

# Syllabus content

## Strand 1: Social and ethical significance

The widespread use of information technology (IT) raises questions about the social and ethical considerations that shape the world today. IB students must become familiar with all the social impacts and ethical considerations described in this section. IB teachers should introduce them as appropriate, using the integrated approach illustrated in the **ITGS triangle**. In this way, students can discuