One example to consider is the da Vinci Surgical System.

Medical research and development

Research and development (R&D) in health technology helps to solve global health problems, improve on existing treatment processes and innovate new diagnostic tools, medications, vaccinations and treatment approaches. Key stakeholders involved in medical R&D include universities, governments, non-profit organizations, private corporations and philanthropic donors.

Many of the countries and communities most impacted by disease and other health risk factors have fewer resources to spend on R&D than healthier communities, which makes it less profitable. As a result, much R&D in these areas relies on philanthropic donations or government allocation of resources. Of course, digital technologies are a key part of the R&D process and are often expensive items.

◆ **Research and development (R&D)**: Work on innovating, improving and introducing new services or products.

ATL ACTIVITY

Research

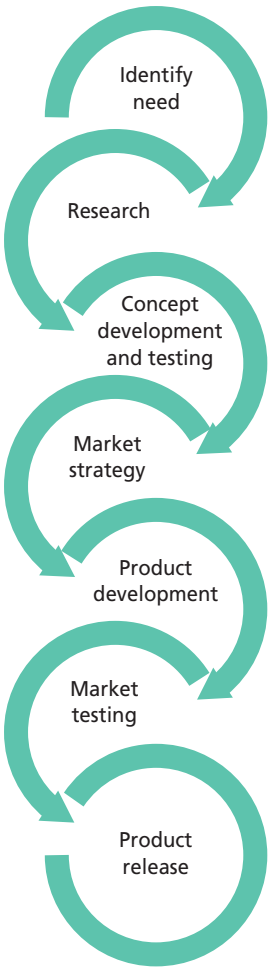
Research how scientists are fighting global diseases using a range of digital technologies for collaboration, data collection and data processing, resulting in modelling and predictions used to develop new products.

Health and wellness records, monitoring and tracking

Paper charts used in hospitals to record data about patients are moving online, where **digital health care records** store vital information, patient history, allergy information and more in a centralized database. This offers immediate and timely access to information, and helps to improve accuracy as the patients' records are stored, searched and analysed and can be shared directly with other stakeholders. Medical professionals are having to spend more and more time documenting and typing these records, while on the other hand IoT devices are increasingly being used to measure and record medical data.

Ransomware attacks on hospitals, are increasing. A 2021 survey of 600 American hospitals found that over 40% had experienced some form of ransomware attack, many delaying patient care, and some increasing death rates.

Another issue is that insurance and medical companies are eager to obtain access to these records for their own purposes, often without due consideration for patient privacy and security. The use of digital health records requires strong laws and regulations to protect patients' privacy.



The seven

◆ **Digital health care records**: Online databases that store patient information.

ATL ACTIVITY

Communication

Create a visual representation that explains in a step-by-step manner how a doctor working in a rural clinic can access electronic medical records stored centrally at the city hospital.

Your visual representation should include:

- a network diagram to show the technologies used to connect the rural clinic to the city hospital
- details of the security measures taken to secure the connection, the central database and the desktop in the clinic
- how the doctor accesses the central database
- what data is stored in the electronic medical records
- how the doctor would search for the patient's records.

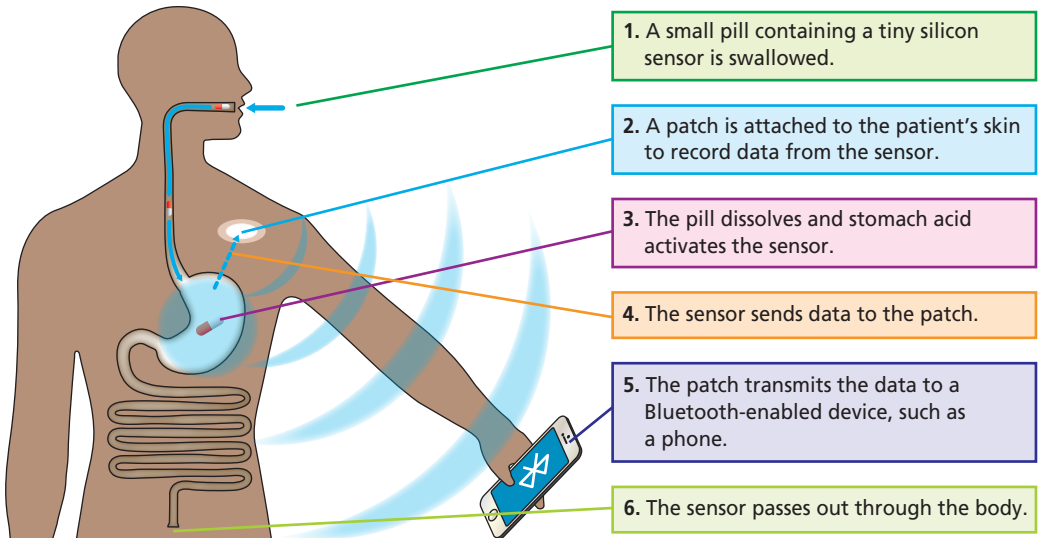
Links

This content link to Chapter 3.4 Networks and the internet.

Patient monitoring outside of the hospital setting has also evolved. Wearable technology and health monitoring software can help patients collect data, monitor their activity and share information with their health care providers.

One study showed that around 50% of prescription drug users are taking their medication incorrectly. **Digital medication**, or smart pills, include ingestible sensors that can monitor vital body functions, as well as when the pill was taken, which can then be transferred by Bluetooth to a patient's cell phone or computer and uploaded to their doctor's records or application, giving doctors access to more data and the ability to ensure that their patients are following their treatment plans accordingly. One key application of this was in the treatment of patients with schizophrenia, which allowed doctors to have reliable data on whether or not their patients were actually taking their medication.

◆ **Digital medication**: Prescription medicine that contain an ingestible sensor; also known as 'smart pills'.



How ingestible sensors work

Wearable devices such as smartwatches are increasingly becoming common as individuals monitor and track their own health and activity levels, but often they are not used effectively, and issues can arise with self-medication and diagnosis based on the data. Doctors and medical researchers are using these devices to collect real-time data from patients, but the quality and use of the data needs to be reviewed.

ATL ACTIVITY

Thinking

To what extent should patients have access to and ownership of the data in their electronic medical records? Reference at least two real-world examples in your response. Possible examples to research are Athenahealth's medical software and the 'CHS Heartbleed' cyberattack.

REAL-WORLD EXAMPLE

Telehealth

During the COVID-19 pandemic, the number of physicians using telehealth services jumped to 90%, up from 32% in the USA before the pandemic. Nearly half of the patients used their smartphones for these services. Because 85% of Americans have a smartphone, telehealth is more accessible if it can be implemented on mobile devices.

However, a University of Michigan study found that older patients, non-white patients and non-English speaking patients were least likely to use the video features in telemedicine, in part due to **internet connectivity** and **digital literacy** issues. In addition to providing medical advice, clinicians needed to provide technical support to teach their patients how to log in and connect to video conferences.

While smartphones and video-conferencing technology make telehealth more accessible globally, there remains a divide in communities that lack digital literacy and network connectivity resources.

Telehealth is growing in some countries and has become one of the main ways of extending health care to remote communities in rural areas, and where there is a lack of medical professionals and accessible facilities.

https://searchunifiedcommunications.techtarget.com/news/252505307/Tech-issues-keep-mobile-telehealth-from-reaching-underserved

ATL ACTIVITY

Social

In groups of three or four, consider an alternative perspective through this role play activity. The roles are:

- patient – you are seriously ill and have visited your local rural clinic
- doctor (rural clinic) – you are diagnosing the patient; you are not a specialist and you have not seen a case like this before, so you call on the help of the specialist in the city hospital
- specialist doctor (city hospital) – you are a specialist supporting the doctor in the rural clinic; you have to try to diagnose the patient
- family member of patient (optional) – you are with the patient and are there to support and ask the doctor questions.

To make this activity more realistic, each doctor should be in a different room using video-conferencing software.

Act out the role play and, afterwards, reflect on your roles:

- How did the patient (and family member) feel? Did they have any concerns? If so, what were they?
- How did the clinic doctor feel about diagnosing the patient? How helpful was the specialist doctor?
- How did the specialist doctor feel about helping the doctor in the rural clinic? Were they able to do a good job? Was it easy to support the doctor in the rural clinic? What were the barriers?

◆ **Internet connectivity**: The ability to connect to the internet.

◆ **Digital literacy**: The ability to use various digital platforms.

Concept connections

- **Change**: Change usually has positive and negative impacts and implications. Some have been listed in the example. Identify some more.
- **Expression**: The issue of problems in communications due to the nature of telemedicine has been raised by both doctors and patients. Identify some of them.
- **Identity**: As a consequence of the lack of physical contact between patient and doctor, the patient might feel that their symptoms and problems are not fully appreciated by the doctor. Identify some examples.
- **Power**: Telehealth has the power to increase the isolation of people and the feeling of lack of control over their lives, but it can also have the opposite impact. Make some inquiries to doctors and patients who use telehealth about this issue.
- **Space**: Telehealth has enabled medicine to enter the virtual world. Are there any uses for virtual reality and augmented reality in telehealth?
- **Systems**: Telehealth requires the interaction between a range of digital technologies. Identify some and explain how they interact.
- **Values and ethics**: Telehealth can be expensive to develop and run. Where should the doctors, hospitals and medical administration put their efforts and money? Which people, communities and regions should have priority?

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 To what extent can telehealth replace face-to-face contact between patients and medical professionals? *[8 marks]*

2 To what extent is telehealth a solution to the barriers of access to specialist health care provision? *[8 marks]*

Links

The content on access to health care and medicine links to Section 5.1A Local and global inequalities.

4.4B The human body

Transhumanism is a movement that aims to use technology to evolve and augment the human experience. This can include a range of methods in which machines and digital technologies are integrated into daily life. Technically, a wearable health watch that counts steps and provides reminders on when to stand up or exercise falls into this category. However, more advanced technology examples may include implanting microchips to help control bodily functions, or using bionic limbs. The main idea is that digital technology can help overcome the physical and mental limitations of the human body.

◆ **Transhumanism**: A movement that aims to use technology to evolve and augment the human experience.

REAL-WORLD EXAMPLE

Technological augmentation, bio-hacking, implanted technology, exoskeletons and organ printing

Google Glass was released in 2012. It incorporated camera and display screens into a network-connected pair of glasses. In theory, it should offer an **augmented reality** experience, overlaying digital information onto the reality in front of you. The product also allows users to check messages, view photos, get directions, and have spy-level access to information. However, costs, limited battery life and data limitations kept the full vision from becoming a reality in the first roll out. The market did not catch on to this wearable computer, and Google shifted its emphasis from the general public to supporting manufacturing industries and integrating their technology into safety goggles.

ATL ACTIVITY

Research

Research the latest versions of Google Glass-type glasses. List the technology involved, how it works, and the impacts and implications.

The integration of digital technology with the human body did not end in 2012, however. **Bio-hacking** is a broad term that encompasses any activity that helps you gain control over your own biology. This can range from nutritional supplements, meditation practices and intermittent fasting to stem-cell injections and more. Others may use implant technology, such as **RFID** computer chips, so that they can open doors or monitor their body nutrient levels using near-field communication technologies.

The underlying philosophy of bio-hacking is that the body's shortcomings can be overcome. However, many bio-hacking techniques ignore the health and safety tests and trials that are part of traditional medicine, making these practices risky, as well as expensive.

- **Bio-hacking**: Any activity that helps you gain control over your own biology.
- **RFID**: Radio-frequency identification.
- **Microchip implant**: Implanting an RFID transponder under the skin.

REAL-WORLD EXAMPLE

Microchip implants

A human **microchip implant** is usually an RFID transponder that contains a unique ID number and connects to an external database that could include information such as medical histories, allergies, contact information, criminal records and more.

In Sweden, thousands of microchips have been implanted in people's hands that make it quick and easy to unlock their homes, enter a gym or sign in at work. The chips are about the size of a grain of rice and usually are inserted near the thumb.

While these chips offer conveniences, they raise privacy concerns about tracking and monitoring the chip's use and patterns, as well as security concerns with the risk for identity theft or increased surveillance. They also raise safety concerns as they could have health complications, including infections. However, advocates argue that the convenience and advantages of implanted microchips will offer a competitive edge in the labour market in coming years.

www.bbvaopenmind.com/en/technology/innovation/technology-under-your-skin

Concept connections

- **Change**: The use of RFIDs has facilitated changes in our lives already. Investigate other possible uses of RFIDs.
- **Power**: The use of RFIDs to access and use places and systems also enables the tracking of our activities. What should be done to limit the use of this information?
- **Systems**: Explain how the use of RFIDs requires the interaction of other systems. Explain how the data will be transferred and used in one of these systems to enable the benefits of RFIDs.
- **Values and ethics**: For current and possible new uses of RFIDs, explore the different perspectives about why they should or should not be used.

ATL ACTIVITY

Research

Research two examples of RFID chip integration used in implant technologies. Research the benefits and possible negatives.

◆ **Exoskeleton**: A wearable robotic tool that supports/strengthens the human body.

Exoskeletons (also known as power suits or augmented mobility) are a wearable robotic tool that was originally used in the military to help lift heavy items. Exoskeletons can range from powered gloves to full body power suits. They enhance the strength and stability of the human body and allow humans to control and operate heavy machinery, lift more, jump higher and otherwise augment the human body. They incorporate sensors, motors, microcomputers and more. Exoskeletons can also be used to help rehabilitate people who have lost the ability to walk, or overcome other physical injuries and disabilities.

Links

This content links to Section 3.7C Evolution of robots and autonomous technologies.

Inquiry

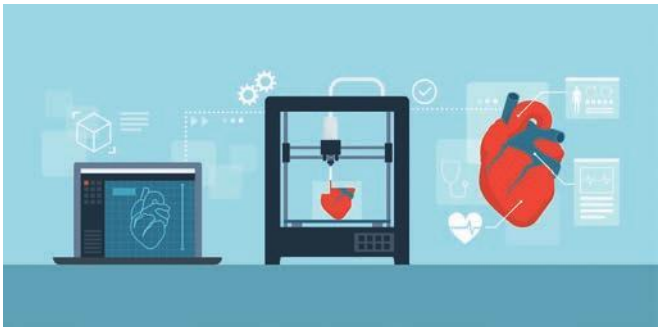
Research two real-world examples of uses of exoskeletons by disabled military veterans, and accident and disaster victims. Discuss the actual and potential capabilities.

◆ **Organ printing**: The 3D printing of organs using a combination of cells, proteins or biocompatible plastic that simulates the skeleton.

◆ **Bioprinting**: The 3D printing of tissues using a combination of cells, proteins or biocompatible plastic that simulates the skeleton.

Organ printing and **bioprinting** use the same additive manufacturing process as 3D printing, by extruding successive layers of material until a 3D object is produced. However, instead of plastic, it prints with a combination of cells, proteins or biocompatible plastic that simulates the skeleton.

Bioprinting files are often created using CT or MRI scans, then 'bioink' is prepared by mixing cells appropriate to the tissue desired. Bioprinting uses an additive manufacturing process, layering the cells in the appropriate layout using one or multiple printheads, Finally, the printed structures are crosslinked, stabilizing the structure by exposing it to the appropriate lights or elements to build covalent cell bond structures. The process results in a natural tissue that can be used to study disease and which may eventually be used more extensively to repair damaged organs and tissues.



■ Bioprinting

ATL ACTIVITY

Thinking

Prepare for a debate: Is bioprinting of human tissues and organs ethical? Are there any legal issues involved?

- Conduct wider research into bioprinting.
- Divide the group into two – one group will support the idea that bioprinting has medical benefits, while the other group will research the ethical and legal objections to bioprinting.
- Conduct the debate and, at the end of the session, take a vote.

Links

The content in this section links to Section 5.2C Diversity and discrimination.

Accessibility approaches for differently abled people and communities

Accessibility innovations go far beyond the settings in smartphones, in many cases providing the necessary accommodations to overcome physical barriers and challenges. **Assistive technology** is any item, equipment, programme or product that enhances the life for people living with disabilities.

◆ **Assistive technology**: Any item, equipment, programme or product that enhances the life for people living with disabilities.

Many tools combine artificial intelligence with camera technologies to help support those with sight limitations by transforming visual and tactile information into auditory information. For example, the 'show and tell mode' on Amazon's Alexa allows it to tell users 'what they are holding' as long as it is visible to the camera. For those who are unable to hold video game controllers, Microsoft has developed a set of 'Eyes First' games that are playable using only eye movements.

ATL ACTIVITY

Research

Research assistive digital technologies. Report your findings by making a table with disabilities in the first column, and digital technology accessibility solutions in the second column.

ATL ACTIVITY

Thinking

Find a personal relevance through exploring the accessibility options available in the operating system, and software such as word processors, on your computer and/or smartphone.

- Try out the different accessibility options on your computer.
- Complete the following table with your findings.

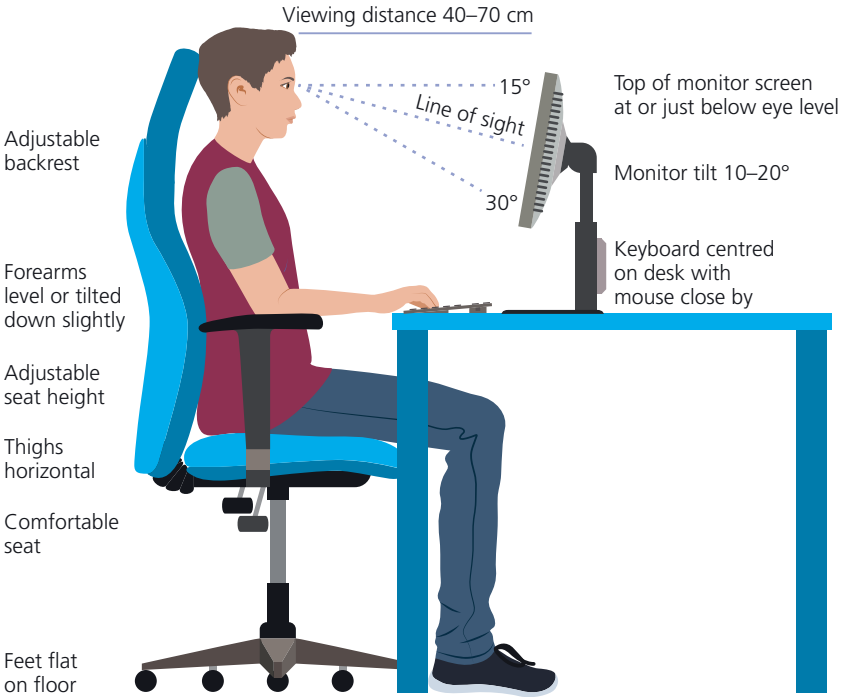
Accessibility feature	Who would benefit?	What are the benefits?
e.g. Magnifier	People with visual impairments	Allows the user to magnify the screen up to 16 times the size, making it easier to read what is on the screen

ATL ACTIVITY

Research

Research the use of digital technologies, including artificial intelligence, to help people with no vision. Compare these digital technologies with those used in cochlear implants for hearing.

Ergonomic design



◆ **Ergonomic design**: Designing workplaces, products and systems so that they meet the physical and emotional needs of the user.

Ergonomic design involves adjusting the tools and environment to meet the physical and emotional needs of the user. Awkward body positions while using a tool, whether working on a laptop or operating large machinery, can result in injury or harm, particularly when a movement is repeated over long periods of time. Ergonomic keyboards, for example, conform to the natural positioning of human fingers, allowing for a better body position and relaxed shoulders. Over time, incorporating ergonomic design principles into the workplace can improve posture as well as prevent back injuries, arthritis and other musculoskeletal injuries.

ATL ACTIVITY

Research

Research the range of health-related problems that are associated with the use of digital devices, their causes and possible solutions.

Complete the following table with notes of your findings:

Health-related problem due to the use of digital devices	Causes	Solutions
Headaches and migraines		
Eye problems, e.g. macular degeneration		
Mental well-being, e.g. depression, anxiety, problems with sleep, obesity		
Repetitive strain injury (RSI), e.g. carpal tunnel syndrome		
Neck and back pain		
Hearing loss due to headphones		

EXAM PRACTICE QUESTION

Paper 1 (core)

1 To what extent are employers responsible and accountable for employees' health issues caused by the use of computers in the workplace, and when working from home? *[8 marks]*

4.4C Mental health

Approaches to understanding and ensuring mental health

Mental health conditions, such as depression and anxiety disorders are increasingly prevalent in developed nations. More than half of their populations are likely to suffer from one of these conditions during their lifetime, and even those who are not diagnosed may still struggle from stress or other mental health challenges.

Digital solutions for mental health range from smartphone apps where users can log their moods and monitor their vital signs, to remote therapy options where users can video chat with licensed therapists. Other offerings include self-assessment quizzes and tools, online resources, forums and support communities. Digital solutions allow for more personalization and discretion, which helps to overcome the stigma that can accompany many mental health challenges in today's society.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 To what extent should users rely on the results of online mental health screening tools, such as online depression screening tests, and the result of web searches on health symptoms? *[8 marks]*

Intersections of digital systems and mental health, for example, attention, addiction and anxiety

Social media apps utilize the same neuroscience and addictive elements that go into planning a casino. They are designed to strategically trigger the release of dopamine – a natural chemical that impacts the feeling of pleasure – in a way that maximizes usage and engagement on the application. The brain reacts to social media in a similar manner as it reacts to addictive drugs. Notifications, infinite scroll and personalized content are all tools used by social media applications to increase your usage and, in many cases, convert your screen time into advertising revenue.

Social media addiction is characterized as being overly concerned with social media, where the urge to use social media is so strong that it starts to impair other important parts of life.

◆ **Social media addiction**: Psychological or behavioural dependence on social media to the detriment of other important parts of life.

Two powerful ways to mitigate the impacts of social media addiction include turning off notifications and setting time limits. Engaging meaningfully in the non-digital world, either with in-person friends or finding a hobby can also help to replace the time spent scrolling through news feeds with something more fun and positive. Taking vacations from social media, such as a screen-free day or a weekend offline, can help as well.

Social media can have a mixed impact when it comes to depression. People who have positive relationships, interactions and support on these platforms have lower levels of depression and anxiety. However, the pressure to compare oneself with others, cyberbullying and negative interactions online can increase depression and anxiety. The types of interactions and relationships a person has online are a significant determining factor in how social media use may impact their mental health.

The impact of digital technologies on mental health extends beyond social media. In 2018, the World Health Organization identified **video game addiction** or '(internet) gaming disorder' as prioritizing gaming over other interests and escalating gaming engagement to the point of interfering or having negative impacts on one's life.

◆ **Video game addiction**: Psychological or behavioural dependence on playing video games to the detriment of other important parts of life.

ATL ACTIVITY

Research

- Explore the 'screen time' features on your phone if applicable. How often do you use your phone? What applications do you use the most?
- Research topics such as 'video game addiction' and 'smartphone OCD', and compare the results with your own personal experience.
- Which of these recommendations might help you to use and engage with your phone more responsibly?
  - Reorganizing your home screen to remove distracting apps.
  - Find a place to charge your phone at night that is away from your bed.
  - Turning off all non-essential notifications.
  - Setting time limits on certain apps.
  - Switching your phone to grayscale so it is less desirable to look at.
- Recommend best practices for your peers to adjust their digital device usage and settings.

◆ **Virtual reality exposure therapy (VRET)**: Therapy designed to reduce a person's fear and anxiety by confronting the experiences in a computer-generated virtual environment.

REAL-WORLD EXAMPLE

Using virtual reality for PTSD treatment

Post-traumatic stress disorder (PTSD) is a psychiatric disorder that can occur when people experience or witness a traumatic event. This can include natural disasters, war, violence or serious accidents. People with PTSD may feel intense and disturbing thoughts, and experience flashbacks back to the traumatic event long after the actual event happened.

Exposure therapy is a treatment that aims to help reduce a person's fear and anxiety by actively confronting the experiences that the person fears the most. For many with PTSD and other anxiety-related disorders, however, it would be unsafe to revisit the traumas that they have experienced. Instead, **virtual reality exposure therapy (VRET)** is being tested as a potential treatment.

VRET allows an individual to safely immerse themselves in a computer-generated virtual environment where they can confront situations or locations that might not be safe in real life. For example, Vietnam combat veterans may be immersed into the same imagery that soldiers experienced while on the front lines. Early studies showed that VRET helps to reduce the symptoms of PTSD and may help people to overcome other fears and anxieties.

VRET remains expensive, however, and its availability is limited compared to traditional exposure therapy. VRET is still being tested for use with younger patients, and for use for other mental illnesses. The potential for self-medication with VRET is still being researched.

www.psychiatry.org/patients-families/ptsd/what-is-ptsd

www.verywellmind.com/virtual-reality-exposure-therapy-vret-2797340

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 To what extent should VRET be used as a preventative treatment for those who work in potentially PTSD-inducing situations? *[8 marks]*

Concept connections

- **Change**: VRET is an extension of current practices where people with PTSD gradually confront their experiences and learn to cope. Investigate the differences between the new and the old practices.
- **Expression**: The use of VRET enables a person to express themselves in a different way than previously by letting them relive the situation.
- **Identity**: The use of VRET is closely associated with a person's identity as it focuses on the experiences of the individual.
- **Power**: There is a significant power relationship between a doctor and patient in any treatment regime. Investigate the use of VRET for self-medication.
- **Space**: Virtual space is at the heart of VRET treatment. Investigate other uses of virtual reality to allow people to experience other environments virtually.
- **Systems**: VRET systems are based on entertainment virtual reality systems. Investigate the differences between VRET and other virtual reality systems.
- **Values and ethics**: There is real potential for both harm and good with the use of VRET as its effectiveness is still being investigated.

Creativity, activity, service (CAS)

Volunteer at a local hospital, senior centre or sports team and see how they are integrating new digital technologies into their practices.

Extended essay (EE)

Explore the impacts of bioprinting on patients in need of organ transplants.

Reflection

Now that you have read this chapter, reflect on these questions:

- How are people in your community using technology to improve their health? This could be through the use of smartwatches that monitor movement and heart rate activity, diet tracking apps, or perhaps you know/are someone with diabetes using applications that monitor insulin levels.
- How do you feel about technological augmentation? Would you want RFID chip implants or a robotic exoskeleton to expand the capabilities of your own body?
- Look at your workspaces, classrooms and study spaces. How could you implement ergonomic design to make them more comfortable and prevent long-term injuries?
- Reflect on your relationship with your digital devices. Log the time spent on your devices and your moods and feelings when using or not using them. How would it feel to spend a weekend off-screen? What steps would you need to take in order to fully disengage from technology for a period of time?
- What supports are available to you, your family and peers if you or someone you know is experiencing mental/emotional health challenges?

TOK

At what point do humans augment themselves to the point that they are no longer considered a human? What are the ethical considerations that must be considered when 3D printing living cells/tissues?

4.5 Human knowledge

UNDERSTANDINGS

By the end of this chapter, you should understand:

- digital technologies are redefining the purpose, methods and outcomes of formal and informal education
- digital societies use digital tools and processes to develop new science and technology.

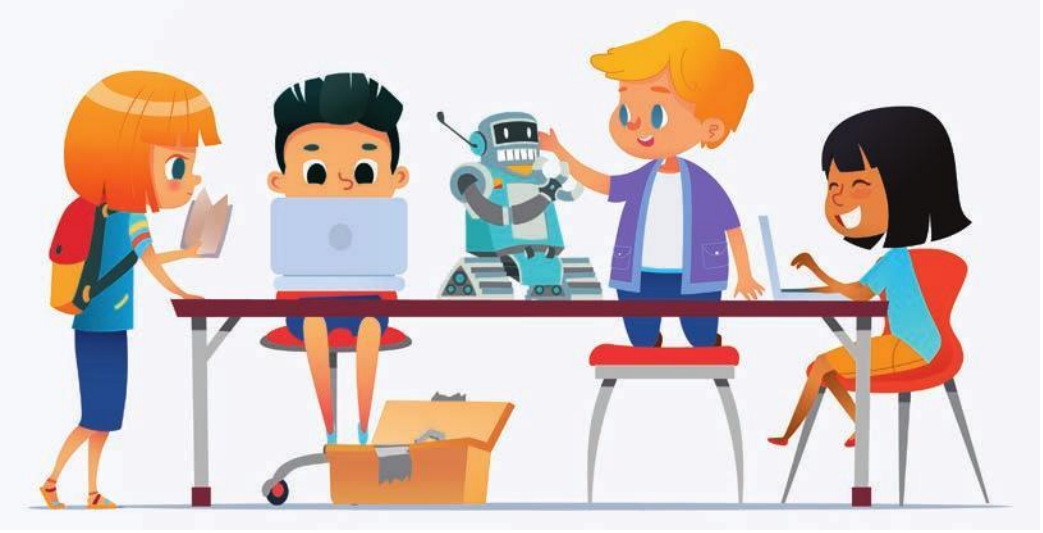
Modern education structures were designed during the Industrial Revolution, with schools aimed to equip students with the skills and values required to work in a factory environment. Schools provided good training in punctuality, following procedures and being agreeable. In today's digital society, however, we are entering a post-industrial era, and the skills and values of the past are no longer sufficient to prepare students as future workers, leaders and citizens.

In the past, education was essential for passing down knowledge from one generation to the next but, with the advent of the internet and search engines, limitless content knowledge is (almost) only a click away.

Advances in digital technology have also shifted innovation and development. Computing power (and eventually quantum computing power) has shifted the distribution and development of knowledge. Computers can run simulations and modify experimental variables much faster than humans can, and quantum computing will further expand the capacity to run tests and make simulated predictions.

4.5A Learning and education

Design and delivery of formal education



Educational systems are changing with the introduction of new digital technologies based **pedagogies**, or teaching approaches, that are evolving to better equip learners with the knowledge, tools and skills they need for jobs that do not yet exist. Students are being taught to use and explore digital technologies, both to develop their mastery of content and their skills and comfort with various tools. A greater emphasis is being placed on **social-emotional learning** and **critical-thinking skills**, and classrooms have evolved from a teacher lecturing to interactive group work, projects and activities based on neuroscience and research in best practices and facilitated by the use of digital technologies.

Teaching and learning regularly utilizes web-based tools to help deliver information, check students' understanding and encourage collaboration. **Creative computing** gives students the digital tools they need to generate their own content and demonstrate their learning in areas such as graphic design, video production, programming and more.

◆ **Pedagogy**: An approach to teaching.

◆ **Social-emotional learning**: Skills that help students to understand their emotions and build empathy and understanding towards themselves and others.

◆ **Critical-thinking skills**: The process of conceptualizing, applying, analysing, synthesizing, and/or evaluating information.

◆ **Creative computing**: The interdisciplinary area at the cross-over of the arts and computing.

ATL ACTIVITY

Communication

A range of digital technologies are used in education today to enhance teaching and learning. Imagine that you are marketing one of these technologies and have been asked to set up an education exhibition to promote it. Your job is to persuade the teachers to buy/use it.

- Research digital technologies of the future classroom.
- Select one digital technology from your research.
- Prepare a display to demonstrate the digital technology being used – this will either be with the actual technology or, if this is not available, you can use a video to demonstrate it.
  - Demonstrate the digital technology being used – in real life or via a video clip.
  - Describe the product including its features and price.
  - Describe the impacts this technology will have on the students' learning.
  - Describe the impact that this technology will have on teachers.
  - Describe the disadvantages for teachers and students of the technology.
  - Suggest ways of using the positives of the technology while minimising the negatives.
  - Cite your sources and include a bibliography.

Remote learning makes education available over a network connection. This can be conducted using video-conferencing software (such as Zoom or Google Meet), hosting and sharing pre-recorded video lessons, broadcasting television and radio content, or a variety of other forms that allow students to access materials without being in the same room as their teacher and peers. **Synchronous** learning occurs in real time and allows for dialogue and live interactions while **asynchronous** learning is available at any time and responses may be delayed or scheduled. Remote learning gives learners access to more courses and content without the need to travel or physically relocate.

◆ **Remote learning**: Education that occurs over a network connection, for example, using video-conferencing software.

◆ **Synchronous**: Remote learning that happens in real time with a live teacher.

◆ **Asynchronous**: Remote learning that can happen at any time, for example, using pre-recorded content.

Remote, or distance, learning was developed decades ago as a solution for students living in very remote areas with only radio contact, for students who could not attend formal schooling due to illness or disability, and for students who had other duties, such as work, and could not find time to participate in education during the day. Universities also offer formal courses through remote learning for the same reasons. Originally these courses were called 'correspondence courses' as all communication was done by physical mail, with the student receiving the work and resources by mail and sending the assignments back by mail. Wherever possible, contact between the students and teachers was made by phone or radio.

ATL ACTIVITY

Research

Research the advantages and disadvantages of remote learning for students and teachers. Base your research on the experiences of friends and family, and secondary research from academic sources or news articles.

ATL ACTIVITY

Research

Research companies, schools and universities that offer online courses for secondary students and university students. If possible, consult teachers and students who use online learning for a range of reasons. Research why and how the online course operates, and find reviews of the course. Try to find why some students succeed with online courses, and why a significant proportion of students do not complete the courses.

Approaches to non-formal and post-formal education, for example, skill training, competency development and self-directed learning

The internet is home to a wide range of human knowledge and learning opportunities that enable learners to access the information they are passionate about, making **self-guided learning** more accessible and available. Many universities publish and share course recordings, and their online platforms offer **massive open online courses (MOOCs)** where a single course if available for a nearly unlimited number of students to participate in.

◆ **Self-guided learning**: A strategy that allows students to direct their own learning.

◆ **Massive open online course (MOOC)**: An online course that is available for a nearly unlimited number of students to participate in.

ATL ACTIVITY

Thinking

Find a MOOC that interests you and try out online learning for yourself.

- Visit an online learning platform, such as Coursera, edX or Udemy.
- Enrol in a class that interests you.
- Take note of the features that they use, such as quizzes, forums, interactive applications, video lectures and more.
- Try to complete a unit or chapter of the course (or the whole thing if you are feeling motivated).
- Respond to the prompt: To what extent are online courses making high-quality learning more accessible? Reference real-world examples in your response.

Skills training is available online for those who want to train in a new field, and for those whose profession requires it. Food safety courses are available online for those who are planning to work in a kitchen setting, for example, and CPR/first-aid training can be completed online before going to a testing centre for a live skills assessment.

There are many different ways for people to be educated and trained. It usually consists of classroom lectures with textbooks, images, videos, podcasts, computers, hand-held devices and other electronic appliances, role play and secondary research, of course, using libraries and the internet. The use of virtual and augmented reality in education and training is becoming more common, however. It can turn a normal lesson into an educational experience, similar to real-world excursions and practical

classes, but with greater capabilities. There are limitations with these new technologies, of course, including the cost and time-consuming design and development. Also, the range and usefulness of the reality depicted can be limited.

Inquiry

Research the use of virtual and augmented reality in education and training to determine how it is used and its effectiveness.

Links

This content links to Section 3.5C Immersive digital media.

Online learning can help to develop a range of competencies. **Competency development** can be achieved through exercises and activities to improve or extend professional skill sets. **Behavioural competencies** include interpersonal skills, responding to feedback and other key traits in how work gets done, while **functional competencies** focus on the technical skills and abilities needed to perform in their job. For example, a paediatric nurse could have very high functional competencies as they take health information for a small child but, if they do not have the behavioural competencies needed to work with children and families, they may receive complaints from unhappy clients.

- **Competency development**: The practice of developing competencies in particular skills.
- **Behavioural competencies**: The interpersonal skills required to do a job well.
- **Functional competencies**: The knowledge required to do a job well.

Inquiry

Discuss the benefits and drawbacks of allowing employees to complete training virtually. Make references to real-world examples in your response. Possible examples include workplace safety, sexual harassment awareness courses, food safety and CPR/first aid.

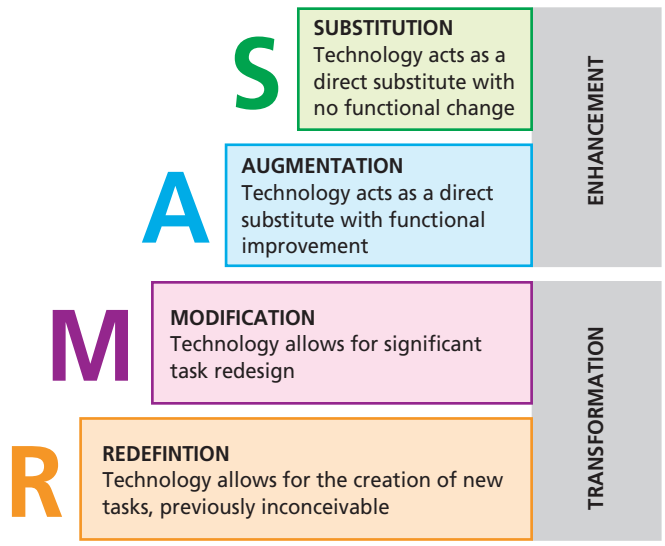
Which of the competencies are more suitable for online learning?

Digital pedagogies

Digital pedagogies are the approaches to teaching that integrate digital tools into the learning environment, and the decision-making involved when deciding whether to use a digital tool in a lesson or to stick with a traditional 'low-tech' approach.

One example of a framework for analysing educational technology is the **SAMR model** through which teachers and learners can analyse how technology is impacting the lesson:

- **Digital pedagogies**: Approaches to teaching that integrate digital tools into the learning environment.
- **SAMR model**: A framework for analysing educational technology.



SAMR model

- Is it **substituting** for a low-tech alternative (such as replacing a poster project with a presentation slide)?
- Is it **augmenting** the experience with a similar but increased functionality (such as incorporating multimedia in the presentation that would not be possible in a poster alternative)?
- Does it offer a significant redesign or **modification**, for example, using a cloud-based platform to allow students to share their work and synthesize their work with their peers?
- Does it **redefine** the learning experience in a way that would not be possible without the technology? For example, students could share their work with learners from a different country and ask questions to see how their findings would be different if they lived in a different location.

All levels of the SAMR model provide educational benefits depending on the course, the students and the outcomes required. It is important to be aware that not all low-level educational apps will be innovative and more effective, however.

ATL ACTIVITY

Thinking

Evaluate an educational app according to the SAMR model.

- Download one educational app on to your phone.
- Interact with the app and then answer the questions in the following table.
- Share your findings with other students to ensure that you have covered all levels of SAMR.

Name of app	
Describe the educational value of the app	
Identify which level of the SAMR model the app is	
Substitution: What would the app substitute in the analogue world with little functional change?	
Augment: Are there any improvements to the current education that could not be achieved before?	
Modification: Are there any modified tasks that you can do with this app better than before?	
Redefinition: Are there any new tasks that would previously have been impossible and would increase the value of the education?	

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 'Many educational digital technologies are useful but do not improve education.' Discuss this statement. *[8 marks]*

REAL-WORLD EXAMPLE

Berkeley deletes online content

At the start of 2017, the University of California, Berkeley (Cal) hosted over 20,000 video and audio lectures that were free and open to anyone who wanted to learn. However, after receiving complaints from Gallaudet University (which instructs using American Sign Language), the US Department of Justice signed an order that required all online education content to be accessible to people with disabilities, such as blind and deaf learners. Cal would have needed to add captions, screen reader compatibility and other accommodations in order for their 20,000 audio and video lectures to comply.

Due to the costly nature of implementing these requirements, Cal decided to remove the publicly available content and began work on developing alternative course offerings that would require a login but would also meet higher accessibility standards. Requiring logins and authentication might also provide intellectual property rights for the professors who develop the courses, and prevent unauthorized redistribution of the content.

www.insidehighered.com/news/2017/03/06/u-california-berkeley-delete-publicly-available-educational-content

Concept connections

- **Change**: Relate the levels in SAMR to the various types of change in Section 2 Concepts.
- **Expression**: How do students in a virtual learning environment express themselves differently than in a physical learning environment?
- **Identity**: As with many online activities, you do not have to display your full identity. To what extent is this useful for online courses?
- **Power**: Access to quality education, such as through MOOCs, is empowering for people in the lower economic and social classes.
- **Space**: Digital technologies allow for both a physical and virtual learning environment, or a blend of both.
- **Systems**: MOOCs are very expensive to develop and maintain as they are complex systems.
- **Values and ethics**: Do governments have a duty to support the development and use of MOOCs as a benefit for society?

Links

The characteristics of computer networks that have been proven valuable in education are discussed in Chapter 3.4 Networks and the internet.

The characteristics of augmented and virtual reality that make them useful for supporting training are discussed in Section 3.5C Immersive digital media.

4.5B Science and technology innovation

Innovation science and technology are essential for progress in human knowledge and the future of our digital society. The growth of data processing and computing power have empowered researchers to conduct experiments on immense data sets in faster time than previous generations. New developments in academic and corporate settings are yielding new products, processes, research and other innovations.

Both corporations and countries understand that investing in research and development (R&D) processes will help them to stay relevant for the future, and they are exploring ways to turn futuristic ideas into present-day realities.

Approaches to scientific and technology research and development

R&D encompasses all work directed toward innovation, creation and improvement of products and processes. It also involves incorporating new data tools such as visualizations, data mining, big data analytics and more.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Quantum computers encode in qubits instead of binary data. Where 8 bits in a computer can represent any number between 0 and 255, 8 qubits can represent those same numbers simultaneously. In research situations, quantum computers are able to examine a multitude of possible combinations and run a variety of simulations simultaneously.

To what extent will quantum computing impact research and development in academic environments? *[8 marks]*

Social media and the interactivity of the internet have opened up many new forms of research. **Open innovation** is a growing trend in which organizations incorporate external sources such as customer feedback, external agencies and patents, into their research and development strategy, rather than relying only on their own internal knowledge and resources. Sometimes R&D teams will intentionally provide journalists and social media with new information to solicit feedback and ideas from the general public.

Citizen scientists are ordinary people who want to become involved in scientific research with the aim of increasing scientific knowledge. They are people in the community with the skills and passion to find answers to questions about the world and how it works.

Sharing knowledge can help all types of research and ultimately can provide social, economic and environmental benefits. Many citizen scientists have an interest or hobby in a particular area, such as ecology, animal behaviour or astronomy, and some are interested in the power of knowledge for causes such as conservation and medical advances. Much of the work of citizen scientists is the collection of data that would be too expensive or difficult for a small research team to do. Other types of work include the simple processing of data, such as examining images of the stars to find interesting or targeted changes. There are many apps that have been set up by research institutions, such as the Smithsonian Institution, that make it easy to participate in research.

- **Open innovation**: When organizations incorporate external sources into their research and development strategy.
- **Citizen scientists**: Ordinary people who want to become involved in scientific research with the aim of increasing scientific knowledge.

ATL ACTIVITY

Research

Research opportunities for becoming involved in scientific research in your local area and also internationally. Make a list of the different types of activities involved.

Report back to your class as they might want to use these opportunities for CAS and their personal interests.

Participating in research as a source of data has also been facilitated by the internet. You can now volunteer (and even be paid) to complete surveys and provide other information as part of market research, take part in online focus groups, and in medical and psychological scientific research.

ATL ACTIVITY

Research

Research opportunities for volunteering in research programs at your local universities and research institutes.

Report back to your class as they might want to use these opportunities for CAS and their personal interests.

REAL-WORLD EXAMPLE

Sci-Hub

Scholarly journals and research often require a subscription to access them. This creates a digital divide, as many scientific research papers are only available to those who can afford them. Much of this research was created in non-profit or tax-funded universities, but the findings are hidden behind a **paywall** by for-profit publishers and databases such as JSTOR or ERIC.

◆ **Paywall**: A method of restricting access to digital content unless a subscription is paid.

Sci-Hub is a free online database website that hosts 85% of all academic papers, many of which normally requires a subscription to access. Many of the articles were obtained using tactics to get access to paywalled material, then uploading the content to the Sci-Hub database. Sci-hub has over 600,000 daily users, with the most per-capita users coming from Iran, Tunisia, Greece and Portugal. Sci-hub bypasses the copyrights and payments of academic publishing companies, but makes these resources available and free for researchers and academics across the globe.

https://thediplomat.com/2020/09/kazakhstans-robin-hood-the-geopolitics-of-sci-hub/

ATL ACTIVITY

Thinking

Discuss the decision by research databases to charge access to published research. Reference real-world examples in your response, such as JSTOR and Sci-Hub.

Concept connections

- **Power**: The academic publishing industry has been criticized for shifting power away from the public scholars and universities that often generate the content and knowledge into the hands of corporate research journals and databases who own the copyright and charge viewers for access to resources created using public funds.
- **Values and ethics**: Is it ethical for researchers to bypass paywalls if they cannot afford to pay for the journals or articles that they need in order to complete their studies (which in theory benefits all of humanity/human knowledge)?

Creativity, activity, service (CAS)

Learn a new software

Teach yourself new IT skills by completing an online course. Before starting, conduct some initial research into which online platforms provide IT courses. Perhaps your school has already registered with a platform that can be used, or see what free courses are available.

Select the platform and the course to register. Work through the required activities, and don't forget to document the journey for CAS.

Reflection

Now that you have read this chapter, reflect on these questions:

- What digital tools are used at your schools? What do you interact with in the classroom? What systems or Learning Management Systems (LMS) tools help with school logistics? Do your teachers use any platforms or tools to share content/information that you don't interact with directly?
- Have you or someone you know learned something independently and/or online?
- What would you do if you wanted to learn a new skill? What options do you have at your disposal?
- Where have digital tools been used effectively in your learning experience? What opportunities for improvement have you noticed? Have you witnessed any changes over the past few years?
- What are current events and focuses for research and development? What is trending in university publications, news stories and other innovative sources?
- What opportunities to be a part of scientific research in your local area interest you?

TOK

Who should own the knowledge that created using taxpayers' money and community resources?

4.6 Political

UNDERSTANDINGS

By the end of this chapter, you should understand:

- political processes use digital tools to promote candidates and agendas, as well as to facilitate civic engagement, political activity and processes such as voting
- governing bodies that define the various organizations, jurisdictions and communities that may have political influence or representation to specific communities are increasingly using digital technologies
- digital warfare and terrorism exist both in the physical and virtual domains; weapons technologies help to develop more effective tools for warfare (and/or terrorism) while digital tools help to facilitate the communication and management of members, groups and other stakeholders
- managing digital technologies is challenging as prior laws and local jurisdictions are not always suitable to meet the new needs and issues that arise in a universal digital society; lawmakers may not be able to adjust and organize quickly enough to keep up with the pace of change, while businesses and criminals may begin to implement their own agendas and policies.

Innovations and challenges move hand in hand in the political context of digital society. Digital voting and campaigning tools can give more voters access to the polls and information that they need to engage in democratic processes, but it has also resulted in a host of security, privacy and misinformation issues that have endangered the institutions, careers and lives of voters and politicians.

Various governments, agencies and non-government actors employ a range of tools and resources to facilitate their agendas. This can include nationwide digital ID cards used to develop a citizen database, online appointment scheduling for government facilities, or local school boards collecting feedback on an upcoming policy decision. In the political context, digital tools may be used to improve the efficiency of an organization, or offer more transparency and interaction to the relevant stakeholders.

Advances in technology, data and artificial intelligence in warfare have created more efficient military operations and have saved the lives of soldiers. Additionally, they have led to major innovations in health, space travel and medicine. On the other hand, reliance on digital systems has created a new platform for warfare, where (nation-backed and politically motivated) hackers can hold companies, regions or infrastructures hostage digitally.

Finally, a digital society has a greater capacity to monitor its citizens. Whether it is speed cameras on the highway or amber alerts to help stop a kidnapping, a more connected society has the capacity for more surveillance. Is greater security worth the privacy trade-offs? Are policies and regulations effective in maintaining security while potentially impacting human rights?

4.6A Political processes

Voting and campaigning

Political processes in a digital society focus on the systems and tools that facilitate the transition of power and information in a nation (or city or region). In a democracy, this includes the processes used to vote and elect leaders, as well as the tools those leaders use to campaign as they run for office. Political processes also include activities by citizens, organizations and corporations to participate and influence the government. This can range from lobbying to organizing like-minded individuals around a political movement or cause. There is also a large amount of advertising and propaganda that is used to promote candidates and/or ideas to influence the population.

Digital tools are used to organize, facilitate and communicate a wide range of political processes. This includes using digital or internet voting platforms to collect and count votes, analyse social media data to help a candidate strategize, and using social media advertising to spread a desired message about a candidate or cause.

Inquiry

Select two recent campaigns or elections that used social media or digital campaigns. They can be from different times and locations. Some examples include Trump using Twitter in the USA, Bolsonaro using WhatsApp in Brazil and the Obama 2008 campaign in the USA.

- Research how they used social media or digital marketing tools to reach potential voters.
- Compare and contrast the approaches used. What did they have in common? What made each one unique?
- Evaluate the success of each campaign.

Voting

The challenge of counting millions of anonymous votes in a short period of time can be greatly reduced through the use of digital and electronic platforms. **Electronic voting systems** may count votes the moment they are cast at specified locations, while **online voting** lets voters cast their ballot without ever leaving their homes. Both of these systems rely heavily on databases to keep track of who is eligible to vote and who receives the votes. However, many critics believe that there could be a risk to the privacy of the voter and the accuracy of the results.

◆ **Electronic voting system**: A digital system designed to count votes the moment they are cast.

◆ **Online voting**: A systems that allows voters to cast their ballot online.

ATL ACTIVITY

Communication

Challenge: Electronic voting machines are meant to make voting more efficient, but there are issues. A variety of voting digital technology is available and can be investigated.

- Using effective online research skills, investigate electronic voting machines that have been used successfully in recent political elections.
- Summarize details of the technology used, including the benefits to the voting process and any challenges that may be faced.
- Draft a proposal for a new electronic voting system for a local use of your choice, for example voting for the school council or local politicians.
- Present your findings to your class.

■ Electronic voting

Political advertising and propaganda

When running for political office, candidates face the challenge of trying to appeal to a wide base of voters who are passionate and opinionated about a variety of issues. In today's society, big data (large data sets that may be analysed using digital technology to reveal patterns, trends and associations) and social media equip campaigns with the tools to market their candidates to individual voters, showing them the messages and media that are most likely to motivate them into a desired action, whether it is changing their voting habits or suggesting a donation. They don't need to waste resources on individuals that the data shows are already set in their beliefs and habits.

Providing individualized content to advertise or promote a politician (or a product) is known as microtargeting. These messages become **propaganda** when they contain biased or one-sided information. Because these messages can be targeted at specific groups and users, it is harder to hold creators accountable for misinformation when compared with radio or television advertisements, which are exposed more scrutiny by larger audiences, the media and regulatory bodies.

◆ **Propaganda**: Biased or one-sided information.

Formal and informal forms of political participation, such as lobbying, political movements and activism

The internet has created a power shift as more and more people have the access and ability to publish and share their thoughts with audiences, viewers and allies around the globe. Even those who are still too young to vote are using social media to learn more about current events, advocate for the environment, protest racial injustice and amplify their impact on issues facing their community. Digital technologies have also changed the way lobbying is conducted: concerned citizens and organizations can communicate with their representatives by email, using online feedback tools and even engaging with their offices on social media platforms.

Links

The content on political speech and activism links to Section 5.2B Participation and governance.

REAL-WORLD EXAMPLE

◆ **Psychographic analysis**: An analysis of people based on their activities, interests and opinions.

Campaigning: A brief history of presidential election advertisements in the USA

Political campaigns build voter profiles by collecting massive amounts of personal data (increasingly available online and for purchase). They use these profiles to target individuals and subgroups with personalized advertisements, news, (mis)information, advertisements and other content with the intent of swaying their views and actions.

While microtargeting tactics, such as the use of direct mail and regional television advertisements (at least in the US elections since 1992), were already being used, they did not become nationwide until the 2004 elections. Four years later, the rise of social media made microtargeting even more powerful.

> *As early as 2008, for instance, the Obama campaign had reportedly gathered as many as one thousand variables about each voter drawn from voter registration records, consumer data warehouses, and past campaign contacts to better target its messaging.*
>
> *Source:* **https://privacyinternational.org/blog/845/voter-profiling-2017-kenyan-election**

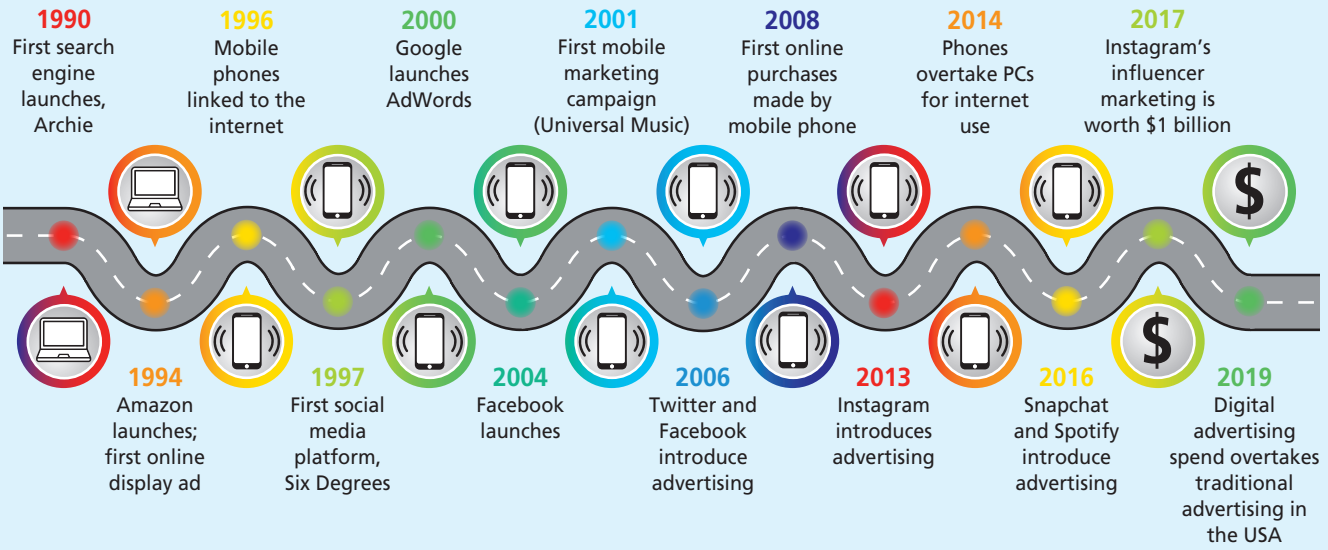
Obama's 2008 campaign combined microtargeting tactics with big data and the strategic use of social media to target statistically influenceable voters and mobilize them towards voting, organizing and fundraising.

Soon, individuals were receiving different campaign advertisements than their peers based on their own unique voter profiles.

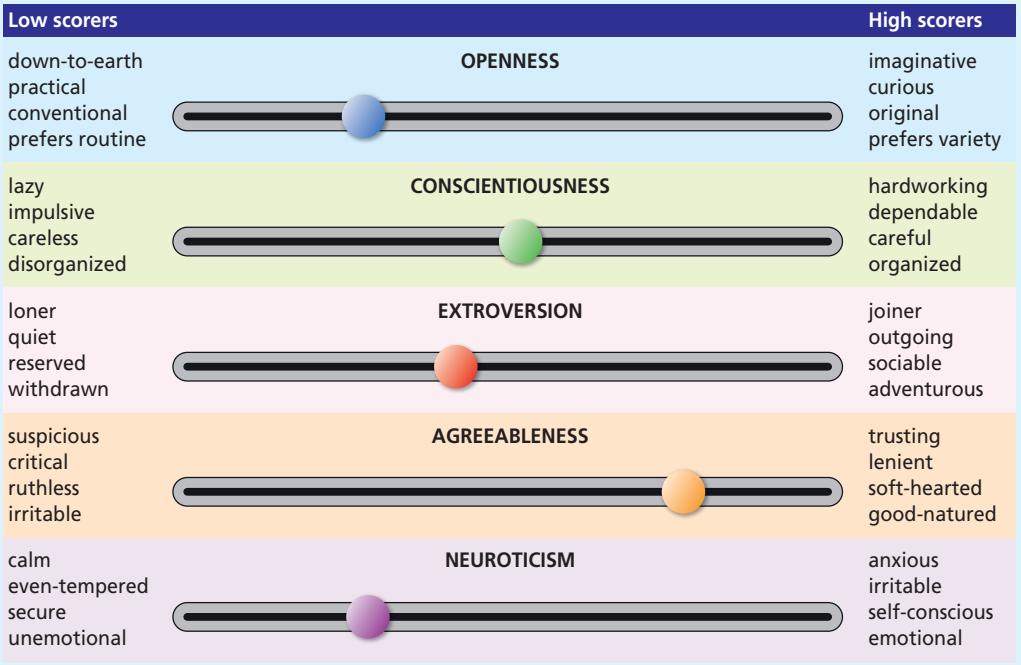
Because the larger population may not ever see the ad, it is hard to hold it accountable to any regulations or fact checking.

As we entered into the 2010s, the interconnection between social media and elections became more standard. Multiple firms that specialized in collecting, analysing and microtargeting potential voters emerged, each vying to shift voters toward their employing candidate. One company involved in this was (the self-described 'global election management agency') Cambridge Analytica.

Cambridge Analytica built a free survey application called 'mydigitallife' but, hidden within their terms and conditions, was that anyone who used the app not only shared access to their own Facebook profiles but also the profiles of all their friends. Soon, with only 270,000 users, Cambridge Analytica could access the names, locations, history of likes, and even some private messages of over 87,000,000 Facebook users. This privacy violation eventually cost Facebook nearly US$5 billion in fines. Using this data, Cambridge Analytica created a **psychographic analysis** of each voter, ranking them on key personality traits such as openness, conscientiousness, extroversion, agreeableness and neuroticism.



■ Digital marketing timeline



■ OCEAN model of personality traits

◆ **Confirmation bias**: The tendency to accept news and facts that confirm our existing beliefs.

Hired by the Republican party Cambridge Analytica used this data to microtarget users with curated content, most likely to move them towards voting for a particular candidate. This content ranged from standard political advertisements to fake news articles camouflaged as sponsored posts. The growth in personalized advertisements often showed potential voters what they wanted to hear, taking advantage of the human capacity toward **confirmation bias** – our willingness to accept news and facts that confirm our existing beliefs. Suddenly, social issues and popular opinions were becoming more polarized. People who only obtain their information from a few sources that they already agree with can be said to be in an echo chamber, as the sources align with and reinforce their existing beliefs.

It wasn't only US politicians and advocacy groups that took advantage of these new campaigning tools.

In 2018, 13 Russian citizens were charged with the crime of interfering in the 2016 US presidential election by using fraudulent social media accounts to impersonate real and fictitious Americans, to:

- purchase advertisements and posts in order to create 'political intensity through supporting radical groups' – many of their posts focused on race, immigration and religion, and some even encouraged minority groups *not* to vote
- organize and promote unofficial rallies targeting specific groups, such as 'Support Hillary – Save American Muslims' and 'Miners for Trump'
- publish political advertisements online expressly promoting Donald Trump or opposing Hillary Clinton in the eight months leading up to the election; a violation of US policy/laws for campaign advertisements.

https://digitalcommons.butler.edu/cgi/viewcontent.cgi?article=1007&context=bjur

www.americanbar.org/groups/crsj/publications/human_rights_magazine_home/voting-in-2020/political-advertising-on-social-media-platforms

www.washingtonpost.com/opinions/2019/11/01/dont-abolish-political-ads-social-media-stop-microtargeting

www.classaction.org/media/comforte-et-al-v-cambridge-analytica-et-al.pdf

www.newscientist.com/article/2166435-how-facebook-let-a-friend-pass-my-data-to-cambridge-analytica/

Concept connections

- **Change**: Given the events of the past, how do you predict elections and campaign advertising will evolve in the future?
- **Expression**: The way that social media works means that anyone can express their own opinion and ideas, often without them being supported by evidence.
- **Identity**: Microtargeting reinforces our political identity by showing advertisements and content that aligns with our existing values and beliefs.
- **Power**: Politicians and others are trying to use digital technology to gain political power as they implement precise microtargeting and other advertising tactics to influence people's behaviour.
- **Space**: Social media creates unique digital spaces that customize content for the specific viewer. It is harder to hold information to accountability standards when the content displayed may not be visible to a broad audience.
- **Systems**: The interconnection of different systems is apparent as data is collected, processed and sold in order to provide advertisers the microtargeting tools to customise content, and ads for individual users.
- **Values and ethics**: Some actors are violating legal and ethical standards in order to promote their own political and/or social agendas.

ATL ACTIVITY

Research

Research current elections around the globe. How are politicians and citizens using digital tools (social media in particular) to organize, advertise and gain support for their causes?

Do not limit your search to national elections. Local/regional elections and campaigns may also offer valuable insights and innovative use of digital tools.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

In the months leading up to the 2017 presidential election in Kenya, advertisements for two websites began to flood Google searches, Twitter, Facebook and YouTube accounts across Kenya. These websites used data collected from social media platforms to target their advertisements and send potential voters to websites that presented a biased outlook, with one highlighting President Uhuru Kenyatta's accomplishments and the other attacking the challenger Raila Odinga.

Kenyatta won the election, but Odinga challenged the results, in part due to the lack of security in the electoral servers. He claimed that the servers were hacked and that an algorithm was inserted to artificially inflate the number of votes for the incumbent president. The Supreme Court accepted this challenge, nullified the election and called for a second election. In the 60 days between the elections, 25 Kenyans were killed and over 100 badly injured in protests.

1 a Outline one method of network security that could be used to protect the electoral servers and the database. *[2 marks]*

b Identify two items of data stored in an online voter database. *[2 marks]*

c Define the term 'algorithm'. *[2 marks]*

2 a Distinguish between electronic voting and online voting. *[3 marks]*

b Explain three steps required for a citizen's vote to be updated in the election database. *[3 marks]*

3 To what extent should social media companies be held responsible for hosting content that led to death, violence and protests during the Kenyan elections? *[8 marks]*

4.6B Governing bodies

Organization and role of local, regional, national and global governing institutions

This subtopic explores the manner in which varying government and non-government bodies, agencies and organizations engage with digital technology to both streamline their internal processes and provide information and services to their end-users (the citizens or organization members).

Many of the same tools that economic institutions use to manage projects, conduct outreach, develop a database of customers and manage their products can be applied here. However, governments and non-government organizations must often adhere to additional laws or policies depending on their location.

We have also seen a rise in non-state actors using digital tools for political organizations or international activities that were once only available to nation states. The following table provides definitions and examples of the different levels of government.

Level of government	Definition	Examples
Global	Operates internationally, trans-nationally or regionally across national borders	UN, EU, Organisation for Economic Co-operation and Development (OECD), etc.
National (central)	A country's political authority	US government, Australian government, etc.
Regional	Governs a particular region and enforces the laws that central government passes	California State Assembly (within the USA), Bali Provincial Government (within Indonesia), local council, etc.
Local	Focuses on a specific community or group	School district, parks and recreation department, etc.

ATL ACTIVITY

Research

Explore government information websites.

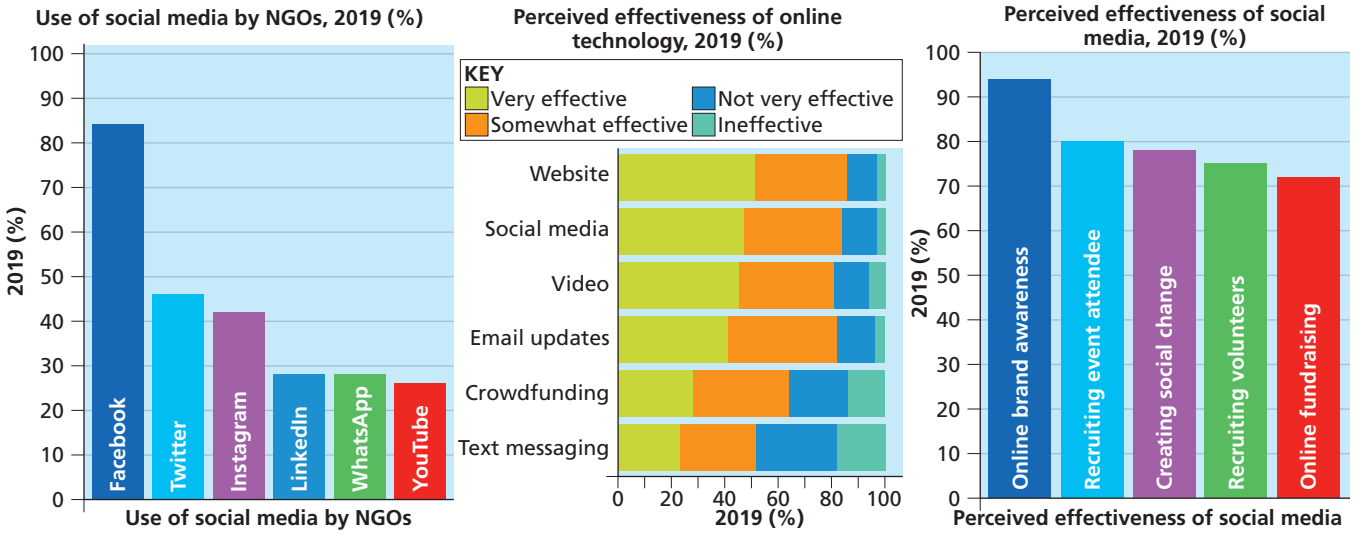
- Search for the government website where you live (usually these have '.gov' in the URL). Explore the website and make notes on:
  - What features are available?
  - What information does it share?
  - What services does it offer?
  - How user-friendly does it feel?
- Now repeat this process for local governing bodies in different countries.
  - What is common between the different sites?
  - Do any of them offer mobile apps (consider installing them)?
- Government tools are often criticised for being outdated, difficult to navigate and inefficient. How does that compare with your findings?

Non-governmental organizations (NGOs) and non-profit organizations (NPOs)

Non-governmental organizations (NGOs) are transnational organizations that operate independently of any government agency. They vary in size from a small collection of volunteers to large, multi-billion dollar corporations with many paid members of staff. By definition, they are also non-profit organizations (NPOs), meaning that any money earned cannot be used for the personal gain of its employees or supporters.

◆ **Non-governmental organization (NGO)**: Transnational organization that operates independently of government agencies.

These groups often focus on humanitarian or environmental causes. They employ digital tools to collect funds, manage volunteers and events, build stakeholder and member databases, send emails and automate common processes.



How technology helps NGOs to increase efficiency and to reach volunteers and donors

Data: https://assets-global.website-files.com/5d6eb414117b673d211598f2/5de82e1550d3804ce13ddc75_2019-Tech-Report-English.pdf

Non-state political actors

In addition to organizational actors such as NGOs and NPOs, non-state actors also includes societal, technological, war-fighting and/or individual actors. Violent non-state actors can include terrorist organizations, guerrilla fighters, organized crime and drug cartels, as well as religious/political extremist groups.

Digital communication tools and modern weaponry technology have shifted the power landscape, giving non-state actors access to a wider audience, strategies and information, as well as more destructive weaponry that was previously reserved for a nation's formal military. The internet has made it more affordable to broadcast, disseminate and exchange information quickly and globally, as well as reducing the cost.

The internet also enables political actors to alter **transparency** (the availability and accountability of information) by changing the accuracy, clarity and freedom of information available. Digital communication tools can be used to increase transparency by reporting or publicizing otherwise hidden events, such as corruption and human rights abuses. However, these same tools can be used to decrease transparency by spreading disinformation, misinformation, fake news and propaganda (biased or one-sided information).

Inquiry

- Identify an NGO, for example Doctors without Borders or Oxfam International.
- Explain its mission and goals.
- Describe the features available (if any) on its website (or mobile app, email, WhatsApp group, social media).
- Evaluate the impact of these features toward the NGO's ability to fulfil its mission.
- Explain challenges or opportunities for further growth that you notice from your inquiry.

EXAM PRACTICE QUESTIONS

Paper 1 (core)

1 Some non-state political actors can deal in fake news, disinformation, misinformation and propaganda. Discuss the responsibility of social media platforms to limit violent and false rhetoric on their platforms.

Possible examples you could use in your discussion are Facebook banning COVID-19 vaccine misinformation (and/or Holocaust denial posts), Twitter suspending Donald Trump's account and YouTube blocking Sky News. *[8 marks]*

REAL-WORLD EXAMPLE

Biometric passports

In 2019, India began to roll out e-chip enabled **biometric passports** (previously only available to diplomats). These passports contained an electronic microprocessor chip in addition to the usual pages for photos, identification information and visas/stamps. This chip contains unique **biometric information**: physiological details about the holder that cannot change, such as their fingerprints. This improves the capacity for authentication, as a visual check of the passport photo can be combined with a fingerprint scan to check that the fingerprints match the data on the chip. The chip can used to store other data also, such as previous travel information.

Storing the data on the passport itself overcomes key issues in security and privacy. The microprocessor is difficult to **counterfeit** and can include software to prevent tampering with the information by unauthorized users or notify officials in case of irregularities. In addition, the holder's fingerprints can be checked by immigration officials without having the privacy risk of their information being stored on a government database. The machine can compare the live fingerprints with the data stored on the passport.

While it requires a large financial investment to distribute the passports and readers, it will pave the way for more automation in Indian airports. Additionally, while airports are transitioning over the new system, they can still implement their existing protocols as the biometric passport includes all of the same details as their existing passports.

India is on track to join a growing list of countries using biometric passports.

◆ **Biometric passport**: A passport that contains an electronic microprocessor chip biometric information about the passport holder.

◆ **Biometric information**: Physiological details about a person that cannot change, such as their fingerprints.

◆ **Counterfeit**: To imitate fraudulently.

ATL ACTIVITY

Research

Investigate the use, or planned use, of biometric identity cards or passports in your country or another country.

- What data is being captured and stored?
- What is the data required for?
- How does the biometric system verify the person using this digital technology?
- Describe the benefits to both citizens and governments of using this type of system.
- Investigate resistance to the use of biometric identity cards or passports in your and other countries.

Concept connections

- **Identity**: Biometric data is unique to the individual. What risks exist by including biometrics in identification databases? To what extent does the use of biometrics both increase the risk of identity fraud and prevent it?
- **Systems**: What events may unfold at the individual and global level as a result of implementing a new ID system? For example, in the big picture, airports will have to invest in new technology, and a global standard for biometric passport data scanning may eventually need to be developed. At a more micro level, individuals will need to register their fingerprints (or other biometric data), increasing the costs and privacy risks of obtaining the document.
- **Power**: Biometric passports give power to authorities to control who can receive them. This provides the government with more power over their citizens.
- **Space**: Biometric passports enable easy access and movement between spaces controlled by different governing bodies, but the trade-off is that more power is given to the governing bodies.
- **Change**: Biometric passports have increased this control, especially now that they can be linked to national and international databases.
- **Expression**: Biometric data is an expression of our identity. It may threaten our identity if the data can be copied and used without our permission.
- **Values and ethics**: The designers and developers of biometric passports have an ethical duty to ensure that the data is protected and only used for certain purposes. Also, do we have an ethical right to use other forms of identification instead, as there are concerns about the security of the data and its use?

4.6C Conflicts and war

Warfare

Military technologies include weapons, vehicles, equipment and infrastructure that is used for the purpose of warfare. Offensive technologies are used to harm the enemy, while defensive technology protects soldiers and infrastructure from their enemies.

Military technology also includes transportation, communication and sensors that are used to move soldiers/weapons, coordinate information between units and collect information from the surroundings.

Military funding is often used to develop new and innovative technology that may later have uses in other contexts. For example, GPS **trilateration** technology, which uses a trio of satellites to pinpoint our phone's location, was originally developed by the US Department of Defense in 1994. The military also invented the first virtual reality simulator in 1979, to help train pilots to fly fighter jets.

Inquiry

The military in many countries have been investing in artificial intelligence, robotics and other digital technologies for use in warfare. With reference to at least two digital technologies, discuss the issues arising from their use and their effectiveness.

Digital warfare

Digital warfare, or cyberwarfare, is the use of digital attacks to disrupt vital computer and warfare systems. Both its name and definition are a point of debate, but it can be broadly defined as covering the use of any digital technology to disrupt or impact the storage, sharing and communication of information or systems. It is also known as 'information warfare' or a 'cyber attack'.

Digital warfare can take a variety of forms, such as international surveillance, or spying on individuals and countries, and even hacking the phones of politicians. **Sabotage** is the disruption of the computers and systems that operate military, economic infrastructure or other vulnerable networks. Distributed denial of service attack (DDOS) involve overwhelming a site or service, such as a bank or database, so that it is not available to its intended users. Additional cyberwarfare tools include ransomware or propaganda when used for political purposes.

◆ **Digital warfare**: the use of digital technology to disrupt or impact vital computer and warfare systems.

◆ **Sabotage**: The disruption of computers and systems that operate military, economic infrastructure or other vulnerable networks.

Terrorism

While there is no globally accepted definition of **terrorism**, it often manifests as the unauthorized use of violence/force to create fear and coerce a government or its people toward a political or social cause. Terrorist groups often lack the military resources to engage in direct warfare successfully, so they prioritize high-profile attacks such as hijackings, kidnappings, suicide bombings and other methods with high shock value.

Digital tools and developments have enhanced computing and telecommunications capacities across the globe. However, these same developments have increased terrorist organizations' communicative capacity, anonymity and ability to coordinate operations remotely. Widespread internet access has offered more outlets for radicalization of individuals and accelerated the mobilization of potential actors.

◆ **Terrorism**: The unauthorized use of violence/force to create fear and coerce a government or its people toward a political or social cause.

ATL ACTIVITY

Research

Ransomware is a major threat to businesses and other organizations. Research how ransomware works, the impacts it can have, and the range of responses to deal with it.

End-to-end **encryption** scrambles messages and data, making it harder for law enforcement to track and disrupt communications. Additionally, **virtual private networks (VPNs)** anonymize the user's internet activity by hiding their location and routing it through a 'secure tunnel', further preventing law enforcement agencies from tracking their activity. The same tools that protect privacy and increase communication capacity can, when combined with terrorist intent and a radicalized user, set the grounds for more efficient and organized terrorist recruitment and activity.

ATL ACTIVITY

Research

Governments and digital technology companies may take action to censor publication or prevent access to information that does not align with the laws and values of the hosting site/nation. However, these tools can often be bypassed through the use of VPNs or other tools.

Investigate censorship in a region of your choosing and see how stakeholders are impacted by it, and to what extent actors are able to bypass these internet constraints.

Find and install a VPN (or a free trial). Try the same search from a few different 'countries'. What do you notice? Visit your favourite media site, such as YouTube or Netflix. Do the recommendations for your viewing change?

Links

This content links to Section 5.2A Conflict, peace and security.

EXAM PRACTICE QUESTIONS

Paper 2 (core)

Source A

Unmanned combat air vehicle used for air strikes.

Source B

Excerpt from a UN report into Libya's uses of autonomous drones to take out rebel forces, March 2021.

On 27 March 2020, the Prime Minister of Libya, Faiez Serraj, announced the commencement of Operation PEACE STORM, which moved GNA-AF to the offensive along the coastal littoral. The combination of the Gabya-class frigates and Korkut short-range air defence systems provided a capability to place a mobile air defence bubble around GNA-AF ground units, which took Hafter Affiliated Forces (HAF) air assets out of the military equation. Libya classifies HAF as a terrorist rebel organization.

The enhanced operational intelligence capability included Turkish-operated signal intelligence and the intelligence, surveillance and reconnaissance provided by Bayraktar TB-2 and probably TAI Anka S unmanned combat aerial vehicles. This allowed for the development of an asymmetrical war of attrition designed to degrade HAF ground unit capability. The GNA-AF breakout of Tripoli was supported with Firtina T155 155 mm self-propelled guns and T-122 Sakarya multi-launch rocket systems firing extended range precision munitions against the mid-twentieth century main battle tanks and heavy artillery used by HAF.

Logistics convoys and retreating HAF were subsequently hunted down and remotely engaged by the unmanned combat aerial vehicles or the lethal autonomous weapons systems such as the STM Kargu-2 (see annex 30) and other loitering munitions. The lethal autonomous weapons systems were programmed to attack targets without requiring data connectivity between the operator and the munition: in effect, a true 'fire, forget and find' capability. The unmanned combat aerial vehicles and the small drone intelligence, surveillance and reconnaissance capability of HAF were neutralized by electronic jamming from the Koral electronic warfare system.

Source: **https://undocs.org/S/2021/229**

Source C

Extract from 'The Story of America's Very first Drone Strike', *The Atlantic*, 30 May 2015

In the autumn of 2001, however, the United States was unwilling to launch a full-scale land invasion in a region 7000 miles from home. Instead, a plan evolved to send into Afghanistan a small number of CIA agents and Special Forces in support of anti-Taliban militias, with the aid of the US Air Force. That first October night was a powerful display of coordination involving laser-guided munitions dropped from the air and Tomahawk cruise missiles launched from the sea. General Tommy Franks, who then led the US Central Command (CENTCOM), the military command overseeing operations in Afghanistan, wrote in his memoir *American Soldier* that the assault involved in total some 40,000 personnel, 393 aircraft, and 32 ships.

But one aircraft did not feature at all in the Air Force's complex planning: a tiny, CIA-controlled, propeller-driven spy drone, Predator tailfin number 3034 which had crept into Afghanistan some hours earlier. It now hangs suspended in the Smithsonian Air and Space Museum in Washington, D.C., its place in history assured. Yet its actions that first night of the war – in which numerous agencies in the vast US military-intelligence machine each played sharply contradictory roles – remain steeped in controversy.

Source: **www.theatlantic.com/international/archive/2015/05/america-first-drone-strike-afghanistan/394463**

Source C

Human Rights Watch released a report stating that representatives from around 50 countries will meet in the summer of 2021 at the UN to discuss worldwide policy alignment on 'killer robots' or 'lethal autonomous weapons systems'. In their report, Human Rights Watch expressed objections to delegating lethal force to machines without the presence of meaningful human control.

Bonnie Docherty, senior arms research at Human Rights Watch said: 'The fundamental moral, legal and security concerns raised by autonomous weapons systems warrant a strong and urgent response in the form of a new international treaty … International law needs to be expanded to create new rules that ensure human control and accountability in the use of force.'

Human Rights Watch proposes a treaty that covers the use of all weapons that operate autonomously that includes limitations and restrictions such as banning the use of killer robots, with many claims reinforcing that meaningful human control must be involved in the selection and engagement of targets. It goes on to define the scope and prevalence of 'meaningful human control' to ensure that humans have access to the data, risks and potential impacts prior to authorizing an attack.

Adapted from: **www.hrw.org/news/2021/08/02/killer-robots-urgent-need-fast-track-talks**

1 With reference to Source A, identify two different or unexpected impacts of 'killer robots'. *[2 marks]*

2 With reference to Source D, explain why it may be difficult to reach global agreement on 'killer robot' policy. *[4 marks]*

3 Compare and contrast how Sources B and C present their messages of events involving unmanned combat aerial vehicles events. *[6 marks]*

4 With reference to the sources and your own knowledge, evaluate the decision to ban automated military technology. *[12 marks]*

4.6D Laws, regulations and policies

Public and private policy, including professional codes, rules and regulations

Digital technologies change so quickly that the legal system cannot keep up with them. National, regional and local policy makers have often adapted old laws to manage and regulate the digital world. Now that is changing, as many countries are passing legislation to guide, regulate or limit new technologies, as well as the companies responsible for creating and operating them.

Internet regulation in the USA has evolved from a 'light-touch regulation' towards reprimanding and punishing technology corporations that fail to protect the security and privacy of their users. In 2016 the EU passed **GDPR** laws, which established standards for privacy, transparency and security for any organization collecting and storing data on EU citizens and/or residents. India is developing its own data-protection infrastructure, while China filters and censors the information that is passed along its network.

Surveillance and monitoring

Given that nearly all data is stored online, corporations, service providers and governing bodies have varied access to the data and information being sent on the web. While this data is often anonymized, in many countries there are arrangements with local law enforcement and governing agencies that give significant access to data and activity that many internet users would presume to be private.

A digital society creates the potential for surveillance and monitoring of online activity, as well as the use of cameras and other sensors, to collect information about activities happening in everyday life (such as traffic movements). Facial-recognition technology is also being deployed in many places to make the surveillance and monitoring of citizens more effective, and more efficient.

Inquiry

With reference to two different sources, discuss the decision to ban police use of facial-recognition cameras in California to prevent crime.

Crime and lawbreaking

Faster than governments and law enforcement can regulate technologies, criminals find new and innovative ways to reappropriate digital tools or break into secure systems, accessing sensitive data and disrupting essential operations. Programmers and developers on both sides of the law compete as governments and corporations work to protect their systems from vulnerabilities and criminals seek out new ways to skirt the law, remain anonymous and conduct illicit activities through the use of otherwise legal (and sometimes illegal) digital tools.

Digital surveillance is the collection of data about a person's online communications, connections, finances and other available information. As you surf the web, information is sent from your device, through your network, to your ISP and ultimately through the internet until it reaches the destination site. Along the route, information is scanned, recorded and stored. While this may seem like a privacy violation, this same information is used by technology companies to offer you the customized and individualized user experience that you expect on today's websites. This data is also used by advertisers and other sites. **Data brokers** are companies that collect and store information about users and sell it on to companies or advertisers.

◆ **Digital surveillance**: The collection of data about a person's online communications, connections, finances and other available information.

◆ **Data broker**: A company that collects and stores information about users and sells it on to companies or advertisers.

With the vast quantities and value of data circulating on the internet, cybercrime is growing at a rate of 15% a year, costing companies US$3 trillion worldwide in 2015 (and predicted to move above US$10 trillion by 2025).

Cyber attacks can result in identity theft of individuals or access to personal accounts (including banks and social media), while for businesses it can disrupt operations or even steal data and trade secrets. Some of the most common cybercrime attacks include phishing, device theft and login theft (the theft of a person's login credentials). Ransomware was in the headlines in 2021 as a major oil pipeline in the US was locked by hackers –the company paid a fee of US$4.4 million (in Bitcoin) to regain access to their oil pipelines.

ATL ACTIVITY

Research

List the types of cybercrime. Make a table that includes definitions and real-world examples.

REAL-WORLD EXAMPLE

WeChat

WeChat, an app that is mainly used in China, facilitates:

- phone calls and text messages
- social media (similar to Facebook, Instagram and WhatsApp)
- a productivity suite (like Microsoft Office or Google Drive)
- banking/payment options (like Google Pay, Venmo, and PayPal)
- its own app store and third-party service providers (equivalent to Uber, Amazon, Travelocity or Deliveroo, for example)
- access to doctors, hospitals, traffic, utility bills, travel visas and driving records.

It is used by 92% of the Chinese market, keeping users in contact with their friends and family, and easing everyday activities ranging from paying for coffee, checking the weather and renting a city bike to making doctor's appointments.

In 2020, WeChat had 1.24 billion users and sent over 45 billion messages a day (including 305 million video messages), with users spending an average of 66 minutes a day on the app (25 minutes longer than the average Facebook user). Most users open the app at least 10 times a day, while 20% of users opened it over 50 times a day. Over a third of all the data on China's networks is WeChat-related.

However, in addition to making civilian life efficient and connected, it also enables the government to monitor and manage its citizens and what content they receive. The internet is highly restricted in China in comparison to other countries; Chinese users cannot access Google, Facebook, YouTube or the *New York Times* (although it is possible to bypass the system with a VPN). This restriction and censorship of the internet is casually known as 'The Great Firewall of China'.

Additionally, WeChat censors content using server-side censorship, scanning messages once they are uploaded to 'the cloud' and blocking those that contain certain keywords. Neither user is notified that the messages were blocked, and the messages may be stored for up to six months.

https://jingdaily.com/3-wechat-savvy-users

www.fabernovel.com/en/article/economy/wechat-the-shape-of-the-connected-china

www.nytimes.com/interactive/2019/11/13/magazine/internet-china-wechat.html

www.bloomberg.com/news/articles/2016-06-09/life-in-the-people-s-republic-of-wechat

https://techjury.net/blog/wechat-statistics/#gref

https://citizenlab.ca/2020/05/wechat-surveillance-explained

ATL ACTIVITY

Thinking

Reflect on your mobile phone use.

- Make a list of all of the activities that you have done on your phone in the last 24 hours.
- List the app/website and duration.
- If someone was to gain access to your activity, what would it say about you?
- Does it represent you accurately? Could it be misinterpreted? Does it reveal too much information about you?
- Reflect on the results and make recommendations on how you could change your mobile phone use.

Concept connections

- **Change**: Cash is becoming less common as more and more businesses rely on mobile payments, as in WeChat.
- **Expression**: To what extent does server-side censorship impact people's ability to express ideas. To what extent does it protect society?
- **Systems**: WeChat is a tool that is integrated into daily life in China. It is used for payments, communication and more, which requires extensive connections between digital systems.
- **Values and ethics**: Some nations value the freedom of speech, while others value respect for authority. Where does your community fall on this spectrum?

Creativity, activity, service (CAS)

Since you have studied impacts and implications of digital technology, what opportunities exist for you to get involved with an issue, organization, movement or political candidate?

Extended essay (EE)

Some ideas to consider developing include:

- Evaluate the impacts of social media on a specific election of your choosing.
- Investigate the security and reliability of voting tools and systems used in elections.
- To what extent are specific laws effective in regulating digital platforms?

TOK

How can we determine the difference between propaganda, information, misinformation and fake news?

Reflection

Now that you have read this chapter, reflect on these questions:

- How do digital tools facilitate election processes in your home town, region and/or country?
- Where do you encounter political advertising, activity and organizations that use digital technology?
- What new innovations in weapons, warfare or communication are being used by armies and/or terror organizations?
- What do you do to protect yourself against cybercrime? Have you come across any suspicious activity on digital platforms?
- What information are you sharing online? What would your ISP observe if they monitored your activities on their networks?
- Examine your school's acceptable use policy for digital technology. How does it align with the reality of digital technology use on your campus? How is it enforced? Do you have any recommendations to improve it?

4.7 Social

UNDERSTANDINGS

By the end of this chapter, you should understand:

- various components of an individual's social identity impacts how one operates in a digital society and the amount of privilege and alliance they have access to in both physical and virtual spaces; some of these components are age, gender, ethnicity, ability, beliefs and nationality
- social class defines an individual or group's access to resources and prestige within their community, and digital society overall
- digital tools are shifting the family dynamic including how people meet, connect and spend time with loved ones.

An individual's experience in digital society is very dependent on their own social identity, the people and communities they engage with, as well as the **dominant cultures** of their social networks.

Social identity markers can be broken down to include factors such as race, education, gender and more. Many of these characteristics are not consciously chosen but are a function of family status, genetics and other factors. Often, having these markers aligned with the dominant culture allows one to experience a set of privileges or advantages.

Intersectionality explores the overlap and interconnection that a specific and unique set of identity markers may create, particularly focusing on the discrimination and disadvantages faced by those who do not align with the dominant group. This often manifests in digital spaces as cyberbullying or online hate speech, where people may be targeted or harassed for who they are. When all or some of your identity markers match the dominant culture, you may experience the world from a place of **privilege**.

While formal **caste systems** (separating groups by social class) have become less common in recent years, **social class** still plays a significant role with regard to the level of resources, access and knowledge available to communities because of their economic, social or cultural wealth. The differences in social status often correlate to access to new and effective digital technologies. This **digital divide** usually corresponds with the level of access to resources in the physical world.

Digital technology is also reshaping how we communicate and stay in contact with friends and family. Social media tools help to keep families and friends connected, even to the extent of using GPS location features to keep track of where your loved ones are at any given time. Online social circles have developed that allow people to build friendships and connections over shared interests, whether as fans of a particular franchise or as collaborators (and competitors) in online games. Communications technology is also redefining romantic landscapes. People download dating apps that target specific identity markers (such as religion or ethnicity), while others are using virtual reality technology to simulate romantic experiences missing in their everyday life.

◆ **Dominant culture**: A culture that has established its own norms and values as the standard for the entire group.

◆ **Intersectionality**: The overlap and interconnection that a specific and unique set of identity markers may create.

4.7A Social components of identity

Aspects related to international-mindedness and/or common humanity

International-mindedness is a mindset in which one sees their connection to the global community and has a sense of responsibility to its members. Internationally-minded people make a conscious effort to embrace and respect diversity, and to learn more about people who have different cultures, appearances and lifestyles than their own. The internet and the ubiquitous use of smartphones have enabled all of us to learn more about other countries and cultures. It is very difficult not to see the connections between the communities around the globe when we look at items in our news feeds; and not just items about issues and events but cultures, appearances and lifestyles.

◆ **International-mindedness**: A mindset in which one sees their connection to the global community and has a sense of responsibility to its members.

ATL ACTIVITY

Research

Research online articles around the world about a significant issue, event or situation from different countries and cultures. You may need to use a translator app to read them. How different and/or similar are the ideas and perspectives from the different sources? How does this show that international-mindedness is being developed around the world?

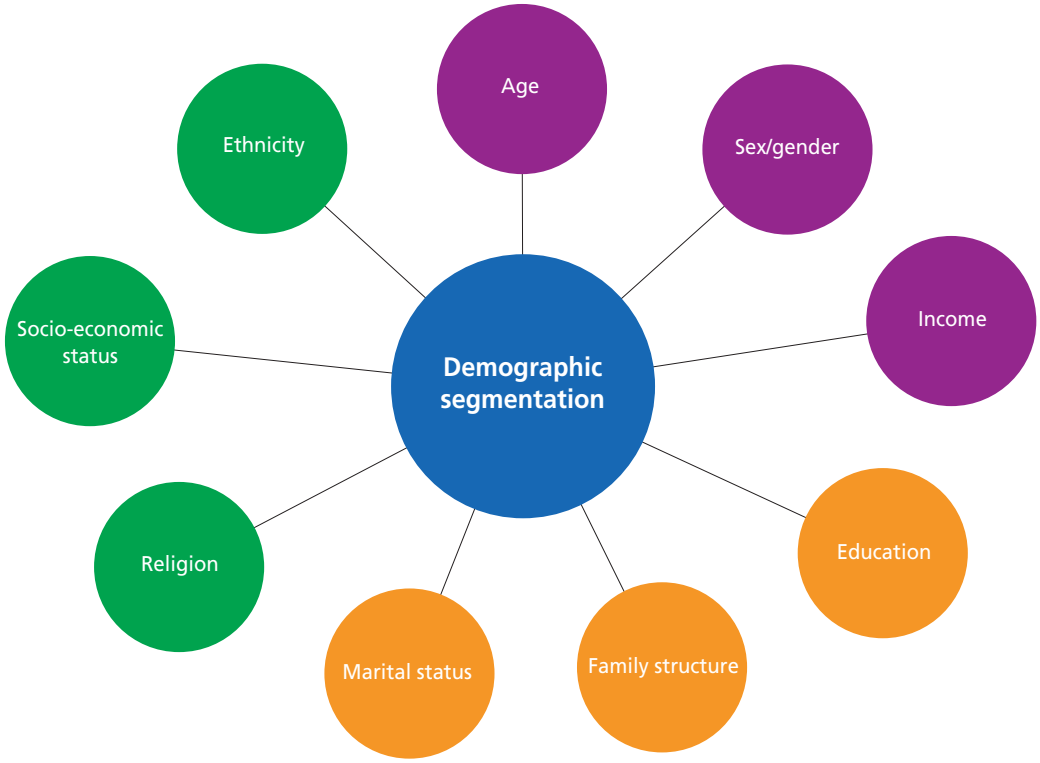
Age and demographic components

Demographic components are statistical data points that are used to characterize or label groups of people. Common examples of demographics include age, gender, occupation, cultural background and family status. Data analysis can be used to identify and explain trends and patterns that influence subgroups of people.

◆ **Demographic components**: Statistical data points that are used to characterize or label groups of people.

Inquiry

Research how demographic segmentation has had an impact on the design, analysis and use of survey data, especially for census surveys designed by national governments.



Gender, gender expression and sexuality

When babies are born, doctors assign a gender based on their biological features. While there are exceptions (about 0.1% of births), babies are usually classified as either male or female. While this initial classification is biological, society places different expectations and norms on individuals based on their gender.

Race and ethnicity

Race is usually defined by physical traits and characteristics such as skin colour or hair texture. **Ethnicity** is the cultural expression and identification shared by large groups of people with a common racial, national, religious, or any other identity marker (or a combination of them). People of the same ethnicity may speak the same language, share cultural beliefs or have common values, while racial identity is often defined by what makes a person's appearance distinct. Race is a purely social construct and has no basis in genetics, however it still has an influence on how one experiences (digital) society. Racial prejudice and bias in the West tends to favour people with white skin over people with darker skin.

◆ **Race**: A social construct based on people's physical traits and characteristics.

◆ **Ethnicity**: The cultural expression and identity shared by people with a common racial, national, religious, or any other identity marker.

Links

This content links to Section 5.2C Diversity and discrimination.

Inquiry

To what extent can digital technology, due to the way it works, perpetuate historical (and present) biases and inequities in society?

Support your answer with findings from at least two real-world examples, for example racial and ethnic colour bias in facial-recognition software and in image-editing software.

Ability status

The term **non-disabled** is used to describe someone without a physical disability (which could be seen or unseen). While a person with a **disability** may, for example, use a wheelchair, have difficulty seeing, or be missing a limb.

Invisible or **hidden disability** is used to describe disabilities that cannot be immediately observed, such as a hearing impairment or mental health condition. Many devices such as cell phones or computers have **accessibility** settings that enable users with a disability to engage with digital technology. This could include text enlargement, voice commands, text-to-speech features and more.

◆ **Disability**: A conditions that limits a person's movement or senses.

◆ **Accessibility**: The quality of being easy to use.

ATL ACTIVITY

Research

Research how **immersive reader technologies** in software such as word processors can help people with accessibility issues.

Links

This content links to Section 4.4B The human body.

Religious beliefs and practices

Religious beliefs may or may not be a central part of one's identity. While many nations permit and encourage a diverse range of religious activities, many also have a national religion or policies that are aligned with religious traditions. Even within the same religion, there is a wide range of diversity in how members practice their religion and even how they choose to connect with it. Common religious practices may include prayer, rituals and dietary guidelines. Major life events such as births, deaths and weddings have often religious components and traditions.

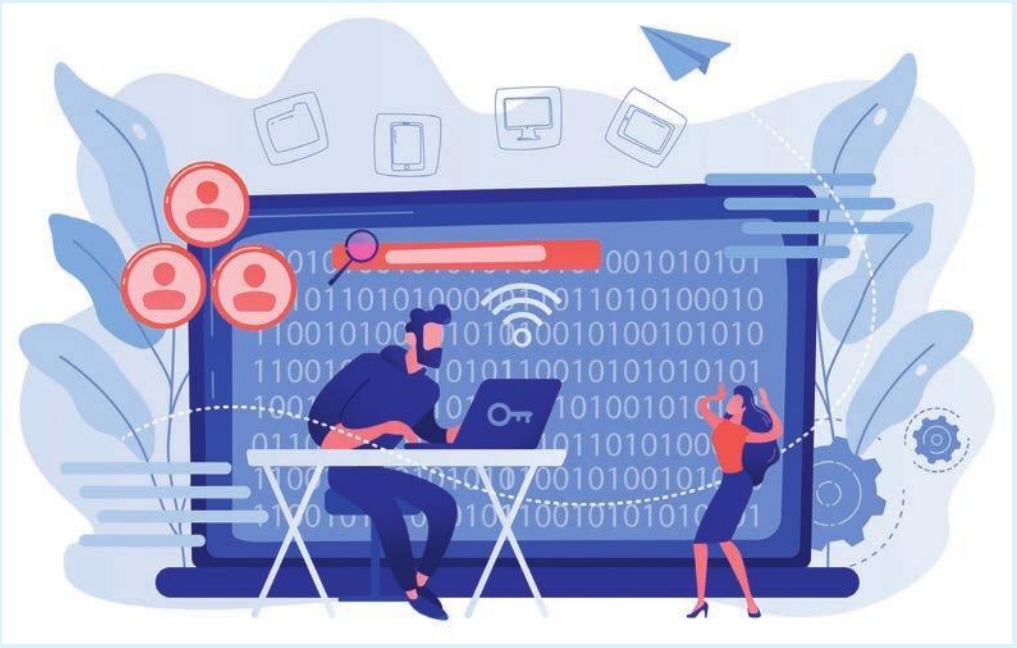
ATL ACTIVITY

Research

Research how religious practices are changing, and beliefs are being promoted, through the use of digital technologies.

REAL-WORLD EXAMPLE

Gamergate



In fall 2014, thousands of people in the gaming community began a campaign of systemic online harassment targeted at several outspoken feminist gamers. It grew into 'an internet culture war' when a collection of misogynists, trolls, cyberbullies and more began using social media to target professionals advocating for the greater inclusion (of women) in games and gaming.

Once a target was selected, often due to their advocacy for progressive changes to the gaming industry, or even for covering other attacks in a non-positive light, they would become the recipient of a barrage of harassment ranging from online harassment, threats and even **doxing** – the publication of personal and/or private information such as addresses, phone numbers and photos.

◆ **Doxing**: The publication of personal and/or private information such as addresses, phone numbers and photos.

Gamergate participants used niche and anonymous social media tools such as 4chan and 8chan to turn Gamergate into a sexist challenge to the integration and growing presence of women in the male-dominated gaming industry. Social media was weaponized to silence the voices of women and progressive gamers advocating for more inclusion in the shared culture of gamers.

The Gamergate participants are most likely representative of only a small extreme percent of gamers. For example, Andreas Zecher received thousands of sign-ups from gaming professionals showing their support in response to his open letter to the gaming community, where he stated:

> *We believe that everyone, no matter what gender, sexual orientation, ethnicity, religion or disability, has the right to play games, criticize games and make games without getting harassed or threatened. It is the diversity of our community that allows games to flourish.*
>
> *Source:* **https://medium.com/@andreaszecher/open-letter-to-the-gaming-community-df4511032e8a**

While the gaming subculture is just one example, it encapsulates the trend toward the systemic use of online harassment and political bipolarism that has emerged (in the US and in many parts of the globe) and the use of social media tools and spaces to amplify the power and voice of a small group with extreme views to silence the voices of others.

https://en.wikipedia.org/wiki/Gamergate_(harassment_campaign)

www.vox.com/culture/2020/1/20/20808875/gamergate-lessons-cultural-impact-changes-harassment-laws

www.washingtonpost.com/news/the-intersect/wp/2014/10/14/the-only-guide-to-gamergate-you-will-ever-need-to-read

Inquiry

Investigate further details about Gamergate to determine the range of issues that it exposed.

ATL ACTIVITY

Research

Research the comments that have been posted in response to online articles about some recent controversial news and current issues. Examine them to see if you are able to identify any trends in the demographic indicators – this could include race, ethnicity, gender, ability, age and more.

ATL ACTIVITY

Thinking

Examine your social media community with a critical eye on the types of posts and people that you are interacting with.

- Visit a social media platform that you use regularly.
- Visit the news feed or wherever you receive information.
- For 10 to 20 items, identify the age, gender, race and political views of the people you are receiving content from.
- Look at the list to see if your platform is providing you a diverse range of sources, or if most of your information is coming from a **filter bubble** of similar sources.
- Are the majority of the posts you interact with coming from people who share your demographic information?

◆ **Filter bubble**: When information only comes from a narrow range of sources dues to algorithms designed to personalize your online experience.

Inquiry

Research the following terms and provide examples:

- social media filter bubbles
- social media echo chambers
- diversity, equity and inclusion initiatives
- cancel culture
- confirmation bias.

To what extent is social media effective in fostering cross-cultural interactions or perpetuating exclusivity, privilege and power?

4.7B Social class

Organization, role and impacts of social class

Social class is a method of classifying people and communities according to their social status. This distinction is driven by three forms of capital:

- economic – material wealth
- social – connections and networks with people in power
- cultural – well-educated and socialized in order to engage with the dominant culture in society.

◆ **Social class**: A method of classifying people and communities according to their social status.

Those with the greatest access to this capital would be in the upper classes. An examination of UK non-internet users (or limited users) in 2015 showed that most come from lower economic households. As a result, there is a correlation between lower socio-economic status and access to digital society.

While digital technology has helped to provide new tools and greater connection to people across all classes, those who are already wealthier have more access to the benefits and opportunities created by it due to greater access and training, which has widened the gap between classes. The interplay between digital technology (automation of jobs), the labour force and the education system (unequal implementation) has also widened the disparity between the 'haves' and the 'have nots'.

Intersection of social class in major areas of life, such as employment, education, health and illness, housing

The **digital divide**, or inequitable access to technological tools and resources, is drawn along class lines. Many jobs in a digital society rely on computer literacy, so those who have access to technology and the skills to use it effectively are more likely to get better jobs and obtain even more resources.

Additionally, the growth of online education and training gives those with access to digital technology more capacity for gaining qualifications, and hence good jobs, through online courses. As more parts of society integrate digital technologies such as online banking, distance medicine and remote working, the digital divide has the potential to further widen the gaps between social classes.

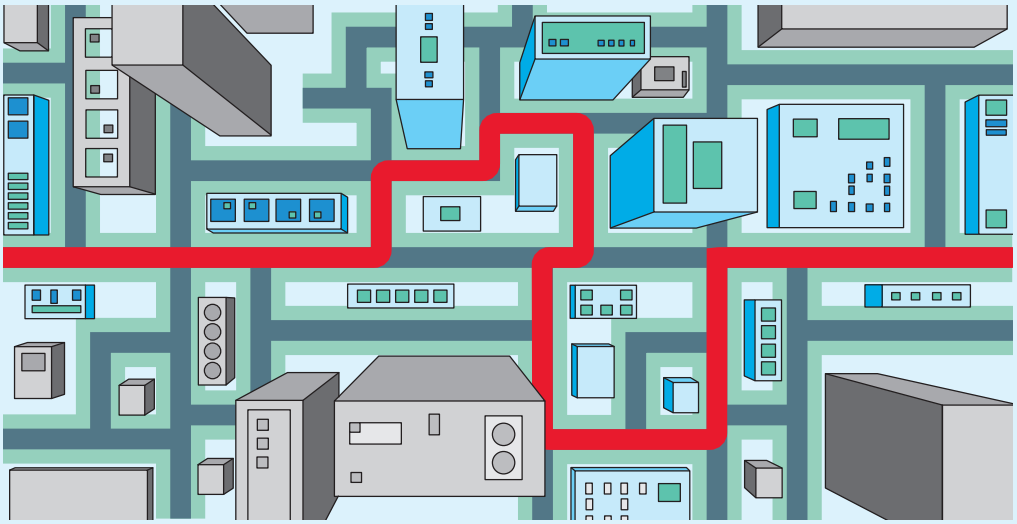
REAL-WORLD EXAMPLE

Digital redlining

In the USA, where you live has a significant impact on many of the opportunities that you are afforded in life. Property taxes are used for school funding in the district, which means that areas with low-income housing often have less money allocated toward their schools than in higher-income areas.

Historic **redlining** (the systemic denial of services to specific communities) also made it difficult for people, mostly living in non-white communities, to access banking, insurance, health care and even supermarkets. As a result, social mobility has been limited in many communities, while wealthy communities have continued to accrue more capital and a higher social class.

Many of these neighbourhoods lack infrastructural resources to ensure access to clean air, pure water, healthy food options, safe streets, public transportation, and more. They are also often situated close to refineries, factories, freeways, resulting in higher instances of respiratory illnesses. This, combined with a more densely populated area as more families/people share smaller living spaces, creates a greater risk for spreading illness (notably COVID-19).



Digital redlining continues this practice in the digital landscape by creating content that caters to specific groups, or by offering connectivity services to specific geographical areas. For example, the internet service provider AT&T received multiple complaints for failing to invest in infrastructure in lower-income city neighbourhoods. These neighbourhoods may be considered less profitable, and this creates an additional challenge for those living there.

The widespread collection of data through the use of digital technologies creates a **proxy discrimination**, where legitimate indicators such as zip code or responses to specific questions can provide high correlation to indicators such as race, disabilities or socio-economic status in situations like job/university applications where those factors are not meant to be considered.

https://thehill.com/policy/technology/352267-att-hit-with-second-complaint-of-discrimination-against-low-income?mc_cid=9646f90f27&mc_eid=e00c29a42c

◆ **Digital redlining**: The systemic denial of digital services to specific communities.

◆ **Proxy discrimination**: Discrimination that occurs due to correlations to indicators such as race, disabilities or socio-economic status.

ATL ACTIVITY

Research

In your neighbourhood, town, city, region or country, find statistics about reliable access to the internet. Where there is a greater or lesser ability to access the internet? Investigate the reasons why. Do this for broadband access and mobile phone access.

Inquiry

Research the impact and implications of the digital divide in:

- employment
- education
- health
- housing.

Explain how these impacts and implications are connected to each other.

ATL ACTIVITY

Thinking

From your research in the previous activities, evaluate:

- 'Everyone has a smartphone now. It is nearly impossible to live in a digital society without one.'
- the potential for digital technologies to be part of the solution for differences between the social classes, and for mobility between them.

REAL-WORLD EXAMPLE

Biased algorithms in the criminal justice system

Predictive policing uses algorithms in an attempt to forecast criminal activities. Computer systems are used to process the large amounts of data that are collected and recorded by police units. Predictive policing may include analysing historical arrest data to help decide where to assign police officers, or determining the likelihood that someone will commit or be a victim to a crime.

While predictive policing aims to increase the accuracy in predicting crimes, there are concerns about transparency and bias in the algorithms used. While using an algorithm may seem unbiased and neutral, the fact that it relies on historical data means that it will recreate and reinforce any biases existing in the data set. So, if a neighbourhood has had many arrests in the past, then the algorithm will send more police there, which will result in more arrests in that neighbourhood, creating a feedback loop where the result of the algorithm further perpetuates the bias in the data.

◆ **Predictive policing**: The use of algorithms in an attempt to forecast criminal activities.

Algorithms are also used when calculating the risk of **recidivism**, or repeated offense. The algorithm uses a range of data including zip code, social media contacts, survey responses and more. One investigation in 2016 found that both black and white defendants had similar accuracy results (around 60%), but the mistakes the algorithm made were very different between the two demographic groups: white defendants were almost twice as likely to be predicted as less risky.

In the USA, social class and crime are interconnected as those from lower classes are more likely to be arrested or imprisoned for crimes than affluent individuals. Prisoners are more likely to be unemployed, with less access to economic capital and, once released, are ineligible for many jobs. While criminal activity (usually termed 'white-collar crime') by the wealthier classes can pose a greater cost to society, these crimes are less likely to be processed and convicted than 'street crimes'. As a result, the criminal justice system reinforces class inequity by more significantly diminishing the access to capital in lower-class areas. The implementation of predictive policing and recidivism prediction furthers this inequality and reinforces the status quo, further marginalizing lower-class communities.

www.businessinsider.com/harvard-mathematician-reveals-algorithms-make-justice-system-baised-worse-black-people-crime-police-2017-6

www.brennancenter.org/our-work/research-reports/predictive-policing-explained

www.propublica.org/article/how-we-analyzed-the-compas-recidivism-algorithm

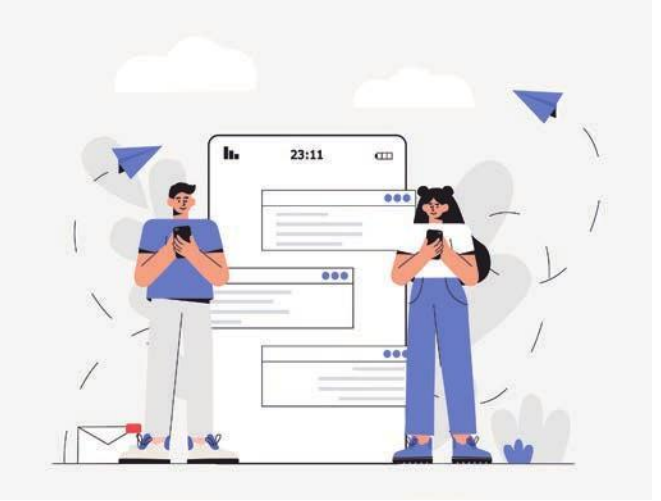
◆ **Recidivism**: The tendency to reoffend.

Concept connections

- **Change**: How different is the digital divide between social classes now from the wealth divide of the past?
- **Expression**: The way we express ourselves is closely tied to the social class we were born into, but this is now changing due to digital technologies; as a famous cartoon once said: 'On the internet, nobody knows you are a dog.'
- **Identity**: Our identity is not as confined to the social class we were born into now that we have access to the whole world through our smartphones.
- **Power**: The power of the social classes depends on privilege and wealth. Where is this challenged and reinforced in a digital society?
- **Space**: The spaces social classes live in are often restricted, but the use of digital technologies is providing greater access to a large variety of 'spaces' to live and operate in, both real and virtual.
- **Systems**: The way societies are being connected and integrated using digital technology systems, locally and globally, is having a large impact on social class.
- **Values and ethics**: Governments should place a high priority on providing digital technology resources and tools to all social classes because of the positive impact that removing the digital divide would have. It would be ethically wrong not to do so.

4.7C Families and relationships

Ways of understanding, forming and connecting families



Family communication is evolving. Parents can keep tabs on the locations and activities of their children; day care centres can provide regular updates and video access as toddlers eat, learn and play; and getting their first cell phone gives pre-teens the ability to communicate with their family and friends 24-7.

Data about families is also growing. New technologies allow DNA analysis so that you can see what countries and nationalities your family comes from. Tracing families back through the generations is now much easier, and the amount of information that can be found is growing as more past records are scanned and made available for searching over the internet.

In addition to social media platforms, families are connecting and using technology to collect and document memories, track chore completion and manage their homes in smaller, more private chats and social media networks.

Video messaging and internet calling has significantly reduced the cost of keeping families connected across the globe. Friends and families can also monitor and share information and location data by updating social media or just keeping their phones on. For example, apps such as Apple's Find My Friends allow users to share their GPS locations in real time, so you can always know where your friends and loved ones are.

The power of digital technologies to connect families and friends is great, but they can also be abused if one person in the relationship becomes too controlling. There are many stories of jealous and controlling friends, parents and partners using digital technologies to spy on activities and to track the movements of friends, children and partners.

ATL ACTIVITY

Thinking and research

At what stage would the use of apps such as Find My Friends become surveillance and an invasion of privacy for you, rather than an aid to keeping in contact with family and friends?

Design and conduct a survey, preferably an anonymous one, about the use of such apps by family and friends.

ATL ACTIVITY

Research

Design and conduct a survey of family and friends, preferably using an online survey app, to gather their opinions about the positives and negatives of using online video meetings between family members and between friends. Focus especially on questions about the impact on the quality of the relationships.

Inquiry

Research cases in the news where digital technologies have been used for controlling purposes in a relationship. Report back to your class with examples, including explanations of how the digital technologies were used, the impacts and implications, and solutions that individuals and society can put in place.

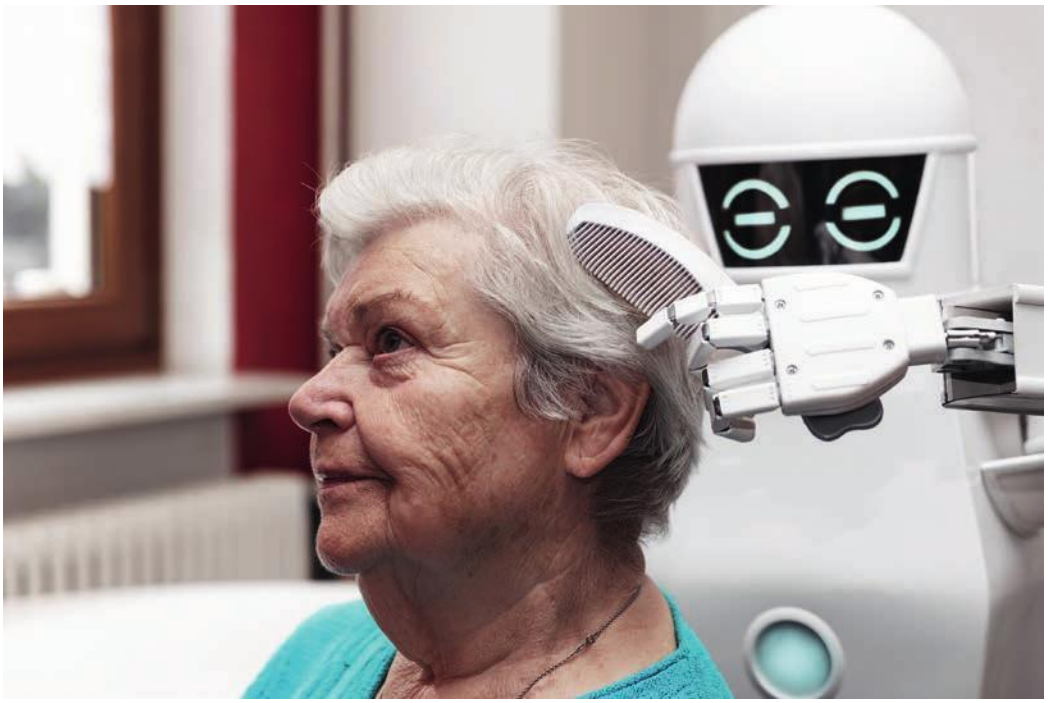
ATL ACTIVITY

Research

Visit a site that can help you investigate your family history (you may need to sign up for a trial period), and be mindful of what details you choose to provide and how those may be used or sold by the site, or discuss the usefulness of such sites with a member of your family that uses them.

Friendship, companionship and personal relationships

Digital tools are being used to provide social and emotional support to certain populations. For example, ElliQ robots will play games and simulate social interactions with elderly people, while collecting and sharing essential information with their doctors and caregivers. Another robot, Milo, specializes in helping children with autism to develop their social-emotional skills by teaching them skills such as recognizing facial expressions and being aware of others' emotions.



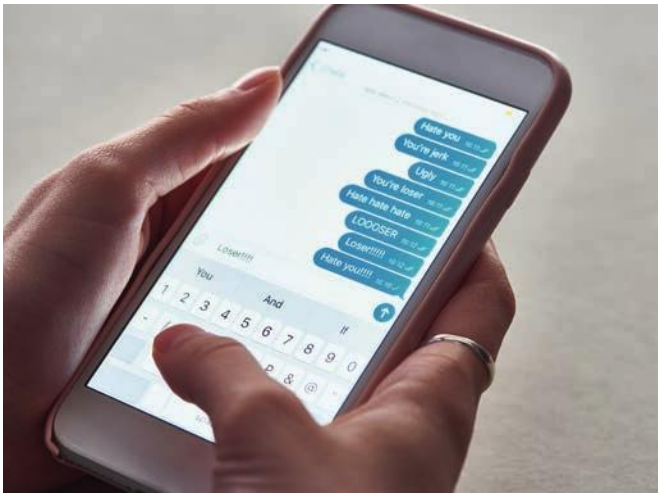
ATL ACTIVITY

Social

Investigate how companion robots are being used.

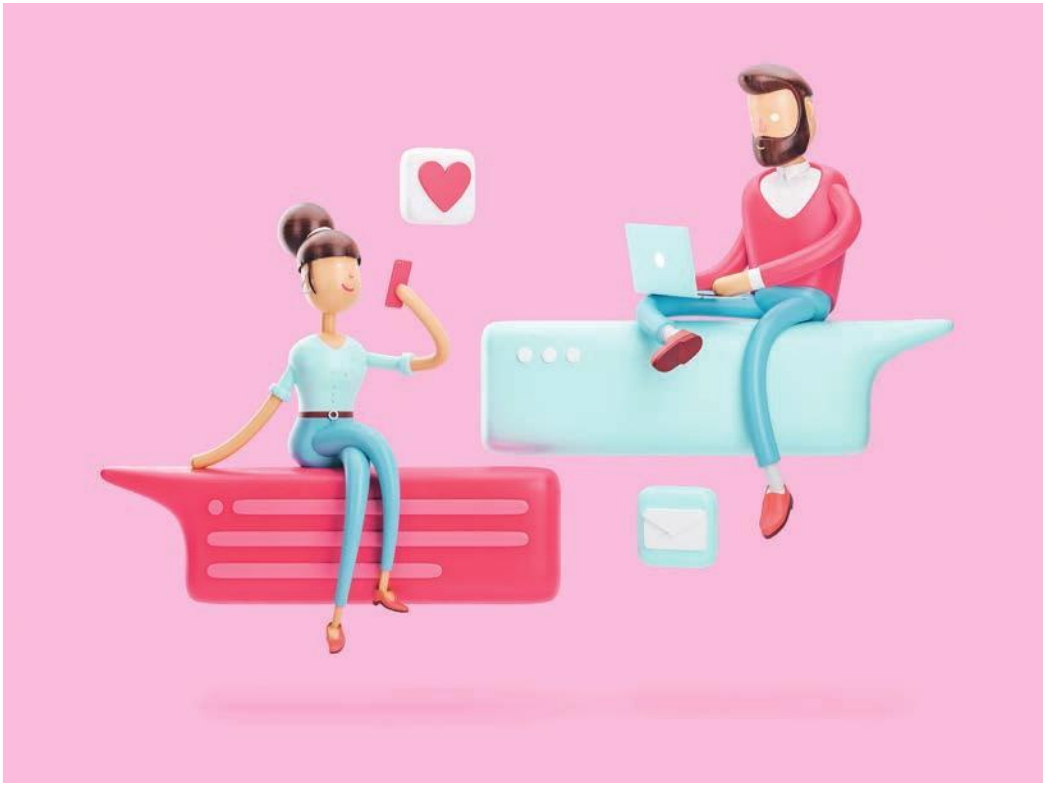
- In groups, research how companion robots (for example, ElliQ, Milo, Moxie, Woobo and Pepper) are being used in each of these situations:
  - elderly people living at home or in care homes
  - children living in care or being at home by themselves while parents work
  - social isolation or loneliness for adults living alone or in isolated situations
  - anyone living with a medical diagnosis (depression, autism, dementia) who has difficulties maintaining social contacts.
- Create a poster with images showing:
  - how the robots are being used
  - their benefits/limitations.
- Share your findings with each other in the group and in the class.
- Hold a discussion to evaluate how companion robots are impacting the quality of life of the people who use them.

Online relationships and group memberships



Communities who share a common identity, practice or belief are becoming more and more prevalent. These can be found everywhere from local Facebook groups and political activism groups, to refugee support groups. Proponents argue that digital technology creates spaces for people to connect and learn about others who belong to specific subgroups. Critics argue that this phenomenon is a form a cultural silo (a reluctance to share information with people outside of the group), which may actually mean that we are becoming less social, that society is fragmenting, and that a lack of familiarity means lack of compassion.

Friends and connections are being formed in digital spaces and forums across the internet. Social media enables people to find like-minded individuals and groups, and to connect with forums, resources and even real-world events. A range of apps exists to help people connect with other people, often uniting or targeting people who share common identity markers. Dating apps may target a specific religion or ethnicity, while meet-up applications may use your location to help you find people with similar hobbies and interests in your area.



REAL-WORLD EXAMPLE

Mystic Messenger dating simulations

The Mystic Messenger app was released in 2016. It is a text-driven visual novel with a strong romantic component. As the player opens the app, they are immersed into an 11-day real-time, role-playing experience where they receive texts, chats, emails and calls from the characters. While interactions are limited to multiple choice responses, players must be attentive to emotional cues to earn affection from the different characters. Success in the game comes from building relationships and successfully 'wooing' the artificial intelligence characters.

When games like Mystic Messenger became popular, sceptics and media outlets reported from a stance of disgust, appalled by the obsessive way fans played, substituting virtual relationships for human ones. In Japan, these games were blamed for the low fertility rates their nation faced. One Chinese commentator claimed that people are drawn to these games because their real lives are 'brutally lacking' in love.

However, one self-proclaimed addict to Mystic Messenger reported that the game made her emotional life feel more stable and fulfilling. She felt she could explore and process her unmet emotional needs in a safe environment. Furthermore, for most players, the game is not a substitute for human-to-human love – it is just a fun game.

www.theguardian.com/technology/2018/sep/26/mystic-messenger-dating-simulations-sims-digital-intimacy

www.vice.com/en/article/78k7qe/mystic-messenger-review

ATL ACTIVITY

Research

Design and conduct a survey for family and friends that asks them about the types of online communities that they belong to. Include questions about the benefits that come from, and issues that arise from, being members of these online communities. Remember, an online group can be small or large, local or global.

Inquiry

Research the benefits and issues associated with online dating sites.

Concept connections

- **Change**: Computer games are much more developed and enhanced than many of the games we play with real objects.
- **Expression**: Do you think humans will choose to interact with artificial intelligence instead of other humans? Could bots and digital simulations ever be a replacement for real human connection?
- **Identity**: Some players of computer games get so involved that their identity in the virtual world can become more important than their identity in the real world. This can lead to game addiction.
- **Power**: The power of computer simulations/games is large and we need to be aware of this power.
- **Space**: Living in a virtual world can disconnect some people from the real world.
- **Systems**: Computer simulations are very complex systems, which is the reason they can be so real. But reality is always more complex and unpredictable than any system the human mind can create.
- **Values and ethics**: The ethical decisions we make and values we display in computer simulations and games can be different from those in our real lives. This can create problems if they are transferred.

Creativity, activity, service (CAS)

Minecraft build battle

- Set up a competition at school for students to design and build in Minecraft under a given theme.
- Research how to host the Minecraft environment and what students will need to do to join.
- Get permission from school to run this competition.
- Invite friends to join in the organization of this project.
- Discuss and agree on the criteria for judging the competition
- Participants will be using their skills and imagination in Minecraft to construct their build, using critical and creative thinking in the process.
- Promote the competition to students in your school.

Extended essay (EE)

Research video game addiction, causes, impacts and solutions in specific contexts including countries, specific games and player involvement.

Reflection

Now that you have read this chapter, reflect on these questions:

- Reflect on your age, gender, race, religion, ability status and other identity markers.
- Reflect on how many of these you display and use when you are online.
- Think of something you like to do online with others. How might someone with different identity indicators have a different perception/experience than you in that experience?
- How do you experience the digital divide? Do you feel you have increased or limited access and opportunity to digital tools, systems and resources? How does your experience compare with other communities in your region, particularly those with more or less wealth?
- How does your family use technology to stay in contact?
- To what extent is it normal to meet people in real life that you met online?
- Can you have meaningful friendships and relationships with people in purely digital spaces?

TOK

Computer simulations and games are models of the real world. To what extent are they close to the real world? When meeting people online, what evidence can they provide to prove to you that they are who they are?

Section 5

HL extension: Challenges and interventions

5.0 Overview of the HL extension

By the end of the Digital Society course, you must be able to identify, analyse and evaluate an intervention related to a real-world example for each challenge topic and the related subtopics, and recommend steps for future action.

The next chapters cover the scope and content of the challenge topics, and model extended inquiries. These can be used to guide your own extended inquiries based on relevant issues you have found within the areas of inquiry for each challenge topic.

Please note, you will not be able to cultivate an in-depth knowledge of every issue and type of intervention relevant to each challenge topic. Instead, the HL extension focuses on developing your inquiry skills, which can be applied to any challenge topics and interventions.

Introduction

In the HL extension, students conduct extended inquiries to address challenges and **interventions** in digital society.

◆ **Intervention**: A digitally-based solution and/or innovation that addresses the impacts and implications for people and communities in the challenge topics.

You will explore challenges that involve the impacts and implications of complex issues in real-world situations. In a digital society, challenge topics are related to various digital systems. You will explore and investigate various challenge topics throughout the course.

You will also explore interventions that attempt to mitigate, intercede, support or resolve aspects related to a challenge topic. You will be required to identify, analyse and evaluate interventions for each challenge topic and your prescribed areas of inquiry, and provide recommendations for future development involving various digital systems.

HL students must use the HL extension framework to identify, analyse and evaluate interventions for each challenge topic in order to recommend steps for future action. Interventions may be explored and investigated individually and collaboratively. The interventions studied must involve digital systems in some way, of course. A change in policy, practice or law, for example, may be considered as an intervention that involves digital systems.

An intervention can be used with reference to a specified challenge to:

- **mitigate** (reduce) the negative impacts
- **intercede** (intervene) in an existing process to reduce negative impacts
- **enhance** (improve) the positive impacts
- **resolve** (eliminate) any negative impacts.

There are three HL extension challenges and interventions topics in the Digital Society course. Each topic has three prescribed areas for inquiry. Consequently, each challenge and related intervention(s) will be categorized in one of the nine prescribed areas for inquiry.

The three topics for HL extension challenges and interventions are:

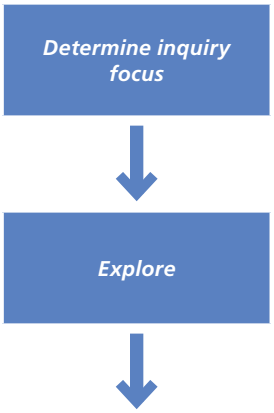
- global well-being
- governance and human rights
- sustainable development.

The steps in the extended inquiry for the interventions

As you explore the inquiry process and apply it to both the HL challenges and interventions, you are required to provide recommendations for future development involving various digital systems.

Extended inquiries align with the inquiry process template introduced in Chapter 1.4. You will further develop, analyse, evaluate and make recommendations for the interventions related to the challenges.

There are four steps in the extended inquiry process for interventions.



1 Determine inquiry focus:
   - area for inquiry
   - inquiry focus
   - current challenge
   - intervention(s)

2 Explore and investigate challenges:
   - Details of the challenges and intervention – the 3Cs:
     - concepts – areas of impact of the challenge and how they are connected to the challenge
     - content – the digital technology in the intervention
     - contexts – people and communities, stakeholders, local/regional/national level.
   - Primary research
   - Secondary research

3 Analyse interventions:
   - Negative impacts
   - Positive impacts
   - Types of interventions:
     - mitigate (reduce) the negative impacts
     - intercede (intervene) in an existing process to reduce negative impacts
     - enhance (improve) the positive impacts
     - resolve (eliminate) any negative impacts

4 Evaluate interventions and recommend steps for future action

   As part of the HL extension framework, you must **evaluate** at least one intervention for the prescribed area for inquiry and **recommend** steps for future action:
   - **Equity**: Does the intervention address the needs, claims and interests of those affected by the challenge?
   - **Acceptability**: Do specific affected people and/or communities view the intervention as acceptable?
   - **Cost**: What are the financial, social, cultural and environmental costs associated with the intervention?
   - **Feasibility**: Is the intervention technically, socially and politically feasible? What are some of the barriers?
   - **Innovation**: Is the intervention innovative in its approach? Has it been attempted before?
   - **Ethics**: Is the intervention ethically sound, and who determines the ethical status of the intervention?

■ HL extension: Challenges and interventions

5.1 Global well-being

UNDERSTANDINGS

By the end of this chapter, you will understand:

- the meaning of global well-being in a digital society
- how global well-being is a significant challenge in our digital society
- challenges faced with food insecurity and access to health care
- impacts of population growth and shifting demographics
- the impacts of automation on the future of work
- how digital technology-related interventions are being used to respond to this challenge.

What is global well-being?

Global well-being is a significant challenge involving diverse issues and concerns. Global well-being intersects in important ways with many digital systems as they are used to address the challenge.

Digital technologies expand the boundaries of information available to people and enhance human productivity, but they also carry risks for people's well-being, ranging from job losses and cyberbullying to breaches of online security and privacy.

In this chapter, we will look at three main areas of inquiry for global well-being:

- local and global inequalities
  - economic inequality and stratification
  - food insecurity and access to safe, nutritious and sufficient food
  - access to health care and medicine
- changing populations
  - population growth
  - shifting demographics (for example, aging and youth populations)
  - migration and the movement of people
- the future of work
  - automation and employment
  - ensuring meaningful and secure employment
  - addressing the collective needs of workers.

Life in the digital age

Digital technologies continue to push boundaries and provide new opportunities, but with it comes significant concerns about people's overall physical and mental well-being. Some argue that our well-being will be improved by these digital technologies, while others believe they will do more harm than good. Those who contend that digital technologies undermine human well-being will also admit that they can improve certain areas of our daily lives, however. As technology continues to advance and integrate further into our lives, we must recognize the benefits and find ways to mitigate the problems.

Looking at how digital technologies can be helpful, we see how they connect people, locally and globally, providing the opportunity to share knowledge and gain educational insight. These technologies can also have a huge impact on our economy, opening up businesses to a world of opportunities. They also provide health resources and services to those who would not otherwise have access. Using these digital technologies has enabled people to improve their lives, allowing them to discover opportunities, socialize and meet other people, make a difference in the world, and expand the quality of digital life.

However, we cannot ignore some of the concerns that arise from the abundant use of these digital technologies. People's cognitive abilities will be affected in a variety of ways, such as their ability to think analytically, their memory, focus and mental resilience. The increase in digital addiction, information overload and the constant interruptions caused by various technologies are also contributing factors to a rise in anxiety, depression, stress and lack of sleep. The pace of digital change is of concern to many as human interactions, privacy, security and more are all at risk.

It is up to us to regulate how these digital technologies are used and to find solutions to potential problems. Governments and industries can help by creating reforms on standards and guidelines, as well as by passing new laws and regulations. Educating people about the impacts of digital technologies on their well-being, understanding the way technology functions, and encouraging healthy usage, are just some of the ways to support the existence of these technologies and strive for a healthy sense of well-being.

www.pewresearch.org/internet/2018/04/17/the-future-of-well-being-in-a-tech-saturated-world

ATL ACTIVITY

Research

- Research and discuss in class a range of factors related to digital well-being.
- Use them to design and conduct a school survey of your classmates about their digital well-being.
- Present the results to your IB coordinator.

5.1A Local and global inequalities

Inequalities are still present in our rapidly developing and changing digital society. The three areas of inequality to be focused on are

- **Economic inequalities and stratification**: In our world, it seems that many people are getting richer and have higher economic well-being than others. The economic gap between social levels in society is increasing, creating economic well-being inequalities.
- **Food insecurity and access to safe, nutritious and sufficient food**: Inequalities in food access cause many problems. There is not enough food of the right type and variety to ensure personal well-being.
- **Access to health care and medicine**: This directly impacts everyone's well-being and is linked to economic and food inequalities, often as a cause and/or effect.

Economic inequality and stratification

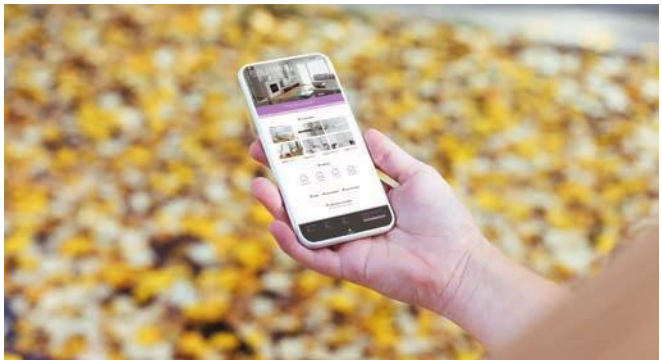
Global stratification

While **stratification** often refers to the unequal distribution of resources between people, global stratification refers to unequal distribution among nations. There are two dimensions to this stratification: gaps between nations and gaps within nations.

◆ **Stratification**: The unequal distribution of resources between people/nations.

Global stratification is often thought of as economic inequality, for example, if we compare one country's average worker's wage to another country. Social inequality, however, is just as harmful as economic discrepancies. Discrimination against race, ethnicity or religion can also create conditions of economic inequality, both within and between nations. Think about the inequity that existed for decades in South Africa. Apartheid, one of the most extreme cases of institutionalized and legalized racism, created social inequality.

Advances in digital technology are revolutionizing our economy. The economic gains from digital technologies are vast and growing, but with these new technologies come new challenges. The rise in economic inequality has increased as digitization has changed the world of business around us. Today's advances in computer systems, software, mobile telephony, digital platforms, robotics, cloud computing and artificial intelligence are growing at rapid speeds. These advances contribute significantly to local and global economic inequalities.



REAL-WORLD EXAMPLE

Is technology increasing inequality?

There is increasing concern around the automation of jobs, especially for those with low-skilled, routine jobs. However, those with low skills have been on the receiving end of almost every change in the labour market over the last 10 years. Since the financial crisis of 2008, employment levels have bounced back, with income rising at a similar pace. This is not true, however, for low-skilled work: their income levels have barely moved in over 50 years. Furthermore, when jobs return after an economic shock, they nearly always require greater skills than before. So, rather than destroying jobs, technology seems to increase the inequality between people with skills and those without.

A recent study from the University of California explored how technology affected wages between 2000 and 2009. It found that while technology coincided with an increase in wages across the board, the average employee saw a rise of just 2.3% while those in managerial positions gained a 9% rise. Those in the boardroom received a substantially larger 19% boost. The researchers suggested that the new technology had allowed the more productive workers to become even more productive, which widened the income gap.

Most new technologies have tended to improve the relative position of skilled workers, carrying out routine tasks while allowing highly-skilled workers to focus on non-routine, more abstract tasks. As these routine tasks are usually carried out by lower-skilled workers, new technology harms them disproportionately.

www.forbes.com/sites/adigaskell/2019/05/03/technology-isnt-destroying-jobs-but-is-increasing-inequality/?sh=7cbf1d5f5e78

Technology has been blamed for a lot recently. Automation and artificial intelligence have supposedly led to substantial job losses, reduced bargaining power for workers, and increased discrimination. It is blamed for growing income and wealth inequality. As a result, demands are being made for the global regulation of technology, and there are attempts to slow down its spread through trade policies and political lobbying.

Rather than blame technological innovation for all of these social problems, perhaps we should look at other factors. We shouldn't be trying to obstruct technological innovation, rather, we should face up to the challenge of bringing entrepreneurship, innovation and business dynamism back to Western economies, characteristics that prevailed in the years after the Second World War, when growth was also more inclusive.

Germany is a particularly useful case to study. In recent decades, inequality has risen fast, and to unprecedented levels since unification. But, unlike in the US, there has been little financialization of the economy and no significant outsourcing of jobs due to globalization. While the US runs a huge trade deficit, Germany runs a large trade surplus. Importantly, evidence shows that automation has created more jobs in Germany than it has destroyed. So, why is inequality rising so rapidly in the EU's largest economy?

For further reading, see:

- **https://oecd-development-matters.org/2019/02/28/can-digital-technologies-really-be-used-to-reduce-inequalities**
- **www.mckinsey.com/featured-insights/employment-and-growth/technology-jobs-and-the-future-of-work**

Links

This content links to Sections 3.6E AI dilemmas and 3.7D Robots and autonomous technologies dilemmas.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Challenge: reducing inequality by providing broadband access to all citizens, which has large economic impacts.

- Research and evaluate one real-world intervention related to a digital system that addresses this challenge using the HL extended inquiry process.
- Recommend steps for future action.

Challenge: increasing labour productivity through access to digital technologies and providing training.

- Research and evaluate one real-world intervention related to a digital system that addresses this challenge using the HL extended inquiry process.
- Recommend steps for future action.

Food insecurity and access to safe, nutritious and sufficient food

Global food security implies that everyone has access to sufficient amounts of safe and nutritious food at all times. **Food security** is something everyone should have access to, regardless of their technical, economic or social development. Food security isn't always possible in many countries, however, due to factors such as lack of education, political instability, government policies, economics, lack of technology development and other controlling factors.

◆ **Food security**: Reliable access to sufficient amounts of safe and nutritious food.

Technology in this respect is defined as the collection of techniques, skills, methods and processes used in the production of goods. The technology required to be food secure is country-specific. It depends on the physical environment, infrastructure, climate, culture, literacy rates, economic conditions and governance.

Developing countries often have food security strategies that follow different paths and processes from those adopted by developed countries. In developing countries, technologies extend over a wide range of areas that include land preparation, soil and water management, seed production, weed management, pest and disease control, farm management and harvesting practices, which includes storage, processing, packaging, marketing and distribution.

Technology can help provide basic food options to vulnerable populations. It can help restore political stability by ensuring that the production of food is based on efficient agricultural activities, sustainable practices, high productivity, dynamic employment, and generating revenue for large numbers of people. Technology can support improved economic growth and social well-being with effective harvest practices to minimize food loss, using effective storage to increase the value of harvested products and ensure long shelf-life, as well as enhancing the marketing of available food at competitive prices, based on effective government policies.

ATL ACTIVITY

Research

Challenge: Food security can be responded to by increasing the efficiency of the transport of food.

Interventions: The use of IoT sensors, blockchain tracking and smart packaging are being introduced to meet the challenges of providing more efficient and effective access to safe, nutritious food.

Research: How successful these digital technologies will be using a real-world example.

ATL ACTIVITY

Research

Challenge: The need for higher crop productivity.

Intervention: The use of digital technologies used to decrease the use of water and pesticides.

Research: How successful these digital technologies will be in keeping food prices down and evaluate how much they reduce the impact on natural ecosystems.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Digital innovations are providing access to safe, nutritious food. Discuss a real-world example in which new digital innovations support this claim, referring to a real-world example. *[12 marks]*

Links

This content links to Section 4.3D Agriculture.

◆ **SaaS**: Software as a service; a software distribution model in which a third-party provider hosts the applications with end-users accessing the software through the internet.

How digital innovation enables food security

Digital technologies have been used in numerous ways to promote food security. Digital technology enables farmers and other people to connect with institutions and information that eventually help in decreasing risk and uncertainty. With access to markets, data and financial services and the help of specific digital technologies, the efficiency of fertilizing, planting, harvesting and selling products increases.

At present, most hunger-alleviation strategies do not feature such types of technologies prominently, but the number is gradually increasing as more people show an interest in emerging economies. These technologies fall under the **SaaS** (software as a service) model. SaaS is already being used in many parts of the world, so we will now examine how SaaS can help to enable food security.

What is SaaS?

SaaS is one of the three components of cloud computing. It is a software distribution model in which a third-party provider hosts the applications, and the end-users can access the software through the internet. We can understand this better with the help of an example. If we go to a restaurant to eat, we order our food and pay for it. We do not pay for the food cost, rent of the restaurant or space, service, cleaning and cooking directly – the restaurant itself handles all of these factors. SaaS works in the same way and offers similar ready-to-use solutions for particular business needs.

■ Software as a service helps to enable food security

How SaaS helps in enabling food security

SaaS technology and solutions can help to resolve issues of access to food, availability of food and climate-smart farming. In the first instance, it can help to prevent a waste of resources such as fertilizers, water and pesticides during the crop cycle, to make sure that the environment that supports food production does not get depleted.

SaaS technology uses data-driven decision-making, which helps with supply chain management, precision farming, warehouse management and climate-smart agriculture. All of these factors contribute to increasing food security by decreasing damages during the production and post-harvest stages. Smart farming enabled through SaaS is a resource-efficient method that can deliver sustainability and higher productivity in agricultural production. Ground truth (real) data is processed through advanced machine learning or artificial intelligence algorithms and combined with satellite data to achieve these features.

Benefits of SaaS technology in food security

- **Multi-tenancy architecture**: This means that a single instance of the software can serve multiple customers. Thus, each application and user share a joint code base and infrastructure that is maintained centrally. Moreover, the multi-tenancy feature reduces the upfront costs of SaaS because of lower maintenance costs and shared infrastructure.
- **Scalability**: If you are an entrepreneur, you will always look for a scalable option. With SaaS applications, you have the opportunity to choose the model that fulfils the requirement of the infrastructure. Moreover, the infrastructure can be scaled up or down whenever required.
- **Seamless integration**: With SaaS, all the necessary and required applications can be integrated easily with each other. This will help in extending functionalities and maximizing revenue.
- **Cost saving**: Lower costs overall is known to be the second most significant driver of SaaS adoption. SaaS does not charge any up-front license fees, and it is often subscription-based. The cost depends on your level of use. If you are using more services and components, the costs increase; if you are using fewer services, the cost decreases.

How food safety helps in promoting food security

The concepts of food security and food safety are mutually connected, and both have a significant impact on daily life but, rather than dealing with the quantity of food, food safety concerns the quality of the food.

If a person has a lot of food but it is not edible, or it is of bad quality, then there is no food safety (as the quality of the food is not acceptable). If there is no food safety, then there is no food security.

ATL ACTIVITY

Research

Research how SaaS can contribute to food security if it is used in a food processing plant.

Access to health care and medicine

Health inequalities are systematic differences in access to health care between different groups of people and the status of people's health. Health inequality is also often referred to as the differences in the care that people receive. It can involve differences in areas such as health status, life expectancy, the prevalence of health conditions, access to care, availability of treatments, quality and experience of care, and even quality of housing.

Differences in health status experienced by people can be determined by a range of factors including:

- socio-economic factors (for example, income)
- geography (for example, region)
- specific characteristics (for example, gender, ethnicity or disability)
- socially excluded groups (for example, homeless individuals).

Links

This content links to Chapter 4.4 Health.

Activity: HL Extended Inquiry

Evaluate

Evaluate the impacts, implications and interventions.

- Have you evaluated the extent of the impacts and implications?
- Have you highlighted the most important impacts and implications that need to be addressed by the interventions?
- Have you evaluated the interventions using the six intervention criteria?

Many people do not find it easy to access health care. The development of different types of e-health has increased to meet this challenge. Consider the following factors of health inequity that digital technologies can help address:

- inequitable access to trusted, reliable health information, which can be addressed by information websites provided by governments, businesses and other organizations
- inequitable access to medical expertise and commodities such as medicines, vaccines, diagnostics and devices, which can be helped with online services.

Investigate some real-world interventions and evaluate their effectiveness.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Examine how digital technologies are being used to address health care inequality. In your response, refer to a real-world example. *[12 marks]*

Activity: HL Extended Inquiry

Evaluate

Evaluate the impacts, implications and interventions.

- Have you evaluated the extent of the impacts and implications?
- Have you highlighted the most important impacts and implications that need to be addressed by the interventions?
- Have you evaluated the interventions using the six intervention criteria?

Recommend

Make recommendations.

- Have you recommended changes and additions to the interventions?
- Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the table below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

■ Prescribed areas for inquiry: 5.1A Local and global inequalities

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Economic inequality and stratification	Social disruption and increased poverty caused by many factors, including lack of access to digital technologies.	Provide affordable broadband access for all citizens as a right with little cost, as many efforts to reduce inequality use digital technologies. Zero-rates service – a lack of disposable income is a major factor that prevents many from gaining internet access. A zero-rates service would provide equal opportunity. Diversifying content – English is the predominant language of the internet, which excludes millions of people from using it. If content was in their native language, it would diversify and expand the range of content.
Food insecurity and access to safe, nutritious and sufficient food	Food insecurity arises from a lack of education and skills, political instability, government policies, economics and trade issues, lack of technology, environmental and climate factors and a lack of communications.	Using digital technology in the production, harvesting, storage, processing, packaging, marketing and distribution of food. IoT sensors, cloud computing, blockchain tracking and smart packaging are being developed to increase efficiency and reduce wastage and prices.
Access to health care and medicine	Health inequalities can involve differences in areas such as access to care, availability of treatments, quality and experience of care, and even access to quality housing.	A large range of e-health interventions are being developed to reduce inequalities in these areas.

5.1B Changing populations

In the modern world, population numbers are still growing, changing in composition and moving around. These changes have both positive and negative implications and impacts, and will be the focus of inquiries in this section. The three areas of changing populations to be focused on are:

- **Population growth**: The number of people in the world is still growing, which creates problems for their well-being.
- **Shifting demographics**: The increase in aging and youthful populations creates economic and social pressures that have an impact on well-being.
- **Migration and the movement of people**: People move from area to area in nations, between nations and between continents to try to enhance their well-being.

Population growth

Most population growth over the last few decades has been in the development of large cities, and megacities (cities of over 10 million people) as people move from rural areas. This places a large burden on governments to ensure the well-being of these populations. Digital technologies are increasingly used to meet this challenge.

The digital technologies mentioned in the following report are well known, and need to be used to mitigate the problems created by megacities. The term smart city is used to describe a city that makes use of these technologies. Examples of these digital interventions can be found here: **www.thalesgroup.com/en/markets/digital-identity-and-security/iot/inspired/smart-cities**

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

The challenge of population growth has led to very large cities. Research the use of digital technologies in a city near you – both those that are in place and those that are planned (future recommendations). Examples might include traffic control systems or use of CCTV networks. Investigate the extent to which they have, or have not, been successful.

Shifting demographics

Digital well-being

Young people today are growing up in a world where technology has always been present. This can have both positive and negative impacts on their lives. While engaging online, connecting with friends, sharing experiences and learning new things can be positive experiences, they can also pose challenges. With the online world being such a huge part of young people's lives, it is important that they become good digital citizens who understand how to use it safely and are aware of how it can impact them.

Our overall well-being is often determined by the physical and emotional experiences we encounter. As technology continues to be a huge part of our lives, it also has an impact on our well-being. This is often referred to as your digital well-being.

Technology and the internet should be there to enhance and simplify our lives, not to cause distraction, worry or upset. Some online experiences can have a negative impact on how young people feel about themselves, their friendships and relationships, and even how they see the wider world.

Links

This content links to Section 4.4C Mental health.

The impacts of technology on aging populations

Technology has the potential to play a significant role in helping older people as they age. Advances in automation and artificial intelligence can be used to assist older workers, reducing the negative effects of aging. For example, automation makes the same task less demanding manually and physically, and hence the workplace can better accommodate older employees.

Smart home devices, such as sensors, cameras, alarms and voice-activated speakers like Google Home or Amazon Alexa can make everyday life more convenient, safer and more sociable.

Research in the field of Internet of Things (IoT) development has recognized several challenges and limitations associated with past smart technology designed to assist in the lives of older people living at home, in particular the need for user-centredness and better integration with broader systems. Technologies such as IoT support the role of the built environment and caregiving to produce outcomes that enable older people to remain autonomous, independent, safe and well at home. However, negative aspects of technology identified by researchers include issues of maintenance, cost and ease of use, and willingness to use, which are all potential barriers to the benefits of smart technology.

Links

This content links to Chapter 3.4 Networks and the internet and Section 3.7A Types of robots and autonomous technologies.

Smartwatches

With the exception of smartwatches and fitness trackers, most wearable technology devices for elderly people are health care-related. Medical alert companies, which offer a monitored service for a monthly fee, have begun to offer multifunction wearable devices integrated with their monitoring services. Several companies have introduced a wrist-worn combination medical alert and smartwatch.

Smartwatches are becoming the dominant wearable technology due to the increased utility over other categories. The Apple Watch Series 4 and above includes an electrocardiogram monitor with atrial fibrillation detection and fall detection. While some of these features require cellular service, those not requiring cellular include heart rate data with alerts, fitness tracking features, Siri conversational assistant and water resistance. Smartwatches also offer valuable apps that can be used in case of emergencies, fall detection and detection of potential medical problems.

Links

This content links to Section 4.4A Medicine and health.

Smart technologies and chronic conditions

Medical device technology can collect biometric data such as heart rate (electrocardiogram and heart rate variability), brainwave and muscle bio-signals from the human body to provide valuable information to address chronic and other health-related conditions.

Four of the top 10 conditions for adults aged over 65 are heart-related, and heart disease is the number one cause of death in the US, with high blood pressure and high cholesterol being two of the top risk factors. Fortunately, many smartwatches and fitness trackers include heart monitoring technology.

Other smart devices are being developed to help monitor health conditions in elderly people, including cholesterol, arthritis and chronic pain, as well as cognitive conditions such as dementia or Alzheimer's disease.

ATL ACTIVITY

Research

You are worried about your grandparents and have heard that IoT can help them with their routine chores as well as monitor them.

Select one room in the house, for example a bathroom, bedroom or kitchen, and suggest what technologies you could buy for them and for what purpose.

ATL ACTIVITY

Research

If elderly people and people with disabilities are relying on digital technologies to communicate, socialize and operate in society, it could also have negative impacts on them, such as increased stress, anxiety and depression.

Research the extent to which less face-to-face, in-person interaction and more digital communication impacts people.

REAL-WORLD EXAMPLE

AI helps to overcome key aging-related challenges

Artificial intelligence such as assistive robots, self-driving vehicles, voice assistants and intelligent homes have the potential to address many aging-related challenges, including the desire to age in place; caregiver burden, including the shortage of professional caregivers; diminished mobility; financial wellness; sense of purpose; health and end of life choices. However, these technologies must consider privacy and consent, balance the needs of autonomy and safety, and protect data against misuse, minimize social isolation, the risks of over-reliance and system failures, to name a few.

www3.weforum.org/docs/WEF_AI_and_Ageing_Workshop_Report_2021.pdf

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 The use of digital technologies in the care of elderly people is increasing, either within a care home setting or in their own home. Examine the use of these digital technologies, referring to a real-world example. *[12 marks]*

Activity: HL Extended Inquiry

Evaluate

Evaluate the impacts, implications and interventions.

- Have you evaluated the extent of the impacts and implications?
- Have you highlighted the most important impacts and implications that need to be addressed by the interventions?
- Have you evaluated the interventions using the six intervention criteria?

One intervention designed to respond to the challenge of older people living alone are robots that they can interact with, be entertained by, and which have some capability to monitor them and remind them of tasks that need to be done.

Investigate some real-world digital technologies designed for older people and evaluate their effectiveness.

Migration and the movement of people

When there is a crisis due to conflict or natural disaster, many people may have to leave their homes, often without identity documents. Technology plays a significant role in the lives of refugees and internally displaced persons (IDPs). It has influenced how international organizations respond to refugee and IDP situations, but it can also be used by refugees and IDPs to access information such as financial or social networks.

Many digital technologies can help displaced populations by providing resources for refugees and IDPs, giving them the opportunity to support themselves. Technologies such as biometric identifiers and mobile apps can provide support in areas such as the distribution of food rations and can help refugees and IDPs find work. New technology applications are being created all the time that can help provide these individuals with the services they need at different stages of their lives. Educational platforms are available to help displaced people and refugees update or acquire new skills so that they can potentially return home and support themselves or their families.

While technology can help support refugees and IDPs, it can also be a threat to their well-being. It may empower individuals to take advantage of the refugees and IDPs for profit. These technologies can also cause privacy and security concerns, as the compilation of sensitive data may put refugees and IDPs at risk. In order to make the technology more secure for these individuals to use safely, decentralized data storage systems need to be used rather than traditional databases.

To achieve better outcomes, political will and public opinion must be mobilized. While social media can exacerbate fears and prejudice toward refugees, it can also be utilized effectively to organize political will. Young people are more inclined to mobilize online via social media than through established political routes, for example. Refugees and IDPs often share personal information on YouTube and Facebook, generating exposure and raising awareness. On a positive note, these technologies can also enable refugees to connect with others in meaningful ways. If these groups come together with the use of technology, they may be able to overcome institutional hurdles and build social trust.

REAL-WORLD EXAMPLE

The Stanford Immigration Policy Lab algorithm

The Stanford Immigration Policy Lab is an international group of educators dedicated to innovation in immigration policy. They evaluate and create policies that encompass the integration of immigrants and refugees around the world. Their work has the potential to improve immigrants' lives and strengthen their surrounding communities. Through the use of large datasets and leading analytical tools, they provide evidence regarding the urgent problems faced. By providing information to those who set public policy, as well as those who serve immigrant communities, their research can impact many lives. The Stanford Immigration Policy Lab uses an algorithm to aid in the human decision-making process of relocating refugees to communities where they can thrive. Technology may increase cooperation and responsibility-sharing by expanding opportunities for interactions and increasing refugee integration.

ATL ACTIVITY

Research

Smartphones are an important tool for refugees to keep in contact with their friends and families, to communicate and share information, for finding important information from government and other sources, to share and publicize their experiences, and to be in contact with people and organizations that want to help. This leads to increased safety and a better chance of finding solutions to their problems.

Research to what extent these benefits are achieved, and to what extent smartphones can create problems through disinformation and targeting by criminal networks and unscrupulous operators.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

Prescribed areas for inquiry: 5.1B Changing populations

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Population growth	The challenge of population growth has resulted in very large cities including some megacities.	Making cities smarter through the use of digital technologies will help large cities to be managed and run more effectively and efficiently. Much of this will happen through the use of data collection and processing across the cities.
Shifting demographics, especially the aging population	The increasing number of elderly people in our populations creates a challenge for their care, especially those who live by themselves.	A variety of interventions have been developed and experimented with, such as having sensors and cameras in the home that can be used to monitor activities, especially for those with disabilities who may struggle to look after themselves. Other interventions include robots that can interact and entertain, and which have some capability for monitoring people and reminding them of tasks that need to be done.
Migration and the movement of people	When there is a crisis due to conflict or natural disaster, many people have to leave their homes, often without having identity documents. Locating refugees is not easy for family and friends either.	Organizations that work with refugees can use digital technology to meet this challenge. They can record their details and items that can be used to prove their identity for access to emergency aid, for work, and can use it to reunite families that get split up. Standard databases are often used but blockchain is now being used as well.

5.1C The future of work

The nature of work and the way work is performed is changing all the time – at local, national and global levels – and this has had several impacts on well-being. While new jobs are being created every day, many are changing significantly and others do not exist anymore. These changes happen for a range of reasons including economic, population and technological changes. The three areas for the future of work that we will focus on are:

- **Automation and employment**: The nature of work is changing due to increasing automation and the use of advanced technologies. Changes in the type of work done impacts the ability of people to maintain and enhance their well-being through work.
- **Ensuring meaningful and secure employment**: A person's well-being is usually connected to the meaningful work they do and the security of their employment.
- **Addressing the collective needs of workers**: In addition to the well-being of individuals, changes to the way we work also impacts groups of workers, often across whole industries and towns, cities, regions and nations.

Automation and employment

Automation technology is becoming an integral part of many modern businesses. While some fear that further automation is a threat to jobs and the economy, others believe that it can advance companies and help to keep workers safe on-site.

Artificial intelligence continues to make automation more efficient and productive, but many people worry that robots are taking our jobs. It is estimated that 50% of jobs could theoretically be automated by current technologies, although only 5% of jobs can be fully automated.

Links

This content links to Sections 3.6E AI dilemmas and 3.7D Robots and autonomous technologies dilemma.

A Brookings Institute report states around 36 million jobs are susceptible to automation. But it's not only automation that is having a dramatic impact on traditional working habits. Advanced manufacturing is integrating new, innovative technologies into the production process, as well as in the final products, and is thus posing similar existential questions about the utility and nature of human capital. All of these factors are set to change the nature of work during the coming decade, which means workers from virtually every industry will have to prepare accordingly.

Advances in artificial intelligence and machine learning may shape the future of work dramatically:

- **Job destruction**: Many expect that job destruction will accelerate under the current pace of technological changes.
- **Quality of jobs**: The rise of non-standard forms of employment in recent years – for example, the gig economy – has major repercussions for the future of work, raising concerns about job security and the quality of working conditions. Employers might benefit in the short term, however, through greater worker flexibility and cost savings, especially if these arrangements are exempt from tax contributions and other employee benefits.
- **Social protection**: The gig economy has changed the traditional definition of 'employment'. The lack of security, protection and legal certainty associated with it will take some time to be resolved.
- **Wage and income inequalities**: Inequality may worsen as lower-income households may find it most difficult to adjust to the new world of work.
- **Social dialogue and industrial relations**: In many countries today, workers can negotiate wage increases, better access to health care and better working conditions through unions. Will these organized institutions be less effective in achieving these objectives as more work is shifted to machines? The increasing use of industrial machines and globalization has made it difficult to regulate work.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

As technology increases productivity and reduces the load on workers doing repetitive tasks, it can have a huge impact on employment.

Research and evaluate one real-world intervention and recommend steps for future actions.

Many of the tasks that workers do now have the potential to be automated. Job-matching sites such as LinkedIn and Monster have changed how people look for jobs and how businesses recruit employees. Self-employed workers are using digital platforms such as Upwork, Uber, and Etsy now more than ever to showcase their skills and challenge traditional concepts about how and where jobs are done in the process.

Since the Industrial Revolution, the workplace has been revolutionized by technological advancements, but the rate at which automation technologies are evolving presently, and the extent to which they may disrupt the workplace, is unprecedented. The use of automation continues to increase as robots gain more advanced performance capabilities that match or exceed those of a human. However, just because automation is technically feasible does not mean it will be adopted in the workplace or that all jobs will be automated.

Digital talent platforms offer the potential to improve the matching of employees to various jobs, bringing transparency and efficiency to the labour market. With their vast search capabilities and superior screening algorithms, online talent platforms can help speed up the recruiting process and minimize the amount of time people spend looking for work, resulting in lower unemployment. By gathering data on people and job vacancies across entire regions, these platforms could ease some geographic mismatches and enable matches that would not have occurred otherwise.

ATL ACTIVITY

Research

As digital technology increases productivity and reduces the load on workers doing repetitive tasks, what is the impact of technology on employment? Research the types of work that are impacted.

Links

This content links to Section 4.2B Employment and labour.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 It is claimed that new generations of intelligent machines, powered by continuing advances in artificial intelligence and robotics, will replace a significant number of current human jobs, but will ultimately lead to more jobs being created.

Discuss this claim, referring to a real-life example. *[12 marks]*

Meaningful and secure employment

Advances in technology may contribute to eliminating certain occupations, but they also create new jobs and new opportunities. In fields including technology development, hardware manufacturing and app creation, many of the new occupations generated in the US in recent years did not exist or hardly existed previously. As such, new technologies can have a large, positive impact on employment.

New and innovative entrepreneurial opportunities can also be made available as these digital technologies advance, giving small businesses more options to make more money. As technology continues to grow and more intelligence is integrated into these systems, less-skilled employees will be able to work with little training. Google, for example, launched its Internet Saathi (Friends of the Internet) programme in India in 2015, in which women were taught how to use the internet and were then employed to provide services in their communities using internet-enabled technologies.

ATL ACTIVITY

Research

Research new jobs that have been created in the last five years that involve digital technology. Make a list of the top 10 jobs and their incomes.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Artificial intelligence has enhanced the way we work in many types of jobs. Discuss this claim with reference to a real-world example. *[12 marks]*

REAL-WORLD EXAMPLE

Algorithmic auditing and AI bias in hiring

Artificial intelligence is often described as a solution to bias and discrimination in hiring. There is growing concern, however, that artificial intelligence itself can be biased, putting companies that use algorithms to drive hiring decisions at risk. The challenge for companies is to figure out how to spot and eliminate discrimination in artificial intelligence.

One possible solution is algorithmic auditing, a process for verifying that decision-making algorithms produce the expected outcomes without violating legal or ethical boundaries. However, algorithmic auditing has come under fire from policy advocates – because it is so new, it lacks standards and is open to vendor influence.

It raises the question: if companies can't trust the process for auditing artificial intelligence, how can they use it at all?

www.techtarget.com/searchhrsoftware/feature/Why-algorithmic-auditing-cant-fully-cope-with-AI-bias-in-hiring

Activity: HL Extended Inquiry

Recommend

Make recommendations.

- Have you recommended changes and additions to the interventions?
- Have you recommended other steps for future actions to address the challenge and its issues?

In a group, conduct a role-play activity on introducing working from home for employees.

- Assign roles: the co-manager, the human resources manager, the tech support manager and the employee working from home.
- Everyone is to research their role with regard to:
  - how their job has changed to enable working from home
  - the technology being used
  - how they will maintain productivity – research the role that each person has at a time when employees are working from home
  - the challenges faced, for example monitoring staff
  - possible interventions for the challenges faced.
- Role play a meeting in which working from home is introduced to the staff. Allow everyone an opportunity to contribute to the meeting and ask questions.
- Discuss recommendations for working from home.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Digital innovations are disrupting the nature of work in many organizations and companies. Using a real-world example, discuss the benefits of digital innovation compared to the negative impacts for employees. *[12 marks]*

Addressing the collective needs of workers

Digital technologies such as artificial intelligence and automation have radically changed the nature of work and employment. The extent and types of change and the issues arising from them are still developing, and no clear end is in sight. The need to address this challenge does not lie solely with the developers and users of these technologies, but needs to include the workers themselves.

A range of interventions are needed, including policies, regulations and laws, as well as technology-based solutions, such as communications tools and digital media. The Digital Society course concepts can be used to investigate this challenge and to evaluate the various interventions. Specifically, a 'power' imbalance has developed between workers and companies that needs to be addressed; 'values and ethics' are also part of the problem and part of the solution; and 'systems' ideas are embedded in the use of the digital technologies and how they are used.

ATL ACTIVITY

Research

Firstly, investigate the range and types of issues that arise from the increased use of digital technologies, such as the increasing number of people working in the gig economy.

Secondly, investigate efforts to resolve, mitigate and intercede in the issues, and to enhance the use of digital technologies. This includes legal and political interventions (laws and regulations) as well as technology-based solutions.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

Prescribed areas for inquiry: 5.1C The future of work

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Automation and employment	Automation of work has impacted low-skilled and routine workers – reducing the range and type of work.	Education and retraining of workers in STEM knowledge and skills. Automation will create new types of employment as has happened in some advanced countries.
Ensuring meaningful and secure employment	Working from home has been welcomed by many people, including those working for companies and those starting their own businesses. There are issues such as monitoring the work done and the intrusion of work into home life, however.	A variety of digital technologies can be used to monitor work being done. Regulations and agreements are being used to keep work separate from home life.
Addressing the collective needs of workers	The advantages and challenges of the gig economy are now becoming much clearer for workers, businesses and society.	Efforts to meet these challenges will not only use digital technology – there will be legal and political interventions involving laws and regulations.

Activity: HL Extended Inquiry

Interventions address challenges through actions. In extended inquiries, you will work with interventions that involve digital technologies. To illustrate how an extended inquiry might be approached, review the following interventions and recommendations for the given real-world scenario.

After reviewing the interventions and recommendations below, investigate other possibilities.

- **Real-world example**: Barrier to internet access
- **Intervention**: Mitigates
  Implement policies to mitigate the digital divide.
- **Possible recommendation for future action**: Cost
  Zero-rates service – a lack of disposable income is a major factor that prevents many from gaining internet access. A zero-rates service would provide equal opportunity.
- **Possible recommendation for future action**: Equity
  Diversifying content – English is the predominant language of the internet, which excludes millions of people who could use the internet if content was in their native language. Diversifying content and expanding the type of content would increase access.

Reflection

Now that you have read this chapter, reflect on these questions:

- How can cyberbullying impact the well-being of individuals?
- What does your digital footprint look like?
- What role does machine learning place in the future of work?
- What types of job automation have happened in your local area?
- How can technology mobilize political will, and increase accountability?
- How will major technological communities transform themselves to reflect the diversity of the populations they serve?
- How can technology be used to facilitate greater responsibility when sharing?
- How can technology assist in mobilizing new sources of funds and improving the efficiency of existing funding?

5.2 Governance and human rights

UNDERSTANDINGS

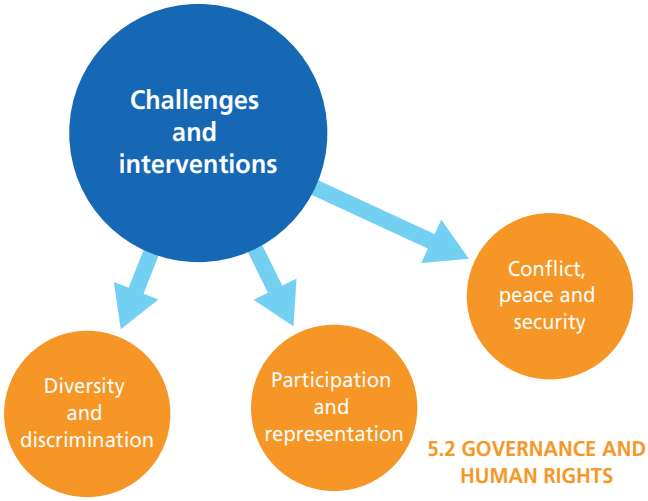
By the end of this chapter, you will understand:

- the relationship between governance and human rights in a digital society
- the challenges faced by governments in an evolving digital world
- the impact technology has on human rights
- how digital technology-related interventions are being used to respond to this challenge.

Human rights in a digital age

In this chapter, we will look at three main areas of inquiry for governance and human rights:

- conflict, peace and security
  - wars and civil conflicts
  - regional, national and global security
- participation and representation
  - political speech and activism
  - access and representation in governing bodies and institutions
- diversity and discrimination
  - gender equality
  - racial and ethnic discrimination
  - ability, access and inclusion
  - tolerance for religions and cultural differences.



5.2A Conflict, peace and security

There is a constant challenge to peace and security in the midst of many conflicts. The challenge of wars and conflicts in and between nations is being impacted by the use of digital interventions, both positively and negatively. Meanwhile, the desire for, and maintenance of, security is being enhanced by the use of digital interventions, but this is not without its own issues.

As new technologies drive change around the globe, new opportunities arise for change in the areas of government relations, conflict, peace and security. However, with these opportunities comes the challenge of keeping up with these changes.

New technologies, including everything from the internet to drones and big data, can help prevent conflict by reducing the gap between warning and response. They can facilitate peacekeeping through new tools to be used in increasingly complex environments, and by empowering local stakeholders.

Peace and conflict

Innovative technologies provide opportunities to collect data surrounding crime and conflict. Crisis mapping, social media mapping and crowdsourcing techniques can all aid in the collection of conflict data. This data can be used to detect trends related to war and peace to better inform efforts to prevent conflict or human rights violations.

However, employing new technologies to avert conflict still faces substantial challenges. These strategies may not be appropriate in every situation. For instance, big data comes with significant risks, such as jeopardizing individual security and privacy if the data were to fall into the wrong hands. It can also intensify conflict if the digital divide coincides with conflict cleavages.

Despite the fact that new technologies have revolutionized the way wars are fought, UN peacekeeping missions have been hesitant to incorporate them. Monitoring and surveillance technology, such as unarmed unmanned aerial vehicles (UUAVs), video monitoring systems and satellite imaging, are some of the technologies being used for peace operations. As the use of new technology in peacekeeping operations grows, governments are paying close attention to the impacts. While UUAVs can help with tasks such as data collection and transportation, they can also become part of the conflict dynamic. In areas such as intelligence gathering, these new technologies are often found to be controversial and can lead to further conflict.

On the other hand, new technologies can provide opportunities for conflict resolution. Data collecting and analysis can empower communities to resist violence and rehabilitate after conflicts. These technologies can be used to generate non-violent, positive attitudes. Unfortunately, access to these technologies is limited and often subject to government manipulation, while individuals confront privacy and security concerns. Furthermore, the same technologies that can be used to distribute peace messages can also be utilized to spread hate messages and misinformation.

Security

Concerns have been raised about the use of communication technology, particularly in relation to how to control the internet and cybersecurity awareness. Cybercrime and cyberattacks can threaten internet users' safety, impede economic and commercial activities, and jeopardize military capabilities. Furthermore, violence in the cybersphere frequently replicates conflict around the globe.

As new technologies transform warfare, the cybersecurity situation becomes even more complicated. New technology has given rise to new uses of force, such as armed unmanned aerial vehicles (UAVs) or drones. Although there is widespread agreement that the use of armed drones is not unlawful, there is no agreement on how to apply international law on the use of force by drones, and there is a possibility that they will increase the geographical and temporal boundaries of force used.

Links

This content links to Chapter 4.6 Conflicts and war.

REAL-WORLD EXAMPLE

Unmanned aerial vehicles

Unmanned aerial vehicles (UAVs) are military aircrafts that are either guided autonomously or by remote control.

They can carry sensors, target designators, weapons or transmitters designed to interfere with enemy targets. Without the need for a human crew, their life-support systems and safety requirements, UAVs are incredibly efficient and have a significantly wider range than their equivalent manned systems.

UAVs were developed from the target drones and remotely piloted vehicles used by the military after the Second World War. Modern UAVs are small drones that resemble model airplanes. Their quiet engines and small size mean that they are virtually undetectable, making them highly effective for battlefield surveillance and determining potential targets.

www.britannica.com/technology/unmanned-aerial-vehicle

ATL ACTIVITY

Research

Challenge: How to monitor and control the use of artificial intelligence when being used in conflict.

Intervention 1: The use of AI technology policies set by international organizations, governments and military forces.

Intervention 2: The use of AI technology is limited when being used in conflicts.

Research both options.

ATL ACTIVITY

Research

Challenge: How to develop and program artificial intelligence with an agreed set of ethical principles when being used by law enforcement.

Research the type of ethics used and evaluate their effectiveness

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Lethal autonomous weapons systems raise serious questions about the conduct of modern warfare. The artificial intelligence decision-making process at the core of these systems is becoming more and more autonomous, with little to no human intervention, so accountability for the actions of the systems becomes more difficult to determine.

Using a real-world example, discuss the impact on society for peace and security from the use of these systems. *[12 marks]*

Activity: HL Extended Inquiry

Evaluate

Evaluate the impacts, implications and interventions.

- Have you evaluated the extent of the impacts and implications?
- Have you highlighted the most important impacts and implications that need to be addressed by the interventions?
- Have you evaluated the interventions using the six intervention criteria?

Recommend

Make recommendations.

- Have you recommended changes and additions to the interventions?
- Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

■ Prescribed areas for inquiry: 5.2A Conflict, peace and security

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Wars and civil conflicts	Removing the digital divide to prevent conflicts. Monitoring conflicts.	Satellite-based internet. UAVs (drones), satellites.
Regional, national and global security	Ransomware attacks and cyber warfare. Control and use of artificial intelligence in military and police equipment.	Protection software. Attacking the sources. Policies for use, programmed ethics.

5.2B Participation and representation

Governments at all levels are using digital interventions to communicate with people and communities. This is mostly positively with people and communities wanting to participate and be represented in their local government. Communication of political ideas and activism of all types is being impacted by digital interventions.

Political speech and activism

Digital activism

The internet and digital media are used in **digital activism** to mobilize individuals to take political action. Online activists frequently use the internet as a tool to distribute information and as a location for protest that amplifies offline protests in a more sophisticated way due to its ability to reach enormous audiences throughout the globe instantaneously. Digital activism includes email and social media campaigns, virtual sit-ins and **hacktivism**.

Online initiatives can be critical in countries where public spaces are regulated or controlled by the military. Online actions are preferable to in-person activities in these circumstances. While much digital activism falls under the umbrella of electronic civil disobedience, some activists argue that these online political gestures should represent a communal interest rather than an individual agenda, and that their goals should be made public so that they are not misinterpreted as acts of cyberterrorism.

Links

This content links to Chapter 4.6 Political.

◆ **Digital activism**: Activism that uses the internet and digital media as key platforms for mass mobilization and political action.

◆ **Hacktivism**: Hacking into a computer system for socially or politically motived purposes.

Commonly used digital tactics include email campaigns, text messaging, social media postings and online petitions. Virtual sit-ins – where a networked community meet to carry out a digital act of defiance using web-based software – can disrupt server functionality, and be carried out by protestors based all around the world. The repeated requests/clicking of the protesters on the targeted web page generates so much traffic that the targeted site's server is overwhelmed. The bandwidth is clogged, causing the website to slow down and eventually shut down.

ATL ACTIVITY

Research

Challenge: Digital technologies, such as dedicated websites and social media, can help people to participate in local affairs and issues. They can be used to connect authorities with their communities digitally to foster trust and transparency, as well as to facilitate communication.

Research the use of these digital technologies for this purpose in your local area.

ATL ACTIVITY

Research

Challenge: Government control of mainstream media and communications, often to the exclusion of other sources of news and information, often to the exclusion of other sources of news and information, such as social media e.g. Facebook, Instagram and Reddit.

Intervention: The use of communications apps (especially those with encryption capabilities), such as WhatsApp, Messenger and Signal.

Research: The use of these interventions for digital activism in various countries around the world.

ATL ACTIVITY

Thinking

Governance of the internet is a controversial topic, in part due to its multi-stakeholder nature. Public authorities have not played a major role in regulating the internet, leaving it largely to private companies by engineers and experts who have made major decisions through unstructured procedures.

To what extent does the government in your country control the internet and how are citizens impacted?

REAL-WORLD EXAMPLE

How social media amplifies political activism and threatens election integrity

From online boycotts to offline gatherings, social media is a proven tool for political activism. It has captured public attention and enabled meaningful political action and protests and, thanks to its decentralized nature, activists are better able to evade censorship and coordinate their actions.

Up to 25 million Americans participated in protests following the death of George Floyd in May 2020, in part due to the widespread attention and coordination on social media.

Social media also has positive and negative implications for political campaigns. It can be used to promote campaigns and target specific voters, but it can also be used to misinform and manipulate voters, making the electoral process vulnerable.

Activists have also used social media to disrupt campaigns. A political rally held by President Trump in June 2020 in the US was pranked by an army of K-pop fans who reserved large numbers of tickets for the rally, leading to a lower-than-expected attendance.

https://theconversation.com/tiktok-teens-and-the-trump-campaign-how-social-media-amplifies-political-activism-and-threatens-election-integrity-141266

Access and representation in governing bodies and institutions

Impact on governance

Crowdsourcing provides opportunities to empower citizens and transform the governance relationship. It has the potential to augment more traditional routes for participation, such as elections and referendums, and can make government decision-making processes more inclusive and transparent. It also allows citizens to assess their outcomes, indirectly increasing their legitimacy. Many countries have experimented with online participation in governance, for example, through websites where citizens can provide feedback to virtual town hall meetings. These approaches can promote a move from vertical towards horizontal power structures.

Mobile phones and social media also present opportunities to empower citizens and transform their relationships with governments. Real-time photos and videos uploaded to social media can expose government corruption or abuse and increase government responsiveness to citizen concerns. These technologies have also revolutionized people's ability to organize and coordinate protest movements. However, some technologies, such as mass surveillance, contribute to the break down of trust between governments and citizens.

The rapid spread of ideas, facilitated by new technologies, can have both positive and negative consequences. The easy manipulation of information and sources, and the risk of viral dissemination without verification, can propagate misinformation. Moreover, social media users risk finding themselves in a position where they are not exposed to differing opinions – an echo chamber – potentially increasing political polarization.

ATL ACTIVITY

Research

Challenge: One main function of a government is to provide information and services for the public. Government information websites are one development in the way this information can be provided.

- For the country that you reside in, and one other, investigate a government website that offers information and services to the public.
- Compare the information that is shared and the level of interactivity of the website.
- How accessible and easy to use were they?

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Smartphone apps have been used in local, regional and national elections by a range of political parties and interest groups to provide information and to influence voters.

Discuss the impacts of this use of smartphone apps. In your response refer to a real-world example. *[12 marks]*

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

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2 Recommend steps for future actions.

■ **Prescribed areas for inquiry: 5.2B Participation and representation**

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Political speech and activism	Misinformation on social media. Trolls attacking public people. Government control of the internet and social media, including censoring.	Laws to remove/censor misinformation. Author identification of social media posts. Use of VPNs, and encrypted messaging.
Access and representation in governing bodies and institutions	Decreasing participation in local affairs and voting.	Dedicated websites and social media for public debate, including polling of ideas. Use of online voting.

5.2C Diversity and discrimination

Most people and communities want their human rights to be respected, an end to discrimination and an acceptance of diversity. Digital interventions can be used to reduce discrimination due to gender, race, ethnicity and ability, but can also be the source of bias. Likewise, religious and cultural tolerance can be enhanced or reduced depending on the digital intervention.

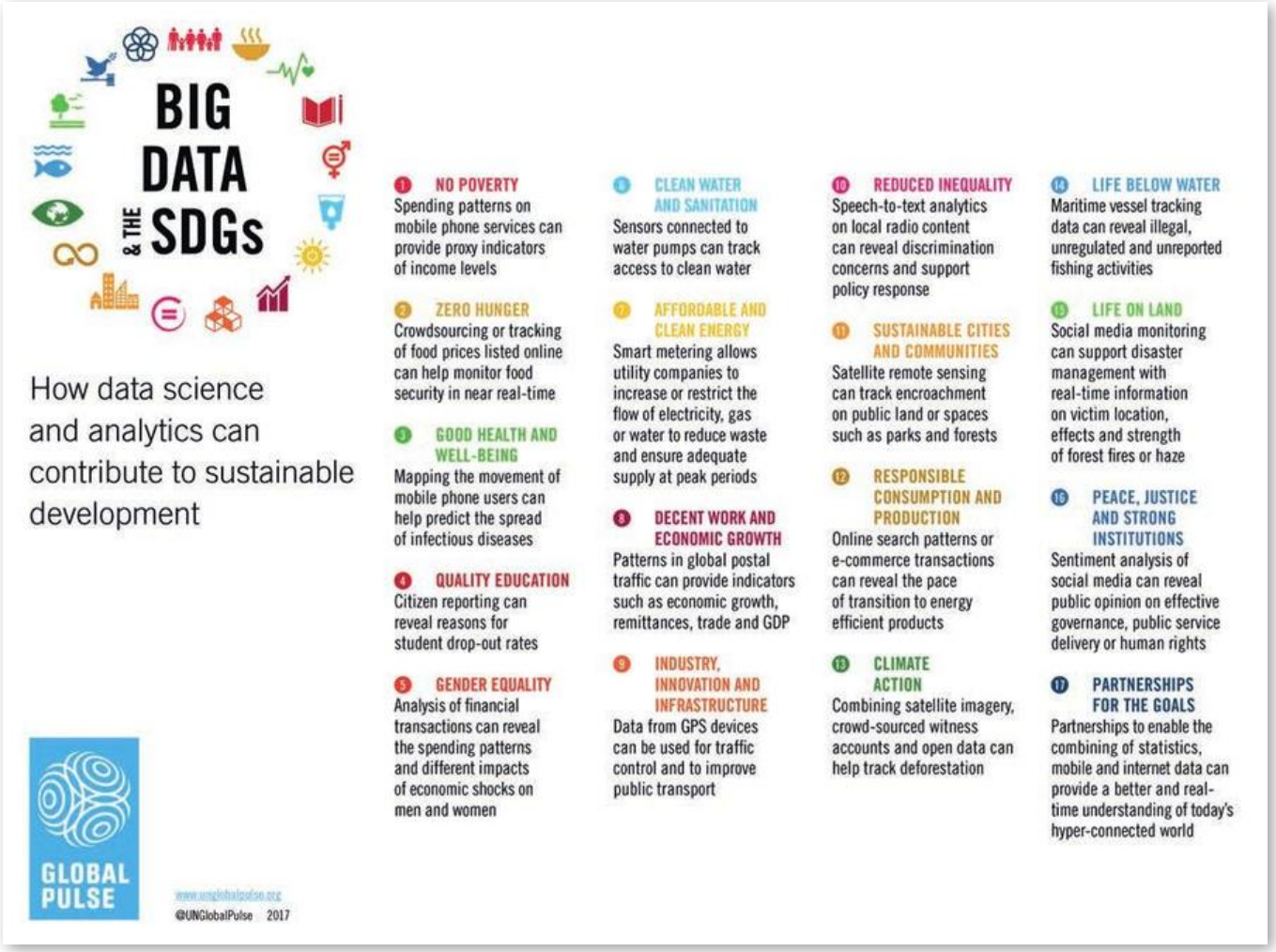
The potential of new technologies to support economic development is widely recognized. However, access to these technologies, or lack thereof, can create a digital divide as access remains highly unequal between developed and developing countries, between the rich and poor, and between men and women within countries.

While 43% of people have access to the internet globally, only 35% in developing countries, 11% in Africa, and 9% in the least-developed countries have access, compared to 82% of people in developed countries. According to the UN's Millennium Development Goals Gap Task Force: 'As long as more people are offline than online, it is not possible to talk about a global information society.' This divide is further exacerbated by lack of content in languages other than English.

Improving access to these technologies in developing countries requires investment, the transfer of technology to the developing world, and increasing the capacity of developing countries to develop new technologies.

Data can be used to establish sustainable development and determine which policies are underperforming and whether new efforts should be introduced. Monitoring and assessing effective policies is incredibly challenging without high-quality data to provide the necessary information. In developing countries, the lack of resources, capacities and opportunities that hinders broader internet access generates similar differences in data quality. The lack of data has the greatest impact on underdeveloped countries. Nonetheless, obstacles in data collection can hinder sustainable development in all countries, regardless of income level.

Collecting data at the national, global and local levels is essential. The use of open data may help to expand the community of analysts and policymakers dedicated to integrating and expanding solutions to meet the UN's Sustainable Development Goals (SDGs). The goal of big data for development is to turn imprecise, complex and frequently unstructured data into meaningful information, but it is currently an unexplored resource for long-term development. Big data's success in assisting development is contingent on government backing and collaboration between governments, the corporate sector and academics. It also hinges on the creation and implementation of new standards for using and sharing big data ethically.



ATL ACTIVITY

Thinking

Challenge: Who should oversee the collection of big data? Some think that the UN should be the depository and safe-keeper of big data by gathering, collecting and storing data from regions where the infrastructure is not safe or sufficient.

Discuss this proposal.

Gender equality

We are witnessing huge changes in the way we live, work and interact with each other as we progress through the fourth industrial revolution. The world is becoming more connected as a result of technological advancements. While this momentum is being used to make data-driven advancement on the UN's SDGs, it also jeopardizes SDG success because women and girls are unable to participate equitably and meaningfully in the digital world.

One of the principles of the 2030 Sustainable Development is to leave no one behind, and this includes gender equality. Unfortunately, limited access to digital technology for women is expanding the significant gender divide. While we know there is a digital divide between men and women, we require more data to understand the significance of the problem, as there is a significant lack of gender-based data, particularly in developing nations.

In some countries, women's opportunities to employ these technologies to improve their social and economic mobility are limited. Furthermore, as technology advances and becomes more expensive, gender divides will likely increase in favour of men. The global employment market is one area where this tendency will have considerable implications. Artificial intelligence is reshaping employment, displacing many of the administrative occupations that were traditionally performed by women in many nations. As such, efforts to develop a more inclusive digital society must not only improve women's access to technology but also teach them flexible digital skills for future careers in engineering and computer programming.

School and community programs are offering STEM (science, technology, engineering and mathematics) education to encourage girls to learn these digital skills. Historically, girls have had less interest in STEM courses in many parts of the world, resulting in only a third of women pursuing these disciplines in higher education. Research into strategies to help young women and girls overcome the social and psychological hurdles that hinder them from pursuing technology-related occupations is ongoing. Programmes such as computer camps, robotics, makerspaces and massive open online courses (MOOCs) are just a few examples that can assist women in gaining expertise and confidence in technology-based skills.

Female role models play an important role in fostering an atmosphere in which women are able to develop their digital talents. Currently, women make up less than a third of technology-related roles and are more likely to have smaller support roles, with less possibility for promotion. Women are also underrepresented at the top levels of technology decision-making positions. The absence of women in these leadership roles results in a lower diversity of opinions, which affects the quality of decision-making throughout the industry. While further study is needed, women must be encouraged to overcome gendered barriers in science and technology jobs.

Racial and ethnic discrimination

In 2020, the UN reported on the need to eliminate racism globally at the 44th session of the UN Human Rights Council. According to the report, Big data algorithms are reproducing discriminatory systems and emerging digital technologies are compounding existing racial and ethnic inequalities.

Links

This content links to Section 4.7A Social components of identity.

ATL ACTIVITY

Thinking

Challenge: Women and other minority groups can create specific, safe digital spaces to discuss and deliberate matters that are important to them.

Which intervention is better: creating special apps, or using established apps such as Instagram?

Links

This content links to Section 4.7A Social components of identity.

The report emphasized that emerging technologies do not exist in a cultural vacuum, but rather reflect racial and ethnic discrimination in today's society. Additionally, it was noted that it will be necessary to impose significant restrictions on digital technologies that fail to meet the criteria outlined in international human rights legal frameworks against racial discrimination.

Technologies such as artificial intelligence are among those that exhibit these racial and gender biases, which can distort the way that facial-recognition systems work. Similar studies have shown how natural language production tools and other machine learning applications can cause discrimination. However, artificial intelligence isn't the only technology that might intensify racial discrimination. Others include:

- targeted internet shutdowns by governments to suppress specific communities and government gatherings
- digital processing of people's biometric data digital identification linked to public services such as food rations and unemployment assistance.

These systems can often exclude people from minority groups, who already face significant challenges in gaining access to these benefits. The UN may need to reconsider its use of biometric data in identifying and monitoring people whose human rights are already under threat as it could result in the further exclusion of refugees and displaced people.

REAL-WORLD EXAMPLE

Facial recognition

Protests in the US over racially discriminatory policing have brought attention to the widespread but unregulated use of facial recognition technology. The FBI and other federal agencies are being investigated to see if the monitoring software has been used in these situations, and several states are considering legislation to outlaw police use of the technology. Major technology companies such as Amazon and IBM are also re-evaluating their facial-recognition research projects due to concerns about human rights.

Face analysis is a particularly powerful, and sometimes troubling, tool used by law enforcement to make their jobs simpler. Facial analysis systems can be used for a variety of tasks, such as unlocking your iPhone, allowing someone into a building, assessing a person's sex or race, or see if their face matches a photograph. The issue is that facial recognition technology is flawed. While this doesn't matter hugely for a locked mobile phone, it is a significant problem when it is used to identify human suspects. For example, Amazon's face-ID technology, Rekognition, once mistakenly recognized female television star Oprah Winfrey as a man.

According to an MIT study of three commercial gender-recognition systems, dark-skinned women had inaccuracy rates of up to 34%, approximately 49 times higher than for white men. Another study found that African people had 100 times greater error rates than Eastern Europeans, who had the lowest rates. When this experiment was repeated using a US database, Native Americans, as well as Asian and black women, had the highest rates of algorithm inaccuracy.

The inaccuracy and bias in these systems are the result of the way they have been developed. Algorithms 'recognize' human faces after being shown millions of images. Unfortunately, if the faces used to train the algorithm are mostly white men, the system will have a harder time recognizing anyone who doesn't match that profile.

Algorithm bias can be eradicated with enough artificial intelligence training and exposure to a large, representative database of individuals. However, experts warn that even a system that identifies people with perfect precision can be hazardous. A system that can correctly identify any individual could mean the end of privacy for everyone. As a result, an increasing number of people are advocating for legislative restrictions on when and how such technology can be utilized.

www.cbsnews.com/news/facial-recognition-systems-racism-protests-police-bias

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Police and other authorities need to identify people accurately in a variety of situations. However, facial recognition technology has been found to be inaccurate and biased, especially for people of colour.

Examine the claim that the use of facial recognition technology will have an overall negative impact. In the response, discuss a real-world example. *[12 marks]*

ATL ACTIVITY

Research

Facial recognition technology has been found to be inaccurate and biased, especially about people of colour.

- Research two solutions that would address the problem of racial bias in facial recognition. One should be technology-based and the other policy-based.
- Evaluate each solution.
- Draw conclusions and make a recommendation.

Ability, access and inclusion

How AI can influence accessibility

Many AI-powered technologies were developed with people with disabilities in mind, while others were created to improve digital inclusion in general. This includes:

- voice control software that converts speech to text or an action for people with physical impairments
- screen reader software, which converts text to speech for people with visual impairments
- automatic translation and caption content for people with hearing loss
- image-recognition software and 'alt text' for people who use screen readers
- summarizing articles for people with reading difficulties
- facial recognition software designed to help people who find it hard to manage passwords.

Website accessibility

Many content management systems are available to help build websites, and some have templates for creating accessible content and layouts. Features such as 'alt text' (alternative text that describes an image) can be provided for images so that people who use screen reader software can understand the message conveyed by the images on the page. This is especially important for informative images, such as infographics. When creating alt text, the text should contain the message you wish to convey through that image as well as any text included in the image.

Image auto-tagging using machine learning

This technology uses machine learning to recognize visual elements within images. It identifies patterns and checks them against a large database to make sense of what the image is. When the image is auto-tagged, screen reader software will be able to read 'alt text' to users.

Links

This content links to Sections 4.4B The human body and 4.7A Social components of identity.

Ways in which technology is making the world more accessible

Self-driving wheelchairs

With an ageing population worldwide – the number of people aged over 65 in the US is expected to increase from 48 million to 88 million by 2050, with many more people likely to face mobility challenges. One tech-enabled solution is self-driving wheelchairs, which use lidar sensors to build a map of the area where they are used and to avoid obstacles. They have been trialled at airports in Japan and in the US.

AI to help you 'see'

New apps are being developed to help people who are blind or visually impaired navigate the world around them. Google's Lookout app uses image recognition technology and machine learning to detect objects and people around it, and provides spoken cues to the user. It is only available on Pixel devices in the US currently but Google says it plans to roll it out more widely soon.

ATL ACTIVITY

Evaluate

Challenge: People with disabilities and elderly people are often discriminated against, both intentionally and unintentionally.

Intervention: A range of assistive digital technologies have been designed to help them to participate in society more fully.

Research, analyse and evaluate some of these assistive digital technologies, especially those that are present in your local area.

Tolerance for religions and cultural differences

Intolerance of different religions and cultures is present in all social media in every country in the world. Often this is expressed by internet 'trolls', individuals who intentionally antagonize and provoke others by posting offensive comments or other disruptive content online. These posts are often full of misinformation, distorted facts and stereotypes.

Laws are being proposed around the world to meet this challenge, and pressure is being put on digital communication and social media companies to take action themselves before being forced by governments.

ATL ACTIVITY

Research

Many studies have been made of the impact of trolls on individuals, businesses and organizations.

- Research detailed examples of the impact of trolls.
- Research different proposals from a range of countries to mitigate and reduce the impact of trolling.

ATL ACTIVITY

Thinking

Challenge: Some religious and cultural groups are not represented fully in popular culture, such as books, movies and digital games, or may only be included in a stereotypical way that perpetuates discrimination. The challenge is to design games and stories that do not rely on stereotypes, and that have storylines that do not discriminate or enhance discriminatory attitudes.

Evaluate the possibility of designing digital games to have a positive impact on this challenge.

ATL ACTIVITY

Thinking

Challenge: It can be difficult to find the true identity of individuals who post offensive material online, and even more so to take legal action against them. One intervention proposed is to force social media companies to ensure they know the authentic identity of each person using their platforms. Laws could then be enacted that allow people who have been targeted to access their identities.

Evaluate this intervention.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

■ Prescribed areas for inquiry: 5.2C Diversity and discrimination

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Gender equality	Fewer women are taking up ICT careers than men.	Policy of proactive hiring of women. Facilitating the study of ICT.
Racial and ethnic discrimination	Trolling of people from different racial and ethnic groups. Facial recognition technology is racially and ethnically biased, and can be used to control different groups.	Special apps and controlled areas in social media that are safe. Policies to control use of facial recognition technology. Improved facial recognition software.
Ability, access and inclusion	Help people with disabilities (focus on one disability only).	Use of assistive digital technologies for individuals. Use of digital technologies to work from home.
Tolerance for religions and cultural differences	Computer games are culturally and racially biased. The use of facial recognition software and other monitoring methods to control different groups.	Design games that are inclusive of different groups. Political action using social media to publicise the problems.

Activity: HL Extended Inquiry

Interventions address challenges through actions. In extended inquiries, you will work with interventions that involve digital technologies. To illustrate how an extended inquiry might be approached, review the following interventions and recommendations for the given real-world scenario.

After reviewing the interventions and recommendations below, investigate other possibilities.

- **Real-world example**: A top medical website is available in French only
- **Intervention**: Resolves
  Automated translation is available for the website.
- **Possible recommendation for future action**: Acceptability
  Evaluate translation software to see if it meets acceptable standards.

Activity: HL Extended Inquiry

Interventions address challenges through actions. In extended inquiries, you will work with interventions that involve digital technologies. To illustrate how an extended inquiry might be approached, review the following interventions and recommendations for the given real-world scenario.

After reviewing the interventions and recommendations below, investigate other possibilities.

- **Real-world example**: Representation of women in engineering programmes
- **Intervention**: Intercedes
  Universities create policies for gender equity in admissions.
- **Possible recommendation for future action**: Equity
  Monitor admission rates to ensure improvements in the representation of women.

Deeper thinking

Human rights in a digital age

The expansion of the digital communication infrastructure and the rapid adoption of digital technologies has resulted in a moment of profound societal transformation and disruption. Human rights protection in the twenty-first century will depend on our capacity to apply long-standing human rights principles to the digital realm.

Human rights are being exercised and violated in new ways all around the world because of digital technology. The internet has evolved into a critical tool for a variety of human rights and economic growth. On the other hand, new examples of how digital technologies are used to undermine human rights emerge every day, from governments banning Twitter and the electronic surveillance of citizens, to the right to be forgotten in Google searches in Europe, or forcing internet users to provide real names to service providers.

Our knowledge of how to defend and respect human rights is being severely challenged as our political, social and legal institutions have not kept up with this transformation. The human rights movement must adapt to the digital environment in which we now live. Data has become an inextricable aspect of our existence. Every encounter we have with technology, from using a debit card in a local store to liking a Facebook post, contributes to the near-infinite bank of data generated by and about us.

Digital technologies govern an entire process by which judgments about our lives are produced that can impact our freedom, our understanding of our place in society, and how others see us. They also have a significant impact on our human rights.

www.hrw.org/news/2014/12/23/human-rights-digital-age#

www.cam.ac.uk/cammagazine/humanrightsinadigitalage

ATL ACTIVITY

Social

The internet has become an indispensable tool for the realization of a range of human rights, but there are new examples of how digital technologies play a role in undermining human rights every day.

In small groups:

- Research the Universal Declaration of Human Rights.
- Select five 'rights' from the list.
- Each person in the group should choose a different technology, for example social media platforms, artificial intelligence and surveillance technologies.
- For your selected technology, research how the technology may have had a positive and/or negative impact on the 'rights' selected above at a global level.
- Share your findings with the group and discuss the short- and long-term implications on citizens.

Reflection

Now that you have read this chapter, reflect on these questions:

- Aside from facial recognition software, what other IT systems may have racial or gender biases?
- Aside from gender and racial inequalities, what other biases have evolved with the increase in the use of technology in our digital world?
- Should governments be allowed to create laws and policies surrounding new technologies that might impact our human rights?
- How has the digital divide impacted you locally, nationally and globally?

5.3 Sustainable development

UNDERSTANDINGS

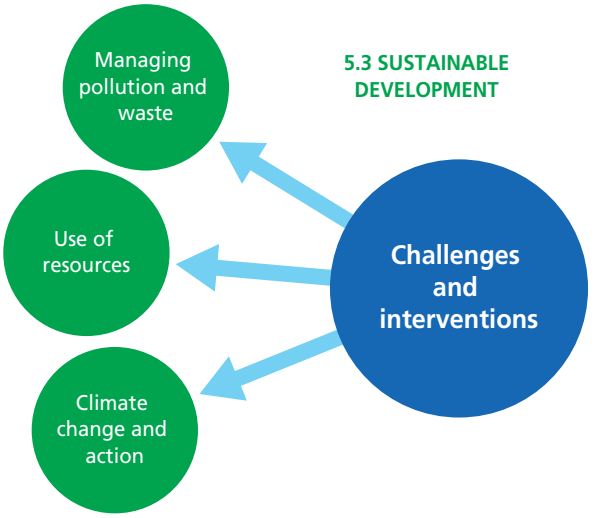
By the end of this chapter, you will understand:

- the meaning of sustainable development in a digital society
- how sustainable development is a significant challenge in our digital society
- how digital technologies can impact the challenges faced by climate change and action
- how digital technologies can be leveraged for pollution and waste management
- how digital technology-related interventions are being used to respond to this challenge.

◆ **Sustainable development**: The ability to meet human development goals without depleting the natural resources that we depend on.

What is sustainable development?

Sustainable development refers to our ability to meet our goals for human development without depleting the natural resources that we depend on. It is a key focus of the UN, and it presents a significant challenge in a digital society.



Digital technologies are critical to the advancement of human development and the creation of more inclusive societies. New technologies, such as the IoT, artificial intelligence and blockchain, are a powerful force for cultural and societal change, but they are also a means for achieving this in a sustainable way.

Historically, our essential individual and cultural needs – nutrition, mobility and buildings for shelter and survival – have been met at the expense of our planet. By harnessing new digital technologies, we can try to meet these requirements in a less destructive manner. We can also use them to avoid the overconsumption of natural resources, reduce pollution and increase equity between different stakeholders.

> *Leveraging the digital age to drive transformative systems change for a climate-safe, sustainable and equitable world.*
>
> *Éliane Ubalijoro, Sustainability in the Digital Age*

Digitalization itself isn't innately sustainable, however. Although it can be used to improve unsustainable systems, it also tends to speed up unsustainable ways of life. While digital technologies can help with everything from sustainable farming to ending poverty, they can also threaten our privacy and security. The digital divide also reinforces existing inequalities found both within and between countries.

ATL ACTIVITY

Research

Research the following questions and document the process used.

- Are digitalization and sustainability opposites?
- Can new technologies such as artificial intelligence contribute to making our lives more sustainable?

UN Sustainable Development Goals

The 17 Sustainable Development Goals of the UN are development strategies designed to address the global challenges we face – including climate change, responsible consumption and production, and environmental degradation – to achieve a better and more sustainable future.

The UN's Sustainable Development Goals

Many of the HL Extension topic areas connect to the Sustainable Development Goals as new technologies can be used to support and accelerate their achievement.

ATL ACTIVITY

Social

With another student, discuss how each of the UN's Sustainable Development Goals is impacted by digital technologies. Share your opinions with the rest of the class to see which line of argument is shared by the majority.

ATL ACTIVITY

Thinking

Give one example of how big data could be used to help achieve each of the UN's Sustainable Development Goals.

ATL ACTIVITY

Research

In groups, create posters or a group collage for the 17 Sustainable Development Goals showing how digital technologies impact each goal. You should address both positive and negative impacts, for example, how digital technologies can:

- drive progress towards achieving the goals
- minimize inequality by providing access to basic services (for example, e-health or online education)
- better connect citizens and improve stakeholder engagement and information management
- increase productivity, efficiency and cost savings
- reduce product waste
- analyse and track progress
- help minimize the impact on the environment
- achieve technological change, such as recycling, waste minimization, substitution of materials, change production processes, control pollution and ensure efficient usage of resources
- negatively contribute to the depletion of resources
- create unequal access to information and contribute to the widening gap between the rich and poor.

In this chapter, we will look at three main areas of inquiry for sustainable development:

- climate change and action
  - global efforts to address climate change
  - national, regional and local efforts to address climate change
- responsible use of resources
  - responsible consumption, production and distribution of products and services
  - designing for responsible use of shared infrastructures and resources, for example, energy, transportation and built spaces
- managing pollution and waste
  - pollution and waste monitoring
  - pollution and waste prevention
  - pollution and waste reduction.

5.3A Climate change and action

Climate change is one of the biggest challenges faced by society today. International treaties such as the 2015 Paris Agreement on climate change and the 2030 Agenda for Sustainable Development have set out the ways that countries can lower their carbon emissions, increase their resilience to the impacts of climate change, and increase their overall sustainability.

◆ **Climate change**: Long-term shifts in the global or regional climate, such as temperature and weather patterns.

Climate change has been accelerating since the Industrial Revolution. The increased use of fossil fuels such as oil and natural gas, combined with the destruction of ecosystems, has led to a net increase in greenhouse gases such as carbon dioxide in the atmosphere. This causes global warming and long-term changes in weather patterns. The effects include the melting of polar ice, rising sea levels and warming waters, and the resulting increase in extreme weather events such as droughts, flooding and hurricanes. It has also contributed to a rise in forest fires across the planet.

Global, national, regional and local efforts to address climate change

Dealing with climate change requires both the reduction of greenhouse gas emissions and interventions to deal with the unavoidable consequences. Advances in technology hold great promise for helping us to achieve these aims and we need to capitalize on these innovations to speed up climate action and ensure a secure future on our planet. Some examples of recent technologies that can be used to either combat climate change or reduce the impact of its effects include the following:

- Less expensive, cleaner energy from renewable resources such as solar, wind and tidal power – an ever-increasing number of organizations, including Google, Microsoft and Apple, and individuals, are transitioning to 100% clean energy.
- Consumers are moving to more sustainable transport methods such as electric vehicles, which are less expensive to operate, are more reliable, and produce less carbon dioxide.
- More data collection is improving our comprehension and models of climate change, giving us more substantial data to act upon.
- Researchers have better technology with which to investigate extreme weather events, make connections and future predictions and provide more direct support following a severe hurricane, for example.
- Social media can be used to encourage climate action and raise awareness of other sustainable development issues.

Some of these technologies have also contributed to environmental pollution, however, for example the mining of raw materials required for solar panels and batteries in electric vehicles. Other technologies have high energy demands, for example, data centres for cloud computing. The rapid development of new technologies has also contributed to an increase in the amount of electronic waste – currently in excess of 50 million tons every year.

ATL ACTIVITY

Research

Research how large amounts of data from monitoring the climate are being collected and processed by scientific and government organizations, both nationally and internationally by agencies such as the United Nations.

REAL-WORLD EXAMPLE

Data centres

Storing data in the cloud may seem simple and efficient but, in reality, this data is stored in enormous digital data centres that consume large amounts of energy. Now an indispensable part of modern computing infrastructures, the number of data centres are set to grow significantly as more and more organizations turn to them for cloud solutions and compliance assurances.

Even with the development of more sustainable energy solutions, the harsh reality is that both small and large data centres consume a lot of power – approximately 3% of all electricity used in the world.

Digital innovations to enable climate action: Blockchain technologies

Blockchain is an effective tool for tracking, reporting and increasing accountability for greenhouse gas emissions in supply chains. It helps organizations by providing carbon emission data that is more reliable and easily accessible. Blockchain technology can be used to track and report on carbon footprint reductions across the entire chain as well as provide real-time data verification, instant authentication and clear data records.

Blockchain enabled platforms have the potential to transform corporate efforts into a collaborative endeavour. They can bring together all stakeholders, including governments and non-profits, and identify specific stakeholders that have reduced their carbon impact.

The European Union (EU) plans to:

- foster the development of blockchain technologies to incentivize stakeholders to decrease their carbon footprint and think about the societal impact of their actions
- establish technical support and investment initiatives to enable blockchain-based digital technologies that help mitigate and adapt to climate change
- develop blockchain-based solutions that create a network between suppliers and consumers, expanding beyond individuals to incorporate all stakeholders in society
- assist national government agencies in the development and adaptation of blockchain-based solutions that support climate action and greenhouse gas emissions reduction
- strengthen Europe's clean technology innovation ecosystem and boost clean technology start-ups with access to funding.

ATL ACTIVITY

Communication

Create an elevator pitch on how blockchain technologies can be used to reduce the impact of climate change by tracking and verifying emissions and other activities.

- Use effective research techniques to find information about how blockchain technologies are being used by different countries to reduce carbon emissions.
- Select one of these and summarize the information.
- Rephrase your findings so that they can be presented in less than a minute.
- Practice, and then record your oral presentation.

Links

This content links to the discussion on carbon footprints in Sections 3.6E AI dilemmas and 4.3B Pollution and waste.

REAL-WORLD EXAMPLE

Drones used to help replant forests

Following intense forest fires in California, some companies are using drones to scatter seeds to help restore the damaged areas. Drones are useful as they can reach areas that might otherwise be inaccessible or dangerous, as burned areas are susceptible to erosion and mudslides. This intervention has not been completely successful, however, as one study found that less than 20% of the seeds actually took root and grew into trees. The majority of the seeds are wasted and forestry officials are concerned this will lead to a shortage of seeds.

www.wired.com/story/drones-replant-forests-seeds-take-root

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Digital innovations are advancing the monitoring of climate throughout the world. Using a real-world example, discuss the impact of this type of digital innovation in helping to address climate change. *[12 marks]*

ATL ACTIVITY

Research

- **Challenge**: Optimize home energy use.
- **Intervention 1**: The use of home energy monitoring apps that display usage (time and amount); homeowners can use this data to change their energy usage.
- **Intervention 2**: The use of smart appliances and a smart controller that automates the control of energy, so that the least amount is used.

Using interviews, surveys or questionnaires, research the effectiveness of these two simple interventions in a range of households, offices and factories.

Weather forecasting to optimize renewable energy

The amount of renewable energy that can be generated by wind turbines and solar systems depends on the weather, and can be subject to wide variations. This is obviously a disadvantage in terms of being able to generate sufficient energy, especially for companies that are selling this energy to the network, where higher prices are paid for more predictable supplies.

Accurate weather forecasts are key to being able to predict the amount of energy that renewable systems are able to produce in advance. This is where machine learning comes in, as machine learning-based models are able to provide greater precision when predicting wind speeds compared to conventional models. It has helped to increase the competitiveness of the renewable energy sector, and can also be used when planning the location of new wind turbines or solar arrays.

Machine learning has enormous potential and can be applied to other areas to help slow down climate change and reduce the consumption of non-renewable resources.

Activity: HL Extended Inquiry

Evaluate

Evaluate the impacts, implications and interventions.

- Have you evaluated the extent of the impacts and implications?
- Have you highlighted the most important impacts and implications that need to be addressed by the interventions?
- Have you evaluated the interventions using the six intervention criteria?

Recommend

Make recommendations.

- Have you recommended changes and additions to the interventions?
- Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

■ Prescribed areas for inquiry: 5.3A Climate change and action

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Global efforts to address climate change	The challenge of climate change, its impacts and implications are being recognised throughout the world.	A range of climate models have been developed and refined; they are being used to predict the future climate. The predictions are being used by governments, companies and institutions to make policies to lessen the impact of climate change, and to manage the effects of climate change.
National, regional and local efforts to address climate change	The challenge of climate change at the national level and below is a matter of local action. Before action can be taken, however, data and information are needed – data about the actual climate and its impact on the natural and human world.	The IoT and other digital technologies are being used to collect and process data so that action can be taken, especially for local challenges. A range of local and regional interventions can be applied, for example the distribution and use of energy and water in homes and offices, food production and supply chains.

5.3B Responsible use of resources

This section considers the responsible consumption, production and distribution of products and services, as well as designing for the responsible use of shared infrastructures and resources, for example, energy, transportation and built spaces.

Responsible consumption, production and distribution of products and services

The United Nations Sustainable Development Goal 12 focuses on the responsible consumption and production of goods and services. This includes the distribution as well. While consumption and production are one of the driving forces for the global economy, the use of resources is having a destructive impact on our planet. So much so, to improve sustainability, societies need to increase the efficiency of using resources and promote more sustainable lifestyles.

Consequently, focus has been placed on three main resources – water, energy, and food.

Water

Although water is a free commodity, only 3% of the world's water is drinkable, the infrastructure needed to deliver water is expensive and production often pollutes our rivers and lakes, while agriculture requires much water for successful crops and livestock. Chapter 4.3 Environmental and the next topic covers pollution and waste management in more detail, which is key to reducing pollution to water supplies as a result of manufacturing and human activities.

Energy

Households consume 29% of global energy while at the same time contributing 21% of CO_2 emissions, and further use of energy efficient technologies could make significant financial savings worldwide. Digital technologies are necessary to help reduce carbon emissions, yet, computer systems themselves have an immense energy requirement for their countless devices, data centres, applications and global networks. IoT devices and IoT smart city initiatives are examples of technologies aimed at reducing energy consumption.

Food

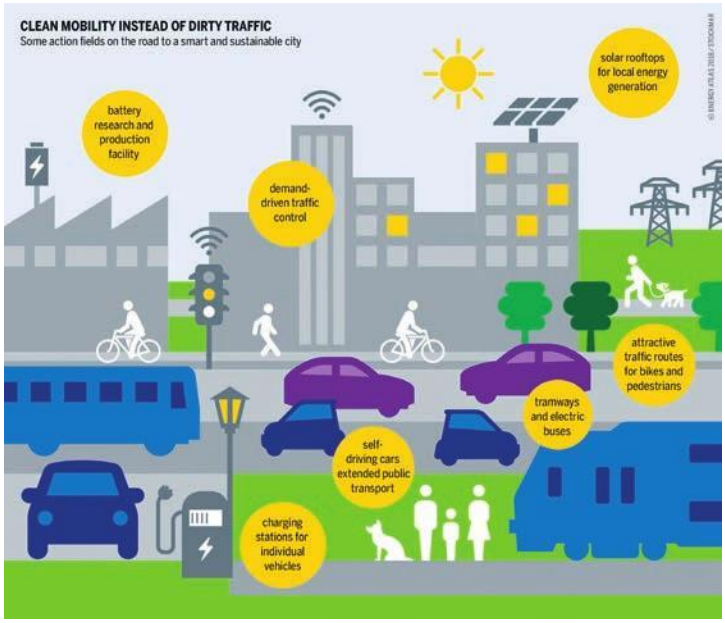
It is estimated that one-third of food produced is thrown away by consumers or retailers; or has been spoiled during transportation or at the time of harvesting. In addition to these figures, overfishing and degrading quality of soil has lessened the ability of our natural resources to provide enough food. Earlier on in this section, we addressed the access to safe and sufficient food. In addition to this, digital technologies such as the use of digital platforms to help connect suppliers with a surplus of food with manufacturers who can use it, can further reduce the amount of food wasted.
See **https://www.un.org/sustainabledevelopment/sustainable-consumption-production/**

Technology can help address many of these issues through looking across supply chains and what happens to products during and after consumption. Chapter 4.2 covered many technologies aimed at increasing efficiency during the production of goods and services as well as the use of smart technologies.

Sustainable transport

When evaluating the sustainability of different methods of transport, we need to consider its social, environmental and climate impacts. This includes the infrastructure that each method of transport requires, for example roads, water or air, and their sources of energy.

Fuel-efficient electric vehicles have become mainstream in recent years, but the next step may be driverless cars and trucks. They are more efficient than cars driven by humans as they are inherently 'smart'. However, they are expensive and resource hungry – more mining is needed for the raw materials required to make them, and the amount of data processing requires more energy hungry data centres.



ATL ACTIVITY

Research

The estimated carbon footprint of the average laptop computer is around 420 kg of greenhouse gases. This includes the carbon emissions during its production and transportation, and the first four years of its use.

- Research the carbon footprint of all of the components in a laptop, as well as their production process and distribution.
- Research ways that this could be reduced and create a proposal.
- Discuss your proposal with your peers and evaluate its effectiveness.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Discuss the claim that driverless cars will reduce our carbon footprint. In your response, refer to a real-world example. *[12 marks]*

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Ride sharing apps can now be used to 'carpool' (share a vehicle between a number of individuals) to travel to work. This reduces the number of cars on the road and saves resources. Discuss the use of ride sharing apps for this purpose using a real-world example. *[12 marks]*

ATL ACTIVITY

Research

How are companies addressing environmental factors and sustainability when designing data centres?

ATL ACTIVITY

Research

Challenge: The world relies on the global distribution of oil and natural gas, which are delivered by sea and land. Digital technologies are used to determine the most efficient route to reduce the carbon emissions of the ships and trucks.

Research how this is done.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

■ Prescribed areas for inquiry: 5.3B Responsible use of resources

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Responsible consumption, production and distribution of products and services	The challenge of connecting farmers to buyers, especially for small farmers, is complex. This challenge needs to be met to ensure the most effective and efficient use of farm products. The challenge of informing and educating people and communities about the responsible use of resources, especially through education about managing pollution and waste.	The use of virtual farmers markets and smartphone apps where farmers and suppliers add information about what they are selling and what they want to buy. Price and delivery negotiations are facilitated, and a payment system ensures the transactions are safe. Smaller-scale farmers, especially those selling special products such as organically certified produce, can join together to enable people to buy directly from the farms using a website. The fresh produce is delivered locally. A local education and information campaign that uses digital technologies, such as social media. An app that can provide instant information about how to dispose of waste at home responsibly. A game about managing waste for children to learn about how to handle waste responsibly.
Designing for responsible use of shared infrastructures and resources, for example, energy, transportation and built spaces	The challenge of managing water and electricity supplies is a complex task. Transportation in large cities is often slow and consumes a lot of resources.	The use of artificial intelligence to collect data about the water and electricity networks to predict where problems may arise and to manage repairs. Data scientists can use software to analyse the data from previous repairs and the current state of the networks. The creation of new smart cities. The modification of older cities with smart technologies.

5.3C Managing pollution and waste

Environmental sustainability refers to the responsible use of natural resources so that future generations are not jeopardized. A big part of this involves the management of pollution and waste through monitoring, prevention and reduction.

The digital transformation of environmental sustainability, through technologies such as artificial intelligence, big data analytics, cloud computing, and the IoT, focuses on four key areas: pollution control, waste management, sustainable production, and urban sustainability.

Companies and organizations are using new digital products and platforms to reduce their carbon emissions, minimize waste and to ensure that their business practices are sustainable. Big data is also changing the way that we measure our impact on the environment. It can be used to enhance food traceability, improve production processes and to certify the environmental performance of goods (that is, their carbon footprint). Blockchain technology also has a lot of potential to reduce carbon emissions, maximize resource usage, extend product life cycles and increase sustainability.

Pollution and waste monitoring and prevention

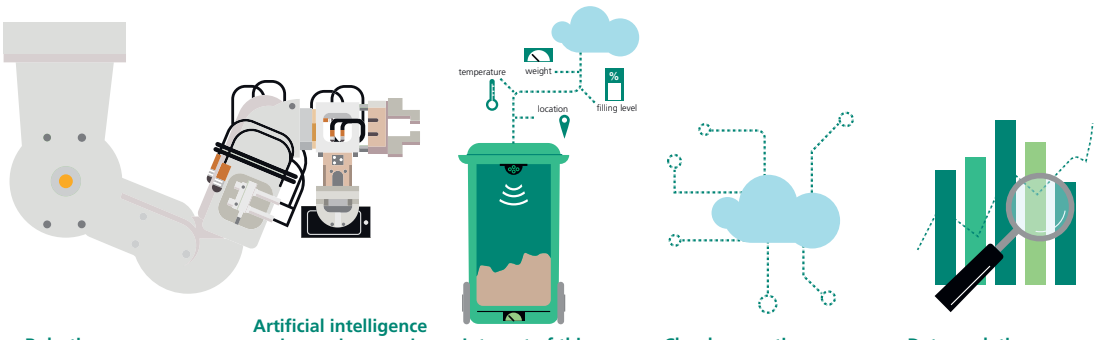
Waste management will be more efficient as a result of digital technology. The twenty-first century is being transformed by digitalization, which is impacting every aspect of society, including environmental technology. It will help us to recover more of the valuable minerals found in waste streams, lowering the amount of raw materials being mined and avoiding the environmental and climate consequences that arise.

The European Environment Agency made the following observations in 2021:

- Technology will be essential to move from a system of waste management towards the management of sustainable materials. Digital technologies make it easier for companies to employ recycled materials, improve purchasing and sorting decisions by consumers, and boost trash source possibilities.
- The majority of advanced digitalization in waste management and treatment is still in the early stages of development. New business models are emerging, including waste-specific software, waste e-trading platforms and business analytics.
- Some digital technologies are already in use in the waste management process but the current situation in Europe is varied, with numerous technologies being used at different scales.
- The waste management sector's digital transformation needs to be coordinated with efforts to make use of digital technology in the development of a circular economy.

Digital technologies in waste management

The rise of digitalization technologies is mainly due to advances in increased processing power, miniaturization and lower costs. Improved digital technologies assist in waste management as well. Robotics, the internet of things (IoT), cloud computing, artificial intelligence and data analytics are examples of specific digital technologies that are being used and that are predicted to have a significant impact on the waste industry's efficiency in the future.



	Robotics	Artificial intelligence and neural networks	Internet of things	Cloud computing	Data analytics
PROCESS	Advancements in the pneumatic sorting process as a result of automation technology allow producing defined waste streams of high purity (over 90 %).	Machine learning — using neural networks based on the use of data or examples to solve problems without explicit programming — is used for classification and pattern recognition in the waste management context, improving the efficiency of sorting.	As more and more devices are connected to the internet or other networks, sensor-supported containers can collect data and transfer it to central units.	Storing and processing of sensor data and cloud based software solutions make it easy to optimise workflows and document failure to collect, failure in sorting or detect waste bins that are not paid for.	Processing and analysing data plays an important role in the recycling industry in order to identify patterns, extract information, discover trends or calibrate models. This knowledge is important in order to evaluate different options for the transition to a recycling economy.
EXAMPLES	- Robots that are able to identify and sort recyclables and critical materials through image recognition/IR scanning/ AI vision systems when dismantling used phones/electronics	- Autonomous, self-driving street sweepers, refuse trucks	- Smart waste bins with identification systems, weighing systems, level sensors, temperature sensors, sofware for optimising logistics	Cloud based software for: - Connection, standardising and optimising internal procedures - Real-time order management, route planning and optimisation, customer self-service, order-tracking and evaluation	- Electronically supported diposition of waste collection vehicles - Evaluation of sensor data for automated sorting plants - Control of waste incineration plants - Drone based data collection on landfills

Use of digital technologies in waste management

Links

This content links to Section 4.3B Pollution and waste.

Improving waste management logistics

Digital technology is being used increasingly in almost every aspect of waste collection and processing. Advances in digitalization have revolutionized certain parts of the logistics, which includes the process of planning, scheduling and dispatching tasks, employees and vehicles. Algorithms can use optimization to identify the best solutions for allocating resources such as people and cars. Telematics, such as GPS systems that use navigation and vehicle tracking software, and enterprise resource planning (ERP) systems, are important examples.

The most obvious outcome of the enhancements is increased efficiency. Waste collection methods can also be better aligned with the objectives of a circular economy. For example, it must be able to respond to shifting waste trends and targets quickly, as well as make on-demand and customized services more accessible.

Incentivizing green behaviour

Digitalisation also allows for the creation of advanced waste management schemes that employ radio-frequency identification (RFID) to track household waste. The waste is tracked by a chip and, once the quantity and quality of separation have been assessed, the information is sent back to the person who generated the waste. Personalized messaging, combined with waste prevention programmes, can help guide customers toward better waste management practices.

ATL ACTIVITY

Inquiry

- **Challenge**: Informing and educating people and communities about the responsible use of resources, especially through education about managing pollution and waste, can use digital technology.
- **Intervention 1**: An app that can provide instant information about how to dispose of waste responsibly at home.
- **Intervention 2**: A game about managing waste for children to learn about how to handle the waste responsibly.

Research and evaluate both interventions used to manage pollution and waste using the HL extended inquiry framework.

Make a recommendation for steps for future action.

REAL-WORLD EXAMPLE

Water monitoring

A number of alarming headlines seem to suggest that the management of wastewater in the UK is deteriorating. In fact, it may simply be a reflection of improvements in wastewater monitoring techniques and accessibility of data since automated monitoring of storm overflows were introduced.

For example, the number of stormwater overflows resulting in sewage spills appeared to rise by 37% by 2020. However, as the monitoring of storm overflows increased by 46%, the Environment Agency believes that the actual number of events remained steady.

Automated monitoring of wastewater collecting networks and storm overflows is giving us a cleared indication of the extent of the problem.

www.kando.eco/recycling-water-has-to-become-the-norm-because-it-is-too-scarce-and-too-valuable-to-waste-3

Pollution and waste reduction

Air, water, soil and workplace pollution are all major concerns. The UN Sustainable Development Goals have a major emphasis on decreasing pollution, with the aim of substantially reducing the number of deaths and diseases caused by hazardous chemicals, air, water and soil pollution and contamination by 2030.

To achieve long-term global development, considerable action must be taken to limit pollution. Traditional pollutants such as residential air pollution and contaminated water supplies are steadily being reduced. For example, the use of more advanced home appliances and energy sources have reduced air contamination in the home, and access to more advanced sterilization facilities have reduced exposure to water-borne micro-organisms. However, there is still much to be done, as traditional pollutants continue to kill over 4 million people each year.

Further technological advancements will be required to develop inexpensive sensors for critical pollutants and innovative platforms for data gathering, validation and analysis.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

1 Recycling facilities for old and/or broken digital devices, such as smartphones, games consoles, laptops and smart TVs, can now be found in most communities. The challenge is to recycle the components and materials effectively.

Using a real-life example, examine the effectiveness of the recycling of digital. *[12 marks]*

ATL ACTIVITY

Thinking

Challenge: Too many cars on the roads creating pollution can be addressed by the use of ride-sharing apps or local social media, so that people can share their cars when commuting to and from work.

Discuss possible interventions and recommendations for future action.

Activity: HL Extended Inquiry

Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications? • Have you highlighted the most important impacts and implications that need to be addressed by the interventions? • Have you evaluated the interventions using the six intervention criteria?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions? • Have you recommended other steps for future actions to address the challenge and its issues?

Below are possible challenges and interventions to show how an extended inquiry can be approached.

In each extended inquiry, several interventions should be considered.

1 Using the chart below, research and discuss at least one additional real-world intervention for each challenge.

2 Recommend steps for future actions.

- Prescribed areas for inquiry: 5.3C Managing pollution and waste

Supporting topic	Possible challenges – inquiries	Possible interventions – extended inquiries
Pollution and waste monitoring	Transportation in large cities often produces large amounts of pollution, chemicals, noise and visual impacts.	The IoT and other digital technologies are being used to collect and process data about chemical and noise pollution, leading to practical, social and political action.
Pollution and waste prevention	A large amount of food is wasted by homes, restaurants, farmers and other food suppliers.	Digital technology can be used to gauge the condition of fresh foods rather than rely on human monitoring. The system uses sensors that collect data on colour, odour, size, time, and so on, and uses food chemistry and artificial intelligence to create a digital picture of the food items being monitored. The data can accurately assess an item's freshness and condition. The intervention can use specialized monitoring equipment, hand-held devices and smartphone apps. The condition of the food can then be used to sell it faster, and customers can buy food approaching the end of its shelf-life at a discount.
Pollution and waste reduction	Managing e-waste is a major challenge with thousands of digital devices being discarded each year.	Three interventions are: • re-sale or gifting devices to needy people • processing the discarded digital devices to retrieve valuable components • requiring manufacturers to reprocess digital products when they are discarded.

Activity: HL Extended Inquiry

Interventions address challenges through actions. In extended inquiries, you will identify and evaluate interventions that relate to digital technologies. To illustrate how an extended inquiry might be approached, review the following interventions and recommendations for the given real-world scenario.

Goal 11 of the UN Sustainable Development Goals is to make cities and human settlements inclusive, safe, resilient and sustainable. Its targets include the promotion of resilience to disasters such as earthquakes.

After reviewing the outline for an intervention below, investigate and evaluate specific real-world examples of how digital technologies have been used as interventions for the challenge of detecting of earthquakes.

- **Real-world example**: Earthquake detection
- **Intervention**: Mitigates
  Specific digital technologies can be used to detect hidden microquakes.
- **Possible recommendation for future action**: Innovation
  Algorithms can be used to detect hidden microquakes within seismic data.
- **Possible recommendation for future action**: Feasibility
  Determine the accuracy of the data and to what extent it effectively detects earthquakes.

Reflection

Now that you have read this chapter, reflect on these questions:

- To what extent can artificial intelligence help to monitor waste management?
- What digital technologies can be used to improve environmental sustainability?
- How can machine learning be used to forecast the energy production of solar power arrays?
- How can you lower your carbon footprint?

Section 6

HL extended inquiry

6.0 Overview of HL extended inquiry for interventions

UNDERSTANDINGS

By the end of this chapter, you should be able to:

- learn about a range of interventions associated with a variety of challenges and how you can select appropriate ones to evaluate
- know how to conduct HL extended inquiries into interventions that address specific challenges
- know how to evaluate interventions using the criteria in the study guide
- know how to formulate and recommend steps for future action that will be assessed in HL Paper 3.

The focus of this section is the interventions that address specific challenges in the HL extension topics. As part of the HL course, you will be required to evaluate interventions and recommend steps for future action that will be assessed on HL Paper 3.

This section directly follows from Section 5 HL extension: Challenges and interventions, which focuses on the following topics for inquiry, and a range of interventions that will address the impacts and implications of the challenges in the topics:

5.1 Global well-being
- local and global inequalities
- changing populations
- the future of work

5.2 Governance and human rights
- conflict, peace and security
- participation and representation
- diversity and discrimination

5.3 Sustainable development
- climate change and action
- responsible use of resources
- managing pollution and waste.

HL interventions and extended inquiry

You are expected to evaluate at least one intervention for each challenge sub-topic as practice before the HL pre-release is published, and also to prepare for HL Paper 1 Section B, where you will be asked to use knowledge of interventions that you have studied in your response.

An important part of each inquiry is to recommend steps for future action based on the outcome of your evaluation. This section will show you how to select and evaluate the nine required interventions.

When the pre-release for HL Paper 3 is published, you will be able to focus on the specified challenge sub-topic and the specified interventions.

The interventions may not completely solve the challenge(s) in the topics. They may need to be a combination of four main purposes

- to **mitigate** (reduce) the negative impacts
- to **intercede** (intervene) in an existing process to reduce negative impacts
- to **enhance** (improve) the positive impacts
- to **resolve** (eliminate) any negative impacts.

Outline of challenge topics and types of interventions for HL

Some specific digital interventions are outlined in Section 5 that you can use to conduct an extended inquiry. However, you are encouraged to identify additional ones to investigate that are local and relevant.

The suggestions that follow show you the types of interventions you can look for in your local community, or regionally or globally, that you can use as a starting point for your investigation.

Topic 1: Global well-being

Inequalities between people and in communities from a local to a global level, focusing on:

- economic differences that are being created and managed using digital interventions
- access to, and production of, sufficient nutritious food that is being enhanced using digital interventions
- access to medical care, including medicines, which is increasingly making use of many types of digital interventions.

The impact of changing populations on the well-being of people and communities:

- Population growth is putting pressure on well-being in many ways, and the impact of sustainable growth is being managed using digital interventions.
- Populations are aging in many places while others have a large proportion of young people, which can be managed using digital interventions.

The changing nature of work for people and communities:

- Employment is being impacted by automation and other uses of digital technology.
- Secure work that is significant and rewarding is being both enhanced and negatively impacted through the use of digital interventions.
- Suitable work for all in the community is being both enhanced and negatively impacted through the use of digital interventions.

Topic 2: Governance and human rights

There is the constant challenge for peace and security in the midst of many conflicts:

- The challenge of wars and conflicts in and between nations is being impacted by the use of digital interventions both positively and negatively.
- The desire for, and maintenance of, security is being enhanced by the use of digital interventions, but often with issues.

People and communities want to participate in and be represented by their local government:

- Communication of political ideas and activism of all types is being impacted by digital interventions, with a range of issues emerging as well.
- Governments at all levels are using digital interventions to communicate with people and communities, mostly positively.

People and communities want their human rights to be respected, an end to discrimination and an acceptance of diversity:

- Gender equality is being enhanced with the use of digital interventions.
- Digital interventions have sometimes increased the impact of racial and ethnic discrimination.
- Access and inclusion, especially with regard to people with disabilities, is being enhanced with the use of digital interventions.
- Tolerance for cultural and religious differences is being enhanced with digital interventions, but intolerance is also increasing.

Topic 3: Sustainable development

Climate change is having a significant impact on the sustainability of our current lifestyles and requires action:

- Global efforts to address climate change and increase awareness and action often use digital interventions.
- National, regional and local efforts to address climate change are also doing the same.

The sustainable and responsible uses of resources in many areas of the world are being challenged:

- Innovative production and distribution of products and services are being developed that impact the sustainability of resources positively.
- Innovative uses of resources in manufacturing are being developed.

Managing pollution and waste is an increasing challenge all over the globe:

- The monitoring of pollution and waste is being enhanced through the use of digital interventions.
- Improved waste management and reductions in the amount of waste being created have been made possible by the use of digital interventions.

6.1 Conducting an extended inquiry

How to approach the selection of an intervention

Once you have selected a challenge topic and an area of inquiry based on the list above, you need to research the specific contexts and interventions, then assess the interventions to see if they are suitable.

An important part of this selection process is narrowing down the specific challenge by looking at the technology that is addressing the challenge. You can then investigate the intervention in detail using the approach given in the example below.

Before you select an intervention, however, you need to consider the specific context, the digital technologies involved and the real impacts.

Possible types of digital technologies in the interventions

A major source of interventions is the development of new digital technologies. Many are associated with this list of technologies, which are often interconnected

- internet of things (IoT)
- artificial intelligence (AI)
- robotics
- distributed and cloud computing
- augmented/virtual/mixed/extended reality (AR, VR, MR, XR)
- networks and devices for accessing networks (for example, smartphones).

How to assess an intervention

Intervention proposals usually start out as general ideas that need to be researched to narrow them down into real-world examples, which address a real challenge, and specific digital technologies, which leads to a specific inquiry focus.

- The specific interventions could be digital technologies that are used by people and communities. A good idea is to find at least two digital technologies that can be compared and evaluated, as you may be required to do this in the HL Paper 3 examination.
- You can also look for different intervention policies about digital technologies and their uses in specific contexts that can be evaluated.
- The inquiry focus needs to be on a specific context with real people and actual communities.
- The positive and negative impacts of the interventions that arise as they address the challenge topic need to be fairly obvious at the start.
- The interventions do not need to be perfect, but they should clearly lead to recommendations and future actions to improve their effectiveness in addressing the specific inquiry focus.
- Make sure that you select an intervention that has a different purpose from the others you have investigated, to ensure the full range is covered.

The final consideration is to match the intervention evaluation criteria in the 'Evaluating interventions' table at the end of this section to your intervention to evaluate it.

How to conduct a HL extended inquiry

The HL extended inquiry model builds on the inquiry process in Section 1. You need to use this model to conduct your inquiry into the interventions. During the course you will select a challenge topic, area of inquiry and interventions to investigate under the guidance of your teacher. When the pre-release is published, you will apply this model to the specified challenge.

The HL extended inquiry model

Starting point	Select a challenge topic that has inspired you and that you would like to study further. • Pre-release will specify the challenge topic and prescribed area of inquiry.
Determine inquiry focus	Narrow down the topic by finding an issue you want to investigate. • Pre-release will specify issues, context(s) and a range of interventions to be evaluated.
Explore	Research and evaluate sources. • Have you explored the real-world example, challenges and the interventions in the pre-release? • Have you researched the interventions and any related digital technologies? • Have you considered the people and communities affected at various levels – individual, local, global? • Have you explored the impacts (actual) and implications (potential impacts) associated with the interventions?
Analyse	Analyse the impacts and interventions. • Have you used the concepts to analyse the interventions? Have you linked them to the impacts? • Have you explained the cause-and-effect relationship between digital technology and the impacts and interventions? • Have you explained how the interventions mitigate, enhance, resolve and/or intercede in the impacts?
Evaluate	Evaluate the impacts, implications and interventions. • Have you evaluated the extent of the impacts and implications for each intervention? • Have you evaluated the interventions using the six intervention criteria?
Reflect	Reflect on your findings. • Overall, to what extent is the focus being addressed successfully by the interventions? • Have you compared the effectiveness of the interventions in addressing the focus issues?
Recommend	Make recommendations. • Have you recommended changes and additions to the interventions to mitigate, enhance, resolve and/or intercede? • Have you recommended other steps for future actions to address the challenge and the related issues?
Communicate	Select how to share the results of your inquiry and structure your response. • Write a report using the style of questions in HL Paper 3 as a guide? • Make a presentation to your class? • Participate in a group discussion?

Most of this inquiry model will be familiar to you from your study of the core sections and the HL challenges, but there are two additional items that need to be studied in this model that are specific to extended inquiries into interventions:

1. The **four categories of intervention** (mitigate, intercede, enhance and resolve) identify what the intervention is trying to achieve and have been explained previously.
2. The **six intervention criteria** (equity, acceptability, cost, feasibility, innovation and ethics) are used to evaluate the interventions:

- the evaluations need to focus on **both the positive and negative impacts** and implications of the intervention, as many people's first reaction is to focus on the negative impacts and implications
- the evaluations, especially the negative ones, lead to **future steps and recommendations**; these must address the features of each criterion specifically in the context of the digital intervention
- many of these criteria overlap with each other and need to be considered at the same time.

■ Evaluating interventions: The six intervention criteria

Intervention criteria	Explanation of the criterion and examples
Equity	Does the digital intervention fairly and equally address the concerns, needs and requirements of specific people and communities impacted by the specific challenge? • Supplying laptops to disadvantaged students with restrictions on their use has impacts on them that are both positive and negative – students get the advantage of using the machines, but they may not be as good as those of other wealthier students. • The use of satellite-based internet connections by remote communities is increasing the ability of all people to participate in a digital society, but they can be expensive and not as effective as mobile or land connections. • The use of generic and universal social media platforms may not satisfy the needs and requirements of minority groups, forcing them to develop their own, at some expense and inconvenience.
Acceptability	Do people and communities impacted by the challenge find the digital intervention acceptable in terms of clearly specifying transparent responsibility and accountability? • The use of electronic voting machines and voting apps may not be acceptable to some due to accountability issues for problems that may arise, such as interference with the voting by hackers or a lack of transparency in the counting. • Electronic voting machines and voting apps can be acceptable to others who value the convenience of using them, such as quick results, no need to travel, and can vote any time. • The use of drones as a recreation toy may not be acceptable to people living near places where they are used due to privacy concerns.
Cost	What are the financial, social, cultural and environmental costs for people and communities associated with the digital intervention? Overall, do these costs outweigh the benefits of the intervention to the people and communities? • The use of facial-recognition software in shops, streets and communities has minor financial costs but can have significant social and cultural implications. • The environmental impacts of mobile phone towers can be too high for some people. • What are the hidden costs and benefits of the growth in online shopping for the various stakeholders – shop owners, shoppers and transportation workers?
Feasibility	Is the digital intervention technically, socially and politically able to be designed, implemented and used? What are the barriers to each of these? • Are laws and policies to enforce social media companies to control trolls and misinformation technically and politically feasible? • Can robotic soldiers be controlled effectively by their artificial intelligence software? • Is it feasible to have an effective digital technologies recycling programme?
Innovation	Is the digital intervention innovative in its approach? Is it some other type of changed intervention, for example, evolutionary or adaptive, transformational, or an extension or combination of earlier interventions? • The development of assistive technologies for people with disabilities and elderly people can be innovative, such as the use of robots, or evolutionary, such as voice-controlled wheelchairs. • The use of e-health is another version of the usual face-to-face consultation between doctor and patient. • Working from home using digital technologies is an adaptation of the office workplace to the home.
Ethics	Does the intervention produce any type of harm for people and communities? What is the nature and type of harm? How and who determines the importance of the digital intervention, especially compared to others' judgements about it? • The rights and wrongs of using smartphone apps installed on children's smartphones to track their movements. • Is the increasing use of digital communications to contact elderly people instead of physically visiting them ethical? • Does the gig economy, which facilitates flexible working hours, have hidden ethical issues associated with it?

6.2 Example of an extended inquiry for an intervention

- **An intervention in global well-being**: COVID-19 pandemic QR track and tracing app
- **Area for inquiry**: Local and global inequalities
- **Inquiry area focus**: Access to health care and medicine (supporting detail item)
- **Issue and context**: Meeting the challenge of the COVID-19 global pandemic

- **Negative and positive aspects of issue**: Every person and community, from small towns to nations, has needed to respond to the pandemic. Many people have been infected and some are dying; medical and hospital facilities have been swamped and cannot cope. Actions have been taken in the hope they can control and eventually stop the pandemic.
- **Interventions**: Some digital technology initiatives have been developed by government agencies to deal with the impact of the global pandemic, such as smartphone apps. Two types of apps have been designed and each has been partially successful:
  - **Track and trace apps**: Intended to track where people have been; if the virus was in that area, they can be contacted to be tested and then isolate so that they do not infect others.
  - **Vaccine passport apps**: Designed to show that a person has been fully vaccinated, or has had the virus, or has recently tested negative. They can be used as a form of entry ticket to participate in community activities, such as entertainment events, shopping and education, and to travel locally and internationally. They are intended to prevent people who could have the virus from spreading it to others present.

Top tips

The two interventions are similar and allow for direct comparison. This allows for depth in the responses to Paper 3, Question 4.

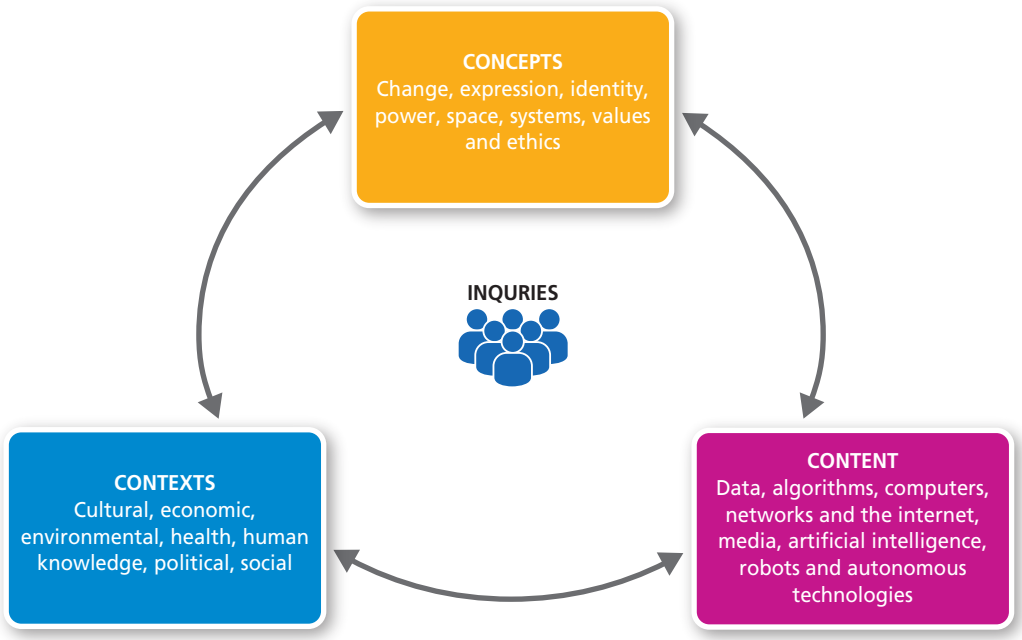
Detailed inquiry into a track and trace app that uses QR codes

Overview of the intervention

When you enter a building or location, you are required to scan a QR code with your smartphone camera, which opens up a link to a government website. The website is linked to a database that records the name of the premises or location, time of entry, and records your name and phone number. More than one person can be added to the list.

If a COVID-19 case is found to have been in the premises or location, the government can use the database to locate all people present at approximately the same time and contact them with details for further action, such as quarantine or isolation instructions.

Details of intervention – connecting the 3Cs



Concepts – application to the intervention

This part highlights the issues that can be found when the concepts are applied to the intervention. All of the concepts have been used in this example, but other interventions may leave some of them out because they are not relevant. The issues raised here can be used for evaluating the intervention with the specific evaluation criteria in the study guide.

- **Identity**: The issue is that a person's identity and private movement data is recorded – this needs to be investigated.
- **Power**: The issue is that this information can be used by people in power, such as police and health authorities, which can be beneficial but also has potential negative impacts as our privacy can be infringed – this needs to be investigated.
- **Values and ethics**: To what extent is the data protected by laws, regulations and policies? Why do people use, or not use, the app? Apply the three ethical frameworks:
  - Virtue: 'I want to be a good citizen and participate in society meaningfully as it combats the virus.'
  - Consequences: 'I want to ensure good consequences for myself and others once the virus is controlled.'
  - Principles: 'The app infringes my personal rights so I will not use it; everyone should look after themselves.'
  - Rules-based: 'I will use the app as I have a duty to be a responsible member of the community.'
- **Systems**: There are links between several systems, for example personal smartphones and government systems – this needs to be investigated.
- **Space**: Our experience of space is now different – it is linked to the possibility of surveillance, which needs to be investigated.
- **Change**: The app is an innovation that has been created for this purpose; it adapts current digital technology, which needs to be investigated.
- **Expression**: The data from the places checked into using the QR code can be put together as a record of your activities and displayed in a map; this not a major concept for this intervention.

Content – digital technologies used

The content should be connected to the content topics specified in the *Digital Society Guide*; for example, this content is in Chapter 3.4. It is advisable to refer back to the content topics for help in understanding the digital technologies used in the intervention.

- Smartphone and camera – to scan an image of the QR code.
- App software – app to convert the image of the QR code to the identification number and location of the business, and to display them on a screen along with your name, phone number and the time of scanning. Once the information is checked (and modified, if necessary), the screen confirm button can be pressed and the information is sent to a government website where the data is stored in a database.
- Government database software – if the government contact tracers learn that a person infected with COVID-19 visited the same place, the software will retrieve the contact details of all the people who visited around that time. These people will be contacted automatically by text message with instructions to isolate and take a COVID-19 test. During the next days, and weeks, there would be further contact between the government and the people affected, for example, to learn the names of others who were with them or the names of people living with them, so that they can also be contacted if the person contacted using the QR information is found to be infected.

Contexts – in the real world

People and communities, stakeholders, local/regional/national level scope:

- At local community level, connected to the regional level.
- Individuals who visit a premises or location, other people present, the owners/managers of the business/site and people working at the location.
- Other stakeholders: government, health authorities, developers of the app.

Analysis of the intervention

The use of the intervention has impacts and implications for people and communities.

Positive impacts and implications

- The app facilities the tracking and tracing of potential COVID-19 infections to enable the isolation of potential and actual infected persons.
- The use of the data is quick and easy. Modern database software can process the individual data, and also look for patterns in the data that are useful to medical and government authorities to prevent and control COVID-19 infections.
- The data includes information that can be linked and used with other software, especially communications/messaging software, to facilitate the control and prevention of COVID-19 infections.
- The data includes phone numbers, which can be used to access movement and contact information from telecommunications companies to highlight areas where the infected person has been and to warn others of this danger.
- The purpose of the data is restricted to a single use, so monitoring of the use of the data is not hard to do.
- Track and trace enables restrictions due to the presence of infections to be localised and controlled, which lessens their impact on people and the economy.
- Timely information through quick contact of potentially infected people will facilitate decision-making by health and government authorities.

Negative impacts and implications

- Possible access to private movement information by police and other authorities.
- The use of the data by government/medical authorities without their knowledge has an impact on people's privacy.
- Time and place data can allow authorities to target the movements of people in a location, for example making the use of local CCTV recordings easier, which has implications for the privacy of a person's activities.
- The laws and regulations regarding the use of the data are not clear as the situation is new.
- Permission to use the data is implicit in the download of the app and the use of the QR code – explicit permission is not usually sought from the person using the QR code.
- It is not clear exactly how the data will be used, who will be using it, when it will be deleted and how secure the storage is.
- People will be wary of using the app at certain locations, which impacts the quality of the data and means that infection tracing is compromised.
- People can be made to download the app, and penalised if they do not, which is an invasion of our freedom.
- People may feel that their privacy and personal rights are being infringed and will not use the app, which means that COVID-19 infections will be harder to control.

Connections between impacts and implications

- The main connection is that the benefits of the app will enable tracking of people who may have come into contact with a person carrying the virus (who may not be visibly sick). This benefit comes at a potential cost, however, as the same data can be used for other purposes around which there are issues.
- Another type of connection that needs to be analysed is which of the impacts are the worst and which are the most important. This can be done by ranking the impacts.
- Another type of connection that needs to be analysed is the extent of the impacts, for example the length of time the impacts have effect, the severity of the impacts on people and communities, the number and range of people impacted, and the location of the impact (local, regional, national, global).

Conclusion

The in-depth analysis above forms part of the ideas that need to be considered when making an overall evaluation of the impacts and implications of the intervention. and the extent to which it is effective in addressing the challenge. It also forms the basis for the recommendations for future steps that are needed.

ATL ACTIVITY

Thinking

Use the bullet points above to write a conclusion. It should consider the positive and negative impacts to come to an overall conclusion about the impact of the intervention on people and communities. Overall, were the impacts positive or negative?

Provide a justification that specifically highlights one or more impacts as being the best and worst, and explain why the overall impact is negative or positive. You can also highlight what needs to be improved. This provides ideas for the recommendations.

Type of intervention

These categories can be used to identify and explain what the intervention is trying to achieve and how it will impact the challenge in various ways. In this case, all of them can be considered to develop a deeper understanding of the intervention.

- **Mitigate**: The use of the data from the app mitigates the challenge of the spread of the virus and its impact on communities. It enables infections to be tracked and controlled, lessening the spread of infections.
- **Intercede**: This app intercedes in the processes to control the spread of the virus by adding an extra method for tracking and tracing infected people, which has positive and negative implications and impacts.
- **Enhance**: This app enhances the tracking of potentially infected people so they can be instructed to isolate and get tested. It makes tracking more efficient as it is fast, cheap and requires little effort by users and trackers. It makes tracking more effective as information about the movements of infected people is timely, specific to the task, detailed and accurate. However, these benefits also enhance some of the negative impacts, especially around privacy and the improper use of the data.
- **Resolve**: This app resolves the issue of tracking of people with the virus or who may potentially have it, which was very difficult due to the lack of data that was timely, specific to the task, detailed and accurate.

Evaluation criteria

The following criteria are used to evaluate the intervention (some will be more useful than others).

Equity

The app is not equitable:

- It can be seen as being an invasion of privacy, so there may be power and ethical issues.
- It requires the use of a smartphone, which some may not have or may have difficulty using.

The app is equitable:

- It is the same for everyone and is easy to use, which all contributes to the fight against the virus.

Acceptability

The app is not acceptable:

- The inconvenience of using the app at each location means that some people will not use it.
- It is not clear who is accountable for issues with the privacy of the data.
- It is not clear how the privacy issues are being handled.
- Fears over the use of the data mean that some people will not use it.
- The transparency of the use of the data is not clear.
- Some minority groups are sensitive to being monitored and will react against the app.
- There is some fear over the future use of the app, especially if it becomes spyware by being hacked or modified without people knowing.

The app is acceptable:

- It is a small inconvenience for people to use to help stop the spread of the virus.

Cost

The app is costly:

- It forces people to buy a smartphone if they do not have one.
- Learning how to use the app may be an issue for certain people.
- Some individuals will have less trust in the authorities due to privacy and cultural considerations.

The app is not costly:

- The financial cost is low for the individual as the app is free.
- It builds a sense of community responsibility and participation, which is valuable.
- The environmental costs are very small as it is a digital resource.

Feasibility

The app is feasible:

- It is technically easy to develop and distribute.
- It is generally socially acceptable, given the need to stop the virus.
- It is generally politically acceptable, as the small political cost is limited to minorities.
- The barriers to use are limited to minorities.

Innovation

The app is innovative:

- It is innovative as this amount of tracking has not been attempted before.
- It is innovative as it is asking people permission to be tracked, whereas systems such as CCTV and facial recognition software do not ask permission.
- The app has potential for incremental change: it can evolve for a different use, such as tracking people's activities.
- Adaptive change of the technology to new circumstances is also possible.
- The app has potential for radical change as it opens up the tracking of movement in a more extended and public way. It is potentially transformational as people become used to being tracked and having less privacy.
- The app also has potential for radical change if the use of tracking is extended to other crises and uses, for example tracking who leaves and enters apartment buildings (normally a private matter) could now be linked to public safety.

Ethics

Considerations about the use and implications of being right or wrong include:

- consequential ethical considerations
  - it is good for overall public health as it combats the impacts of the virus
  - it has potential negative impacts on our privacy
- rule-based ethical considerations
  - impacts on the right to privacy
  - impacts on the right to free decision-making
  - it is a rule from the health authorities and the app must be used
- virtue-based ethical considerations
  - being a good citizen to help society, which means it should be used
  - people who do not use the app might be labelled as not being 'good citizens' and could be reported to authorities.

Reflection on the overall success and effectiveness of the intervention

Overall, the app has been successful in helping to combat the spread and impact of COVID-19. There are concerns and issues that need to be addressed, however, especially those held by various minority groups in society, about privacy and human rights. The long-term implications also need to be addressed, as the app opens up new ways of tracking people, and the accountability and responsibility for the app, especially for the future, is not clear. The practical success of the app and the future development and use of such apps needs to be considered.

Recommended step(s) for future action based on the evaluation criteria

Overall, most of the negative evaluations can be partially mitigated and the positives enhanced using the following steps. They will intercede in the current use of the app and hopefully resolve the main privacy issues.

- The first is to work with community leaders and other important and influential people, asking them to talk to people in the community with concerns and to attempt to mitigate or even resolve the issues. These leaders can also be used in advertising campaigns using news and social media.
- The second is the improvement of the rules and regulations concerning the storage and use of the data collected. These need to be reviewed by a government-appointed privacy commissioner, who will make recommendations. Ideally this would be an independent commissioner with the power to implement regulations and to hold people accountable if privacy issues are found.
- The third recommendation is to have other track and trace methods available, such as paper-and-pen registration at shops and venues, for those without smartphones.
- The long-term impacts of apps such as this one are connected to the larger issues around privacy in a digital society and need a high-level governmental and political response.

Top tips

The recommended steps for future action should be realistic and avoid being speculative. The needs of the specified stakeholders must be considered, and the recommended steps need to be connected to the operation and use of the app.

Activity: HL Extended Inquiry

Carry out a similar intervention inquiry for a vaccine passport app – the other intervention mentioned as a response to the challenge of COVID-19 – that is used in your community or elsewhere.

Reflection

Now that you have read this chapter, reflect on these questions:

- Each digital device you use, and the software it has installed, is an intervention to a challenge that someone encountered. Reflect on the reasons why and how you use your digital devices. What challenges do each device and app help you to meet?
- Reflect on the type of interventions associated with each digital device. To what extent do the devices and apps mitigate, intercede, enhance and/or resolve the challenges?
- To what extent are the devices and apps you use successful and effective in meeting your challenges?
- What are some recommendations for improving each device and app?
- Remember that policies, regulations and laws – even though they are not digital technologies – can also be considered to be interventions. Select an app: are there any policies, regulations or laws that should be implemented when using the app? Be inventive and creative! Einstein said: 'Imagination is more important than knowledge.'
- Can you use the six intervention criteria to evaluate your possible intervention(s) for the digital device and app selected?

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Section 7

How to approach external assessments

7.0 Overview of external assessments

Introduction

At the end of the course there are two examinations for SL students and three examinations for HL students.

The subsequent chapters in this section will visit each of these exam papers.

■ Overview of digital society examinations for SL students

	Weighting	Duration	Total marks
SL Paper 1	40%	1 hour 30 minutes	40
SL/HL Paper 2	30%	1 hour 15 minutes	24

■ Overview of digital society examinations for HL students

	Weighting	Duration	Total marks
HL Paper 1	35%	2 hours 15 minutes	52
SL/HL Paper 2	HL 20%	1 hour 15 minutes	24
HL Paper 3	25%	1 hour 15 minutes	30

The information below applies to all examinations.

Before the examinations you must have:

- **Discussed** appropriate scenarios relating to digital society in class on a regular basis.
- **Understood** the meaning of the command terms found at the end of the *Digital Society Guide* and what kind of response is expected for each of them.
- **Planned** answers in class for questions that require extended responses, especially those that use the following command terms: 'discuss', 'evaluate' and 'to what extent'.
- **Practised** writing responses on SL/HL Paper 1 Section A for all parts (a, b and c) and the common SL/HL Paper 2 questions and received feedback from your teacher and other students. HL students should also practise answering HL Paper 1 Section B and HL Paper 3 questions.
- **Used** digital society terminology in responses (and avoided using words such as 'something', 'thing', 'stuff', and so on).

When reading a question in the examinations, it is important that you identify the

- **command term** used (and the kind of response and the depth required)
- **stakeholders** (and how they are involved in the scenario)
- **digital systems** and **digital society terminology** used in the specified scenario
- relevant **concepts** in the specified scenario.

ATL ACTIVITY

Thinking

A list of the command terms for this course is given below. You need to become familiar with these so that you can use them effectively in the examination.

Complete one of the following activities:

- Create a game to help you link these different terms to their definitions, for example a sorting and matching game.
- Create online flashcards for each of these terms.

Command terms for each assessment objective level

AO1	
Define	Give the precise meaning of a word, phrase, concept or physical quantity
Identify	Provide an answer from a number of possibilities
Describe	Give a detailed account
Outline	Give a brief account or summary
State	Give a specific name, value or other brief answer without explanation or calculation
AO2	
Analyse	Break down in order to bring out the essential elements or structure
Distinguish	Make clear the differences between two or more concepts or items
Explain	Give a detailed account including reasons or causes
Suggest	Propose a solution, hypothesis or other possible answer
AO3	
Compare	Give an account of the similarities between two (or more) items or situations, referring to both (all) of them throughout
Compare and contrast	Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout
Contrast	Give an account of the differences between two (or more) items or situations, referring to both (all) of them throughout
Discuss	Offer a considered and balanced review that includes a range of arguments, factors or hypotheses; opinions or conclusions should be presented clearly and supported by appropriate evidence
Examine	Consider an argument or concept in a way that uncovers the assumptions and interrelationships of the issue
Evaluate	Make an appraisal by weighing up the strengths and limitations
Justify	Give valid reasons or evidence to support an answer or conclusion
Recommend	Present an advisable course of action with appropriate supporting evidence/reason in relation to a given situation, problem or issue
To what extent	Consider the merits or otherwise of an argument or concept; opinions and conclusions should be presented clearly and supported with appropriate evidence and sound argument

Applying command terms

ATL ACTIVITY

Thinking

In this activity, we will use the example of cookies to demonstrate the different ways to answer questions using a variety of command terms.

- On your own, try to complete the same activity but with a different topic of your choice, for example, computer games.
- Compare your answers with other students' and your teacher's answers.

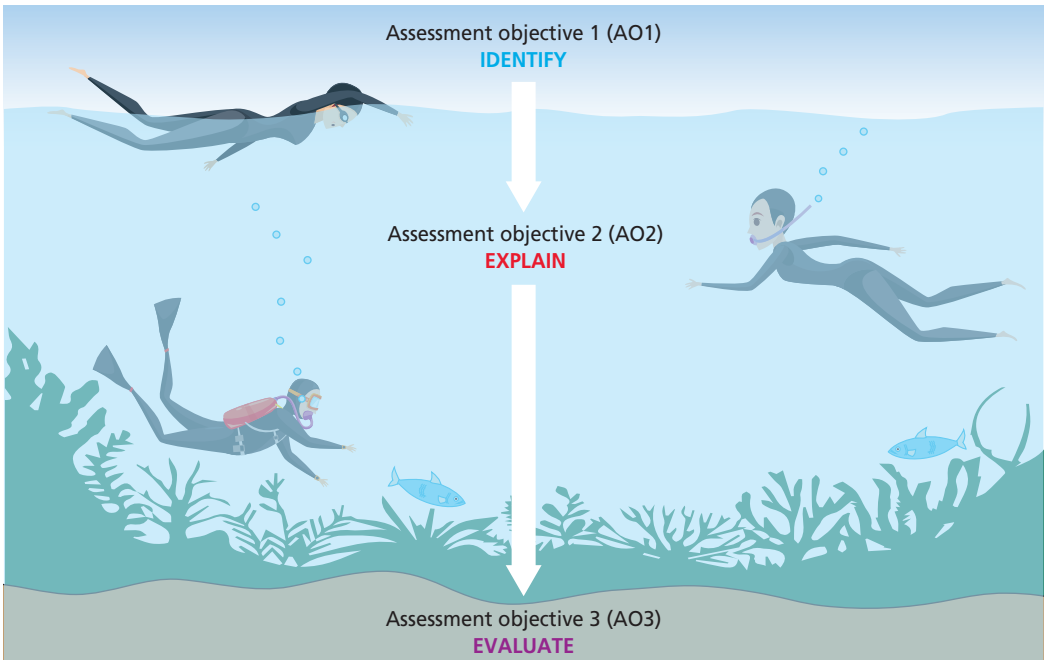
Command term	Sample question	Possible marks	Possible answers
Identify	Identify two types of cookies.	1–2 marks	Oatmeal, chocolate, chocolate chip, peanut butter, macadamia
Outline	Outline the reasons for baking cookies.	2 marks	Quick, therefore easy to bake. Small treat, therefore cheap to make.
Describe	Describe a chocolate chip cookie.	2–4 marks	A small cake, typically round and flat and with a crisp or chewy texture. Made from dough. Includes chocolate chips inside or on top of the cookie. Chocolate chips can range in size and amount of cocoa.
Explain	Explain one reason for eating cookies.	2–6 marks	Cookies have a sweet flavour and a texture that is soft but crunchy at the same time, making them a pleasure to eat.
Distinguish	Distinguish between chocolate chip cookies and oatmeal cookies.	2–4 marks	Chocolate chip cookies are sweeter than oatmeal cookies as they are made with chocolate chips instead of oats.
Analyse	Analyse the decision to bake chocolate chip cookies for a bake sale.	6 marks	Reasons for: • they are already in portion sizes • they keep fresh for longer compared to cakes • they are popular with students. Reasons against: • not everyone eats chocolate • some people have gluten allergies • individual wrappers add to the cost.
Compare	Compare how cookies are made by the top brands to those that are home-baked.	6 marks	An extended response could be based on the following points: • They both use the same base ingredients. • They both use machinery to make cookies, but on different scales. • They will both be packaged in an airtight container.
Contrast	Contrast how cookies are made by the top brands to those that are home-baked.	6 marks	An extended response could be based on the following points: • Cookies made by top brands may include more preservatives and will last longer, whereas home-baked cookies will not. • Home-baked cookies may be made by hand, whereas top-brand cookies will be mass produced.
Compare and contrast	Compare and contrast the role of cookies in Western and Asian diets.	6 marks	An extended response could be based on the following points: • Both could be considered part of a snack. • Both could be consumed with a hot drink. • The flour used may be different – Western brands tend to be wheat-based, whereas Asian brands may be rice or tapioca based. • Snacking on cookies at any time is acceptable in Western diets, but it may not be in Asian cultures.

Command term	Sample question	Possible marks	Possible answers
Discuss	Discuss the nutritional value of cookies as a snack.	8–12 marks	Include an opening paragraph in this response (see the PEEL template later in this chapter), followed by a paragraph that talks about the ingredients and their nutritional value. A third paragraph would discuss the ingredients that are negative for good nutrition. End with a paragraph that concludes what the overall nutritional value of the cookie is with your opinion.
Evaluate	A student purchased cookies for their recess break. Evaluate this decision.	8 marks	In the response, include an introductory paragraph about the choices available to a student at break. Follow this with a paragraph on the benefits/pros of buying a cookie at recess break. The third paragraph would be the drawbacks/cons of buying the cookie. The final paragraph should weigh up the pros and cons of the decision.
To what extent	Peanut butter cookies are one of the most-liked cookies at the ABC school cafeteria; however, many students have peanut allergies. To what extent should the ABC school ban peanut butter cookies?	8 marks	In this response, include a short introductory scene-setting paragraph. It should be followed by a paragraph of reasons to ban peanut butter cookies, then a paragraph to support peanut butter cookies. The final closing paragraph should then weigh up the decision to ban the cookies, supported by the arguments made.
Recommend	Recommend a solution, based on student, parent and school impacts, to address the issue of peanut and other allergies.	12 marks	Banning of foods that contain nuts and other allergens is not effective – as so many foods contain them, it would severely restrict the foods that are still allowed at the school. So, instead students and teachers need to be trained about the dangers and how to treat allergies. In this response, the recommendation would follow the student response to the `to what extent' command term in the box above. The 'recommend' question is 12 marks as it combines two responses.

Extended-response questions: Deep dive

Students often identify great ideas but then merely list them rather than providing the depth required in extended responses. It is important that you understand each of the command terms and the depth that is required for each response.

IB mark schemes provide examples of valid points or arguments, but each of these ideas require the answers to be developed fully, according to the command term specified.

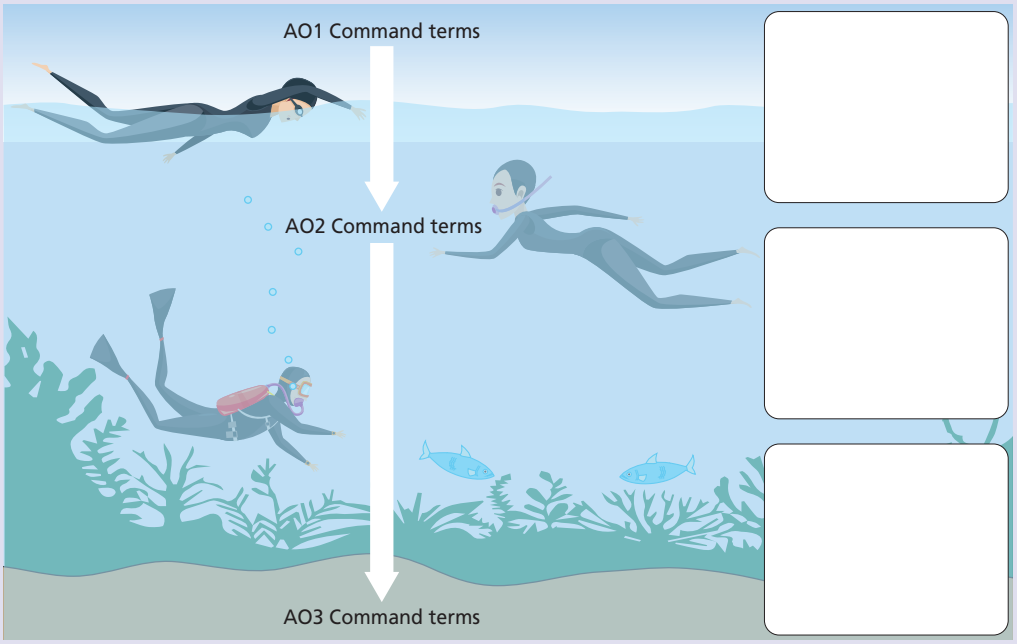


ATL ACTIVITY

Thinking

Look at the command terms given below and sort them into the different assessment objective levels on the diagram.

analyse compare compare and contrast contrast describe discuss distinguish evaluate explain identify justify outline recommend to what extent



Now, look closely look at the command terms for AO1, AO2, and AO3 to see how they build upon each other.

AO1

These terms focus on knowledge and understanding. For example, you may need to *describe* how the digital system functions, or *define* digital society terminology.

These questions use mark schemes with short answers that can be marked as correct or incorrect.

AO2

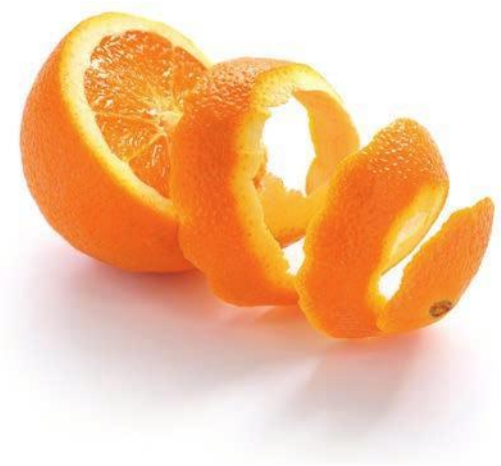
These questions require you to develop initial statements, either in the form of an analysis or an explanation. They either use mark schemes, with answers that can be marked as correct or incorrect, or markbands that describe the level of performance across the whole extended response answer. These are applied using a 'best-fit' approach, choosing the level that is most appropriate for the response even if it is not a perfect fit.

AO3

These questions require you to synthesise the comments made in the analysis so that conclusions can be drawn, opinions expressed and recommendations made. They use markbands only as they are extended-response questions.

Developing your response: Arguments and conclusions

Print and laminate this PEEL page and use it when practising examination-style questions as you work through the next chapters. The PEEL chart is very useful for constructing and developing paragraphs that include conclusions and your point of view.



P	E	E	L
POINT	**EVIDENCE**	**EXPLORATION**	**LINK**
Increasingly complex answer			
Start with a clear topic sentence. Your point should support your argument.	Add evidence or an example to reaffirm your initial point and develop the argument.	Explain *how* your evidence/ example supports your point. Give further information to support relevance.	Link the point to your topic sentence or to the point in the next paragraph.
First of all … We can argue that … On one hand … We can see that … Furthermore/Moreover …	For example … This is demonstrated by … Source A shows … This is supported by …	This means that … It can be argued that … This suggests that … This shows that …	Therefore, we can see … It is clear that … It is essential that …
Example: Facial recognition use in high schools to check attendance *We can argue that facial recognition has improved its reliability over recent years, reducing the false identification of individuals.*	**Example**: Facial recognition use in high schools to check attendance *As of April 2020, one of the best facial-identification algorithms has an error rate of just 0.08%.*	**Example**: Facial recognition use in high schools to check attendance *This means that matching subjects to clear images, such as school ID photos, can achieve almost perfect accuracy.*	**Example**: Facial recognition use in high schools to check attendance *Therefore, because of the high accuracy rates, we can see that the use of facial-recognition algorithms can play a larger role in identifying students' daily attendance in schools.*

ATL ACTIVITY

Communication

Practice using PEEL in your responses

- Revisit the cookie command term exercise on page 374–375. Use the PEEL worksheet to modify your responses to questions that require complex answers.
- Restructure your answers so that they follow PEEL. Include each letter in your response to clearly identify the different elements, for example: *'One reason for eating a cookie is that it is convenient (P) because cookies are already pre-cooked and packaged (E). At home, the cookie jar is always full and within reach on the table (E), which is why a cookie will always be the snack I go to first when I come home from school (L).'*

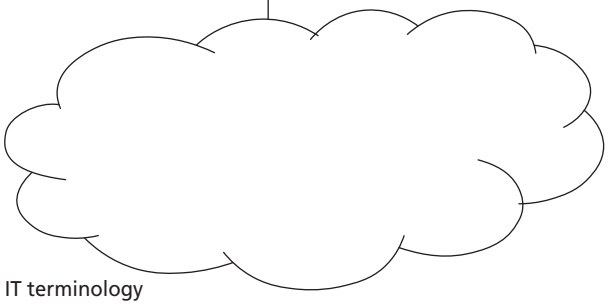
In the following chapters you will have further opportunities to use the command terms and develop your writing using PEEL as you practise the different types of examination papers.

Preparing for extended responses (AO3) in Papers 1, 2 and 3

Significant planning for an extended response is needed, so make use of additional paper provided to plan using a simple tool like this planning worksheet.

The 'cloud' question planning sheet

	+	−
Discuss	*	*
Examine		
Evaluate	*	*
Justify		
Recommend	*	*
To what extent		



IT terminology

Examples, Opinions/Conclusion:

Extended responses require you to consider multiple perspectives. You can use this planning worksheet to specify the following:

- the stakeholders
- the digital systems involved
- the advantages and disadvantages, associated costs and benefits or associated claims and counter-claims.

Remember:

- to increase the depth of your response, you need to provide reasons why each point is a positive or negative
- your analysis should be balanced
- your conclusion/recommendation must refer back to the comments in the analysis.

Digital society command terms – more information

Each exam paper uses command terms that indicate the kind of response and the depth required. It may be a short answer question (AO1) or an extended response question (AO3).

■ **Digital society command terms (2024 onwards)**

Digital society terminology is the terminology associated with the development, use and impact of digital technologies on individuals and societies.				Answer question Use digital society terminology Description Detail for command term	Answer question Use digital society terminology Description Detail for command term Use real-life examples Impacts and implications Balance (perspectives) Evidence from research Give conclusions/opinions
Answer question	Answer question Use digital society terminology Description Detail for command term	Answer question Use digital society terminology Description Detail for command term	Answer question Use digital society terminology Description Detail for command term Give positives and negatives	**AO3**	
AO1		**AO2**			
Identify: Provide an answer from a number of possibilities. **State**: Give a specific name, value or other brief answer without explanation or calculation. **Define**: Give the precise meaning of a word, phrase, concept or physical quantity.	**Describe**: Give a detailed account. **Outline**: Give a brief account or summary.	**Distinguish**: Make clear the differences between two or more concepts or items. **Explain**: Give a detailed account including reasons or causes.	**Analyse**: Break down in order to bring out the essential elements or structure. **Suggest**: Propose a solution, hypothesis or other possible answer.	**Compare**: Give an account of the similarities between two (or more) items or situations, referring to both (all) of them throughout. **Contrast**: Give an account of the differences between two (or more) items or situations, referring to both (all) of them throughout. **Compare and contrast**: Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.	**Discuss**: Offer a considered and balanced review that includes a range of arguments, factors or hypotheses; opinions or conclusions should be presented clearly and supported by appropriate evidence. **Evaluate**: Make an appraisal by weighing up the strengths and limitations. **Examine**: Consider an argument or concept in a way that uncovers the assumptions and interrelationships of the issue. **Justify**: Give valid reasons or evidence to support an answer or conclusion. **Recommend**: Present an advisable course of action with appropriate supporting evidence/reason in relation to a given situation, problem or issue. **To what extent**: Consider the merits or otherwise of an argument or concept; opinions and conclusions should be presented clearly and supported with appropriate evidence and sound argument.
1–2 marks		2–6 marks	4–6 marks	6–8 marks	8–12 marks

Reflection

Now that you have read this chapter, reflect on these questions:

- Do you know how to approach the different command terms in examination questions?
- Can you match the command terms with the different assessment objectives (AOs)?
- Do you know how to use PEEL in extended responses?

7.1 Approaches to Paper 1

UNDERSTANDINGS

By the end of the chapter, you will have:
- gained an understanding of how to prepare for Paper 1
- looked at sample Paper 1-style questions for both SL and HL, and how to approach them
- seen how the mark scheme is applied to a sample Paper 1-style question for both SL and HL.

Introduction

The main purpose of Paper 1 is to assess your ability to identify, analyse and discuss various scenarios using the concepts, content and contexts you have learned in the course.

- **SL Paper 1** questions will address common SL and HL syllabus and real-world examples.
- **HL Paper 1** questions will address common SL and HL syllabus and real-world examples, as well as the HL extension in Section B.

Overview of SL and HL Paper 1

	SL Paper 1	HL Paper 1
Weighting	40%	35%
Duration	1 hour 30 minutes	2 hours 15 minutes
Total marks	40	52
Paper details	Answer two of four questions Each question has three parts: **a** 6 marks **b** 6 marks **c** 8 marks	Two sections on the paper: • **Section A**: Answer two of four questions (these are the same questions as SL Paper 1), 40 marks • **Section B**: Answer one of two questions, 12 marks (not subdivided)

SL Paper 1 and HL Paper 1 Section A

You can practise Paper 1-style questions at any point in the course. When learning about the content of the course, you should explore new articles for possible scenarios. When you are studying a specific context, try more extended-response questions and make links to different concepts.

In both SL and HL, you will choose two of four questions. Each question has three parts: a, b and c. The style of these questions, sample responses and mark schemes are discussed here.

Part a: Knowledge and understanding questions (AO1)

AO1: Knowledge and understanding

Define Describe Identify Outline State

[2 marks]

These questions use command terms that require you to demonstrate knowledge and understanding.

Define	Identify	Describe	Outline	State

EXAM PRACTICE QUESTIONS

Paper 1 (Section A)

a **Identify** two characteristics of a key field in a database. *[2 marks]*

Sample student response

It is unique. ✔ It identifies one record in a database. ✔

Mark scheme

- Unique identifier.
- Identifies a record in a database.
- A field that holds unique data.

The student has gained both marks, although a better answer might be: 'A key field is the unique identifier for each record in a database.' This response states the word being defined, then gives the correct definition.

Top tips

Take a minute or two to brainstorm the keywords, then write two or three clear sentences, or one combined sentence.

Part b: Application and analysis questions (AO2)

These questions use command terms that require you to demonstrate application and analysis.

Analyse	Distinguish	Explain	Suggest

EXAM PRACTICE QUESTIONS

Paper 1 (Section A)

b **Explain** the difference between data matching and data mining. *[4 marks]*

OR

b **Distinguish** between data matching and data mining. *[4 marks]*

Top tips

- Take a few minutes to organize your ideas, then write a description with examples.
- Use the PEEL method to plan your paragraph responses.
- Be sure to address both data matching and data mining, highlighting the points of difference.

Sample student response

Data matching describes the effort to compare two sets of collected data. It compares records in different databases to find individuals who appear in more than one database. For example, a person in the genetic profile database may also appear in a database of diseases. Data matching may link databases on key fields, for example, to build up information about a person. The genetic database could be linked to other databases to identify the citizens.

Data mining is the process of analysing a large batch of information to discern trends and patterns. Data mining looks for hidden relationships and patterns in data. For example, data between genetic profiles and various diseases. It does not identify individuals rather it identifies patterns in the data, i.e. it uses a number instead of a citizen's name.

Mark scheme

Points that can be used in the response:

- Data matching
  - compares two sets of data
  - compares records (usually using key field matching) in different databases to find the data about the item that appears in more than one database, usually to combine the data into a more complete record
  - data in one database aligns with data in the other databases about the same item.
- Data mining
  - analysing hidden patterns of data
  - look for patterns to make better decisions.

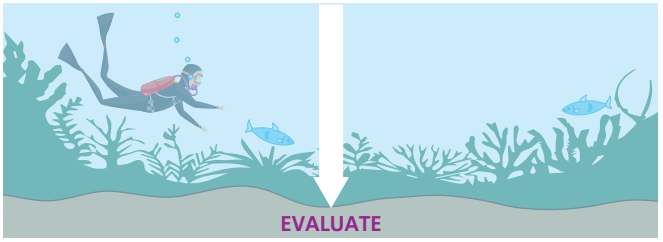
Markband

In addition to the paper-specific analytic mark scheme points listed here, marks for part b can be allocated using markbands. While level descriptors are written in the form of individual bullet points, markbands are applied holistically using a best-fit approach.

1 mark	Limited response about each item, shows little understanding of the topic.
2–3 marks	Reasonable description of each term, but the answer may be unbalanced and not clearly show the difference.
4 marks	Response is a clear, detailed and balanced explanation of the difference between data matching and data mining.

The sample student response above has the qualities of the top markband (4 marks).

Part c: Evaluation and synthesis questions (AO3)



These questions use command terms that require you to demonstrate evaluation and synthesis.

Discuss | Examine | Evaluate | Justify | Recommend | To what extent

Other AO3 command terms – compare, compare and contrast, and contrast – are primarily used in Paper 2.

EXAM PRACTICE QUESTIONS

Paper 1 (Section A)

c **Discuss** reasons why students may be uncomfortable with the use of facial recognition in high schools to take attendance. *[8 marks]*

Sample student response

The student listed the following advantages and disadvantages in their planning notes and then explained them in the first part of their response.

Advantages of facial recognition:

- *can decrease time – faster than manual attendance*
- *strengthens security measures – increases safety and security of students*
- *helps find missing students – can quickly scan and record who is present and scan for those missing*
- *makes attendance more efficient – eliminates human error.*

Disadvantages of facial recognition:

- *threatens privacy – personal data is stored in the school database*
- *imposes on personal freedom – violates personal rights*
- *technology is still new – may not be reliable*
- *errors can implicate innocent people – gender bias, racial bias, etc.*
- *technology can be manipulated – may not accurately record student attendance data.*

Note that your response is expected to include terminology related to the social and ethical impacts, as well as references to the facial recognition scenario.

ATL ACTIVITY

Thinking

Rewrite the advantages and disadvantages given in the sample student response in an extended format, explaining how they are advantages and disadvantages.

Top tips

Remember to use the worksheets from Chapter 7.0 to organize your response in order to provide the depth and analysis required in extended-response questions. It is important that you address the specific command term for each response.

- Take 5 to 10 minutes to organize your ideas using the 'cloud' worksheet.
- Use the PEEL method to plan your paragraph responses.
- Write a balanced, descriptive response with depth and analysis, appropriate terminology, opinion and a conclusion.
- Take specific note of the command term used and what the question is asking. Make sure that you are answering the question asked, not the question that you wanted. Is it referring to one of the concepts?
- To show in-depth, accurate knowledge, you must use what you have learned during the course about the information in the sources and apply it to the question.
- Throughout your response, use information and examples from sources, so that there is explicit reference to support your narrative.

After explaining the advantages and disadvantages, the student writes an overall conclusion:

Students may be uncomfortable with the use of facial recognition to take attendance because it raises a variety of privacy issues. Facial-recognition software will rely on a database of student photos and indicators that could make them uncomfortable. If their photos are stored and not secure, this information could be leaked, and their photos could be reposted over the internet or used by bullies. However, these concerns can be addressed by using a local database that is secured and encrypted. This will prevent remote access to the information as well as limit the availability of stored content. Using a third-party platform or online software creates a risk that students' personal identification data could be shared/accessed publicly.

Additionally, automation of attendance may make students concerned about the accuracy and reliability of the program. The AI system may misidentify students, particularly if they make any significant changes to their physical appearance.

Mark scheme

The top markband for this question is 7–8 marks.

7–8 marks	• The response is focused and demonstrates an in-depth understanding of the demands of the question. • Response demonstrates evaluation and synthesis that is effectively and consistently supported with relevant and accurate knowledge. • The response is well-structured and effectively organized.

The sample student response above has all of the qualities given in the top markband, so it scores a perfect 8.

HL Paper 1 Section B

This section only appears in the HL Paper 1. HL students are expected to answer one of two 12-mark extended-response questions based on the HL extension. Your responses require evaluation and synthesis, as well as an analysis of claims and counter-claims related to the HL extension. Additional stimuli may be provided in the question.

EXAM PRACTICE QUESTIONS

Paper 1 (Section B)

HL topic: Global well-being

Area of inquiry: The changing population

Challenge: The use of digital technologies is increasing in the care of elderly people, either in care homes or their own homes, who have limited movement and other disabilities due to age and medical conditions.

Discuss the use of these digital technologies, as their overall impact has been questioned by some people. In your response, you need to refer to a real-world example.

1 **Context-based response**: In your response, refer to a real-world example within one of the following contexts: social, health or cultural. *[12 marks]*

OR

2 **Concept-based response**: In your response, refer to a real-world example and one of the following concepts: identity, values and ethics, or power. *[12 marks]*

Top tips

'Discuss' is a command term that requires a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence. A balanced review usually includes recommendations for the future to resolve, mitigate and/or intercede in negative issues, and to enhance positive impacts.

Top tips

Consider the following tips when approaching this HL Paper 1 Section B question:

- Only one example is needed to support your arguments.
- Only one concept or context needs to be addressed, depending on which is referenced.
- Select a real-world example that you have studied within the prescribed area of inquiry.
  - If **contexts** are specified in the question, ensure that the context of the use of the digital technology is one of those specified – in your planning notes describe how the example has impacts and implications in that context.
  - If **concepts** are specified in the question, ensure that the example is connected to one of the concepts – in your planning notes include a range of points to show how it is connected.
- Use the 'cloud' planning worksheet to analyse and list a range of positive and negative impacts and implications, organized to support the claims and counterclaims relevant to the question. Counter-claims *must* be provided for Section B responses.
- Prepare a balanced overall conclusion to the question, including links to the impacts and implications to support your conclusion.
- Include recommendations in your conclusion as well.
- Use the PEEL method to plan your conclusion and recommendations.

Writing your response

- Write your response ensuring that all your points are explained with supporting evidence from the real-world example.
- The first part of your response needs to be a justification of your choice of real-world example referring to the context or concept you have chosen. Provide a specific real-world context by describing who, where, when, what, why and how.
- The second part of your response should be an analysis and explanation of the positive and negative impacts and implications in the context of the real-world example. Ensure that you have linked and evaluated them where possible, for example, some uses of the digital technology are both negative and positive at the same time in different ways and for different reasons, and some are better or worse than others for a variety of reasons that need to be specified and justified.
- The last part of your response needs to state your conclusion clearly, with references back to the positive and negative impacts and implications to justify it. This will involve evaluating the impacts and implications, and synthesizing them into an overall answer to the question.

Step 1: Choose a response starting focus – introduction

This is a list of possible starting points you could use to construct a response based on the contexts and concepts the question asks you to refer to. Some suggestions about the digital technologies you could include, and a brief scenario, are also provided.

Context-based question:

- Social: Keeping in touch with family and friends, and having companionship.

  Scenario and digital technologies: Easy to use a tablet-style computer with teleconferencing, email and messaging software OR use of robots and robotic creatures they can communicate with.
- Health: Monitoring the activities of the elderly person living by themselves in case of accidents and medical events.

  Scenario and digital technologies: Using cameras, motion detectors and voice-detection devices to passively and actively monitor the activities of the elderly person.

- Cultural: Being part of groups and having access to other activities.

  Scenario and digital technologies: Easy to use a tablet-style computer so the elderly person can join groups of people with similar interests, and have access to entertainment and streaming services.

Concept-based question:

- Identity: To have an identity is closely connected to having relationships with others, singularly or in groups, with some common characteristics such as ethnicity, nationality, culture.

  Example and digital technologies: Elderly people often find keeping in contact with others difficult as movement and abilities are impacted by age and health issues. Access to an easy-to-use tablet-style computer will enable them to keep in contact with others and groups that they identify with.
- Values and ethics: Elderly people with limited movement and other disabilities may not be treated well by their families as they may be seen as a burden.

  Scenario and digital technologies: Using digital communication devices instead of visiting elderly people in person may be ethically questionable.
- Power: Power imbalances usually arise when there is a difference in circumstances, in this case due to limited movement and health issues, which gives the carers power over elderly people.

  Scenario and digital technologies: Some members of families, and also friends, may use their power to move elderly people into care homes, or to make them stay in their own homes for financial and other reasons. In this situation, the digital technologies listed in other focus suggestions above can be used to lessen the impacts and implications of the power imbalance.

Step 2: Explaining your starting point

The first part of your response needs to be a justification of your choice of real-world example, explaining the connection to the context or concept you have chosen in detail. Provide details of the specific real-world context by describing who, where, when, what, why and how.

The response requires accurate and relevant knowledge that the starting points above do not include. Personal examples of situations and people you know about are very useful.

ATL ACTIVITY

Thinking

For each of the starting points suggested above, write an introductory justification of the approach to the question.

Step 3: Analysis of relevant and accurate knowledge

Relevant and accurate knowledge is required, so the next step is to make a list of a range of impacts of the digital technology, as the question states that 'the overall impact has been questioned by some people.'

You need to show an analysis by structuring your list and making connection points between them wherever possible. You need to show that the points are relevant and accurate by explaining how and why the impacts and implications come about from the use of digital technologies.

The following sample student analysis focuses on the social context: keeping in touch with family and friends, and having companionship.

Positive impacts (claims/advantages/benefits):

- Voice calls are easier than with normal phones because mobile phones are not locked in one location, and the use of a speakerphone feature means the device does not need to be held, which helps people with disabilities.

- Text messaging on a smartphone is good for quick and frequent contact with family and friends, and can include images.
- Video-conferencing software such as Facetime, Zoom and Skype, are good for more intimate and in-depth contact with family and friends.
- Email is good for detailed contact with family and friends when there is space and time for the inclusion of stories and reasons for decisions and actions.
- Phone calls with communications apps cost practically nothing as they can be part of the overall mobile internet package or broadband connection package.

Negative impacts (counterclaims/disadvantages/costs):

- These forms of communication are very useful, but they cannot replace the depth and intimacy of face-to-face communication. Written text can often be misunderstood, and video conferencing does not allow for the same amount of non-verbal communication that face to face can provide.
- There will be a tendency to make too much use of the digital devices and not make physical visits for face-to-face time with elderly friends and relatives, which is what they actually need and want.
- The technology chosen will need to be simple and easy to use so that the complexities of the technology do not overwhelm elderly people. For example, video conferencing can be difficult to set up and use all the features; email apps can be complex to use; and the integration of images, links, text can be very complex.
- Technical help to set up the digital technologies, train elderly people and maintain digital technologies needs to be quickly and easily available. A member of the family or a friend can often supply the expertise, but probably not quickly enough so, at times, leaving elderly people 'stranded'.

Step 4: Evaluation and synthesis – the overall answer with recommendations

Your response requires **evaluation and synthesis** as well as a consideration of counter-claims, so the list in step 3 needs to be developed into sections that discuss the claims, and then the counterclaims. It is also a good idea to include **recommendations** about how to resolve the issues, explaining how this could be done.

In this discussion, you should highlight and explain links between the impacts and also the extent of the effects of the impacts. A useful technique is to highlight the best and worst impacts, evaluating (explaining) why they are the best and worst for the scenario.

Finally, the names and situations of people you have knowledge about from personal contacts or through news items should be included. These should have been included in the initial justification of your starting point.

Generally, the three forms of communication cover the needs of elderly people. The digital technology will cover many of the regular needs of elderly people for communications, and also the urgent and irregular needs when something happens or something needs to be done, often in a medical situation.

However, the negative impacts are very real for many elderly people, and will only get worse over time if their mental and physical health declines. Clearly, digital technologies need to be suitable to the individual situation of the elderly person. Eventually, the use of digital assistants such as Apple's Siri and Google's Alexa will need to be included, and may even become the main means of communication over time.

The issue of keeping up face-to-face contact needs to be addressed by family and friends, otherwise they can easily get into the routine of digital communications rather than personal communications.

The question raises the issue that 'the overall impact has been questioned by some people'. Clearly, the analysis and evaluation of the impacts above highlights that all is not perfect, and the negative impacts need to be considered comprehensively rather than addressing them when the needs arise. This would mean a much better result for elderly people.

ATL ACTIVITY

Thinking

For each of the starting points given in step 1 above, develop and analyse a list of positive and negative impacts and implications, explain them, and then write an overall evaluation and synthesis.

Mark scheme

The top markband for this question is 10–12 marks.

10–12 marks	• The response is focused and shows an in-depth understanding of the demands of the question. • Response demonstrates evaluation and synthesis that is effectively and consistently supported with relevant and accurate knowledge. • Counter-claims are effectively addressed in the response. • The response is well-structured and effectively organized.

Although the sample student response could be improved by direct reference to real people, such as 'my grandfather or grandmother', given the time limit and pressure of an examination it has achieved the top markband and would be awarded a perfect 12.

ATL ACTIVITY

Thinking

Choose a sample Paper 1 Section B question from one of the HL challenge topics in Section 5.

- Use the cloud planning worksheet to plan out your answer.
- In small groups, compare the planning documents that you have developed.
- Challenge each group to write an overall evaluation and synthesis conclusion based on the plans of the other groups, using the PEEL worksheet to help construct it.

Reflection

Now that you have read this chapter, reflect on these questions:

- Do you know how to approach the different command terms in examination questions?
- Can you match up the command terms with the different assessment objectives (AOs)?
- Do you know how to plan answers to extended-response questions?
- Do you know the differences between SL Paper 1 and HL Paper 1?

7.2 Approaches to Paper 2

UNDERSTANDINGS

By the end of the chapter, you will have:
- gained an understanding of how to prepare for Paper 2
- looked at sample Paper 2 questions and been guided on how to approach them
- understood how the mark scheme is applied to a Paper 2.

Introduction

Paper 2 is a source-based examination paper that addresses the common SL and HL topics in an integrated way. There will be four sources on a common topic and four compulsory questions.

The main purpose of Paper 2 is to assess your ability to interpret and analyse new information and relate this to the concepts, content and contexts you have learned in the course.

■ Overview SL/HL Paper 2

Weighting	SL 30%, HL 20%
Duration	1 hour 15 minutes
Total marks	24 marks
Paper details	Four questions: 2 marks, 4 marks, 6 marks and 12 marks

Preparing for Paper 2

You can practise Paper 2-style questions at any point in the course. When learning about the content of the course, you can practice questions similar to questions 1 and 2. When you are studying a specific context, attempt extended-response questions similar to Questions 3 and 4, making links to different concepts.

You will use the steps below at different points in your learning.

Determine Paper 2 focus	From Sections 3 (content) and 4 (contexts), select a topic. • How will you narrow down the topic for a Paper 2 practice? Are you going to use the example in the book, work with your teacher, or choose for yourself? • Decide on the context, linking it to a real-life example and the technology used, and identify the primary stakeholders.
Explore	Find four suitable sources. • Identify sources that have different perspectives or claims. • Find sources in different formats, for example infographics, graphs, video/audio clips and text.
Question 1	Interpret the sources. • Identify or state specific facts from the sources. • List the digital society terminology used and define these terms. • Outline or describe the technology, impacts and consequences arising from the sources.
Question2	Apply and analyse. • From the sources, provide an explanation of how impacts occurred or suggest reasons why for specific stakeholders. • From the sources, analyse the scenario, identifying the positive and negative claims presented.
Question 3	Compare, contrast, or both. • Select two of the sources and identify how the perspectives or claims are similar and/or different. • Practice writing a more developed response. • How can you use your knowledge from the course? Which concepts, content or contexts could be applied?
Question 4	Write an extended response and make a link to the source and the course concepts, content or contexts. • Choose a relevant concept from Section 2 and use this as a lens when answering this response. • Evaluate the significance of the impacts and implications for stakeholders. Have you weighed up the positive and negative impacts and implications? Are the impacts and implications short or long term? Do negative implications have solutions?

ATL ACTIVITY

Social

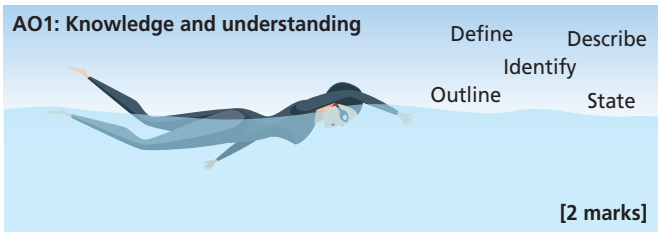
Select a topic that you'd like to explore further with a partner.

- Identify a recent news article for one of the topics studied in class.
- Find four additional sources related to the topic from the following list, considering different perspectives:
  - one text source (such as a news article or research article)
  - one social media post (for example on Twitter or Instagram)
  - one visual (an image, diagram or infographic)
  - one set of data (for example graphs, tables, statistics)
  - one multimedia post (for example an excerpt from video or podcast).
- Explain to your partner why you chose each source and how it relates to the topic and the other sources.

Approaching each question

Question 1 (2 marks)

You will be required to demonstrate your knowledge relating to one of the sources. This could include interpreting the data presented in the source, identifying a claim or perspective, or linking it to a digital society topic.



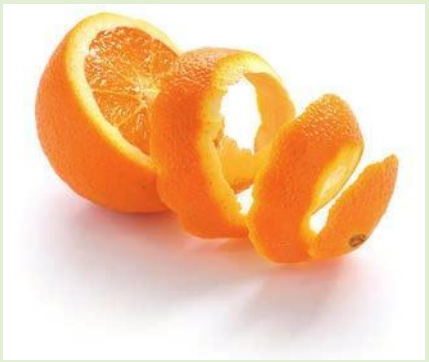
Top tips

Use the reading time to become familiar with the four sources and which source is referred to in each question. When the question asks you to 'identify' or 'state', it is acceptable to use bullet points in your answer.

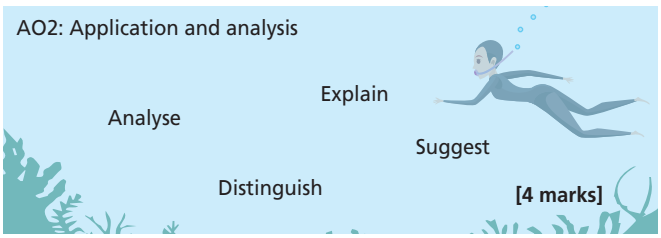
Question 2 (4 marks)

Top tips

Use elements of PEEL when answering any AO2 or AO3 questions.



You will be required to apply or analyse information from one or more of the sources. This could be identifying the differences between the claims made in two of the sources, or giving reasons from a particular perspective.



Top tips

Make sure you know how to approach the command term in the question, use your knowledge from the course, and make specific reference to the sources when writing your response.

Using transition words and phrases can help you signal to the examiner that you are demonstrating critical thinking. Practise using these words within your answers.

■ Using transition words and phrases in your responses

Command term	Transition words and phrases
Analyse	Furthermore … In addition … On the other hand …
Distinguish	One difference is … (focus on first item), and a second one is … (focus on second item)
Explain	Because … Due to … One factor causing this is …
Suggest	One solution could be … One proposal is …

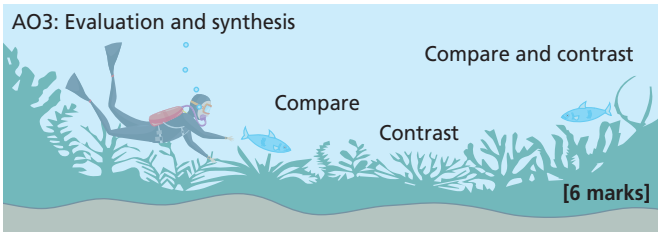
Question 3 (6 marks)

Question 3 requires more insight into the information provided by two of the sources. Comparing ('source X is similar to source Y …') or contrasting ('source X is different to source Y …') the information provided in the sources is the main focus of this question.

You may be asked to do both, **compare and contrast**, where you will be required to provide both similarities and differences of the two sources in order to earn full marks.

When writing your responses, you should use keywords such as 'whereas', 'in contrast', 'likewise', 'similarly' and 'however'.

Note that the command terms 'distinguish' and 'contrast' both require you to identify the differences, but in Question 3 you will be required to give a more detailed account of the differences.

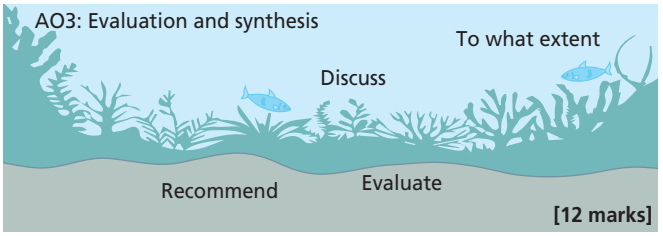


Top tips

This question is worth more marks than Question 2. Make sure that you refer to both sources in your answer, giving enough detail and making enough valid arguments.

Question 4 (12 marks)

Question 4 is an extended response and is worth 50% of the marks on this paper. Therefore, you should aim to spend at least 35 minutes writing this essay. This question will integrate the 3Cs: concepts, content and contexts.



When evaluating, responses may be signposted with keywords such as 'overall', 'therefore', 'in my opinion' and 'weighing up'. You should use the points made previously to support your evaluation, otherwise it is only an opinion.

Mark scheme

In addition to a list of paper-specific analytic mark scheme points, marks for Question 4 are also allocated using markbands. While level descriptors are written in the form of individual bullet points, markbands are applied holistically using a best-fit approach.

Before starting to write

- Spend several minutes planning out the essay so that your response is well structured and organized. Use the 'cloud' worksheet from Chapter 7.0 to help you plan.
- Take specific note of the command term used and what the question is asking. Make sure that you are answering the question asked, not the question that you wanted. Is it referring to one of the concepts?
- To show in-depth, accurate knowledge, you must use what you have learned during the course about the information in the sources and apply it to the question.
- Throughout your response, use information and examples from the sources, so that there is explicit reference to support your narrative.

Top tips

When writing an extended response, be sure to develop your answers. For example, when you make a claim, support it with details and examples, and connect it to the overarching question. Evaluate the significance of the points being made compared to other points and the implications of your arguments.

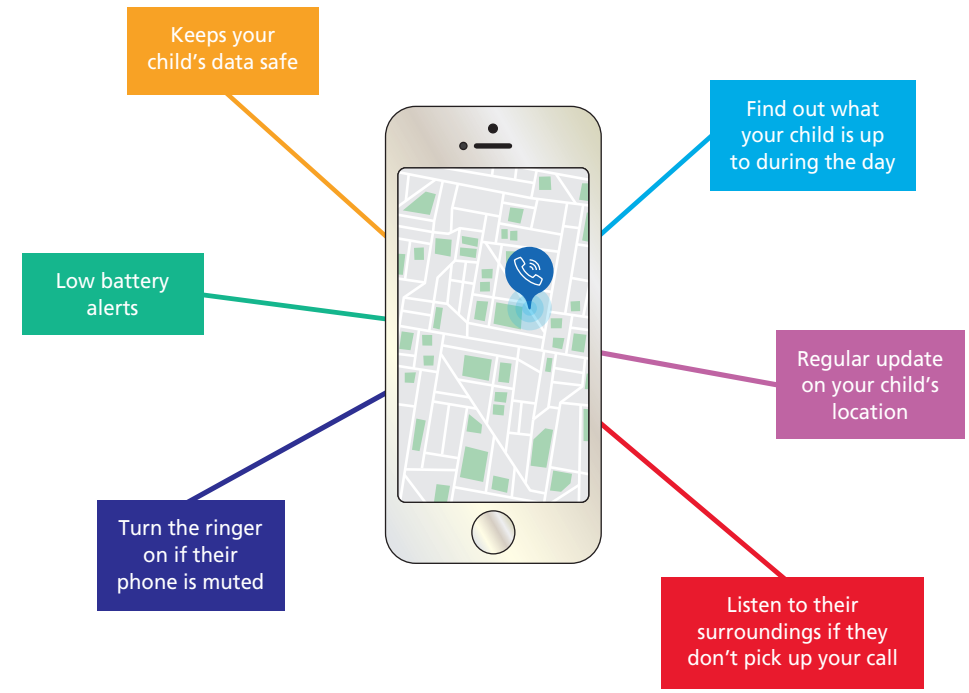
Practice Paper 2

Now that you have some understanding about Paper 2, here is a sample Paper 2 including sources, questions, mark scheme and sample answers. Try to approach this as if you were in examination conditions. Read the sources and questions, and use the tips and guidelines to write your answer. Once you have finished, refer to the mark scheme to see how well you did.

EXAM PRACTICE QUESTIONS

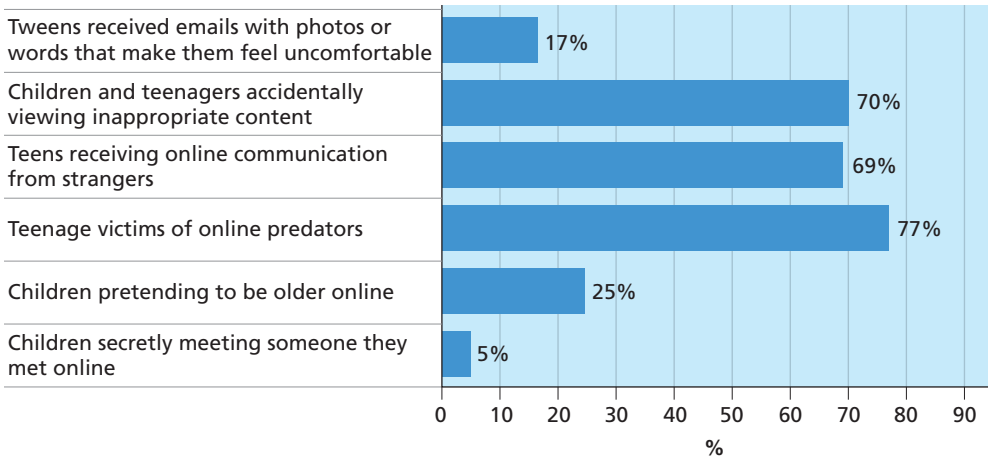
Paper 2

Source A



■ Track My Child app

Source B



Adapted from www.guardchild.com/statistics *and* www.mmguardian.com/blog/should-parents-monitor-their-childrens-texts-and-phone-activity

Source C

Parents monitoring of children

There are a number of reasons why monitoring a child's phone makes sense. These can include seeing if they are cheating in their school work, texting undesirable people or to protect them from being cyberbullied or being groomed by child predators.

A 2016 study published by Pew Research Center found that parents feel compelled to take a wide range of steps to oversee their teenagers' online activities and convince their children to use mobile phones in an appropriate and conscientious manner. These include:

- checking the websites that their teenagers visited
- befriending or following their children on social media
- knowing the password of their child's cell phone
- going through their child's call records and text messages
- holding talks with their children about suitable behaviour when using mobile phones
- introducing rules or 'digital punishments', such as taking away their children's mobile phones as a reprimand
- using technology to supervise the cell phone habits of children or track their child's location.

However, parents are aware that their children may be taking additional steps to circumvent the measures their parents are putting in place, and as a result hiding certain aspects of their online presence.

Adapted from **www.mmguardian.com/blog/should-parents-monitor-their-childrens-texts-and-phone-activity** *and* **www.wired.com/story/parents-should-monitor-teens-electronics**

Source D

The ethical dilemma

Parents are responsible for their children until they reach adulthood, and they are most likely paying for their phones, but is it ethical to spy on your children without their knowledge? Could this lead to a lack of trust in the relationship between teenagers and parents? Will the use of tracking technologies create a culture of surveillance parenting? Some important aspects to consider include:

1. Some companies are tracking for profit. Tracking apps typically collect data that can be sold to third parties such as advertising agencies. The apps use push notifications to gain as much data as possible.
2. Risks of leaking private data. Should the data become de-anonymized, there is the potential for serious breaches of privacy. Information related to children's whereabouts can reveal valuable data about them.
3. It can break the trust that is central to a healthy parent and child relationship. Tracking apps diminish this trust and could potentially push the child towards rebellion.

Adapted from **https://theconversation.com/why-parents-should-think-twice-about-tracking-apps-for-their-kids-114350**

Questions

1. With reference to Source A, identify two uses of the mobile tracking app by parents. *[2 marks]*
2. With reference to Source B and knowledge from the course, explain two ways a child may be at risk when using their mobile phone. *[4 marks]*
3. Compare and contrast what Sources C and D reveal about the impacts of mobile phone monitoring on parents and teenagers. *[6 marks]*
4. From parents tracking their child's phone to the use of location services in apps and the nationwide monitoring of citizens to control the spread of infection during the pandemic, mobile phone users are being tracked in many aspects of life.

   With reference to the sources and your own knowledge, discuss whether the use of mobile phone monitoring and tracking has enabled the abuse of power. *[12 marks]*

Top tips

For Question 1, view the image of what the app can do and make a link to how a parent may use it.

Consider using the following writing framework:

A parent may use the tracker to:

- *Use 1: …*
- *Use 2: …*

Top tips

Question 2 is worth four marks, so provide two reasons. The information in the source presents statistics related to online behaviour of students. Use your knowledge of digital citizenship and the statistics to explain how children may be at risk when using their phones.

Consider using the following writing framework:

One risk is … This may be because ….

Another risk is … because….

Top tips

Question 3 is worth six marks. Review the mark scheme for guidance on to how to structure your answer. For example, topics from the articles could include trust, privacy and protecting the child. Once you have the ideas, make reference to both sources when making your arguments.

Consider using the following writing framework:

In Source C … parents … trust … which can be seen in …

In contrast … in Source D …

When writing your responses, you should use keywords such as 'whereas', 'in contrast', 'likewise', 'similarly' and 'however' to clearly identify the connection between the two sources.

Top tips

For Question 4, plan your essay so that your response is well structured and organized.

- Take specific note of the command term used and what the question is asking. 'Discuss' means to provide a balanced argument, with opinions and conclusions based on the arguments being made.
- Make sure your essay includes a final paragraph where you are able to provide your opinions and conclusions based on the arguments developed in the body of the essay.
- To show in-depth, accurate knowledge, you must use what you have learned on the course about the information in the sources and apply it to the question.
- Use what you have learned in the course to add more detail to the points made in your plan, developing each point made.
- Throughout your response, use information and examples from the sources, so that there is explicit reference to support your narrative.
- From the sources, identify examples of when mobile phone monitoring has been used to give someone more or less power. Relate this question to specific contexts that you have studied on this topic. Use these as specific examples in your narrative.

Mark schemes and sample student responses

Sample student response

1 *Source A shows that parents can use this app to check their child's location when they go out with their friends. They can also use it to make the phone ring if their child has muted it.*

Mark scheme

1 Answers may include, but are not limited to the following points.

A parent may use the tracker to:

- check on their child's location when going out with friends
- alert the child if they are trying to contact them and their sound is off
- check that their child is where they say they are
- allow their child to go out independently, because parents have a way to check that they are safe
- check on their child if they are not answering their phone.

Sample student response

2 *Source B shows a child may be at risk because the internet hosts a range of inappropriate content, or content intended for mature audiences, a child may be at risk of accessing content related to drugs, alcohol, pornography or violence. Another risk is that teenagers may be approached by online predators. Catfishing is when people pretend to be someone else online and this may result in inappropriate relationships between young users and adult users. This could result in the transmission of inappropriate photos or even unsafe meet-ups in real life.*

Mark scheme

2 Answers may include, but are not limited to the following points.

A child might be at risk due to the following:

- a child pretending to be older to register for sites that have content designed for adults, which may cause psychological harm
- a child accidentally accessing inappropriate content, which they might copy, that may cause them physical or mental harm
- a child may meet with a stranger who may cause them physical or emotional harm.

One mark for each point, up to a maximum of two marks; and one mark for each development of the point up to two marks.

Sample student response

3 Both sources discuss parents tracking their children's cell phone use. While Source C presents different methods of how parents can monitor their children's device activity, Source D focuses on the risks that this monitoring creates for children.

Regarding data, Source C focuses on a range of ways that parents access data and usage information from their children. It does not discuss the privacy risks of that data being further accessed by other stakeholders. Two of the key claims in Source C focus on third parties accessing the data, either through resale or leaking of data from tracking apps.

Both sources indicate that building a strong relationship is one way of fostering safe and responsible mobile phone use. Source C encourages discussing suitable behaviour, or even enforcing consequences by taking the phone away, while Source D demonstrates that sometimes fostering a safe and responsible way can be unethical, especially if the teenager is unaware of their parents' actions.

Mark scheme

3 Answers may include, but are not limited to the following points:

- **Trust**: Source C includes activities performed by adults that suggest a lack of trust of their children, including the checking of websites visited, going through their child's call record and installing apps. In comparison, Source D highlights that parents who monitor their children do not build a trusting relationship.

  This could have a negative impact on parents' relationship with their teenagers, and teenagers may rebel against these actions as a result.
- **Privacy**: Source C describes ways that adults breach the privacy of their children, for example having access to the pin code of their phones, in particular if it is without their knowledge or consent.

  In comparison, Source D also describes breaches of privacy, specifically when parents who have installed the tracking apps have not read the terms and conditions about what data is collected by the company and who it is shared with, for example advertising agencies. There is also the risk that data can be de-anonymized and reveal information about the child including their online behaviour and communications.

  Both sources demonstrate a loss of privacy, whether it is from their own family members or third parties. How this data is used will determine the impact it has on the child.
- **Protecting the child**: Source C, states that parents feel compelled to protect their teenagers when using their mobile phones to go online. They use a range of methods from education to monitoring.

  In contrast, however, Source D claims that, instead of protecting the child, these activities can have the opposite effect and could ultimately lead to rebellion.

  In comparison, the idea of children rebelling in Source D is supported in Source C which says that children will bypass measures put in place by their parents.

  Overall, parents need to find a balance between protecting their teenagers from exposure to undesirable content and people, and overprotecting them, which could leave them unprepared for adulthood or force them to rebel and potentially be exposed to more undesirable impacts.
- **Ethics**: Source C observes that it is the parent's moral obligation to protect their children, which is supported by the opening statement in Source D.

  However, Source D highlights that the measures taken by parents can lead to unethical surveillance parenting.

  Overall, a parent may have a differing opinion and will justify their actions to be ethical.

Do not expect all of the points above, and allow other valid points. Award marks for each effective point of comparison up to a maximum of six marks. If the view of only one source is discussed, award a maximum of three marks. For responses that discuss the sources separately, rather than in a continuous comparison, award a maximum of four marks.

Sample student response

The sample below is an example of a conclusion based on the argument points that you need to have explained previously in your response.

4 Overall, parents can use mobile phone monitoring to retain power or control over their children as they navigate their way from childhood to adulthood. As Source C suggests parents can use a range of tools to monitor their child, whether it is through unlocking their phone to read their text messages or installing software so that they can see what they are looking at, who they are chatting with and how much they are using their phone. Perhaps their children do not talk to their parents as much as they used to and so, in this way, parents will have more knowledge. Knowledge can lead to power; so, for example, a parent knowing more about their child by using apps such as those in Source A can help them feel as if they still know them and make parenting decisions based on this. The power can also be in the form of control, for example, a parent may feel that their child is spending too much time on the phone, which is not good for their well-being, or can be victims of online predators or view inappropriate content as shown in Source B and so can intervene using technologies to impose screen time limits, for example. Overall, as parents are ultimately responsible for guiding their children to becoming good digital citizens, such technologies can help them take back some control of their children, which they are doing for their own good.

As well as monitoring mobile phone usage of children, the same issues of power and control are also very real in a number of other situations. For example, an abusive person may track their partner's phone, often without their knowing about it. Location services use tracking to determine if locations around the city are busy or not, and this is very useful for drivers to determine the quickest way to go; as Source D states, companies are tracking for profit and but they also have the potential to provide some form of advertising to passengers in the car as they browse their social media and news apps. Track and trace of citizens is very useful during emergencies, such as during the Covid-19 crisis, but many people were worried that it could become another form of government control, which has happened in some countries. So, overall the situation is the same for all types of tracking – there are benefits but the negatives need to be addressed explicitly and effectively, otherwise people might start to take action with their mobile phones to limit the tracking.

Mark scheme

4 Question 4 is assessed using markbands in conjunction with these marking notes.

Arguments may include, but are not limited to:

- Mobile phone monitoring to enable power
  - From Source C: parents can use mobile phone monitoring to retain power or control over their children as they navigate their way from childhood to adulthood.
  - Parents who monitor their children may empower their children to have more freedom and independence.
  - Location services in apps give companies more data about a subscriber's location and activities; this empowers the companies to provide more targeted advertising.
  - Governments have used track and trace apps to monitor citizens, which has given them the power to identify citizens who have been in close proximity to a virus.
- Mobile phone monitoring to abuse power
  - Source D identifies the misuse of power, with the tracking apps selling data to third parties.
  - Parents using tracking apps without their child's knowledge is unethical and could be considered an abuse of power by adults.
  - Likewise, location services can provide location data to companies that might misuse the data and sell it to third parties or the government.
  - Mobile phone monitoring apps have the potential to be hacked and put power into the hands of the hackers.
  - Governments have used track and trace apps to monitor people's movements in order to track the spread of a virus in a pandemic; however, some countries have used location data for other purposes, for example the tracking of criminals.

Markband

The top markband for this question is 10–12 marks.

10–12 marks	• The response is focused and shows an in-depth understanding of the demands of the question. • Relevant and accurate knowledge is demonstrated throughout, adding insight to the response. • There is consistent and effective integration of evidence from the sources. • The response is well-structured and effectively organized.

Reflection

Now that you have read this chapter, reflect on these questions:

- Do you know how to select sources on a topic so that you can practise Paper 2?
- Do you know how to approach each question in Paper 2?
- Have you tried a practice Paper 2?
- Can you use the mark scheme to guide you on how to write extended responses?

7.3 Approaches to the HL pre-release and Paper 3

UNDERSTANDINGS

By the end of the chapter, you will have:

- gained an understanding of the HL pre-release and its relationship to Paper 3
- gained an understanding of how to prepare for Paper 3 using the HL pre-release and your work on challenges and interventions
- looked at a sample pre-release and associated Paper 3 with answers
- seen how the mark schemes and markband level descriptors in the study guide are applied to a practice Paper 3.

Overview of the pre-release and Paper 3

This chapter covers how to approach the HL Paper 3 and contains a practice pre-release and Paper 3, with a mark scheme and sample answers. Before continuing, you need to read the example below, and look at the specimen papers and mark schemes.

■ Overview of HL Paper 3

Weighting	25%
Duration	1 hour 15 minutes
Total marks	30 marks
Paper details	Based on pre-release material Four questions: 4 marks, 6 marks, 8 marks and 12 marks

The paper contains four questions designed to assess your knowledge and understanding of interventions for a particular HL extension challenge topic and your ability to evaluate them and to recommend steps for further action.

A pre-release will be published prior to the examination that specifies the real-world context of the particular challenge topic that is the focus of the questions. The pre-release will contain specified interventions that are applied to the issues of the challenge topic. You will need to investigate these interventions using extended inquiries.

The results of your extended inquiries into the specified interventions will most likely be needed to respond to Question 4.

Paper 3 will include additional material linked to the specified real-world digital interventions in the pre-release. In addition to the information contained in the pre-release, you will need to consider connections to the digital society concepts, content and contexts in order to respond to the questions, to understand the issues of the challenge, to evaluate the interventions and to recommend steps for future action.

It is recommended that a significant amount of the 90 hours for the HL extension be devoted to the study of the challenge topics and the related interventions that are researched and analysed. The rest of the time should be devoted to the study of the interventions in the pre-release, and practising for HL Paper 1 Section B and HL Paper 3.

Preparing for Paper 3

Before you read further, go to the sample Paper 3 on page 405, read it and then return to this page and continue.

The most important factor in your preparation for Paper 3 is the requirement of Question 4: the need to include material from 'your own inquiries'. Question 4 is worth 12 marks (40% of the mark for Paper 3). If your response to Question 4 does not contain significant direct detail (who, when, where, what) from your own extended intervention inquiries, it is likely to be marked in the 4–6 markband, while good use of your own inquiries would be marked in the, 7–9 markband.

The pre-release will specify the real-world context from part of a selected challenge from the digital society HL extension. You must use the pre-release statement to plan and conduct extended inquiries into the digital interventions mentioned and others associated with the context. This is to be done in the time between the publication of the pre-release and the date you will sit the Paper 3 examination. The information in the pre-release may include possible resources, terms and approaches to help you with your extended inquiries. If you are lucky, you might conduct an inquiry into a context and intervention that is used in the actual Paper 3.

Paper 3 will include a stimulus about a specific real-world digital intervention to the challenge outlined in the pre-release, and your extended intervention inquiries should provide you with extra material to compare and contrast with this intervention and to make recommendations about which intervention/s should be used.

In your extended intervention inquiries, you need to also include connections to the digital society concepts, content and contexts:

- The appropriate concepts need to be applied to your own inquiries.
- Content details of the digital technologies used need to be researched.
- Different contexts, as well as the one presented in the pre-release, need to be a focus of your own inquiries.

You also need to make use of the various types of interventions: mitigates, intercedes, enhances and resolves. You need to be able to categorize the interventions in the pre-release, and those in your own inquiries, using one or more of these categories. You should also consider explaining why the intervention does *not* fit a particular category.

All the intervention evaluation criteria – equity, acceptability, cost, feasibility, innovation and ethics – need to be used on the pre-release intervention(s) and your own interventions; if they cannot be used, say why. Remember, there is more than one way of applying these criteria, apart from the obvious way.

Notes preparation

In the days before the Paper 3 examination, you need to summarize all your notes from your own inquiries based on the pre-release material in the format of the example intervention inquiry in Chapter 6.2.

Using your notes – evaluations and recommendations

You need to develop comprehensive and well-supported evaluations of the interventions focusing on how they *are* and *are not* successful in addressing the specific challenge in the pre-release, in as many aspects as possible. Classify them into strong and weak levels of success and not being successful.

You need to make a number of detailed recommendations on how to improve the success of the interventions in addressing the specific challenge in as many aspects as possible. For each one, you

need to explain how they will improve the response to the challenge, and how the improvement may be limited in its success because of trade-offs and negative implications if implemented. No recommendation will completely address a particular challenge as they are complex.

Practice questions

In order to understand the focus of each type of question and the various command terms used in each question, practise designing and answering questions. You can see how this can be done in the sample questions for the practice pre-release that follows.

Ensure that you have understood the various command terms, and how to answer the questions that include them by revisiting the explanations and descriptions in Chapter 7.0.

Practice pre-release

The pre-release statement below contains the real-world nature of a selected challenge from the digital society HL extension. The information presented in it includes possible resources, terms and approaches to consider for an extended inquiry.

The pre-release statement should be used to plan and conduct extended inquiries into relevant digital interventions to prepare for Paper 3, and possibly use in the responses. The length of the pre-release is about 400 words maximum.

PRACTICE PRE-RELEASE

- **Topic**: Global well-being challenge
- **Area for Inquiry**: The future of work
- **Focus**: The gig economy

The development of smartphones and apps has facilitated a new form of service and product delivery called the gig economy. The gig economy has become popular with workers as it provides flexible access to paid work. Businesses also enjoy the benefits of being able to hire workers in a flexible manner.

An example of a gig worker is Paul, who works at a local furniture manufacturing company. He increases his income by doing gig work during the evenings and at weekends. He has worked as a ride-share driver for companies such as Uber, and uses apps such as Airtasker to find small jobs in his local area.

Challenges

- Businesses need to develop a way of maintaining contact with gig workers so that they can organize the work that needs to be done.
- Gig workers need job security and rewarding work so that they can continue this type of work.

Interventions

Businesses, especially larger ones, have developed specialised apps, while others, usually smaller businesses and individuals, rely on community-based marketplace apps to gain the benefits of the gig economy. The focus of the investigation will be on two different models for organising the gig economy:

- ride-share apps developed by a specific business, such as Uber
- gig work apps developed for use by members of the community in an open marketplace, such as Airtasker.

Issues

Creating an easy-to-use app for gig workers is challenging. It needs to provide all the information required in an appropriate and clear format, and must have intuitive features that businesses and workers will find useful, such as access to payment records.

The gig economy has raised a number of practical, legal and ethical issues for workers that need to be addressed by businesses and government regulators. These include:

- consideration of the role of trade unions
- lack of recognition of laws and regulations relating to work
- the use of ratings systems
- working conditions
- safety considerations.

Another issue for the companies is that some ride-share and delivery services have accumulated financial losses, then tried to make a profit by passing costs on to their workers and the people and companies they serve.

Are these interventions incremental or disruptive innovations? It can be argued that ride-share companies are taking business away from established transportation services and companies, even though they are using innovative digital technologies. It can also be argued that small job apps are very efficient and effective in connecting people who want jobs done with those who can do them, which seems to be truly innovative.

Investigation

Conduct extended inquiries into the real-world contexts of these interventions, and the impacts and implications for real-world businesses, workers, people and communities, especially in your local cities and regions.

Investigating a variety of sources about the impacts and implications is an appropriate starting point. Interviewing actual gig workers, gig employers and other people associated with them should also be done if possible; reviewing comments on social media and elsewhere about gig work is a useful substitute if not.

You also need to:

- use the concepts as lenses to explore the issues involved to help develop questions about the gig economy
- use the content topics to explore the range of technologies involved in the interface between businesses and workers, as well as the underlying technologies, such as backend business database systems and networks.

Gig economy workers

Practice Paper 3

Paper 3 includes stimulus material about a specific real-world digital intervention implemented to address these challenges. Your responses to the questions that follow need to reference your extended inquiries into specific examples of these interventions. You should also consider relevant connections to the concepts, content and contexts.

EXAM PRACTICE QUESTIONS

Paper 3

The stimulus material below provides information about a digital intervention to the challenge described in the pre-release statement. After carefully considering the material, answer all the questions that follow using the stimulus and your own knowledge from the course.

Source 1

Intervention feasibility

Paul is a gig worker who works at a local furniture manufacturing company. He increases his income by doing gig work during the evenings and at weekends. He has worked as a ride-share driver for companies such as Uber, and uses apps such as Airtasker to find small jobs in his local area.

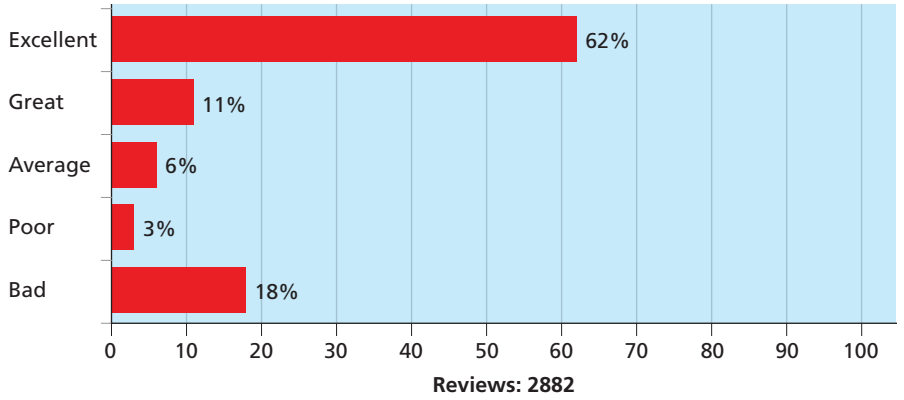
Before becoming a gig worker Paul investigated these two ways of increasing his income by looking at reviews of both Uber and Airtasker. He then contacted friends, relatives and local people who used the apps to obtain gig work. He also found online reviews from ride-share drivers and passengers, as well as from gig worker job posters and taskers.

After this research, he felt that gig work could provide secure and meaningful employment.

Source 2

Intervention acceptability

The following chart gives a summary of some gig work app reviews:



Mostly they were very good, but there were clearly issues for a significant number of people who worked as gig workers, or people who used the ride-share and job task apps.

Source 3

Intervention cost and equity

Taken for a ride!

Hundreds of drivers for ride-sharing apps used in New York claim they have been deceived with false promises of big earnings, according to court papers. The drivers claim the company wrongly classified them as independent contractors in a bid to deny them appropriate pay and job security.

In a lawsuit, a driver claimed he earned less than US$5 an hour after taxes and expenses, well below the US$15 an hour minimum wage in New York City. This led to negative impacts on him and his family from the extra hours he had to work to take home a reasonable wage.

Adapted from the New York Post*:* **https://nypost.com/2021/03/13/like-uber-ride-sharing-app-via-accused-of-mistreating-drivers**

Source 4

Interventions as innovations

Unions have produced reports looking at the implications for workers in the gig economy, especially those that provide online-facilitated, task-based work. These reports explore the risks associated with the breakdown of traditional jobs into short-term tasks. The reports say that gig economies have used the cloak of innovation to pursue unethical and outdated labour practices.

Adapted from **https://apo.org.au/node/68082**

Questions

1 Knowledge and understanding questions (identify and describe command terms).

   a **Identify** two ways/methods that Paul could be notified by gig work apps, such as Airtasker, of a job that has been posted that he might be interested in responding to. *[2 marks]*

   b **Identify** two features of a gig work app, such as the Airtasker app, that help Paul to organize his gig work. *[2 marks]*

2 Application and analysis questions (explain and distinguish)

   Explain how an app's backend digital technology, such as that used by the Uber app, facilitates the payment of workers in a reliable way. *[6 marks]*

3 Evaluation and synthesis questions (evaluate and discuss)

   With reference to your inquiries into gig work apps and the gig economy, **discuss** the ethical issues that have emerged for Paul. (Ethics criterion) *[8 marks]*

4 Evaluation and synthesis questions (recommend and evaluate)

   The success of ride-share apps such as Uber is based on the assumption that they should be able to address the challenges of providing secure and rewarding work for gig workers as well as meeting the requirements of the ride-share companies.

   Based on an evaluation of the current working conditions for gig workers, **recommend** improvements to ride-share apps that would enable them to satisfy the requirements of both Paul *and* the ride-share companies.

   Your response should include your inquiries into how the gig economy operates as well as the implications for workers such as Paul. *[12 marks]*

Top tips

Question 3 may focus on one or more of the criteria for evaluation of interventions and recommendations.

Top tips

The actual Paper 3 will contain stimulus material based on a specific scenario, as above. You will be expected to incorporate this information with the research carried out in the time allocated to the study of the pre-release statement.

When answering Question 4, do not be tempted to 'regurgitate' a standardized response. These types of responses do not address the specific requirements of the question well enough and are unlikely to move you beyond the 'adequate' markband.

Mark schemes and sample student responses

Note that some of the sample student responses given below are more detailed and comprehensive than you could provide in the limited time of the actual exam.

Mark scheme

1 a Award one mark for a way or method identified if the way/method is a specific type. The name of an app is not to be awarded marks unless it is combined with the type of method.

b Award one mark for each feature if it enables Paul to select tasks that have specific characteristics.

1 a Answers may include but are not limited to: Email, text message (SMS/MMS), messaging apps (such as WeChat, Messenger), messages or alerts section of the gig worker app, alerts from the gig worker app that appear on his smartphone.

b Answers may include but are not limited to:

- a browse tasks feature with various filters for type of work and location
- Paul can specify his skills and experience, which can be matched with the tasks offered and then displayed
- Paul can specify the time and location that he is prepared to work
- Paul can specify the amount of money to be paid for the task.

Mark scheme

2 Award up to four marks for the description of the steps used to record the task details, and calculate and pay the driver the correct amount. At least four different steps are required covering data collection, processing of the data and how the payment is made.

Award up to two marks for an explanation of two reasons why the reliability of payment is achieved.

2 Answers may include but are not limited to the following descriptions and explanations:

Description of steps

- Using the app, the driver sets up a direct deposit process by supplying their bank account details to the ride-share app company.
- The driver accepts a driving task and performs the task.
- When a task has been finished, the ride-share app's backend digital systems will calculate the payment to be made to the driver. The amount depends on the distance of the journey, the time it took and the time of day, as the rate charged to the passenger varies according to how high the demand is and other factors such as cancellations and road tolls. The details of the task are stored in the backend database.
- Once each week, on the same day, the total payment for the work done is made to the driver's specified account.
- The driver is notified of the transfer, the total amount and the full details of each trip by email, or by using a statement feature of the ride-share app or website.

Explanation of reliability

- The transfer of the payment is done through a secure payment transfer method to the account of the driver.
- The amount of the payment is determined reliably by a standard process using the data and programs in the backend digital systems.
- The details of the payments are available for the driver to check easily.
- If there is a problem with the payment, the driver can resolve the issue by checking the data stored in the systems and by supplying other evidence.

Mark scheme

3 The top markband for this question is 7–8 marks.

7–8 marks	• The response is focused and shows an in-depth understanding of the demands of the question. • Response demonstrates sustained evaluation that is relevant and well-supported throughout. • The response is well-structured and effectively organized.

3 Answers may include but are not limited to the following ethical issues:

- The gig work app is a new way of organizing tasks to be done, and it is partially outside the legal and ethical requirements put in place by existing business regulations and union control. This means that there are few regulations, policies and laws to govern it and prevent harm to posters and taskers. This can lead to unethical actions and harmful outcomes.
- The review system in the gig work app allows for reviews from both taskers and posters, but they are not reviewed for truthfulness unless a complaint is made or if the review does not meet their guidelines. This may adversely affected Paul as well as posters, who may not be allowed to post or perform tasks. This is unethical.
- The standard of skills of the workers on the app may be incorrectly described. A tasker may be deceiving the poster if they do not have the required skills to do the work. This is unethical.
- It may be possible to post unethical tasks, for example, students may post a task for someone to do their school or university assignment. This means that cheating is being facilitated, which is unethical.
- Payment for tasks is open for some negotiation between posters and taskers, which means it may vary for a similar task. This means that taskers and posters may pay, or be paid, too much or too little. This is unethical.
- A poster may be a company that needs an extra worker for a task, but the payment could be at a lower rate than a normal worker and with worse conditions. This means the poster is cheating the tasker, which is unethical.

The following sample shows one student's conclusion for Question 3:

The most important concern that underlies many of the ethical impacts listed above is the lack of monitoring of the arrangements between the poster and tasker. The app company is basically a facilitator and is not involved in the direct interaction between poster and tasker to a significant degree.

At the centre of this concern is that the tasker lacks secure work for a stable and reliable income, and also lacks the benefits that have been developed over time for most permanent jobs. This can lead to unethical conduct on the part of the poster and the tasker as listed

in the examples. This can be seen as exploitation of taskers, especially those that struggle to get permanent work and will take on many of these tasks under unethical conditions just to make a living.

Clearly these concerns can be addressed though more ethical arrangements between the poster and the tasker, which should be monitored by the app company as the central facilitator. Specific ethical concerns can be addressed by a set of criteria that the company can apply to the arrangements between poster and tasker. These criteria would best if made into a law and monitored by the government.

The sample answer above would be awarded the top markband and goes beyond the expectations of a response written under examination conditions in terms of length and detail.

The response is focused and shows an in-depth understanding of the demands of the question:

- There are a significant number of points, relevant and pertinent, that show an in-depth and focused understanding of the ethical considerations.
- There is a final, well-justified conclusion that draws the points together, which naturally leads to a recommendation, if it was required by the question.

The response demonstrates sustained evaluation that is relevant and well-supported throughout:

- The points are relevant to the various reasons for the ethical issues.
- The points are clear and explained well, providing reasons why the situation is an ethical issue.
- A fully developed use of these points would use connecting terms such as, 'furthermore', 'additionally', 'however', 'but', 'conversely', 'likewise', 'in addition', 'on the other hand' or 'whereas' to show evaluative and analytical connections between the ethical issues.

The response is well-structured and effectively organized:

- The list of points can be well structured using the connecting terms in the previous bullet point.
- The overall conclusion compares many of the points made to form an argument.

ATL ACTIVITY

Thinking and communication

Develop a complete written response to the question using the points listed above, making connections between them and including your own version of the conclusion. Show your response to other students and your teacher for comment.

Mark scheme

4 This question focuses on the intervention evaluation criteria of cost and feasibility, which are connected to the words in the question: 'secure' and 'rewarding'.

The response needs to address the two main aspects of the question:

- **Secure work** has two interpretations – reliable, well-paid work over a significant length of time, and a safe working environment.
- **Meaningful work** is interpreted as being work that suits the worker's circumstances and is personally satisfying.

The top markband for this question is 10–12 marks.

10–12 marks	• The response is focused and shows an in-depth understanding of the demands of the question. • Response is well-supported throughout with relevant and accurate knowledge. • Recommendations are presented and well-supported with a clear consideration of possible trade-offs and implications. • The response is well-structured and effectively organized.

Top tips

Your response to Question 4 must be supported by your own inquiries, carried out as directed in the pre-release statement. Research should be done in your local community, as well as in regional, national and international news articles (references to these are not included in the sample response as it would not be possible to give them in an examination).

Top tips

These sample points are limited in length and need to be explained in more detail in your own response. They also refer to the gig worker, Paul, mentioned in the pre-release and in the examination paper. In order to show that your response is supported by your own inquiries, you should **refer specifically to people and situations from your own inquiries** instead of referring to Paul's more generic circumstances.

4 Answers may include a range of points, but are not limited to the following points:

- **Secure work** – achieved by Paul, who uses the app set up by the ride-share company:
  - Paul can find work at any time of the day.
  - Paul can find work on any day of the week.
  - Payment for the task is assured.
  - Payment for cancellation of trips is made.
  - Money is not handled by Paul, which could create a risk.
  - Paul's car can be used so the expense of buying and setting up a special one is avoided.
  - The communications technology is not expensive or hard to set up as it is based on Paul's own smartphone. All he needs to do is download the app and register with the app company.
  - The work can supplement Paul's income from his other job.
- **Secure work** – not achieved by the use of the app:
  - There can be issues when working at night or in isolated areas.
  - There are not a large number of rides available at certain times of the day, so Paul may need to wait a significant amount of time between jobs.
  - The location of pickups can be in areas that may not be safe for Paul.
  - Passengers who have used drugs/alcohol, or who might be violent or otherwise disturbed, may be encountered.
  - Passengers can provide negative ratings, which can risk Paul's chances of employment.
  - There are many drivers opting to work during busy times, which can mean less work for Paul.
  - Many rides are for short distances and do not pay much.
  - There is no sick leave, paid holidays or other entitlements that you would get in a normal job.
  - Low pay on slow times and days.
  - Paul needs to maintain his own car and pay for fuel.
  - The ride-share company could take a large percentage of the fare.
  - Little chance of job advancement and promotion for Paul.
- **Meaningful work** – achieved by Paul who uses the app set up by the ride-share company:
  - Paul can select when to work, which suits his personal circumstances.
  - The passengers are rated by Paul and other drivers, which ensures that problem passengers are not encountered often.
  - Most passengers like to have a chat during the ride, which can be meaningful and entertaining for Paul.

- Different and interesting types of passengers are encountered, which makes for interesting jobs for Paul.
- Paul does not need to go to a central location for work, saving personal time.
- Paul starts work from any location without having to commute, which can be time consuming.

- **Meaningful work** – not achieved by the use of the app:
  - There can be times when Paul has to wait a significant amount of time between rides, which can be boring.
  - No consistent contact with other workers means that Paul is usually working alone, which can be an issue.
  - Passengers can leave negative ratings, which puts pressure on Paul to be extra friendly.
  - It is difficult to obtain help from the ride-share app headquarters, which means issues and problems may not be solved easily.
  - The work can involve long hours on slow days, taking Paul away from other duties and interests.
  - Significant breaks may be difficult to obtain if Paul wants to make the most money.
  - Sitting in a car for a long time can have a detrimental effect on Paul's health.

Sample student response

The following sample shows one student's overall evaluation of the success of the ride-share app in providing meaningful and secure work for Question 4:

With regard to secure work, it is clear that a gig worker such as Paul does not have a large amount of reliable and well-paying work guaranteed over a length of time. The ride-share app allows Paul to select rides and earn money when it suits him, but there is no guarantee that he will earn enough money for his needs on any particular day or week. Paul has the advantage of the ride-share company finding work for him, which others may need to do for themselves. If he gets sick or some other circumstance happens and he cannot drive, however, then he will not earn any money, and the expenses of maintaining a car are not lessened significantly.

With regard to security at work, the dangers and risks are similar to other taxi drivers, but with the advantage of not having to carry money.

With regard to meaningful work, Paul can select when and how often to work, which suits his circumstances and provides satisfying work. The work is not boring as Paul has contact with different customers, which is meaningful. So, overall, working as a ride-share driver is to his advantage, but the work can be boring if there are few rides, or frustrating if there are a number of short rides that do not pay well. There is the added advantage that not much time is wasted with commuting or going to a central location, and the work is not physically demanding, but contact with other workers is minimal, taking away some part of job satisfaction.

Overall, the work can be secure and meaningful enough if the expectations of Paul for well-paid and very satisfying work are limited. This is the reason why many drivers do this work as a supplement to other work, or have enough other income and satisfaction to work part time. This means that, overall, the intervention is successful in meeting the challenge of meaningful and secure work for Paul, and is the reason for the success of the ride-share type intervention in the community.

The student then made the following recommendations:

Clearly, the regulation of ride-share apps needs to be discussed and negotiated by all sides – the ride-share company, the drivers (sometimes through their unions) and the government – to develop laws, regulations and policies to ensure these issues are addressed. Ride-share companies need to become proactively involved in more positive action with regard to issues noted above to avoid the need for too much government legislation. Drivers may have to put up with these issues being unresolved for a while as this process will take time.

A recommendation is that a form of binding contract be used between ride-share companies and drivers that addresses the issues that can arise between them. This can be facilitated by ride-share companies, but improving working conditions for the drivers may mean that the price of rides has to go up, which may reduce the popularity of the ride-share app.

The sample answer above would be awarded the top markband and goes beyond the expectations of a response written under examination conditions in terms of length and detail.

The response is focused and shows an in-depth understanding of the demands of the question.

- There are a significant number of points, relevant and pertinent to the focus of the question, that show an in-depth and focused understanding of the question.
- There is a final, justified evaluation, with associated recommendations, that answer the question comprehensively.

Response is well-supported throughout with relevant and accurate knowledge.

- There is a long and wide-ranging list of points that are explained with reference to actual situations from the student's research.
- Reference is made to the student's research into the issues found by local gig workers in their community.

Recommendations are presented and well-supported with a clear consideration of possible trade-offs and implications.

- Specific recommendations are made for each of these two stakeholders – the gig workers and the ride-share companies – which are based on the list of impacts and implications provided.
- There is an evaluation comment for each recommendation to show that there are implications and trade-offs associated with these recommendations.

The response is well-structured and effectively organized.

- There is a structured listing that explains a range of points, with appropriate supporting evidence, based on the two stakeholders.
- The list of points is divided, based on the two stakeholders, and evaluations and specific recommendations are made for each one.

ATL ACTIVITY

Thinking

Practise providing detailed answers to the other sample questions given below, questions from past Paper 3s, questions designed by your teacher, and others that you and your friends can think of.

Your answers need to be as detailed as possible. You can use the sample answers provided here as a model to structure your answers, especially the extended responses for Questions 3 and 4. Ask your teacher to mark your responses, and get feedback from your classmates. Your answers should be longer and take longer to prepare than you will have in the examination, but the extra effort will ensure you are familiar and comfortable with the requirements of top-ranked answers

EXAM PRACTICE QUESTIONS

Paper 3

Further practice questions of each question type (1, 2, 3 and 4) are given here for you to attempt; they all relate to the sample Paper 3 given earlier in this chapter.

1 ■ **Describe** two features of a ride-share app, such as the Uber app, that help Paul organize his gig work. *[4 marks]*

■ **Describe** two stakeholders associated with the use of gig work apps. *[4 marks]*

2 **Explain** how an app such as Airtasker uses backend technology that facilitates the linking of a gig job poster and a gig worker. *[6 marks]*

3 ■ **Evaluate** the success of such apps as Airtasker or Uber in addressing the challenge of secure and rewarding work for Paul. (Equity criterion) *[8 marks]*

■ **Evaluate** the potential that the use of apps such as Airtasker and Uber will need to be regulated by the government. (Feasibility criterion) *[8 marks]*

■ **Evaluate** the acceptability of the use of gig work apps by the stakeholders in terms of accountability and responsibility. (Acceptability criterion) *[8 marks]*

■ **Evaluate** the impact on gig economy workers of the working arrangements and conditions. (Costs criterion) *[8 marks]*

■ **Discuss** the types of change that gig work has brought about compared to more traditional types of work. (Innovation criterion) *[8 marks]*

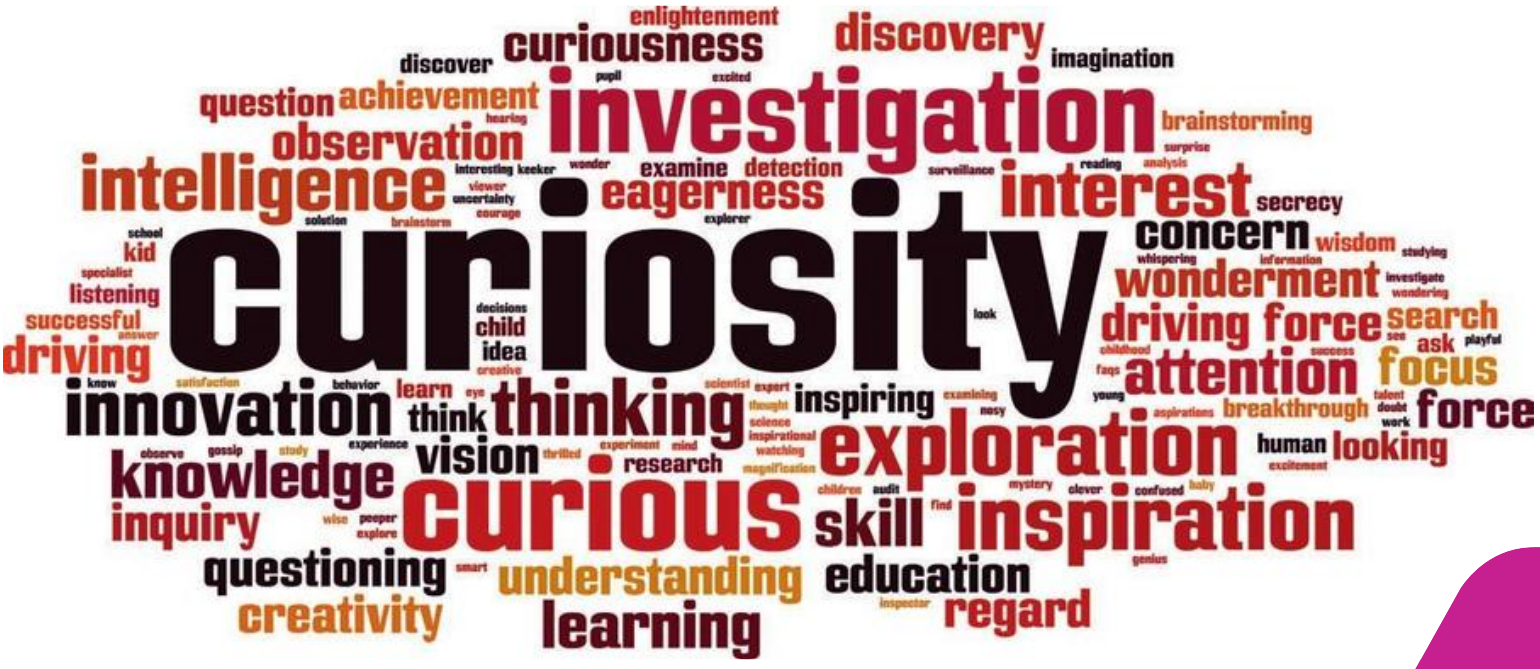
4 ■ With reference to gig work apps such as Airtasker and Uber, and your own inquiries into the gig economy, **evaluate** which one addresses the challenge of secure and rewarding work for people like Paul more effectively, including recommendations for improvement. *[12 marks]*

■ With reference to gig work apps such as Airtasker and Uber, and your own inquiries into the gig economy, and based on an evaluation of the issues that have emerged for Paul and others, **recommend** future steps that would address them. *[12 marks]*

Reflection

Now that you have read this chapter, reflect on these questions:

- Do you know how to investigate using the pre-release materials?
- Do you know how to prepare for the Paper 3 examination?
- Do you know how to approach each question in Paper 3?
- Do you know how to approach the extended response questions in Paper 3?
- Do you know how to include the results of your own inquiries into the pre-release statement into your answer for Question 4?
- Have you completed a practice Paper 3?



Section 8

Inquiry project – internal assessment

8.0 Overview of the inquiry project

The inquiry project is an individual inquiry into the impacts and implications of digital systems for people and communities. It is a common requirement for both SL and HL students. The inquiry project is 30% of the final assessment in the SL course and 20% of the final assessment in the HL course.

Approximately 30 hours of in-class time are allocated to the project, but additional time for research and development is also required.

The inquiry project involves using the inquiry process in order to:

- conduct initial research and plan an inquiry focus
- develop and refine an inquiry focus (inquiry question related to real-world examples and the 3Cs)
- explore and collect research from diverse and relevant secondary and primary sources
- investigate impacts and implications of chosen digital systems/technologies for people and communities
- develop findings and conclusions
- develop the skills required for preparing the recorded multimedia presentation
- proofread the inquiry process document (IPD) and presentation
- receive and act on teacher feedback at each stage of the inquiry process.

Inquiry project submission requirements

The following components will be zipped in one file for submission.

Inquiry project submission requirements

Inquiry Process Document (IPD)	A written document that does not exceed 1500 words in total. It has two parts: • **inquiry focus** (maximum of 300 words) • **claims and perspectives** (maximum of 1200 words). The cover page includes the topic and the total word count for the inquiry focus and the claims and perspectives.
List of references	A list of references of *all* resources used in the content and development of the project. It also includes the three sources listed in the IPD claims and perspectives. It should be included at the end of the IPD.
Presentation	A recorded multimedia presentation (maximum of 10 minutes in length). The content of the presentation should be aligned with the IPD and the list of references.

IPD

You are advised to use the following structure to ensure that it includes all required sections. The IPD will be assessed using criterion A and criterion B.

- **Cover page**
  - topic (not the inquiry question)
  - total word count in the inquiry focus and claims and perspectives
  - do not include any school information or personal identifying information.

- **Section 1**: Inquiry focus (300 words)

  Word count in Section 1: ___ words

  A Inquiry question

  Statement of the inquiry question

  B Real-world example(s)

  Description of a real-world example and the connection(s) to the inquiry question

  C Connections to digital society concepts

  Description of connection between the inquiry question/real-world example with the digital society concepts

  D Connections to digital society content

  Description of connection between the inquiry question/real-world example with the digital society content

  E Connections to digital society contexts

  Description of connection between the inquiry question/real-world example with the digital society contexts

- **Section 2**: Claims and perspectives (1200 words)

  Word count in Section 2: ___ words

  A Source in standard bibliographical format

  Three to five paragraphs (approximately 400 words in total) that address:

  – Purpose/overview: Thorough description of the claims and perspectives of the source.
  – Authority/reliability: Justify the reliability of the source/expertise of the author or creator.
  – Usefulness: Explain the usefulness of the source for the inquiry and presentation.

  B Source in standard bibliographical format

  Three to five paragraphs (approximately 400 words in total) that address:

  – Purpose/overview: Thorough description of the claims and perspectives of the source.
  – Authority/reliability: Justify the reliability of the source/expertise of the author or creator.
  – Usefulness: Explain the usefulness of the source for the inquiry and presentation.

  C Source in standard bibliographical format

  Three to five paragraphs (approximately 400 words in total) that address:

  – Purpose/overview: Thorough description of the claims and perspectives of the source.
  – Authority/reliability: Justify the reliability of the source/expertise of the author or creator.
  – Usefulness: Explain the usefulness of the source for the inquiry and presentation.

List of references

This should include *all* references in a standard format that are used for:

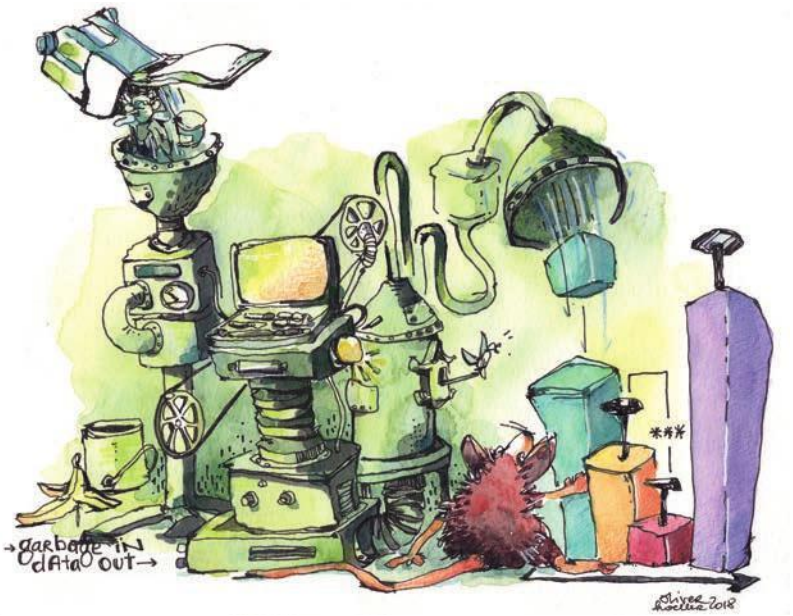
- the content of the presentation
- the development of the presentation.

Subheadings should be used as appropriate, and all three references in the claims and perspectives section must be included. For online sources, the URL and date of access must be given.

You should include:

- **Secondary research**: books/articles, audio, images and videos.
- **Primary research**: interviews, surveys, investigations.
- **Sources for development of the presentation**: applications, tutorials.

GIGO



GIGO stands for 'garbage in, garbage out' and originated in the early days of computer programming. It means that what comes 'out' can only be as good as the inputs that go 'in', and this needs to be kept in mind throughout all of the stages in the inquiry process and the creation of the presentation.

The final inquiry project can only be as good as the work that goes into its development: information collected, resources used, analysis, tools and techniques, organization and communication. Consequently, it is important to ensure the quality of your work at every stage of the process.

In a broader sense, GIGO applies to a number of real-world situations too. For example, the decisions that come out of a particular situation can only be as good as all of the information that was collected and considered when making the decision.

Presentation structure

You now need to consider how to organize your multimedia presentation and communicate effectively using the general advice offered here.

- **Introduction**: Begin the presentation by presenting both the inquiry question and the real-world example (inquiry focus) and introducing its significance for digital society – this should be the same inquiry focus provided in the IPD.
- **Setting the scene**:
  - Present supporting information in order to understand the real-world example, the use of digital technologies, and how they contributed to the impacts for people and communities.
  - Additional real-world examples and information that support the inquiry focus can be highlighted.
  - References should be made to digital society contexts, content and concepts as relevant.

- **Analysis and evaluation**: This section provides:
  - findings from both secondary research and/or primary research
  - the student's own analysis and evaluation of the impacts and implications of the digital systems for people and communities, supported by evidence.
- **Conclusion**: This must be well-supported and be relevant to the analysis and evaluation that has taken place in order to:
  - provide the answer to the inquiry question
  - present the student's new understandings and perspectives on their inquiry focus following on from their analysis and evaluation
  - present additional considerations, emerging trends and future developments.

Presentation organization and communication

Logical organization

You must consider the best approach to organize your presentation logically and communicate evidence and ideas so that they support understanding. Visual and/or audio cues should support the transition between the subtopics in the presentation.

Coherent and effective use of media and techniques

Determining the best applications and methods along with how to effectively present content requires research. Think about they ways that professionals communicate their ideas. What tools and techniques do they use?

Your presentation must integrate visuals, text and/or sound effectively so that they support understanding. This does not happen by accident.

Effective communication is also important so that the teacher and/or moderator can accurately mark your presentation.

Important considerations for an effective, coherent multimedia presentation follow here:

- An audible recorded commentary in your own voice should be used throughout the presentation. Text-to-speech tools may also be used for the recorded commentary as long as the text is your own work.
- Any audio-visual material included in the presentation needs to be seen and clearly heard. The volume of audio material needs to be reduced or turned off during your commentary to ensure that it is audible.
- Visual material must be legible and consistent with the audio track.
- All text must be legible and follow guidelines for displaying text and subtitles in presentations.
- All sources for content must be cited (for example, source of images, video, audio, interviews). Text and audio is advised so that the source is clear at the point at which it is being used.

Inquiry process for developing the inquiry project

It is important to follow a step-by-step inquiry process throughout the development of the inquiry project. The following table outlines the steps in the process and the necessity for on-going feedback from the teacher.

■ Steps in the inquiry process for developing the inquiry project

Inquiry process	Student action	Follow-up with teacher
Determine inquiry focus	**1** Identify the inquiry topic and initial inquiry question. Plan your timeline for developing and submitting the inquiry project as required. Conduct initial secondary research and draft the inquiry focus, which explains the connection between the inquiry question, the specific, relevant real-world example(s) and course concepts, content and contexts. Include a list of references for those sources used thus far. At this stage it is too early to enter any information under the claims and perspectives heading.	**1** Check if the inquiry topic is appropriate for digital society and seek advice on how to conduct further secondary and primary research. Discuss the draft of the inquiry focus with your teacher and the next steps in conducting research.
Explore	**2** Conduct secondary research, collect relevant visual evidence and note the sources in a social bookmarking service such as Diigo, Pinboard or other application. As you conduct your research, enter resources in your list of references using any standard format. **3** Collect primary material and data for the presentation, for example photos, screenshots, video footage, surveys, interviews, observations and investigations.	**2** Discuss findings and visual evidence with your teacher and determine any further secondary research that may be needed. Discuss findings up to now and reflect on what primary research is needed as evidence. **3** Check with your teacher whether the material you have collected is appropriate or if additional research is required.
Analyse and	**4** Analyse and evaluate evidence collected and how it relates to your inquiry focus.	**4** Discuss with your teacher whether your analysis/evaluation is appropriate or if it requires more depth or breadth.
Reflect	**5** Reflect on your findings. Draft the IPD. Finalize the list of references.	**5** Present your work to your teacher according to the established internal deadlines and make adjustments based on the feedback provided.
Communicate	**6** Begin planning the approach for your multimedia presentation and determining the best tools, techniques and content to use. **7** Create a draft storyboard for your multimedia presentation (see Chapter 8.5). **8** Create a detailed storyboard with screens, descriptions and citations. **9** Write the script for the storyboard for each screen or section of the multimedia presentation. Include evidence and audio citations. **10** Develop your multimedia presentation using best practice for the media that you are using. Aim to produce a quality product. **11** Finalize the IPD by writing the claims and perspectives section and proofreading the inquiry focus. **12** Submit your IPD, list of references and multimedia presentation.	**6** Seek your teacher's advice as needed on tools, techniques and organization of content. **7** Discuss your storyboard with your teacher. **8** Show your storyboard to your teacher to make sure it follows an organized, logical sequence. **9** Make sure to follow your teacher's guidance. **10** Present your work to your teacher according to the established internal deadlines. **11** Make adjustments according to the feedback provided by your teacher. **12** Submit your work to your teacher according to the established internal deadlines.

The use of the inquiry process in the inquiry project will be considered in more depth in the following chapters. You are advised to read these chapters as well as consulting the *Digital Society Guide*. Topics include:

- how to meet the assessment criteria for the inquiry project
- the skills required to complete the inquiry project successfully
- the tools and methods required
- how to manage the inquiry project
- a step-by-step guide through a practice inquiry project.

8.1 Developing an inquiry focus

UNDERSTANDINGS

By the end of the chapter, you should understand:

- how to identify an inquiry focus
- appropriate topics for a digital society inquiry project
- what is required in the inquiry focus for the digital society inquiry project
- how to formulate an inquiry question
- how extensive your exploration needs to be.

The inquiry focus in the IPD

Criterion A of the digital society inquiry project states:

> *The inquiry process document provides an inquiry focus with an explanation of the connection between the inquiry question, a specific, relevant real-world example as well as course concepts, content and contexts.*

For full marks in this criterion:

> *The focus includes an inquiry question and a thorough explanation of its connection to a specific, relevant real-world example and course concepts, content and contexts.*

The maximum word count for the inquiry focus section is 300 words.

Where do we start in order to identify an inquiry focus?

You need to identify a digital society topic of interest. In order to do that, you can start by researching a real-life example, a news item or several secondary sources that cover the same or similar topics. Through searching and reading relevant news items, watching videos and/or listening to podcasts in a digital society area that interests you, you will be able to rule out topics that do *not* have sufficient material available to develop a meaningful project, as well as identify topics that do allow for meaningful investigation.

You will probably be able to identify one, or a few, topics that not only interest you but which can meet the requirements of the digital society inquiry project through deep exploration, analysis and evaluation. Once you have selected one or a few topics, you need to decide which topic will be the core of your investigation. Keep in mind that your topic must be focused enough so that you are not overwhelmed with too much information.

What topics can be used for a digital society inquiry project?

You need to look for topics that:

- deal with digital systems that impact people and communities
- present opportunities for secondary and primary research
- have an element of uniqueness in the topic, perspective or approach taken to develop the inquiry.

For example, when you think of a smartphone and how much it has impacted a specified individual or group, you are thinking of a digital system that would be appropriate for an inquiry project.

The same can be said for social media, robots or digital technologies, such as autonomous vehicles. In fact, almost every digital system has impacts, as well as potentially having the power to transform our society for good or bad.

Look for a topic that inspires you and is something that you would enjoy exploring. You should avoid topics that might have been over-explored already, however. When you investigate a topic that has been explored many times in the past already, there will be a tendency to compare your work with previous work, which will not be beneficial. Your topic needs an element of uniqueness in order to impress your audience.

Key ideas to help you find your topic

Make sure that your topic:

- inspires you and is one that you would enjoy exploring
- focuses on a digital system that has impacts on individuals and societies
- allows for sources to be obtained that provide differing claims and perspectives
- is recent and has an element of 'uniqueness'
- allows for primary investigation and/or research
- allows for a range of appropriate secondary sources to be accessed.

What is required in the inquiry focus?

Your inquiry focus must address digital society concepts, content and contexts. You can check the list of concepts, content and contexts in the syllabus outline in the *Digital Society Guide* or in this textbook.

Formulating an inquiry question

After selecting a topic, your next step is to formulate a concise and focused inquiry question related to this topic that is worth exploring. Your inquiry question will identify the focus of your inquiry project and will direct the entire development of your project. The final goal of your project is to provide a coherent answer to this question.

The inquiry question must not be one with an obvious answer, for example: 'Can the use of smartphones in the classroom have a negative impact on learning?' Anyone, with or without a digital society background, can think of several reasons why using a cell phone during a lesson may not be good for learning – most of those reasons would probably be associated with distraction. A 'yes/no' question is not appropriate either.

In the example provided, a much better question might be: 'To what extent does the use of smartphones in the classroom have a negative impact on learning?' However, this is still a question with obvious answers and lacks balance between positive and negative impact. Therefore, the inquiry question requires more refinement.

Continuing in this scenario, you might learn that the DP biology teacher and students make extensive use of smartphones in the classroom. You might contact the biology teacher informally, which results in a more-refined inquiry question to pursue: 'To what extent does the use of smartphones in the biology classroom benefit the teaching and learning that takes place?' This question is more interesting, since its answer is not so obvious and the research and investigation has the potential for uniqueness arising from the secondary research and also from the local DP biology class. The DP biology teacher may also be able to give helpful guidance for the secondary research. The local situation may also provide the possibility for primary research through interview, survey, observations and investigations in becoming familiar with the approaches being used in the biology classroom.

Broad topic (yes/no question is not suitable)	Can the use of smartphones in the classroom have a negative impact on learning?
Refined question	To what extent does the use of smartphones in the classroom have a negative impact on learning?
Inquiry question	To what extent does the use of smartphones in the biology classroom benefit the teaching and learning that takes place?

Steps to formulating your inquiry question:

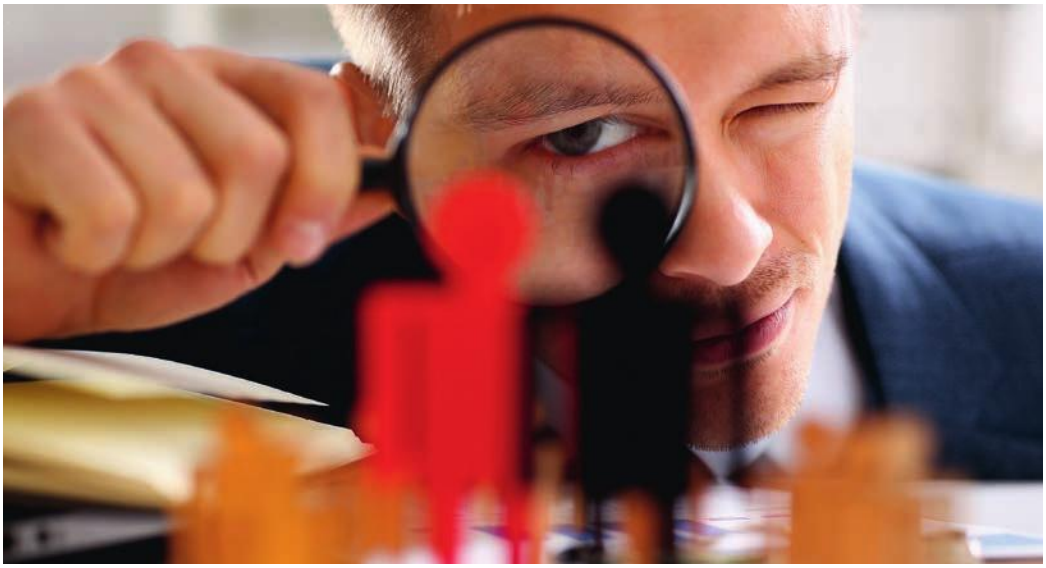
- Identify what interests you about the topic you intend to explore and what makes it unique.
- Ensure your inquiry question is focused and stated concisely.
- Perform preliminary research to learn more about the topic to ensure the inquiry project is viable.

- Avoid simplistic research questions (such as 'yes/no' questions) and vague wording (such as 'easy' and 'good').
- Avoid broad topics that cannot be covered in the 10-minute limit for your multimedia presentation.

Formulate an inquiry question that is:

> *… open-ended, thought-provoking and worth considering from different perspectives.*
>
> Digital Society Guide

Keep your focus



Once you have formulated your inquiry question and identified the course concepts, content and contexts connected to it, this is where your focus must be. All your exploration must be focused on answering your inquiry question, and so must be your presentation. As you progress through the research and the development of your inquiry project, constantly ask yourself whether what you have written is relevant to answer your inquiry question. Anything that is not relevant is off-course and should be removed.

How thorough does my exploration need to be?

Your exploration needs to be as thorough as possible. Anyone can formulate an opinion about almost anything and support that opinion with shallow information that they heard from somebody or found somewhere. Digital society students are expected to demonstrate that they understand how to:

- conduct academic research and provide supportive evidence
- investigate the truth related to an inquiry question thoroughly
- discuss their findings with authority supported by evidence.

Inquiry focus example

Let's examine an example of the preliminary steps taken in the development of an inquiry focus and the inquiry focus section of the IPD.

1. Research through various news items until one topic of interest is located. During the search, a news item published by the BBC on 13 September 2021 was found. The headline is 'Fake Walmart news release claimed it would accept cryptocurrency'.

Reading through the article, one learns that the fake news release caused the value of Litecoin to jump from £125 per token to nearly £170, before it was deleted.

The topic selected was 'fake news and its social and ethical impacts'.

2 Formulate a provisional inquiry question: 'To what extent can fake news about cryptocurrencies cause economic damage for customers and businesses?'

3 Identify course concepts, content, and contexts that have a connection to this inquiry question.

Looking through the topics in the 3Cs in Section 2 through Section 4, this question can be connected to: values and ethics (concept), media (content) and economic (context).

4 Write the IPD inquiry focus section on fake news and its social and ethical impacts.

IPD EXAMPLE

Section 1: Inquiry focus

Word count: 286 words (headings are not counted)

Inquiry question

To what extent can fake news about cryptocurrencies cause economic damage for customers and businesses?

Real-life example

The cryptocurrency Litecoin had a sudden surge in price because of a press release saying that Walmart would accept payment in Litecoin in all of its digital stores. Walmart later stated the announcement was a fake. However, by that time the story had already been made public on both the GlobeNewswire service, which is used to distribute company press material widely, and the official Litecoin Twitter account. When the release was published as fact, the price of Litecoin jumped from about £125 per token to close to £170, before falling back near its original price, at £128.

Connections to the 3Cs

- **Concepts** (connects the real-world example above to specific concepts)

  Values and ethics are ways to determine what is right and wrong, fair and unfair, just and unjust, legal and illegal, proper and improper. Fake news is unethical and, in some countries, it is also illegal. Fake information about Walmart accepting Litecoin for payment aimed to give those who created the fake news an unfair economic advantage at the expense of others, who end up suffering financial losses.

- **Content** (connects the real-world example above to specific content)

  Media such as GlobeNewswire and Twitter have an obligation to spread news as quickly as it is received, often without checking the source and accuracy of the information thoroughly. The ethics of media is often superseded by its need to spread breaking news before everyone else, regardless of the damage it can cause if the information is found untrue.

- **Contexts** (connects the real-world example above to specific contexts including impacts and stakeholders)

  Economic impacts: Fake news about cryptocurrencies has the power to cause abrupt changes in the stock market, causing irreparable losses to customers and businesses. Those who published the fake news expected high profits from the anticipated increase in the value of Litecoin before the value dropped again.

ACTIVITY

Practice developing an inquiry focus

Let's suppose you have an interest in facial recognition, which is a relevant area to study. It is also extremely broad. However, you will need to conduct preliminary research into facial recognition and consider a range of articles on the topic.

One news item was published by the *Guardian* on 11 August 2021, called 'TechScape: Is Apple taking a dangerous step into the unknown?'

This article is very rich in material and can be used to trigger a deep exploration that will answer a thought-provoking inquiry question.

1. Search for this article on the internet, read it and list some areas connected to it that you could explore in more depth in order to create a meaningful inquiry project and multimedia presentation. If you cannot find this particular article, look for an article with a similar topic. A summary of the technology is given here:

> *Apple's tool, called neuralMatch, will scan images before they are uploaded to the company's iCloud Photos online storage, comparing them against a database of known child abuse imagery. If a strong enough match is flagged, then Apple staff will be able to manually review the reported images, and, if child abuse is confirmed, the user's account will be disabled and the National Center for Missing and Exploited Children (NCMEC) notified.*
>
> *Source:* **www.theguardian.com/technology/2021/aug/06/apple-plans-to-scan-us-iphones-for-child-sexual-abuse-images**

2. Formulate a thought-provoking inquiry question based on the article above. The question must not have a simple answer and must not use vague words.
3. Identify concepts, content, and contexts connected to your inquiry question.
4. Write a draft inquiry focus section in an IPD with no more than 300 words.
5. Compare your work with at least two of your peers. Comment on what you like about their work or what you would change, and on what you would change in your work after what you have seen theirs. Note that this collaboration is only appropriate for this practice activity – in the actual inquiry project you must work individually.

8.2 Assessment criteria and working with sources

UNDERSTANDINGS

By the end of the chapter, you should understand:
- how to achieve high marks for the digital society inquiry project
- how to use citations and references appropriately.

The *Digital Society Guide* provides the assessment criteria that are used for the assessment of the inquiry project. The criteria are the same for both SL and HL inquiry projects.

The following checklist provides additional detail that may help you to maximize your marks. You should use both the assessment criteria and the question checklist as you develop your inquiry project.

Checklist for inquiry project assessment criteria

Requirements for the IPD

Two sections of the IPD are assessed:

- inquiry focus – the inquiry question, the real-world example and the digital society concepts, content and contexts
- claims and perspectives.

The list of references for the entire inquiry project should be included at the end of the IPD.

Criterion A: Inquiry focus (3 marks)

- Does the inquiry focus have a concise and focused inquiry question?
- Does the inquiry focus have an inquiry question that can be researched?
- Does the inquiry focus include a description of a relevant, real-world example involving digital systems and/or digital technologies?
- Does the inquiry focus include a thorough explanation of the connection between the inquiry question, the real-world example and the related digital society concepts, content and contexts?
- Is it a maximum of 300 words?

Criterion B: Claims and perspectives (6 marks)

- Have three sources been used for the claims and perspectives?
- Are the three sources included in the list of references?
- Are there source references, headings, labels and captions as appropriate? (Note that these elements do not count against the word limit for this section.)
- Is each source:
  - relevant and appropriate to the inquiry focus
  - contemporary (not more than three years old)?
    NOTE: this is not a requirement, but it is highly recommended (see Key ideas, page 422).
- Is there a discussion addressing each source's origin and purpose, meaning and methods as well as corroboration and use?
- Is there a thorough discussion of the claims and perspectives of each source?
- Is there a justification of why the sources are useful in the inquiry?
- Do the sources provide a balance of claims and perspectives?
- Is the section a maximum of 1200 words?

Requirements for the presentation

- Does the presentation align with the content of the IPD?
- Does the presentation address the inquiry question in a well-structured and organized manner?
- Does the presentation use visual material, text and/or sound to communicate effectively?
- Is the student's commentary audible and free from extraneous sound that interferes with the quality?
- Does the presentation use subtitles and text where necessary to effectively support communication?
- Does the presentation display and/or present audio citations appropriately?
- Is the presentation a maximum of 10 minutes in length?

Criterion C: Analysis and evaluation (6 marks)

- Is the analysis balanced?
- Is the analysis sustained and well-supported by evidence?
- Does the analysis address all parts of the inquiry focus?
- Does the evaluation build on (rather than restate) the analysis?
- Does the evaluation provide opinions underpinned by the analysis?
- Does the evaluation show evidence of original thinking?
- Does the evaluation relate to the inquiry focus and the inquiry question?

- Does the evaluation consider the impacts and implications of the digital systems for people and communities?

Criterion D: Conclusion (6 marks)

- Does the conclusion address the inquiry question with supporting evidence?
- Does the conclusion provide additional insights into the inquiry focus following on from the analysis and evaluation?
- Does the conclusion provide a thorough and substantiated discussion of emerging trends and future developments that relate to the inquiry focus?

Criterion E: Communication (3 marks)

- Does the presentation communicate effectively through its organization of ideas and supporting material?
- Are the various media used coherently and integrated seamlessly.

List of references (document) and citations within the presentation

You must include all sources in a standard format that were used in developing the presentation (all content material, resources and techniques). There is no word limit for this content.

References must be:

- consistently and appropriately cited (written, visual and/or verbal) at the point of use in the presentation
- logically organized (alphabetical, or in order of use in the multimedia presentation)
- listed in a standard format with complete information, for example using one of the following styles:
  - MLA (Modern Language Association)
  - APA (American Psychological Association)
  - Harvard
  - Chicago/Turabian.

Note that references to online sources must include the URL and date of access.

8.3 Skills for the inquiry project

UNDERSTANDINGS

By the end of the chapter, you should understand how approaches to learning (ATL) skills contribute to developing a successful inquiry project:

- self-management skills
- thinking skills
- communication skills
- research skills
- social skills.

One of the most significant outcomes of the inquiry project are the skills that you will develop. These skills are vital for the quality of your project, and they will be important for future studies and life as well. In the paragraphs that follow, we will explore the ATL skills that are necessary for the development of a successful digital society inquiry project.

Self-management skills for the inquiry project

Self-management involves both knowing what to do and having the ability to manage all of the stages involved in the inquiry process and when developing the multimedia presentation, IPD and list of references. You must know how to avoid distractions while working on a task, so that you can maintain focus and stay productive.

Self-management skills focus on personal responsibility in the following areas:

- **Organization**: You need to be organized with your allocation of time, physical space, energy and mental capabilities in order to achieve your goal of developing an excellent inquiry project.
- **Goal setting** is the ability to determine what you want to achieve with your project in a clear and well-defined manner. It enables you to manage your time and actions.
- **Time management** allows you to prioritize tasks, avoid distractions, maintain focus and meet deadlines. It is necessary to work to a timeline in order to complete all of the stages in the inquiry process and to develop all of the components of the inquiry project.
- **Self-motivation** is the driving force in taking the initiative and completing tasks. In order to be self-motivated, your inquiry focus must be one that you are personally interested in developing.
- **Stress management**: Handling stress before it becomes an issue will allow you to focus on your project and make steady progress. Whenever you face a challenge, it is best to consult with your teacher for guidance.
- **Accountability** is the act of taking personal ownership of your thoughts and actions. When you maintain responsibility, you're better equipped to evaluate your work and determine the best way to proceed to complete your project.

At the outset of the inquiry project, you are advised to identify your inquiry focus and the subtopics that emerged from your preliminary research used to formulate your inquiry question.

Thinking skills for the inquiry project

Thinking skills refer to the abilities of:

- processing information, selecting relevant pieces of information and ignoring irrelevant ones
- storing and retrieving information, and arranging it so that it can be used more effectively
- breaking information down in order to understand it in more depth
- making connections and combining information
- evaluating ideas in order to present and defend points of view, make decisions, produce new information, or create new ideas or ways of viewing things.

Your creative and critical thinking skills will be constantly required throughout the development of your project.

Identifying your inquiry question

To begin with, you will need to identify the inquiry question by researching articles and news items until you find a topic that seems worth investigating (this is discussed in detail in Chapter 8.1). Questions you might ask yourself include:

- Is this a topic that I will enjoy exploring?
- Will this topic be interesting to those that will watch my presentation?
- Will I be able to find enough relevant material for this topic?
- What inquiry question can be asked about this topic that will grab the attention of my audience?
- How can I make this question specific and not too broad?

Developing your inquiry project

After you have decided on your topic and the inquiry question, you will need to keep your inquiry focus in mind throughout the project. Again, thinking skills will be required:

- You need to find several sources that present different perspectives and points of view.
- You need to make certain that you are not selecting only data that supports your initial view.
- You also need to evaluate the credibility and reliability of your sources of information and establish which information is most important to address the inquiry question.
- You need to gather, analyse and evaluate sufficient evidence for the conclusion of your presentation.
- Finally, you need to think about the best way to present all your relevant material and findings in your multimedia presentation.

Communication skills for the inquiry project

In the context of the inquiry project, these skills refer to organizing your presentation in such a way that:

- its structure has a logical flow, clearly highlighting the inquiry focus
- the 'right' presentation is delivered to the 'right' audience (in this case, the examiner that will assess your work), providing solid research and evidence so that they are interested in the presentation
- the speaking is clear and concise, uses audio tracks relevant to the context being presented, and there is no extraneous noise or other distracting audio tracks
- arguments are formulated in a convincing manner, creating a presentation that connects directly to the inquiry focus and inquiry question
- there is sufficient evidence to answer the inquiry question and leave the examiner with a strong final impression
- a connection is made to the inquiry focus and inquiry question, and with a clear understanding of the points that were explored.

For a successful video presentation, you will need to produce content and communicate it effectively through a variety of digital media tools. This is more than knowing how to use a word processor or write an email – it includes being able to create and communicate using rich media such as images, photographs, text, video, speech and sound. In order to do this for your multimedia presentation, you are most likely to use a video production application and/or slideshow presentation.

Video presentations

A video presentation must have professional-like quality, have good audio and video quality, be within the 10-minute time allowance and, above all, must be relevant to the topic.

It is best to use original video and visual material whenever possible. Original primary research, such as interviews, observations and investigations, often contribute to video footage and other visual evidence.

Slide show presentations

A useful rule for a slide show presentation is the '6 × 6 rule'. It limits any text to six words per line and six lines per slide for legibility and conciseness. Too much text can be monotonous and tiring for audiences to read. You must refine your thoughts into short lines and use the narration to expand them in more detail. Be careful to time your presentation, however, to ensure your narration matches the correct slide.

The presentation must be dynamic, so that you keep the attention of your audience. Presentation expert David JP Phillips provides the following tips for creating engaging presentations:

- deliver one message per slide
- avoid text sentences
- make the most important element of the slide the biggest in size
- use contrast to steer focus
- use a maximum of six objects on a slide
- use a dark background.

Presentation guidelines

In order to combine your research, short videos and recordings into a meaningful and interesting 10-minute video, you should consider these guidelines:

- **Your topic must excite you**. If you are really eager to learn more about the topic you are investigating, chances are your presentation will be exciting.
- **Learn everything you can about your topic**. Go deep, gather facts and search for leads on interesting characters and storylines. The gems of your research are sometimes buried deep out of sight.
- **Make a plan**. The planning phase typically accounts for 50% of the time you will spend on your presentation – it's that important. The better you prepare, the smoother filming and editing will go. For instance, if you know exactly what shots you're looking for, shooting them is quick and they require fewer edits. Create an outline. Think about how you're going to share your findings. What's the structure? The style? Is there existing footage or photos that help develop your arguments, or will everything need to be shot brand new? Where will your primary sources come from? What are the most important points of your topic that you want to emphasize? What are the most compelling elements of your topic? How can you keep the audience interested in your presentation from beginning to end? It can be difficult to hold the viewer's attention, so think about visual ways to keep people engaged throughout the whole video. Is there some relevant fact you can film, or can you use some short video that has already covered the same topic?
- **Create a shot list**. This is a list of the footage and interviews you'll need to make your presentation.
- **Plan your interviews**. Often the best way to learn about people and their experiences or expertise is through their own words. Most expository, participatory, observational, and performative documentaries contain interview footage. Don't be afraid to ask questions that might seem dumb or obvious. You never know how many viewers have the same questions but have been afraid to ask, or where those answers might lead. Follow these up with informed questions based on your research.
- **Start shooting**. Keep in mind that your video will mainly be viewed by one or more IB examiners, because that can dictate your shooting and storytelling style. When you're shooting an event, be sure to capture a variety of angles including close-ups, medium shots and wide shots.

- **Capture a lot of footage**. As you shoot your video, you won't really know what it will be or where it will go, so try to capture everything. This takes the pressure off from trying to get the perfect shot or interview.
- **Organize your footage** and all the elements of your presentation. Don't lose footage that you worked hard to collect. Download everything to your computer device and keep a cloud storage backup. Arrange everything in properly named folders, so that you can find what you need quickly when the time comes to create and edit your full video.
- **Write a script**. Once you have collected your short videos from other sources, your slide shows are ready and all of your original footage is shot, it is time to start organizing it into a script. Although your project video will not be scripted like a professional film, you can create a broad outline or even draw up storyboards to help you think about the footage you need and the possible directions your presentation might take. Pinpoint the most compelling elements of your topic and start crafting 'mini scenes' around those events. Remember, a script isn't necessarily what's spoken or a voice-over. A script describes what the audience is seeing and hearing.
- **Begin editing**. Once you're all set with equipment, you need to start putting down your elements in a sequence. The art of editing is to create a 'roller coaster' ride of emotion – with some fast parts and some slow parts – to produce a dynamic viewing experience.
- **Start with a hook**. Many film trailers start in the middle of the story or action, then jump back to explain to viewers how they got there. You might try that in your video to catch the attention of the viewers. That out-of-order introduction is your hook.
- **Include voice-over narration**. This is extremely important for the digital society inquiry project, so that you can provide important information or explain who's who to your viewers.

  For slide shows, keep in mind that some action must be happening while you are talking, for example an arrow moving and pointing to a specific area of the slide or some sort of highlighting a sentence. Watching an image stuck on the screen without any action for more than 15 seconds can be very tedious. Likewise, be careful to not overdo the action – it can distract the viewer's attention and can be quite annoying.
- **Create animated title sequences** that engage your viewers from the start. You can also use graphics to give your viewers details such as the time, place and the names and titles of interview subjects.
- **Be prepared to rewrite your script**. You need to recognize that sometimes things don't go as anticipated, and you might need to rewrite your script and reorganize elements of your video.
- Make sure that your presentation is **clear and concise**, and that your narration is spontaneous.
- Make sure that your final product does **not go over 10 minutes**, since this is the limit determined in the digital society inquiry project criteria.

In addition to these points, further requirements of the digital society inquiry project need to be taken into consideration:

- Any **audio facts and figures need visual evidence**, for example creative use of text, diagrams, images and video to get the message across. It is too difficult to simply listen to statistics. Also keep in mind that the visuals on the screen need to support the audio.
- **Sources of evidence** need to be included within the inquiry project where relevant. For example, if the audio track refers to the author/originator of the particular item, it should also be cited in a small font on the presentation. Citing sources adds validation to the content being presented.
- The sections of the video should be clearly **organized** into parts that are aligned with the assessment criteria.
- Use **original content** wherever possible.

Research skills for the inquiry project

These skills refer to the abilities of knowing how to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills.

In order to develop a successful digital society inquiry project, you need to know how to:

- carry out basic internet searches for sources that will help you to answer your inquiry question; Google and Wikipedia may not always be reliable, but they are very helpful as a starting point to help you find a topic
- narrow and refine search queries to get better research results
- locate and extract information that is relevant to the inquiry focus
- organize the information that you find – you will be seeing a huge amount of information, from web pages to PDFs to videos; if you are unable to keep this information organized in some way, you may lose it or you might not be able to cite something correctly
- evaluate information found on the basis of accuracy/trustworthiness, validity, appropriateness for needs, importance, and social and cultural context, for example by:
  - checking whether the source agrees with other sources that you have found
  - checking that the author is an expert in the field
  - verifying information from several sources (rather than going off of one webpage, make sure that at least two other places say something similar)
- pursue further information to gain a broad perspective (exploring deeper than the first options)
- review, analyse and interpret information in a manner that brings up a solution
- avoid distractions and make good use of your time
- respect the intellectual property rights of other creators and producers, using citations or getting permission to reproduce material.

You are expected to have the necessary technical fluency needed to engage with computers and the internet. You should know how to use computer programs such as word processors, web browsers, email and other communication tools, such as wikis, blogs, image manipulation software, presentation software and video creation/editing software, etc. to showcase learning.

It is also expected that you will have or acquire more sophisticated abilities for accessing and using knowledge resources, such as search engines, online databases and cloud computing. It will be necessary to know how to download images from the internet and insert them into presentation slides or videos, in addition to using alternative text for images to support those with visual disabilities.

Your research will be considered good if you are able to find good evidence to answer your inquiry question. At times you might find that the answers you get contradict your original beliefs, so keep an open mind. Research is not about confirming what you already know, but about learning as deeply as possible about the topic you are exploring.

A final piece of advice on this topic: remember to use library resources as well as internet resources. Be sure to check out library websites for research guides or access to specific databases.

Social skills for the inquiry project

During the development of your digital society inquiry project, you will need to interact with several people.

- Your teacher will introduce the internal assessment requirements and expectations, and will guide you with directions for the project. As you get started and move on the development of your project, you will need to approach your teacher frequently to present your work, discuss any questions and seek confirmation that you are on the right path. Do not wait until the last minute to come to your teacher – this is something that needs to happen regularly throughout your project (see 'Inquiry process for developing the inquiry project' in Chapter 8.0).
- Although the digital society inquiry project is an individual project, you might need some help from other teachers and peers in order to learn how to use the necessary software to create your presentation. You cannot have someone else do the work for you, but you are allowed to seek help so that you learn how to do the work.
- For a successful project, part of your project needs to include primary research. You may need to interview people or create and perform surveys. Plan ahead for these situations. Spend some time identifying relevant people to interview who can truly contribute to your project findings. Then, contact that person to learn if they would be available and willing to answer your questions. Once you get confirmation, make an appointment. Prepare your questions carefully and make sure they are meaningful for the topic. Dress appropriately for the interview, and act in a friendly but professional manner, especially if you are approaching high-ranking people.

8.4 Tools and methodologies for the inquiry project

UNDERSTANDINGS

By the end of the chapter, you should understand:

- the web tools that can help you with your inquiry project
- the methods of inquiry that can be used for your inquiry project
- the tools that can be used for data collection.

Information technology tools for research

A significant number of web tools can help you in your inquiry. The list below is just a sample of web tools and it is by no means exhaustive. Hopefully, it will give you a good idea of where to start.

- Search engines, such as Google, Bing and Baidu, or more academic search engines such as Google Scholar, Library of Congress, and so on.
- Social bookmarking, research and knowledge sharing tools, such as Diigo (**www.diigo.com**) and Pinboard (**https://pinboard.in**). You can use them to bookmark and organize relevant news items as you find them, so you can easily find them again later when you are working on your inquiry project.
- Personal dashboards, such as Netvibes (**www.netvibes.com**). You can place IT news sites on the dashboard and the RSS feeds will do the rest. You will be able to see new IT news headlines every day.
- Software that helps with the creation of surveys and the collection of results, such as Google Forms, Surveymonkey and MS Forms.
- For the presentation itself, there is a plethora of great software available, including text editors, image creation, photo-editing software, presentation software, video editors, and screencasting tools. You are advised to research 'design guidelines' and 'best practice' for the tools that you plan to use to create your multimedia presentation.

For a complete list of tools that may be beneficial for the development of your inquiry project, search the internet for 'toptools4learning' – you will find useful tools out there that you did not even know existed!

Methods of inquiry

Research can be divided into two types:

- Quantitative research, which deals with numbers and statistics. Quantitative methods allow you to systematically measure variables and test hypotheses.
- Qualitative research, which deals with words and meanings. Qualitative methods allow you to explore concepts and experiences in more detail.

Although there are possibilities for quantitative research in the digital society inquiry project, most of your research will be qualitative. Qualitative research is generally used to explore values, attitudes, opinions, feelings and behaviours of individuals and to understand how these affect the individuals in question.

Researchers using qualitative methods are concerned with individuals' perceptions of specific topics, issues or situations, and the meanings they assign to their lives. This kind of research is important for generating theory, developing policy, improving educational practice, justifying change for a particular practice, and illuminating social issues. It may also be used to explain the results of a previous quantitative study or to prepare for the development of a quantitative study.

Links

This content links to Section 3.1B Types of data.

Qualitative methods include data collection through interviews, observation, discussions and review of documents (such as diaries and historical documents). The results of qualitative research are descriptive or explanatory rather than predictive, and are typically time-consuming to collect and analyse.

Qualitative data collection methods play an important role in impact evaluation by providing information that helps us to understand the processes behind observed results and assess changes in people's perceptions of their well-being. Furthermore, qualitative methods can be used to improve the quality of survey-based quantitative evaluations by helping to generate evaluation hypotheses, strengthening the design of survey questionnaires and expanding or clarifying quantitative evaluation findings. These methods are characterized by the following attributes:

- they tend to be open-ended and have less structured protocols (for example, researchers may change the data collection strategy by adding, refining or dropping techniques or informants)
- they rely more heavily on interactive interviews; respondents may be interviewed several times to follow up on a particular issue to clarify concepts or check the reliability of data
- they use triangulation to increase the credibility of their findings (that is, researchers rely on multiple data collection methods to check the authenticity of their results)
- usually their findings are not generalizable to any specific population, rather each case study produces a single piece of evidence that can be used to seek general patterns among different studies of the same issue.

Regardless of the kinds of data involved, data collection in a qualitative study takes a great deal of time. The researcher needs to record any potentially useful data thoroughly, accurately and systematically, using field notes, sketches, videos, audiotapes, photographs and other suitable means. The data collection methods must observe the ethical principles of research.

Tools for data collection

Methods used for data collection could include questionnaires, interviews, observation and investigative techniques. The process for collecting data must be carefully considered to avoid bias and provide for sufficient and reliable data collection.

Questionnaires

A questionnaire is a list of questions related to one topic. A good questionnaire:

- deals with an important or significant topic
- clearly states its purpose, either on the questionnaire itself or on its covering letter
- only seeks to collect data that cannot be obtained from resources such as books, reports and records
- is as short as possible – it should only be long enough to gather the essential data
- is attractive in appearance, nearly arranged and clearly duplicated or printed
- has clear and complete directions, and important terms are clarified
- has objective questions with no clues, hints or suggestions
- presents questions in an order from simple to complex
- avoids double negatives, adverbs and descriptive adjectives
- avoids 'double barrelled' questions (putting two questions in one question)
- includes questions with an adequate number of alternative answers
- is easy to tabulate, summarize and interpret.

Interviews

An interview is a two-way method that permits an exchange of ideas and information. A good interview:

- can probe into causal factors, determine attitudes and discover the origin of the problem
- deal with young children and people of differing levels of education appropriately
- can make cross questioning possible to better judge the sincerity, frankness, truthfulness and insight of the interviewee
- helps the investigator to gain an impression of the person concerned
- can deal with delicate, confidential and even intimate topics
- has flexibility
- does not allow interviewees to change their earlier answers.

Observations

Observation is an objective, direct technique of evaluation in which behaviour is observed in natural situations to study an object, an event or a problem. Good observation:

- is planned systematically to serve a research purpose
- is related to more general propositions and systematically recorded
- is subject to checks and controls with respect to validity, reliability and precision
- establishes a cause-and-effect relationship
- is both an objective and subjective evaluation technique
- can be formal or informal
- can be quantitative as well as qualitative.

Investigations

Investigations involve examining original documents, policies, laws, publications, photographs, video footage or events to determine to what extent a claim is true. It can also include experiments with digital technologies to demonstrate how a particular outcome was achieved in a real-world example. Good investigative techniques:

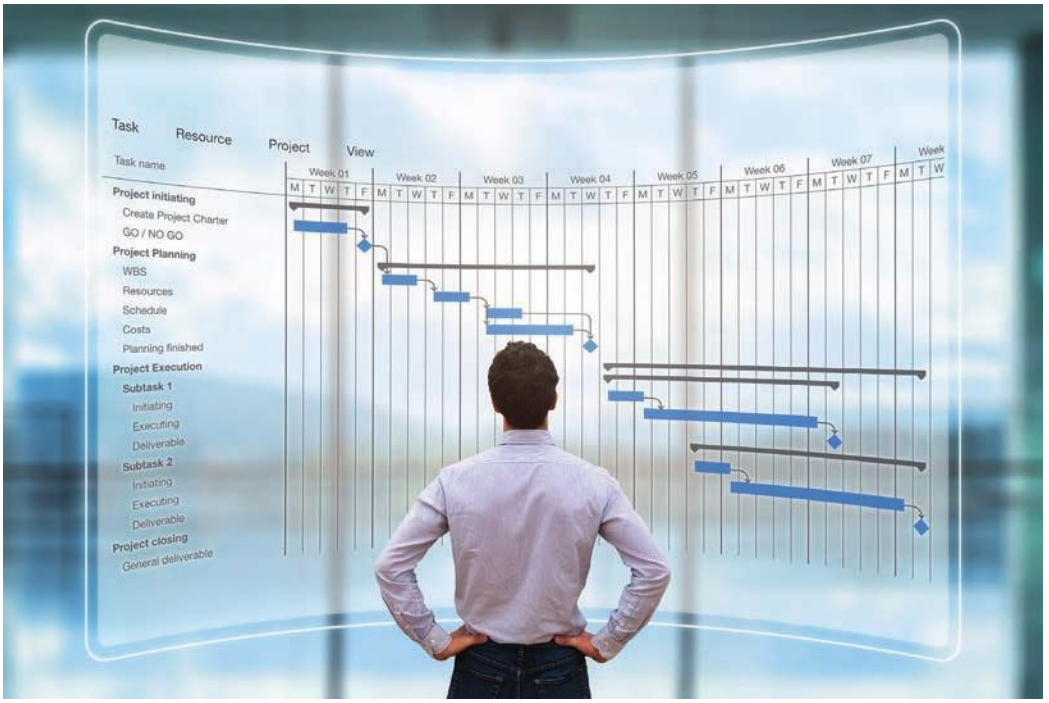
- are conducted using well-defined processes
- can be replicated by simulations or further experiments
- can be used to demonstrate how digital technologies were used and produced a specific outcome.

8.5 Project management

UNDERSTANDINGS

By the end of the chapter, you should understand:

- how to manage your content
- how to manage your time
- how to manage your process
- how to manage your backups.



The management of the digital society inquiry project involves the combination of processes, methods, skills, knowledge and experience to meet the inquiry project assessment criteria.

Although your ideas for the project can be valid, and you can even complete the project to an adequate level of acceptance, your project will be successful in reaching the goal that was originally expected if you make sure to have:

- good planning
- sufficient and appropriate secondary and primary research
- organized data collection (content, visual material, sources)
- realistic time frames and good time management
- investigation into the best methods for developing the presentation
- inadequate consideration of the requirements for the IPD.

Planning and proper project management are essential to avoid failure. In this chapter we will focus on best practices to manage your content, planning, time and backups to successfully develop your project.

Managing your content

To ensure you are following a clear workflow throughout the development of your project, you will need to keep your content organised, and keep track of its status and progress. Doing this will help you to speed up the process and ensure that only high-quality content will be published in your documentation and multimedia presentation.

Categorize and organize content

Maintain accountability of your content production and organization by keeping the content all in one place (with a backup on a cloud service or on an external storage device), defining the upcoming tasks to gather missing content, tracking changes in your inventory of content, and setting deadlines.

Create an up-to-date, detailed inventory of every single piece of content you gather for the project. Place everything in organized, properly named files and folders. Make sure you divide your folders by categories (types of media you will be using, sub-topics of your main topic, and so on). Also, make sure you follow a consistent approach to naming your files and folders to avoid confusion.

At an early stage of the project, you will identify the real-life example that will be the basis for your inquiry question and your project. Create folders for different related topics around this real-life example – this will make it easier to link your main topic and inquiry question to those topics in an organized manner.

Mapping content

Rather than just piling up content randomly, you should always tie each piece back to a need or a goal you want to achieve. Map each piece of content to a different stage of your inquiry document or presentation. Doing this will allow you to then strategically link a piece of content to another that's in the next stage of the project.

Tracking content

Keep track of everything in one place when you're creating and managing content with a simple spreadsheet. This will help you document and find the content you are going to publish quickly. Make sure you include bibliographical notes, such as authors, titles, date of publication, and so on, as you will need this to refer back to the content in case it is necessary to cite it in your inquiry document and/or presentation.

Creating a storyboard

You are also advised to outline the sections of your multimedia presentation in a storyboard – a tool for maintaining an overview of the overall plan for the presentation – that will continue to be updated and refined as your research progresses. It can be in the form of a simple table created with word-processing software, like the example storyboard template given below.

It can be initiated by filling in the main entries in the first column, including the inquiry question and main sections. As your inquiry project evolves in consultation with your digital society teacher, rows can be rearranged, added, deleted and edited as needed. The table may only contain a few rows with some text at the beginning, but more rows and details will be added as the inquiry process progresses.

Example of a storyboard for developing your multimedia presentation

	Overview: Description for slide/sequence	Sketch of slide/sequence to represent a section of the presentation	Script for each slide/sequence (actual text for audio or outline)	Resources used for visual material/audio/script
1	Title screen with the inquiry questions	To what extent can an individual control their digital footprint? 		
2	Introduces two perspectives of how a digital footprint is created	Keep a close watch over our own digital footprint!  Our actions! Actions of others!		
3	First section: Identify specific actions taken by an individual that contribute to their digital footprint	How does an individual contribute to their digital footprint?		

Managing your time

Time management – how we choose to use and organize our time – is something many of us struggle with. Effective time management allows us to make the most of our day, accomplishing tasks more quickly and prioritizing those that will make the most impact. Lack of proper time management is the reason why many great ideas go to waste and projects end up unfinished.

Let's look at some best practices on time management that can be applied in the development of the digital society inquiry project.

SMART goals

SMART goal-setting techniques have been popular since 1981, when a paper called 'There's a S.M.A.R.T. way to write management's goals and objectives' was published by George T Doran. The idea is pretty simple – every SMART goal should be created using the following criteria:

- **Specific**: It needs a clearly defined outcome (what you want to achieve).
- **Measurable**: There must be a way to measure progress.
- **Achievable**: The goal can be met with available resources.
- **Relevant**: It must fit a bigger picture and you must know why you want to achieve the goal.
- **Time-bound**: It has a clear deadline for when the goal must be achieved.

Prioritization

Once you have your goals written in a SMART way, you should break them down into concrete, actionable tasks. These tasks must then be prioritized. The Eisenhower Matrix is one of the most popular frameworks for prioritizing tasks, which recommends arranging tasks into one of these four categories:

- urgent *and* important – do first
- not urgent *and* important – schedule
- urgent *and* not important – delegate
- not important *and* not urgent – eliminate.

Urgent tasks in the scope of the digital society inquiry project are tasks that are time sensitive, meaning that you have strict deadlines by which to finish them.

Important tasks, on the other hand, are the ones that contribute to your project goals and are things that you really want to have as part of your document and/or presentation. Important tasks are the ones that are part of your project vision.

Of course, you should always tackle urgent and important tasks, so it's important that you spend most of your working time on these tasks (urgent *and* important).

You should schedule the important but not urgent tasks in your calendar so that you do not forget them. As you cannot delegate your project tasks to anyone else (the digital society project is an individual assignment), you will also need to give some attention to the urgent but not important tasks. Tasks that are neither important nor urgent should just be ignored.

Kanban

'Kanban' is a Japanese word meaning a billboard or signboard, but it is also an additional excellent practice for managing your time. The main idea is to have a visual board that helps you to track progress on your goals.

On a large posterboard or whiteboard, you should draw three columns visualizing the stage of each specific task. The columns will be labelled as 'to do', 'in progress' and 'done'.

Then you need sticky notes. Each sticky note represents a task that needs to be completed. You simply write the name of the task that needs to be completed on the note and stick it into one of the columns, depending on the phase the task is in. This should produce a nice visual representation of your tasks and which stage they are at. You can then move the sticky notes through these columns based on your progress.

Consider using different colours of sticky notes for different types of tasks.

Managing your process

Process management refers to the identification, improvement and management of processes. Effective process management in the scope of the digital society inquiry project has several benefits, for example it enables agility, allowing you to review and adapt processes quickly and remain responsive to unforeseen situations. It also promotes efficiency, which means that bottlenecks are quickly identified and resolved, reducing delays.

There are five key stages in the process management lifecycle.

Analysing

The analysis stage is an important pre-step before the main process management lifecycle kicks in. At this stage, you should envision how you will approach the project and analyse how you can improve your initial plan.

Designing/modelling

The ideal process should be designed during this stage. The aim is to create a sequence of logical steps that visually document the end-to-end process of development of your project. Additional information may be added once these steps have been documented, such as the time and duration of tasks, where they occur, who is involved and how information flows through the process. After the process is fully mapped, you should review it to ensure its accuracy and check your ability to meet the plan.

Implementing

At the implementation – or execution – stage, you carry out your plan. This may require the addition of technology, procedural updates, or changes to resourcing or ways of working.

Monitoring

During the monitoring stage, data is collected on your performance. Information should be gathered about whether the process you are following is effective and whether the expected goals are being achieved. Performance data can also inform decisions as to what steps should be taken next.

Optimizing

At this stage, the process is continually refined based on the information and experience you gathered in the monitoring stage and as your project goals change over time. As the project advances you may find that your processes have become sub-optimal or overly complex. In these cases, it may be worth creating an entirely new process to support the changes.

Managing your backups

Computers crash and data is lost more frequently than you might think. You do not want to take the risk of losing all your valuable work and the time that you have spent developing it. You must have been reminded to backup all of your data by your IT teachers numerous times, but do you actually do it? While data storage and recovery are fundamental IT activities, the key message here is that you must be proactive about protecting and securing your resources.

- Set backup schedules and follow them precisely. Modify schedules as needed to accommodate process-related changes, but try to keep to the schedule.
- Arrange for multiple backup repositories, for example on-site, remotely in a cloud or with a managed data backup service provider.
- Test your data backup and recovery activities to check that the technology works, and that the data is available and can be recovered.
- Use technologies to free up storage space. Sufficient space for mission-critical data is essential to backup management, regardless if backups are completed on-site or remotely. Depending on your project needs, free up storage space on-site with technology such as de-duplication software.

8.6 Practice inquiry project

Now that you have an overview for developing a successful digital society inquiry project, it is time to practice. Tie your shoes and get ready!

UNDERSTANDINGS

By the end of the chapter, you should understand:

- the stages in the inquiry process for developing the inquiry project
- how to develop your own inquiry project.

Please refer to the inquiry process in Chapter 8.0, as you will be following it in order to complete the activities.

The inquiry project starting point

Starting point

The first step to get started with your digital society inquiry project is to identify a real-world example (stimulus material), which will trigger the inquiry question and the entire inquiry focus. In order to do that, you should read several news items and watch several videos related to digital society. You should be looking for an up-to-date topic of interest, which clearly has its focus on the use of digital system(s), and through which it is possible to identify impacts and implications for people and communities.

ACTIVITY

Think of a digital society topic of interest and research news items related to it on different websites. Keep a record of the ones that might be useful starting points for your digital society inquiry project. You should select at least 10 sources, then choose the one that seems to be the most appropriate. Keep the other nine (or more) as they may still be useful, either to replace the source selected initially or as supporting sources for your project.

To be an appropriate news item (or real-world example) for the inquiry project, the article must include a relevant digital system and address impacts and implications for people and communities. You should also check the reliability, verifiability and validity of your sources by checking their origin and purpose, as well as corroboration and use (see the *Digital Society Guide*).

Creating an inquiry focus

Through our search, we identified an excellent podcast on the 'alt-right pipeline' by Matthew Suescun called 'We explored internet extremism so you won't have to'. 'Alt-right' is an abbreviation of alternative-right and identifies an ideological movement characterized by the use of online media to disseminate right-wing content; it is provocative and often connected to racism, religious intolerance and opposition to gender equality.

The podcast can be found here:
https://soundcloud.com/user-426817413/we-explored-internet-extremism?

The podcast discusses the mechanisms of the alt-right pipeline and how it attracts impressionable audiences, as well as the impact of echo chambers. Should your inquiry project follow in this line of thought, your inquiry question would most likely address the alt-right pipeline or echo chambers. Rather than jumping right into it as your topic of choice, however, you should continue to look at possible alternatives. If you felt sure that this would be a good topic for your digital society project, you should continue looking for articles that have a similar focus, even if the topic is slightly different.

We continued our search and selected some potential news items that could also be used, for example, this article from MIT Technology Review, 29 January 2021 called 'YouTube's algorithm seems to be funneling people to alt-right videos': **www.technologyreview.com/2020/01/29/276000/a-study-of-youtube-comments-shows-how-its-turning-people-onto-the-alt-right**

Here is a summary of its content:

> *A study suggests that YouTube is a pipeline for extremism and hate. More than 330,000 videos on nearly 350 YouTube channels were analysed and manually classified. They were labelled as either media, 'alt-lite' intellectual dark web, or alt-right. The alt-right is what is traditionally associated with white supremacy. Those who affiliate with the 'intellectual dark web' justify white supremacy on the basis of eugenics and 'race science'. Members of the alt-lite purport to not support white supremacy, though they believe in conspiracy theories about 'replacement' by minority groups.*
>
> *More than 26% of people who commented on alt-lite videos tended to drift over to alt-right videos and subsequently comment there. The researchers found that YouTube's algorithm often directed users who searched for specific keywords toward increasingly violent, extreme content. About 60,000 people who commented on alt-lite or intellectual dark web content got exposed to alt-right videos over a period of about 18 months.*
>
> *We are not quite sure exactly what makes people move from alt-lite material to the far-right stuff. But this research suggests that YouTube's recommendation algorithms may play a significant role. YouTube has long struggled with the balance between maintaining free speech and addressing hate speech.*
>
> *Source:* **www.technologyreview.com/2020/01/29/276000/a-study-of-youtube-comments-shows-how-its-turning-people-onto-the-alt-right**

ACTIVITY

Search the internet for the podcast mentioned above and, if you are able to find it, listen to it. Look the article too and read it. If you cannot find either of them, research for and read three articles that address similar topics and then write down three areas that could become the focus of your inquiry project.

Keep in mind that the focus of the project does not need to be the most obvious focus of the article you are using as the starting point for your project. It may be a marginal area covered in the news item or even an area just slightly related to what has been covered in the news item. Once you have selected your inquiry focus, you will research other sources and will be able to find articles that are mainly focused on the area of your choice.

Formulating an inquiry question

Based on the real-world example, we can now draft an inquiry question. This question will help us to plan what other sources we should explore. It does not need to be perfect at this point; in fact, it can be very general. It can be refined later as we move on with our exploration of the topic.

For our example, it seems that our focus should be on the impacts and implications of the alt-right movement or on how online media has been leading users to embrace extremist movements. However, from the same article it is possible to infer that the algorithms used by YouTube may be making the decision on what content should be emphasized and what content should be hidden from the general audience.

The inquiry question determines the inquiry focus. So, if you decide that your inquiry will be on how algorithms can influence and impact society, everything else (including the alt-right movement) will become secondary in your research and will only be used to support your main topic. For the purpose of modelling the inquiry project process, we have decided to follow this direction in our investigation. We have kept the news item we summarized above as our real-life story.

The digital system mentioned in the article is YouTube, but we have decided to expand our investigation to other social media (such as Facebook) in order to explore in more depth whether social media's algorithms, by allowing certain content and blocking other content, have been used to favour some groups and ideas, while threatening free speech and depriving a large number of other users from sharing their own ideas, thus guiding users to react and think a predetermined way and therefore impacting the entire society.

ACTIVITY

Based on the information provided in the paragraph above, formulate your own inquiry question. Compare it with the inquiry question we have decided to use for our investigation.

Initial inquiry question

Our initial inquiry question is:

- To what extent do algorithms used by social media sites, such as Facebook and YouTube, interfere with the free expression of ideas and influence their users by promoting their own political views and blocking opposing ones?

Our inquiry will now explore the connections to the course concepts, content, and contexts that we should focus on in order to have an effective investigation. There are multiple possibilities, so an in-depth investigation must focus on a limited number of them.

You can find a list of course concepts, content and contexts in the *Digital Society Guide* and in Sections 2, 3 and 4 of this textbook.

ACTIVITY

Considering the proposed real-world example, the initial inquiry question and the list provided in the *Digital Society Guide*, identify relevant concepts, content and contexts that could be part of the inquiry focus in your opinion.

The inquiry focus

In our example, we decided to focus on:

- **Concepts**: The *power* exerted by social media to influence the thoughts and actions of its users, possibly causing *change* and affecting the *identity* of people and communities (see *Digital Society Guide* Sections 2.1, 2.3 and 2.4).
- **Content**: The content of our inquiry is clearly the *algorithmic* and *digital media dilemmas* (see *Digital Society Guide*, Sections 3.2E and 3.5D).
- **Contexts**: The contexts are the *online communities* (subcultures) and *political advertising and propaganda* (political process) (see *Digital Society Guide*, Sections 4.1D and 4.6A).

The real-world example, the inquiry question and the specific concepts, content and contexts will now define the inquiry focus of our investigation.

Explore

Once the inquiry focus is clear, you will need to explore and collect information from other relevant secondary sources, which will provide claims and perspectives that will be useful in the inquiry.

Criterion B of the digital society inquiry project requires a discussion of the claims and perspectives for three sources, including a justification of their usefulness in the inquiry. Obviously, the three sources will be selected after searching for and reading dozens of possibly relevant articles.

ACTIVITY

Considering the inquiry question we have established and the concepts, content and contexts we have identified, explore and select three other sources that could be part of the digital society inquiry project.

When you select your sources, keep in mind that in order to determine whether or not the source is reliable and relevant, you must check its origin and author, its main ideas, and how it compares and contrasts with other sources that have attempted to explain the same topic, (see Criterion B IPD Claims and Perspectives and/or the *Digital Society Guide*, Researching/Claims and perspectives).

For our sample, we have selected the following sources:

1 An article from The Verge published on 2 July 2021 called 'Facebook confirms tests of a new anti-extremism warning prompt'.

It can show up if you've seen extremist content.

> *Facebook says that it'll continue to remove extremist content that violates its rules, though the company has had issues tracking down and removing similar content, even from groups that it's actively tried to kick off the platform. Facebook has long been the subject of scrutiny from the public and lawmakers, as many say that its algorithms divide people and push them towards extreme ideologies, something the company has itself recognized.*
>
> *Facebook says that the tests go along with its Redirect Initiative, which "helps combat violent extremism and dangerous organizations" in several countries. According to its webpage, the program (as the name implies) redirects users to educational resources instead of further hateful content.*

Source: **https://www.theverge.com/2021/7/2/22560108/facebook-anti-extremism-prompt-user-resources-content-moderation**

2 An article from *The Conversation* from 16 May 2021 called 'Beyond a technical bug: Biased algorithms and moderation are censoring activists on social media'.

> *Social media platforms have been under scrutiny because of their erroneous censoring of grassroots activists and racial minorities. So, were these really about technical glitches? Or did they result from the platforms' discriminatory and biased policies and practices? The answer lies somewhere in between. There is an inherent belief that AI systems are less biased and can scale better than human beings. In practice, however, they are easily disposed to error and can impose bias on a colossal systemic scale. While AI is celebrated as autonomous technology that can develop away from human intervention, it is inherently biased. The inequalities that underpin bias already exist in society and influence who gets the opportunity to build algorithms and their databases, and for what purpose. As such, algorithms do not intrinsically provide ways for marginalized people to escape discrimination, but they also reproduce new forms of inequality along social, racial and political lines.*
>
> *Source:* **https://theconversation.com/beyond-a-technical-bug-biased-algorithms-and-moderation-are-censoring-activists-on-social-media-160669**

3 An article from the Harvard Business Review from 12 November 2019 called 'When algorithms decide whose voices will be heard'.

> *Everything digital we do daily (such as using our smartphones, checking social media, buying products online) is analysed and determined by algorithms. Search engines decide what to present and how to rank what is presented when we type a query, and algorithms are the ones responsible for these decisions. But what happens when algorithms decide whose voice gets to be heard? What if only a selected group of individuals gets heard? We need to reflect about this, and checks and balances need to be developed to ensure our lives and our future are not determined by algorithms.*
>
> *Adapted from* **https://hbr.org/2019/11/when-algorithms-decide-whose-voice-will-be-heard**

Criterion A – IPD inquiry focus

One of the requirements for the inquiry project submission is the IPD, which is a written document that does not exceed 1500 words total. Criterion A is based on the IPD.

The IPD includes the inquiry focus, which provides an explanation of the connection between the inquiry question, the real-world example and the course concepts, content and contexts. The maximum word count for the inquiry focus section is 300 words.

ACTIVITY

Considering the proposed inquiry question and focus, write the first part of the IPD. This section must not be longer than 300 words and must explain the connection between the inquiry question, the real-world example and the course concepts, content and contexts (see Chapter 8.1 for an example).

Criterion B – IPD claims and perspectives

The other section of the IPD addresses the claims and perspectives. That is where you should demonstrate how research was conducted with a discussion of the claims and perspectives for the three selected sources, including a justification of their usefulness to the inquiry. Only the most relevant sources for the discussion should be selected. All other sources and materials used in the inquiry must also be included in the list of references, however. The discussion for each source should justify why and how the source supported the inquiry and your understanding. It should also address the source's origin and purpose, meaning and methods, as well as corroboration and use. The maximum word count for the claims and perspectives section is 1200 words.

For the maximum number of marks under criterion B, you must provide a thorough discussion of the claims and perspectives for each source that includes a clear justification for their usefulness in the inquiry.

Some claims can be made based on statements presented in the selected sources of our sample. Some of the statements that have been selected and the possible claims that could be made are discussed below. Whether these claims are real or not needs to be thoroughly discussed, and this discussion should be supported through the use of other sources.

Source 1: Facebook confirms tests of a new anti-extremism warning prompt

- Users may receive an alert saying that they may have been exposed to extremist content. Facebook is, therefore, the one deciding what extremist content is.
- Facebook redirects users to educational resources instead of further hateful content. Therefore, Facebook makes the decision of what users will see to combat this exposure to extremist content.
- Facebook removes content and accounts that violate its rules. Therefore, Facebook is the one who decides what/who needs to be removed.

Source 2: Beyond a technical bug: Biased algorithms and moderation

- Social media platforms have been under scrutiny because of their erroneous censoring of grassroots activists and racial minorities. Therefore, social media platforms erroneously censor users.
- BLM activists were frustrated when Facebook flagged their accounts, but didn't do enough to stop racism and hate speech on their platform. Therefore, Facebook flags some accounts but does not do anything about others with different views.
- Did this result from the platforms' discriminatory and biased policies and practices? Therefore, platforms practice discriminatory and biased policies and practices.
- Algorithmic bias may jeopardize some people who are already at risk of being wrongly categorized as offensive, criminals or even terrorists. Therefore, algorithms have bias.
- The inequalities that underpin bias already exist in society and influence the people that build algorithms and their databases, and why they do it. Therefore, algorithm bias is determined by those who build the algorithms.

Source 3: When algorithms decide whose voices will be heard

- Our day-to-day consumption of all things digital is increasingly being analysed and dictated by algorithms. Therefore, we do everything as we are told by algorithms.
- Some dating apps use 'collaborative filtering,' which generates recommendations based on majority opinion. Therefore, over time, such algorithms reinforce societal bias by limiting what we can see.
- Implemented incorrectly, AI will only repeat the mistakes of the past. Therefore, AI is not perfect and does make mistakes.
- Organizations must be open and transparent in disclosing what defines fairness and biases. Therefore, as it is today, organizations carry their own bias.

ACTIVITY

Research other sources that support or deny the claims made above.

Analyse and evaluate

Analyse

Explore

Criterion C – analysis and evaluation

At this point, you must already be thinking about your presentation. It needs to start with an introduction, where you present the inquiry focus (which must be the same one you identified in your IPD) and provide an outline of its significance for digital society.

Following the introduction, you will need to analyse and evaluate the impacts and implications of the digital systems for relevant people and communities. The presentation will be completed with a conclusion, where you will reflect on the new understanding and ideas that came as a result of the analysis and evaluation, and you will discuss possible new trends and future developments.

Criterion C states that: 'The investigation stage of the inquiry includes sample supporting questions useful to consider for analysis and evaluation.' Refer to the *Digital Society Guide* (under Inquiry stages, Investigate) for some supporting questions that can help you in your analysis and evaluation.

In order to achieve the maximum number of marks in Criterion C, your analysis and evaluation of impacts and implications for people and communities must be effective, sustained, and well-supported by evidence.

So, let's take a look at the sources we have selected and extract some statements that require some analysis and evaluation, and which will end up causing impacts and implications for people and communities.

Source 1: Facebook confirms tests of a new anti-extremism warning prompt

- When Facebook algorithms detect 'extremist' content, a pop-up message redirects users to a support page. But who decides what is extremist content?
- Facebook claims that it removes content and accounts that violate its rules, but who makes Facebook's rules? These rules therefore determine what people can see.

Source 2: Biased algorithms and moderation are censoring activists on social media

- The article claims that 'social media platforms have been under scrutiny because of their erroneous censoring of grassroots activists and racial minorities'. When posts about missing and murdered indigenous women and girls (MMIWG) disappeared from some Instagram accounts, Instagram explained that this happened due to a technical bug. However, the doubt persisted over whether these were really technical glitches, or the result of the platform's discriminatory and biased policies and practices.
- Social media platforms sometimes remove posts at request of and/or in coordination with governments, either to maintain their market access or to protect themselves from legal liabilities, through the use of artificial intelligence (which helps identify and remove prohibited content).
- Algorithms decide what users can and cannot post online.
- What is considered offensive is bound to social context.
- The inequalities that underpin bias already exist in society and influence the people who build algorithms and their databases, and why.

Source 3: When algorithms decide whose voices will be heard

- While we may have the *perceived* power to express ourselves digitally, our ability to be seen is increasingly governed by algorithms programmed by fallible humans.
- What if algorithms operating in a black box decide whose voice is prioritized?
- What if the internet becomes a guarded space where only a select group of individuals get heard – and, in turn, our society is shaped by those voices?
- Whose values will the algorithms be based on?
- When institutions do not have diverse staff that reflect the demographics they serve, the outcome of their algorithms can disproportionately impact those who 'don't belong'.
- How does society prevent this?

Remember that an effective analysis requires balance; that is, you need to present the advantages as well as the disadvantages of each situation. For example, it is positive to stop people from being influenced to become extremists as this can harm society deeply; on the other hand, by removing content from the view of users, the media is actually influencing people to think the way the company thinks, which can harm society even more.

An effective evaluation will take the points raised in the analysis and move further by discussing the consequences of the advantages and disadvantages. By properly evaluating each situation, it will be possible to get to the impacts and implications for people and communities.

As mentioned before, the analysis and evaluation must be sustained by evidence. Any claim that is not sustained by evidence is considered to be an opinion, and personal opinions are not acceptable in an inquiry.

Reflect

Criterion D – Conclusion

The final part of the presentation is the conclusion. In the conclusion, you are expected to reflect on your research and findings, emerging trends, future developments, and further insights, considering what needs to be shared and how.

Keep in mind throughout the construction of your presentation that the whole presentation must lead towards answering the project inquiry question, and the conclusion must answer that question.

Reflect

ACTIVITY

Write a list of findings, emerging trends, future developments and further insights that you were able to extract from what has been discussed so far regarding this sample inquiry project. This can be done in bullet points at first. Once the list is done, can you write your conclusion in paragraph format for the presentation?

Communicate

Criterion E – Communication

Your presentation must be organized in a logical manner so that those watching it will be able to understand it. Media must be used coherently. Refer to Chapter 8.3 for the communication skills that you are expected to demonstrate through your presentation.

Start the presentation with your inquiry question and then, throughout the presentation use the material that you prepared following the guidelines for Criteria B, C and D. You might also consider using a few short videos that will support your claims, and your analysis and evaluation.

For our example, we selected three videos that deal with algorithmic bias and how algorithms can influence us. In your research, you will need to look at a lot more than just three videos in order to select those that are really appropriate, but the ones we have selected will give you an idea of what is expected to enhance your presentation. The three videos we selected can be found at YouTube. They are:

- Algorithmic bias explained: **www.youtube.com/watch?v=bWOUw8omUVg**
- Is the YouTube algorithm controlling us?: **www.youtube.com/watch?v=XuORTmLhIiU**
- How social media algorithms shape the way we get information and news: **www.youtube.com/watch?v=gdG4vorlWOU**

In case one or more of the three videos cannot be viewed in your region, consider this fourth video: How news feed algorithms supercharge confirmation bias by Eli Pariser, Big Think **www.youtube.com/watch?v=prx9bxzns3g&t=10s**

A good part of the presentation will be made up of slides. Refer to Chapter 8.3 for good practices in the creation of slide shows.

Your presentation must not be longer than 10 minutes. Once you are done recording the first draft of your presentation, watch it and take note of needed corrections and possible areas for improvement. Record your presentation a second time and repeat the procedure. Do it as many times as necessary – the time invested in doing this is worth it, since the project represents 20% of your final digital society grade if you are an HL student and 30% if you are an SL student.

Communicate

ACTIVITY

Based on the work done so far for this sample inquiry project, prepare a 10-minute presentation following the guidelines and hints provided. Exchange your presentation with a few classmates – provide feedback to them and have them provide feedback to you.

Remember, this is only for the purpose of practice – the actual inquiry project must be your own individual work.

Reflection

Now that you have read this chapter, reflect on these questions:

- How are you planning to get started with your inquiry project?
- What digital society inquiry topics attract your interest the most?
- Which of these topics will be most interesting to those watching your presentation?
- How do you plan to conduct your secondary research?
- How do you plan to collect primary data and original material for your presentation?
- What skills are needed in order to complete all of the components in the inquiry project?
- How will you organize your time to ensure you complete all of the components in the inquiry project?
- How do you plan to evaluate your own work to make certain that the inquiry project assessment criteria have been met?

Section 9

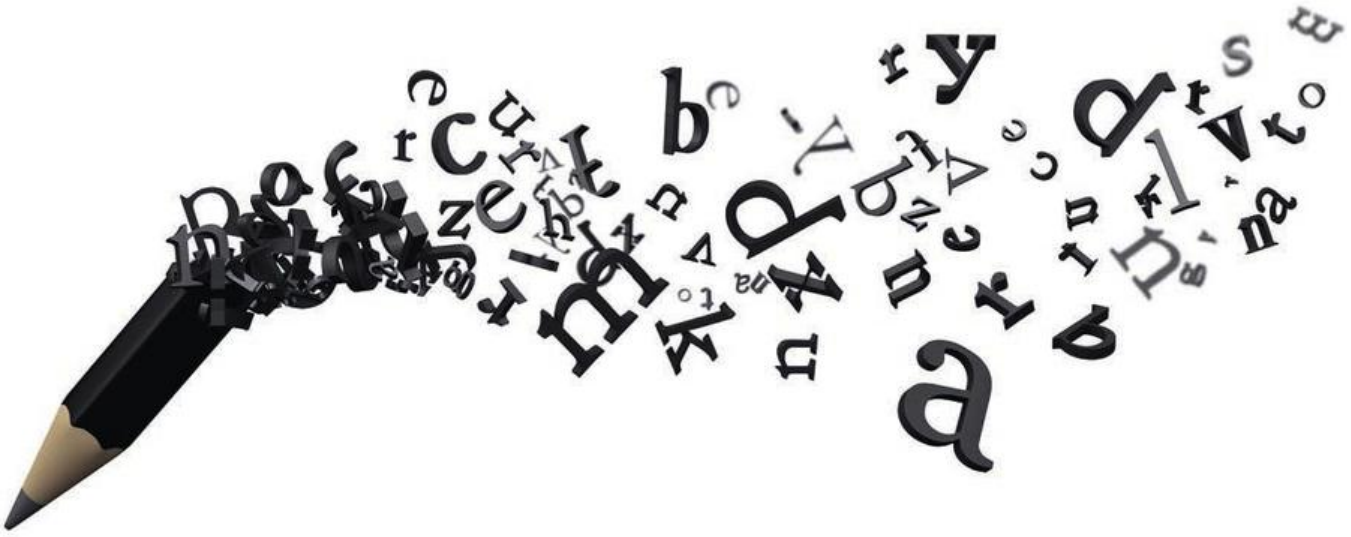
Digital society extended essay

9.1 Approach to the digital society extended essay

UNDERSTANDINGS

By the end of this chapter, you should understand how to:

- state a concise research question
- use formal secondary and primary research and investigations
- manage the research process, which includes planning, recording findings and recording sources using an accepted format
- support arguments with evidence from your research
- use critical thinking in analysing the findings from secondary and primary research and investigations
- use effective communication skills in sharing findings, providing conclusions and citing sources of evidence and your bibliography
- follow IB guiding principles for academic integrity in the extended essay.



Although not mandatory, IB strongly recommends that students carry out research in a DP subject that they are currently studying to ensure that they have sufficient knowledge of the subject. If you decide to develop a digital society extended essay, you are expected to be taking the Digital Society course. In this case, you will be investigating a topic of interest that is included in the Diploma Programme *Digital Society Guide* or relates to digital society.

The extended essay will help you to develop the research, thinking, self-management and communication skills that you need to fulfil the requirements for the IB Diploma, and will support you in your future studies and work life. Your extended essay supervisor will provide you with ongoing guidance throughout the inquiry process.

What makes a digital society extended essay?

If you choose to write your extended essay in digital society, it may be because one of the ATL activities or inquiries has sparked your interest to learn more. A digital society extended essay will provide you with an opportunity to research an area of interest relevant to the Digital Society course in order to add knowledge to an existing body of research, and should be relevant to the course concepts, content and contexts.

The main topic for the extended essay must be completely different from the topic chosen for the inquiry project. Consequently, you will embark on a second topic for your independent research. Be sure to follow the guidelines provided by your extended essay supervisor regarding requirements and deadlines.

For the extended essay, you will submit one written essay of 4000 words or less, as well as a Reflections on Planning and Progress Form (RPPF) with the three formal reflections that you will write throughout the process.

Outline of a successful digital society extended essay

Here is a basic list of what is required for a successful digital society extended essay and some observations.

- The **title page** must contain the extended essay subject area (digital society), the title of the essay, the research question and the word count. The student must not include the name of the school, their teacher, or their own name. This page must not be numbered.
- The **research question** must be properly narrowed and sharply focused. It must allow primary investigation, so the scope of the question must be narrow (a small city, a district, a small company, a school or a grade level, for example, rather than a big city, a multinational company or a country), and/or the age group investigated must be limited. Broad topics (for example, games or social media) must also be avoided. It is advisable that the connections to the 3Cs (concepts, content and contexts) should be apparent in the statement of the research question, but they do not need to be all explicitly stated.
- The **contents page** must include all of the sections within the essay (headings and subheadings) with page numbers. The page numbers must be correct. It should not include the title page or the table of contents in the list, however. This page must not be numbered.
- The **introduction** must state the research question and may include the reasons why the candidate has selected the topic. This is not mandatory but it is recommended as it speaks of the importance of the topic. The introduction, in most cases, includes some evidence from research that underpins the importance of the topic.
- The **methodology** describes the type of primary and secondary sources the candidate will be using in the investigation. The most successful essays will have at least 25 secondary sources and relevant primary sources, such as interviews with experts and/or meaningful surveys with an adequate sample (not surveys with small samples selected 'at random'). The methodologies used for conducting secondary research and primary investigations and research need to follow accepted academic practices for data collection, analysis and presentation.

- Students should describe and explain, in as much depth as possible, the main **digital systems** involved in the topic. The explanations need to be relevant to what is being investigated, otherwise the student takes the risk of going off course. If the student spends too much of the essay describing the digital systems, however, the essay becomes descriptive, when it is expected that the essay should be mostly analytical.
- **Findings** from the formal secondary research should cover what was found on the internet and in books and magazines and so on, that was relevant to the research question. These findings may come from a global level (all the world). Students should use the findings from their secondary research as the basis for conducting primary research and investigations. For this reason, most/all secondary research needs to be completed before engaging in primary data collection.

  Findings from formal primary research and investigations can be presented graphically, for example, giving the results of survey findings in a pie chart. Primary research and investigations should be at the local level.
- **Analysis of the findings** can take place in three ways in an extended essay:
  - a comparison of findings from secondary sources/authors
  - an analysis of findings from primary research, such as a comparison of outcomes of interviews, surveys, observations, examination of original material, and so on
  - an analysis of claims from secondary sources compared with outcomes from primary research.
- **Common errors** made by students who choose to carry out surveys include:
  - providing a report of the results of a survey and identifying the report as an analysis (an analysis is an explanation of *why* the results are as they are; a report is just a description)
  - extrapolating the results of a survey to the whole world (for example '60% of people consider themselves addicted', instead of '60% of the participants of the survey consider themselves addicted')
  - failing to indicate how many participants are in the survey or to indicate why (and/or how) these participants were selected (the majority of candidates say they were selected 'at random', which is the same as saying that there was no methodology to select the participants).

  Well-defined processes must be used when conducting a survey and analysing the results to avoid/minimize bias.
- The goal of the extended essay is to answer the research question, so the whole essay must be aimed at that. In the **conclusion** the student must summarize their findings, present solutions if applicable and demonstrate the conclusions. It is not simply the statements in the extended essay repeated at the end of the essay.

Additional considerations

- It is very important that arguments, analysis and conclusion are all supported by **sources**. Any claim made without support is considered an opinion, and opinions must be avoided. The essay is a work of formal academic research and investigation and not a place to express personal opinions.
- Inclusion of visual material within the body of the extended essay, for example **diagrams**, **images** or **screenshots**, may be helpful when explaining how a digital technology is involved in the specific topic. Visual outcomes from surveys (such as pie charts and bar graphs) may also be needed in the extended essay. Images need to have titles and the source should be cited; in addition, either the paragraph above or following an image should explain the image. The examiner should not need to 'guess' why an image has been included or what it is attempting to show. All sources for images must be included in the bibliography.

- Every claim made in the essay must have a source, unless it is common knowledge. When in doubt whether the claim is common knowledge or not, it is best to cite the source. As pointed out in an earlier observation, if a claim is made but is not backed by sources, that is considered opinion. Throughout the essay, the candidate must provide **references** to the sources being used. The **bibliography** is a complete list of all these sources. There must be no source in the bibliography that has no corresponding references in the essay. Likewise, there must be no references in the essay that are not listed in the bibliography. The references and the bibliography must have exactly the same sources.
- The process for *how* primary research has been carried out must be included in the body of the extended essay. The presentation of the *outcome* of interviews, surveys, observations and examination of original material should be presented in an accepted manner in the **appendix**. It should include graphs of surveys, samples of responded surveys and transcripts of interviews.

  Since all marks for the extended essay come from the body of the extended essay, the body must refer to and cite specific parts of the information that is included in the appendix and include those parts within the extended essay. It should be possible to understand the extended essay without referring to the appendix. The **appendix is for academic support of the material.**
- The **reflections** written in the Reflections on Planning and Progress Form (RPPF) must be analytical explanations (real reflections of the extended essay experience, challenges and decisions) and not descriptive entries (such as, 'I did this … I did that … then I did that other').

An excellent source for the extended essay research processes (secondary and primary) is the Purdue Writing Lab website (**https://owl.purdue.edu**). Click on the Site Map tab on the main menu and look for Research (research and citation, conducting research, research overview, conducting primary research, and so on).

Formal reflection sessions and the RPPF

As a part of the extended essay, you are expected to show evidence of your intellectual growth, critical and personal development, intellectual initiative and creativity. To this end, you are required to complete three reflections on the RPPF. These are explicitly assessed under assessment Criterion E (engagement). The depth of your reflections will demonstrate that you have constructively engaged with the learning process and also will demonstrate the skills that you have learned. The three reflections must not go beyond 500 words in total.

It is very important to keep in mind that your reflections must be what the name says – reflections are not descriptions! You must not use your reflections to describe what you did during the extended essay development process step-by-step. Instead, your reflections must be evaluative and include reference to your capacity to consider your actions and ideas in response to challenges you have experienced in the research process. Descriptive reflections will not be awarded more than two marks out of six in Criterion E.

Initial reflection

At the start of the extended essay development process, you will approach your supervisor with your ideas, the topic (or possible topics) you want to investigate, and possibly one or more initial research questions to be discussed. Consider sending an outline of your research proposal to your supervisor prior to this meeting so that your supervisor has the opportunity to review your work and ensure that the reflection session will be focused and productive.

Your supervisor will use these ideas as the basis for your discussion so that you come to a conclusion about the topic you will be researching. Your supervisor will also guide you to create a workable

research question. Your initial ideas and the outcome of this initial meeting will be the basis for the reflections you will be writing in the initial reflection section of the RPPF. This initial reflection should be about 150 words long.

Interim reflection

The interim reflection session will happen somewhere close to the midway between the first formal reflection session and the completion of your essay – most likely when you have had the time to perform a great part of your explorations, written at least 1000 words, and experienced your first challenges.

You will have a chance to discuss your achievements so far with your supervisor, as well as the difficulties you have been facing. More importantly, you will have a chance to look ahead at how to overcome these obstacles and reach your desired goals for the extended essay. Your supervisor will check whether you have collected a proper range of sources and will guide you on what still needs to be done in order to produce an appropriate full draft of your essay.

The outcome of this interim session will be the basis for the reflections you will write in the interim reflection section of the RPPF. This reflection should be about 150 words long.

Final (*viva voce*) reflection

The *viva voce* reflection session happens at the end of the extended essay process, after you have completed and handed in your extended essay to your supervisor. This is an opportunity to sit with your supervisor and look back at your difficulties and successes along the way, to reflect on your strengths and weaknesses, the experiences you have had, and especially on how you can use these experiences and the skills you have acquired to face your future challenges at university and throughout your life.

The outcome of this *viva voce* session will be the basis for the reflections you will write in your final reflection section of the RPPF. This reflection should be about 200 words long.

Academic integrity

According to the IBO, as stated in the document 'A principled approach to academic integrity', academic integrity is a guiding principle in education and a choice to act in a responsible way whereby others can have trust in us as individuals. It is the foundation for ethical decision-making and behaviour in the production of legitimate, authentic and honest scholarly work.

Plagiarism, on the other hand, is presenting someone else's work or ideas as your own, by incorporating it into your work without full acknowledgement.

As pointed out in the notes on references and bibliographies above, you must provide references to the sources being used throughout your essay in a standard academic format. The essay must provide the reader with the precise sources of quotations, ideas, points of view and images. Accurate citations can either be given within the text or in footnotes, with full references listed in the bibliography. Failure to comply with this requirement will be viewed as academic misconduct and will, therefore, be treated as a potential breach of IB regulations.

Therefore, ensure that you have acknowledged all sources of information and ideas in a consistent manner, so that you do not take the risk of being considered in breach of academic integrity.

9.2 Development of a digital society extended essay

The purpose of this chapter is to provide a sample outline for an actual digital society extended essay. The research topic for your extended essay will be a different one, of course, but this chapter will give you an overview of the investigation you will need to perform and the various sections that may be used to develop your essay.

At the end of the chapter, you will also be given an opportunity to perform a sequence of activities that will help you to select a relevant topic for your extended essay, formulate a working research question, create your extended essay outline, create an annotated bibliography for your secondary research, plan your primary research, and write your reflections.

Outline of a sample digital society extended essay

Topic

Impacts and implications of Instagram in the lives of high school students

Research question

To what extent does Instagram influence and control the actions of XXX high school students?

Note: "XXX" represents the name of a specific high school, so the scope of the investigation is narrow and the research question is sharply focused.

Table of contents

Introduction

Includes the significance of the use of Instagram by high school students and the value of the investigation. The introduction includes citations to the evidence for the claims.

Research methodology

- Secondary research using academic books and internet sites. At least 25 secondary sources will be used.
- Primary investigation through interviews with at least three experts and a survey with at least 100 high school students. The questions are based on findings from the secondary research.

Digital systems background

- How did Instagram evolve as a social network?
- Technical aspects of how Instagram functions and is accessed.
- Characteristics of Instagram algorithms and features that keep users logged in:
  - pull to refresh
  - infinite scrolling
  - like button
  - notifications.

  Include visual evidence – screenshots, images, diagrams – to support the explanation.

- Advantages of using Instagram:
  - expansion of social life (virtually)
  - entertainment
  - economic profits
  - personal publicity.
- Problems caused by the use of Instagram
  - addiction
  - peer pressure
  - social isolation
  - loss of focus in the real world.
- Comparison between findings from secondary research (global level) and findings from the primary research (local level).

Conclusion

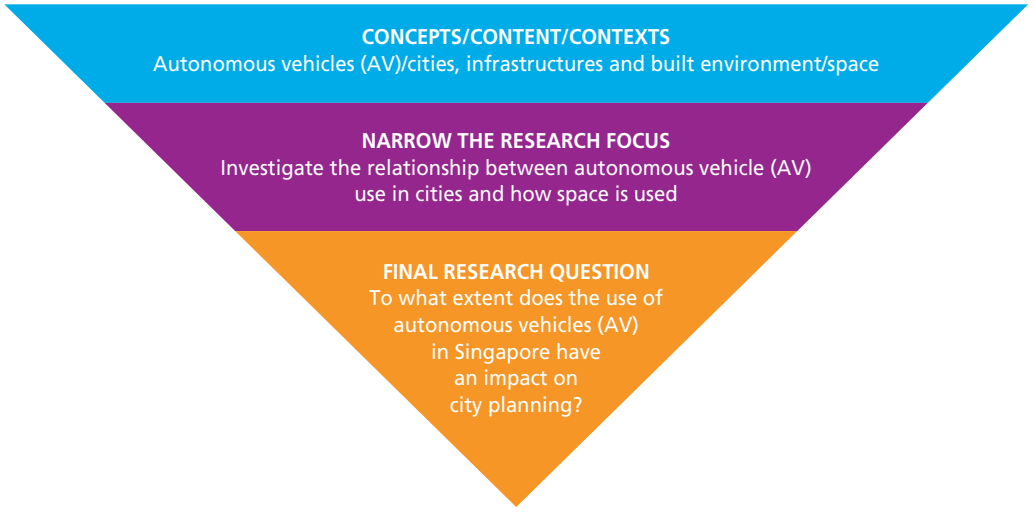
Answers the research question based on evidence provided from secondary and primary research.

Bibliography

Appendix

- transcripts from interviews
- summary of the outcomes from the survey conducted with 100 high school students.

Approaching a digital society extended essay with activities



■ How to narrow down the research focus

ACTIVITY 1: REFINE THE RESEARCH QUESTION

Many of the essays submitted to the IB have research questions that are far too broad. Consequently, they do not achieve full marks in Criterion A. Consider the following research question:

> *To what extent have the changes in digital technology been positive for education in the XXX school?*

While 'XXX school' may be narrow enough, as it identifies the school, 'changes in digital technology' is not, because there may have been an extensive number of changes in digital technology in the school since, let's say, the year 2000. Maybe you could restate this question as:

> *To what extent have the changes that occurred since 2018 in digital technology used in the XXX school been positive for its students' education?*

Think about another question that is too broad and needs refining. For example:

> *To what extent has playing games affected high school students' grades?*

Can you refine this question so that it becomes narrow enough to allow effective primary research?

Here are some hints. How many high school students are there in the world? Too many, right? How many are there in your school? Still too many? Then, how about focusing your question only on IB students in your school? How about games? Isn't that also a too broad area? After all, there are all sorts of games, from educational games to extremely violent games. What kind of game is the favourite one played by many of your classmates? Maybe that is the game that you should focus on. Can you properly refine the question now?

ACTIVITY 2: INITIAL IDEAS

Initial ideas

Look back at any of the initial ideas you have noted down from previous chapters.

Select one of these and put some of your ideas down on paper? Convert them into a mind map or spider diagram.

What questions evolve as you put down your ideas? What further research should you do?

Go back to your original ideas and refine them based on the further research.

Confirm the topic

Once your initial ideas have been developed, you should have a working research question to begin your research. You will then be ready for the next stage in the process.

An example of an extended essay topic is:

> *Conduct an in-depth study of how algorithmic bias is impacting decision-making in businesses.*

ACTIVITY 3: NARROW THE FOCUS

It is now time to start narrowing the focus.

More focused research

What has already been written about this topic and research question? Once you have a range of sources for the topic and research question, review the sources to check that you have collected sufficient and appropriate evidence to start writing the essay.

- Do the sources help you understand the topic better? Do they help you narrow the research question?
- Are the sources credible?
- Do the sources provide different perspectives on the topic?
- Do the sources agree with the general viewpoint, or do they contradict it?

Narrow your focus

While your secondary research will use resources that will allow you to come to conclusions about the answer to your question from a broader perspective, your primary research needs to be conducted in a much narrower scope. For that, you need to narrow your research question and consequently your focus.

From Activity 2, you should be looking at specific business and even at specific companies – ideally a company that is established in your city so you can approach managers, staff, and/or clients of the company for effective primary research. For example, the research question could be narrowed at this point from 'businesses' to 'financial institutions'.

ACTIVITY 4: PHRASING THE RESEARCH QUESTION

Once you have converted the ideas into a topic, it is time to narrow the topic into a research question. Do you need to do any more research in order to do this? Write down a few research questions. They may not be perfect at this point. Perhaps you need more research to find out how feasible the question is.

For example, the following research question would be too broad:

> *To what extent is the evolution of computing impacting the environment?*

How can research help narrow this down? Which aspects of evolution and the environment could you focus on? Why would this be an interesting investigation?

Keep in mind that it is mandatory that the research question must be a question and not a statement.

You should also avoid using a yes/no question (a question that can be answered with a simple 'yes' or 'no', such as 'Did the grades of the high school students at XXX school improve during the COVID-19 pandemic, when their classes were carried only online?').

ACTIVITY 5: CREATE AN EXTENDED ESSAY OUTLINE

Creating an outline will help you to organize your thought processes and take the mind map or spider diagram from Activity 2 to the next level. Review the 'Outline of a successful digital society extended essay' in Chapter 9.1 and the example in the beginning of this chapter.

Your extended essay outline may include:

- an introduction (the research topic, rationale for the topic and research question)
- methodological approach to the essay
- proposed chapters for the digital technology and discussion (analysis and evaluation): contexts, digital technologies, impacts, issues, dilemmas and relevant approaches that have been used to address issues
- conclusion (brings the essay to a close, answers the research question)
- bibliography
- appendix.

ACTIVITY 6: CREATE AN ANNOTATED BIBLIOGRAPHY

Creating an annotated bibliography will help your supervisor determine if you are ready to start writing the extended essay.

It is advisable to use online tools for making citations and bibliography entries in an accepted format. Include additional information for each source:

- some background information about the author
- the intended audience of the original source
- the reliability of the source
- a brief outline of the main argument and conclusion made
- the relevance of the source to the concepts, content and contexts in the essay.

ACTIVITY 7: CONDUCT PRIMARY RESEARCH

As part of the investigation stage of the extended essay, consider what types of primary research would support the findings from the secondary research.

For example, suppose your topic is 'the impact of robots in health care' and your research question is 'to what extent does the Da Vinci Surgical System impact on the health care provided by XXX hospital in the city of YYY?'. Identify one or more suitable persons to interview for primary research.

- Who would you choose and why?
- What questions could you ask them?
- How might they help further your research into your chosen topic?
- What other type of primary research could you use to further your investigation?

Once you have completed each of these activities, you should now be ready to write your extended essay.

ACTIVITY 8: WRITE A DRAFT OF EACH OF YOUR REFLECTIONS ON THE RPPF

This activity is actually three activities. Before you work on them, make sure to review the section 'Formal reflection sessions and the RPPF' in Chapter 9.1. Do not work on any of these activities until you have met with your supervisor for your formal reflection sessions. After you have formally met with your supervisor, make sure to work on the activity that applies to the required reflection.

- Write a draft of your initial reflection.
- Write a draft of your interim reflection.
- Complete the *viva voce* with your supervisor and then write a draft of your final session reflection.
- After writing each reflection, read it and ask yourself the following questions:
  - Is this reflection evaluative or descriptive?
  - Does it include reference to my capacity to consider my actions and ideas in response to the challenges I experienced during this process?
- If your answer to the first question was 'descriptive' and/or for the second question was 'no', rewrite your reflection and, after reading what you wrote, ask yourself the same questions again.

Reflection

Now that you have completed this chapter, consider this inquiry process checklist for developing the digital society extended essay.

Checklist: Inquiry process for developing the extended essay

Determine inquiry focus	• Have you selected a suitable digital society research question for your extended essay? • Have you decided on an appropriate methodology to carry out the inquiry process for your topic?
Explore	• Have you identified at least 25 relevant secondary sources for the development of your essay? • Have you collected relevant evidence from your secondary sources that will enable you to write your essay and help you to further narrow your investigation focus as necessary? • Have you selected relevant images to be used in the essay?
Explore	• Have you selected the method(s) to be used for your primary investigation and data collection based on the findings from your secondary research? **Survey(s)** • If you decided to collect data from survey(s), have you selected participants so that the sample is a true representation of the members of the community you are investigating? • Have you developed a strategy to collect and analyse the information collected? • Have you prepared meaningful questions for your survey? **Interview(s)** • If you decided to use one or more interviews, have you selected the people to be interviewed, so that their answers reflect the thoughts of experts in the area or of those whose knowledge in the area will be very meaningful to the outcomes of the investigation? • Have you developed a strategy to approach the people you selected for the interviews? • Have you prepared meaningful questions for your interviews?
Analyse ***Evaluate***	• Have you drafted the arguments that you are going to make in the essay? • Have you drafted an analysis and evaluation of the findings: – from your secondary sources? – from your primary research? – from your findings from the secondary research as they relate to the primary research?
Reflect	• Have you determined the arguments you will use in the conclusion for answering the research question? • Have you set up an extended essay outline as preparation for the table of contents?

Checklist: Extended essay document and RPPF

As you write your extended essay, be sure to refer back to the questions above and to the additional checklist below.

Reflect	• Have you written an introduction that clearly states the research question and the reasons why you selected the topic, using supportive evidence as needed? • Does the table of contents indicate the logical development of the extended essay? • Are the relevant concepts, content and contexts for the research question presented in the body of the extended essay? • Have you described and explained, in as much depth as necessary, the main digital systems involved in the topic? • Have you used appropriate images, diagrams and screenshots in your essay? Have you labelled all the images, diagrams and screenshots, properly citing the sources and referring to each one of them in the paragraph before or after it? • In the body of the essay, have you identified the methods used for primary data collection, including the details on how interviews/surveys/observations were conducted? • Have you compared the findings from secondary sources/authors?
Communicate	• Have you analysed the findings from primary research, for example, compared the outcomes of interviews, surveys, observations and/or examination of original material? • Have you analysed the claims from secondary sources and compared them with outcomes from primary research? • Have you included a suitable conclusion that clearly answers the research question? • Have you cited the sources throughout the essay properly using an accepted format? • Have you included a bibliography with a complete list of the sources in an accepted format? Do all citations in the essay correspond to entries in the bibliography? • Have you included evidence in the appendices from primary data collection and results, such as formal transcript from interview(s), survey and sample responses, survey results (tables, graphs), formal observations and original material as appropriate? • Are the pages numbered? • Is the word count for the body of the extended essay within 4000 words?
Reflect	• Have you written a suitable initial, interim and final reflections in the RPPF?
Communicate	• Have you written an overall maximum of 500 words in the three sections of the RPPF? • Have you made sure to write evaluative reflections, not descriptive ones?

Section 10

What's next?

This course provides an opportunity to investigate and study the real world we live in. Specifically, the focus is on the use of digital technologies in our changing world and their impacts and implications. Digital technologies are transforming how we think, communicate, collaborate and create, both at a personal level and in a range of contexts from local to global levels.

The course develops ATL skills and attributes of the IB learner profile and prepares you for further study in a variety of fields and professions. Your passions, interests and experiences are at the centre of the course, which aims to empower you as citizens who not only participate in digital society but take responsible action as well.

This course enables you to better understand this changing digital world and to imagine where we, individually and as communities, might go next. Throughout the Digital Society course, the approach has been to direct you to investigate your own real-world examples, rather than rely on using specific examples given in this book.

Lifelong learning for academic life and for careers that do not exist now

If you continue your studies beyond your IB Diploma Programme, there are many university courses that include topics relating to digital society, and specific degree programmes in digital society studies.

While all future academic studies are likely to involve digital technologies, possible areas for further investigation include:

- computer science and innovation for change in a digital society
- governance and law in digital society
- organizations and relationships
- digital media
- digital sociology and digital culture
- sustainable future
- robotics and automation
- cyber security
- data science.

As well as possibly continuing your studies into the impact and implications of digital technologies in society, you can use your knowledge and understandings in most areas of your life. During this course, you have investigated many of these in your study of digital technologies in a wide range of contexts.

Work life

In the business world, the use of digital technologies is essential at all levels and for many purposes. The Digital Society course has enabled you to investigate a number of contexts in the area of business, and to explore these using the seven concepts. The most important of these is the ethical concept, as all actions in business – both passive and active – can produce positive and negative outcomes for people and communities. Your studies will have prepared you to understand diverse perspectives, the ethical and practical use of digital technologies, and the development of innovative new technologies.

Social life

The study of the use of digital technologies in this course has provided an opportunity for you to reflect on your own use of digital technologies, and how they impact you, your friends and family, and local and other communities of differing sizes and make-up. Reflecting on your and others' uses provides an opportunity for you to develop as a person, especially if you use the IB learner profile as a lens to become a more empathetic and principled digital citizen.

Political life

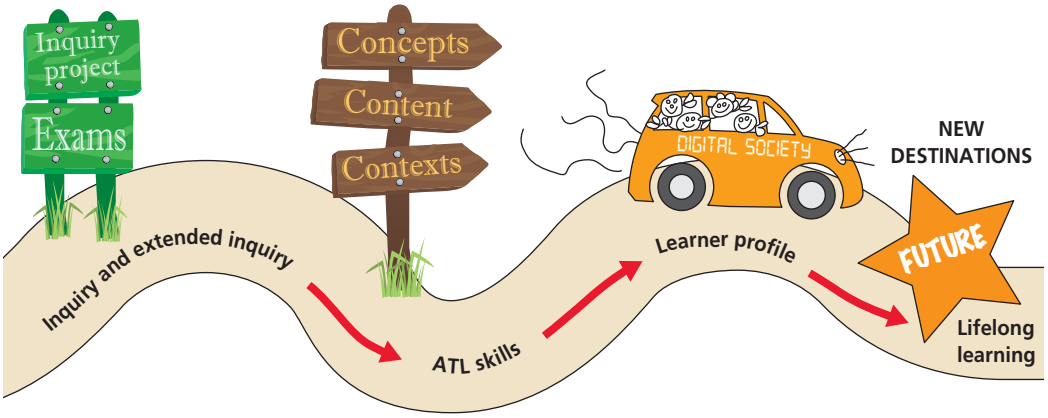
This course has provided you with a window into how the political life of the societies you live in operate in digital contexts. 'Societies', more than one society, has been used here as you will now be capable of being curious and engaged observers and thinkers in the many places you will most likely have the privilege to live in. This course has equipped you to be a force for balanced truth, a genuine digital citizen, in a world of often toxic social media, the dissemination of misinformation, and often purposeful disinformation.

Creative life

Digital technologies are changing our cultural worlds at all levels, not just in our business, social and political cultures but in our creative cultures as well. Our recreational lives now involve extensive use of digital technologies, with both positive and negative impacts. They are also changing our reality, as the virtual world has real impacts in the same way that the real world does. This course has enabled you to investigate some of them, and to be able to analyse, evaluate and make recommendations for future actions, so that you can enhance your creative endeavours with digital technologies in practical and responsible ways.

Path to the future

Wherever you might go next in this changing world, this course equips you to be citizens, decision-makers and leaders in our digital society. The course has shown you how to be reflective, think ethically and be emphathetic as you investigated, analysed, evaluated and made recommendations for the future about the use of digital technologies for individuals and communities. Along with the knowledge, skills and personal attributes you have developed, you have also gained an understanding of the necessity to take action in our digital society.



■ Digital society – path to the future

The best way to predict the future is to invent it.

Dr Alan Kay

Glossary

Accessibility: The quality of being easy to use.

Accountability: A person is accountable for the consequences arising from a decision that has been made. Accountability is a concept that is focused on what has happened. A person can be responsible for getting items done, and then can be accountable for the consequences.

Actuator: A device that moves or controls some form of mechanism.

Additive manufacturing: Adds raw materials layer by layer to build an object or product, as in 3D printing.

Air pollution: Pollution released into the air either through exposure to heat or burning.

Algorithm: A procedure or formula for solving a problem that is based on a sequence of steps.

Analogue: Continuous physical quantities and signals.

Anonymity: The use of digital technology to conceal a person's true identity.

Anthropomorphism: Attributing human characteristics to non-human entities.

Application software: Software that serves a specific purpose, such as a word processor or video editor.

Assembly language: Used by programmers to write code for special hardware or so that a task can be performed very quickly.

Assistive technology: Any item, equipment, programme or product that enhances the life for people living with disabilities.

Association rule: Uncovers how items are associated with each other and reveals relationships between items in large databases.

Asynchronous: Remote learning that can happen at any time using pre-recorded content.

Augmented reality (AR): Digital content overlaid on to a real-world experience.

Automation: The increased use of technology in a process, which reduces the need for human involvement.

Autonomous vehicle: A vehicle with the ability to drive itself and operate without human intervention.

Bandwidth: The maximum rate of data transfer at any one time, measured in hertz (Hz).

Behavioural competencies: The interpersonal skills required to do a job well.

Big data: Term used to describe large volumes of data, which may be both structured or unstructured.

Binary: A system used to convert verbal logic statements into mathematical ones.

Biodiversity: The variety in animal and plant life in a particular community or ecosystem.

Bio-hacking: Any activity that helps you gain control over your own biology.

Biometric information: Physiological details about a person that cannot change, such as their fingerprints.

Biometric passport: A passport that contains an electronic microprocessor chip biometric information about the passport holder.

Bioprinting: The 3D printing of tissues using a combination of cells, proteins or biocompatible plastic that simulates the skeleton.

Bit: A binary digit – either a 0 or a 1.

Black box algorithm: An algorithm that provides insight without clarity on how the conclusions were reached from the data input.

Blockchain: A digital ledger of transactions that is duplicated and distributed across a network of computers

Borderless selling: The process of selling goods across national borders.

Brick and mortar store: A retail outlet with a physical building.

Byte: A group of binary digits (usually eight).

Cache: The small amount of memory built into the CPU that stores data while it is being processed.

Cancel culture: Public backlash on social media when a person or organization says or does something that is considered objectionable or offensive.

Carbon footprint: The total greenhouse gas emissions caused by a person, place or product.

Cashless society: A society in which all transactions are carried out electronically.

Celebrations: Important events and milestones that are honoured and observed within a culture.

Censorship: The suppression or banning of certain content, speech or other information.

Central processing unit (CPU): The part of a computer that carries out and controls the computer's instructions.

Citizen scientists: Ordinary people who want to become involved in scientific research with the aim of increasing scientific knowledge.

Client–server network: A type of network where data is stored centrally on a server and access is given to each device (client) connected to the network.

Climate change: Long-term shifts in the global or regional climate, such as temperature and weather patterns.

Cloud network: Incorporates some or all of the network capabilities on a public or private cloud platform.

Cobot: Robot designed to work alongside humans and augment their capabilities.

Code of conduct: A set of rules outlining the standards that must be followed within an organization.

Competency development: The practice of developing competencies in particular skills.

Computer: A machine or device that processes data, performs calculations and conducts operations based on algorithms provided by software and hardware programs; it can input data, process it, store it and produce an output.

Concentric diversification: When a business adjusts their existing product lines to meet a wider customer audience.

Concepts: In digital society, these are powerful, widespread ideas that open up different perspectives and provide insight during inquiries into the real-world use of digital technologies.

Confirmation bias: The tendency to accept news and facts that confirm our existing beliefs.

Conglomerate diversification: When a business adds new products that are completely separate from their existing operations.

Content: In digital society, this is the study of the digital technologies used.

Contexts: In digital society, this is the study of digital technologies in a variety of real-life examples.

Copyleft: When owners of original work allow others to use their copyrighted property freely under specific conditions.

Copyright: Legal protection for the creators of literary and artistic works including books, music, paintings, films and computer programs, which may also be digital.

Counterfeit: To imitate fraudulently.

Creative computing: The interdisciplinary area at the cross-over of the arts and computing.

Critical-thinking skills: The process of conceptualizing, applying, analysing, synthesizing, and/or evaluating information.

Crowdfunding: Collecting money over the internet to support start-ups, charities and other causes.

Crowdsourcing: Collecting information/ideas/work from a large group of people, usually over the internet.

Cryptocurrency: A digital currency that use blockchain technology to create a decentralized encrypted ledger.

Customer review: Is the evaluation of particular items posted by previous customers or users.

Customs: Traditional ways of behaving or doing things.

Cyberbullying: Bullying carried out online, for example, on social media.

Cybernetics: The study of communication and control in both living things and machines, especially automatic control systems such as the human nervous system, and mechanical–electrical communication systems.

Data: Raw and unorganized facts and figures, which may be in the form of numbers, letters, characters or images.

Data broker: A company that collects and stores information about users and sells it on to companies or advertisers.

Data deletion: the sending of the file to the recycle bin, which removes the file icon and pathway of its location.

Data compression: Is a process that reduces the size of a file by re-encoding it to use fewer bits of storage than the original file.

Data erasure: The destruction of data at the end of the data life cycle.

Data integrity: Refers to the trustworthiness of the data and whether it has been compromised.

Data masking: The process of replacing confidential data with functional fictitious data, ultimately anonymizing the data.

Data matching: The process of comparing two different sets of data with the aim of finding data about the same entity.

Data mining: The process of finding patterns and correlations, as well as anomalies, within large sets of data.

Data privacy: The ability for individuals to control their personal information.

Data reliability: Refers to data that is complete and accurate.

Data visualization: The process of converting large sets of data into charts, graphs or other visual presentations.

Deepfake: Synthetic media created with the use of deep learning/artificial intelligence.

Demographic components: Statistical data points that are used to characterize or label groups of people.

Digital: Discrete signals with a finite set of values.

Digital activism: Activism that uses the internet and digital media as key platforms for mass mobilization and political action.

Digital citizenship: The responsible use of digital technology.

Digital divide: The gaps between members of society who have uneven access to computers or the internet, and those who do have access.

Digital health care records: Online databases that store patient information.

Digital literacy: The ability to use various digital platforms.

Digital media: Video, audio, images and other content that is created, encoded and stored before sharing to the user(s). Encoding is the process of converting the media into a computer-readable format.

Digital medication: Prescription medicine that contain an ingestible sensor; also known as 'smart pills'.

Digital nomad: A person who works remotely and is not tied down to any particular location.

Digital pedagogies: Approaches to teaching that integrate digital tools into the learning environment.

Digital preservation: The process of ensuring that source material is stored and accessible in a digital format regardless of technological changes that may take place over time.

Digital redlining: The systemic denial of digital services to specific communities.

Digital revolution: The advancement of technology from analogue electronic and mechanical devices to digital.

Digital surveillance: The collection of data about a person's online communications, connections, finances and other available information.

Digital warfare: the use of digital technology to disrupt or impact vital computer and warfare systems.

Digitalization: The use of digital systems to change the structure and/or operation of a business, institution or organization.

Digitization: Changing analogue data and information to digital.

Disability: A conditions that limits a person's movement or senses.

Discriminate: The unjust treatment of people based on gender, social identity, race or disability.

Disinformation: False information that is deliberately created and spread with the intent of influencing public opinion or obscuring the truth.

Distribution: The movement of products from farmers and growers to customers.

Distributed denial of service (DDOS) attacks: Overwhelming a site or service so that it is not available to its intended users.

Diversification: When a business enters into a new market or industry.

Diversity: In business, this refers to the inclusion of people from a range of demographic indicators.

Domain name server (DNS): A server that translates domain names into IP addresses.

Domain-specific AI: Artificial intelligence that perform tasks better than humans in certain domains.

Dominant culture: A culture that has established its own norms and values as the standard for the entire group.

Doxing: The publication of personal and/or private information such as addresses, phone numbers and photos.

Drone: A remote controlled or autonomous flying robot.

Echo chamber: An environment in which people only hear beliefs and opinions that echo their own.

E-commerce: The buying and selling of goods and services online.

Ecosystem: A community of living organisms and the physical environment that they live in.

Electronic voting system: A digital system designed to count votes the moment they are cast.

Embedded computer: A combination of hardware and software designed to perform a specific task and incorporated into an electronic or mechanical system.

Encryption: The process of converting readable data into unreadable characters to prevent unauthorized access.

End effector: A mechanical or electromechanical peripheral device that can be used to grip objects.

Ergonomic design: Designing workplaces, products and systems so that they meet the physical and emotional needs of the user.

Ethnicity: The cultural expression and identity shared by people with a common racial, national, religious, or any other identity marker.

E-trading: The trading of financial products, such as stocks, bonds or other assets, online.

E-waste service: A business that collects obsolete electronic devices and sorts them into recyclable and non-recyclable elements.

E-waste: Discarded electronic and electrical devices.

Exoskeleton: A wearable robotic tool that supports/strengthens the human body.

Expert system: A computer system that acts like a human expert in a specific subject area.

Fake news: False or misleading information presented as news.

False positive: A test result that incorrectly suggests a condition is present.

Filter bubble: When information only comes from a narrow range of sources dues to algorithms designed to personalize your online experience.

Firewall: Hardware or software designed to block unauthorized access to a network by inspecting incoming and outgoing network traffic.

Flowchart: A visual representation of an algorithm showing an overview from start to end.

Fluidity: The ease with which people can join/leave digital subcultures.

Food security: Reliable access to sufficient amounts of safe and nutritious and food.

Form: The physical nature of a work of art, for example painting, graphic design, sculpture, literature, film, music, theatre, fashion and architecture.

Forum: Online discussion sites that allow users to post and reply to messages.

Functional competencies: The knowledge required to do a job well.

Gamification: Applying elements of game playing to other activities to encourage participation or efficiency.

GDPR (General Data Protection Regulation): Legislation designed to harmonize data privacy laws across the EU.

Genre: A category of art.

Geographic information system (GIS): A system that connects data to a map.

Gig economy: Labour market in which individuals and organizations exchange short-term/task-based services using digital platforms.

Global positioning system (GPS): A satellite-based navigation system.

Global sourcing: Buying materials, goods and services from all over the world; the supply-side equivalent of global selling.

Green computing: The study and adaptation of computer design, engineering, manufacturing, use and disposal to reduce their negative environmental impact.

Guidelines: Norms and rules for membership and participation.

Hacking: Unauthorized access to a computer or network.

Hacktivism: Hacking into a computer system for socially or politically motived purposes.

Hashtag: A word or phrase preceded by the symbol # to classify or categorize the accompanying text.

Heritage: The objects and qualities that are passed down from generation to generation.

Horizontal diversification: When a business adds on products/services that are complementary to their core business.

Hub: A networking device that broadcasts data to all devices on the network.

Identity theft: When someone steals your personal information with the intention of committing fraud. They may use your information to apply for a credit card or gain access to medical services.

Inclusive: In business, this refers to an environment in which people of all backgrounds feel valued, safe and respected.

Inference engine: The part of an expert systems that uses programmed rules to interpret and evaluate the facts in the knowledge base.

Influencer: Social media celebrities with large numbers of followers.

Information: The output after data has been processed, organized or structured, to convert it into something that is ready to visualize or analyse; it provides context for the data.

Infrastructure: The structures and facilities, such as roads, buildings or power supply, that allow a place to operate effectively.

Insourcing: The practice of finding existing employees to complete a task rather than outsourcing it.

Intellectual property: The outcome of thought or intellectual effort, for example a new invention or an original design. It also refers to the legal protection of that work.

International-mindedness: A mindset in which one sees their connection to the global community and has a sense of responsibility to its members.

Internet: The global collection of networks and networking technologies that link billions of users worldwide.

Internet connectivity: The ability to connect to the internet.

Internet of things (IoT): Internet-connected devices that collect and share data.

Internet service provider (ISP): A company that provides internet access and other related services to its customers.

Internet trolls: People who leave intentionally provocative or offensive messages online in order to get attention, cause trouble or upset someone.

Interoperability: Allows different digital technologies or systems to connect and exchange data with one another without restrictions.

Intersectionality: The overlap and interconnection that a specific and unique set of identity markers may create.

Intervention: A digitally-based solution and/or innovation that addresses the impacts and implications for people and communities in the challenge topics.

IP (internet protocol) address: A logical numeric address that is assigned to every node on a network.

Knowledge base: Facts and rules in an expert system.

Knowledge: Meaning can be derived from information and applied to achieve a set goal.

Light pollution: Excessive light in the environment.

Local area network (LAN): A group of computers or devices that are connected on a single site.

Loot box: A virtual consumable that contains a random/mystery item. These can be purchased or won in games/apps.

MAC address: A unique identifier assigned to every piece of hardware.

Machine code: Sometimes called object code, machine code is written in binary (0s and 1s) or hexadecimal instructions that the computer can respond to directly. Each type of computer has its own machine language.

Mainframe: A large computer used by businesses to host databases, servers used for transactions and business applications. Mainframe computers require high-level security measures.

Malicious software (malware): Software designed to steal data or damage computers/IT systems.

Massive open online course (MOOC): An online course that available for a nearly unlimited number of students to participate in.

Medical diagnostics: The equipment, tools and processes that professional medical personnel use to make a diagnosis.

Meme: An image, video, piece of text – typically humorous in nature – that it copied and spread rapidly by internet users, often with slight variations.

Metadata: A set of data that describes and gives information about other data.

Metropolitan area network (MAN): A network that covers a larger geographical area, such as a city.

Microchip implant: Implanting an RFID transponder under the skin.

Microtargeting: The strategy of using consumer data and information to create personalized content and advertisements.

Micro-transactions (mtx): The purchase of virtual goods for small sums of money in games/apps.

Microwork: Short-term projects completed quickly for payment.

Misinformation: False or inaccurate information that is mistakenly or inadvertently created or spread; the intent is not to deceive.

Mixed reality (MR): Blending the real world and digital world to create new experiences.

Mobile service provider (MSP): A company that offers cellular connection to mobile phone subscribers.

Modem: A device that converts digital data into analogue data so that it can be transmitted over a telephone line.

Moderation: A system designed to ensure messages posted online comply with the rules set by the online community.

Moore's Law: The number of transistors in a dense integrated circuit doubles every two years.

Motherboard: A circuit board that allows data to travel to the different components in a computer.

Multi-factor authentication: The use of multiple methods of authentication to verify a user's identity.

Multiplicity: A future in which artificial intelligence and robots are developed to work alongside people, rather than to replace them.

Nearsourcing: The practice of establishing operations as close to where the end-products are sold as possible.

Net neutrality: The concept that all data requests on the internet should be treated equally by the internet service providers (ISPs).

Netiquette: Rules that apply to your online behaviour to ensure the proper use of data, apps and programs.

Netizen: A person who uses the internet in a socially responsible way.

Network: A series of interconnected nodes (connection points) that are able to transmit, receive and exchange data. The data may have various formats including text, sound, images and video. Examples of nodes include computers, servers and routers.

Network interface card: Device responsible for converting data into a digital signal and communicating this data to a network.

Network protocol: A set of agreed rules that state how to format, send and receive data.

Noise pollution: Excessive noise in the environment.

Non-fungible token (NFT): A unique digital artifact (usually drawings, music or art) combined with blockchain technology to allow a unique identification and authentication of the artifact.

Non-governmental organization (NGO): Transnational organization that operates independently of government agencies.

Office automation system: A system designed to centralize and organize data, improve communication between workers and departments, manage calendars and facilitate collaboration in businesses.

Office design: The functional and decorative components of the working environment.

Offshoring: The practice of moving corporate operations overseas.

Online community: A group of people united by a shared interest or purpose who use digital tools to communicate with each other.

Online exhibition: An exhibition in a virtual venue (cyberspace).

Online forum: Any platform where people can post and discuss messages.

Online marketplace: A digital platform that allows individual sellers and buyers to trade.

Online voting: A systems that allows voters to cast their ballot online.

Open innovation: When organization incorporate external sources into their research and development strategy.

Open-source software: Is free of charge and free of copyright, allowing the source code to be modified, often by an open-source community. However, there is no guarantee that the software will be bug free or support readily available.

Operating system: Software that manages the hardware, software and memory of a computer as well as providing a user interface.

Organ printing: The 3D printing of organs using a combination of cells, proteins or biocompatible plastic that simulates the skeleton.

Outsourcing: The practice of moving corporate operations to another local company.

Paywall: A method of restricting access to digital content unless a subscription is paid.

Pedagogy: An approach to teaching.

Peer-to-peer network (P2P): A decentralized network in which each computer is equally responsible for storing and sharing data.

Personal area network (PAN): The smallest type of network, consisting of the connected devices that are in close proximity to an individual.

Personal computer (PC): A general purpose computer designed for individual use.

Phishing: A type of social engineering that involves sending fraudulent messages designed to trick users into revealing sensitive information.

Planned obsolescence: The development of products with intentionally short lifespans so that companies can get repeat sales as devices are replaced or upgraded.

Pollution: The introduction of substances or energy into the natural environment that cause a negative impact.

Popular culture: The music, dances, movies, performances, art and other forms of expressive media enjoyed by a society.

Predictive policing: The use of algorithms in an attempt to forecast criminal activities.

Primary data: Original data collected for the first time for a specific purpose.

Primary research: First-hand research in which you collect original data.

Prioritization algorithm: A sorting algorithm used to prioritize tasks.

Privacy: The ability of individuals and groups to determine for themselves when, how and to what extent information about themselves is shared with others.

Professional service robot: Semi-autonomous or fully autonomous robots developed to assist humans in commercial settings.

Propaganda: Biased or one-sided information.

Proprietary software: Is often downloaded after paying for a license or subscription. In return for payment, users can expect updates and help from the company. Proprietary software is copyrighted which denies users access to the source code (so that it cannot be modified) and restricts the sharing of the software.

Proxy discrimination: Discrimination that occurs due to correlations to indicators such as race, disabilities or socio-economic status.

Proxy server: Computer system that acts as an intermediary between the client on the network and the internet, providing an additional layer of security.

Psychographic analysis: An analysis of people based on their activities, interests and opinions.

Psychometric survey: A survey designed to measure an individual's mental capabilities and behavioural style.

Qualitative: Descriptive, non-numerical data.

Quantitative: Data that can be measured and converted into numbers.

Quantum computing: The technology that uses quantum mechanics to create powerful quantum hardware which can solve complex problems faster than existing supercomputers.

Race: A social construct based on people's physical traits and characteristics.

Radicalization: The use of the internet to share ideas and resources that are radically different from those in mainstream society.

RAM (Random Access Memory): Short-term memory where data is stored temporarily while it is being processed or viewed on screen.

Ranking system: The assignment of a number or short description to data to indicate first to the last in a data set.

Ransomware: Malware that infects a computer and effectively locks the user out of their own device and demands a payment to unlock it.

Real-time: Happening now or live.

Recidivism: The tendency to reoffend.

Recycle: The process of converting waste into reusable materials.

Relational database: A database that has more than one table.

Remote learning: Education that occurs over a network connection, for example, using video-conferencing software.

Remote working: Conducting business and completing tasks from anywhere that employees are able to connect to the essential networks from, for example, working from home.

Research and development (R&D): Work on innovating, improving and introducing new services or products.

Reshoring: The practice of bringing previously outsourced jobs back from overseas, also called 'inshoring'.

Responsibility: A person is responsible for a decision that needs to be made and its implementation. Responsibility is a concept that is focused on future actions that need to be taken.

RFID: Radio-frequency identification.

Rite of passage: A ceremony or tradition that marks when an individual leaves one group and enters another, for example a birth, marriage or death.

Robot: A programmable machine that can complete a set task with little or no human intervention.

Robotic surgery: Surgery carried out using robotic systems, for example mechanical arms controlled by a surgeon.

Router: A networking technology that transfers data from one network to another by the most efficient route available.

SaaS: Software as a service; a software distribution model in which a third-party provider hosts the applications with end-users accessing the software through the internet.

Sabotage: The disruption of computers and systems that operate military, economic infrastructure or other vulnerable networks.

SAMR model: A framework for analysing educational technology.

Secondary data: Data that has already been collected by someone else for a different purpose.

Secondary research: Research carried out by someone else.

Secondary storage: Is non-volatile, long-term memory, used to store programs and data until they are required.

Secure Socket Layer (SSL): Is a protocol developed for sending information securely over the Internet by using an encrypted link between a web server and a browser.

Self-guided learning: A strategy that allows students to direct their own learning.

Server: A large computer dedicated to managing network resources. They can use specialized server hardware or can be a regular computer with a server-specific operating system capable of managing network resources.

Service robot: Robot developed to assist humans in completing tasks that are less desirable, such as dull, dirty or dangerous jobs.

Sharing economy: Assets or services that are shared between individuals, often using an online booking system.

Singularity: The hypothetical future where artificial intelligence becomes so advanced that it is superior to human intelligence.

Smart city: A city that integrates sensors, voice recognition and other new technologies to better manage transportation, energy distribution and other services.

Smart home: Home equipped with internet-connected lighting, heating and other electronic devices.

Social class: A method of classifying people and communities according to their social status.

Social engineering: In internet security, this means tricking a user into sharing their username and password with a fraudster.

Social media addiction: Psychological or behavioural dependence on social media to the detriment of other important parts of life.

Social-emotional learning: The integration of social and emotional skills into the curriculum.

Solid pollution: Solid waste material.

Spamming: Sending unsolicited emails, mainly for the purpose of advertising.

Speed: The length of time it takes for data to be transferred, measured in megabits per second (Mbps).

Stratification: The unequal distribution of resources between people/nations.

Streaming: Multimedia (especially video and audio) that is delivered digitally with little or no intermediate storage.

Strong AI: Artificial intelligence that can develop consciousness and make decisions better than humans.

Subculture: Smaller cultural groups that exist within a larger culture.

Subtractive manufacturing: Creating an object by cutting or carving a larger material into the desired shape.

Super AI: Artificial intelligence that surpasses human intelligence.

Supercomputers: Refers to high-performance computers capable of high-speed calculations that are required in scientific and engineering fields.

Surveillance: Is undertaken to collect information about people which can be used for a variety of purposes, both positive and negative, even though surveillance has mainly negative connotations. Surveillance can be conducted using technology, or through observations by people. The information collected can be used to control and influence those being observed and others.

Sustainable development: The ability to meet human development goals without depleting the natural resources that we depend on.

Switch: A networking device that forwards data packets more efficiently than a hub.

Synchronous: Remote learning that happens in real time with a live teacher.

Systems thinking: A way to think about structure and order in human, natural and built environments.

Technique: The way an artist uses their technical skills to create their art.

Telemedicine: The remote treatment of patients.

Terrorism: The unauthorized use of violence/force to create fear and coerce a government or its people toward a political or social cause.

Transaction processing system: A system designed to incorporate all of the resources, software and hardware needed to manage sales, purchases and other transactions.

Transhumanism: A movement that aims to use technology to evolve and augment the human experience.

Translation app: An app that translates one language into another allowing communication in real time.

Transmission control protocol/internet protocol (TCP/IP): Protocol that defines where data is to be sent to and from (IP), and how the data is to be broken down into smaller sections before sending (TCP).

Transparency in algorithms: the ability to understand and be able to explain the inner workings of the algorithm.

Transport Layer Security (TLS): Is an improved version of SSL and is a protocol that provides security between client and server applications communicating over the Internet.

Trending: A topic that experiences a sudden surge in popularity on social media platforms for a limited period of time.

Trilateration: Technology that uses three satellites to pinpoint our phone's location.

User interface: The means by which human users interact with a digital technology. The intent is to make the user's experience straight forward, intuitive, and requiring minimum effort to achieve the desired outcome.

Utility software: Software designed to perform specific useful tasks that either help to analyse, configure or maintain the computer.

Validation: In databases, this means that only valid (suitable) data can be entered.

Verification: In databases, these are checks that the data entered is the actual data that you want, or that the data entered matches the original source of data.

Vertical diversification: When a business takes over a new part of their supply or production chain.

Video game addiction: Psychological or behavioural dependence on playing video games to the detriment of other important parts of life.

Virtual conferencing platform: Digital platform that allows multiple users to video chat at the same time, for example Zoom or Google Meet.

Virtual personal assistant: Voice-controlled helper mainly found in smart speakers or mobile phones.

Virtual reality (VR): A simulation that provides a completely immersive environment for the user.

Virtual reality exposure therapy (VRET): Therapy designed to reduce a person's fear and anxiety by confronting the experiences in a computer-generated virtual environment.

Virus: A type of malicious software comprised of small pieces of code, often attached to legitimate programs or emails.

VoIP (voice over internet protocol): Allows users to make voice calls using a broadband Internet connection instead of an analogue phone line.

Water pollution: Pollution released into water.

Wayfinding: The technologies and systems that give directions to people as they navigate a physical space.

Weak/narrow AI: Artificial intelligence that has a limited function or can only perform a specific task.

Wearable medical device: A device that can be worn to provide continuous, real-time data to improve the treatment, diagnosis and monitoring of patients.

Wide area network (WAN): A national or international network; the largest example is the internet.

Wireless access point (WAP): A device that creates a wireless local area network to improve coverage throughout a building.

Wireless networks: Use of wireless technologies to connect the different nodes to form a network.

Wisdom: The application of knowledge.

World Wide Web (WWW): The websites and web services that are hosted on web servers and identified by their URL (uniform resource locator).

Youth culture: The culture and social norms of teenagers and young adults.

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Section 4 Contexts

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Section 9 Digital society extended essay

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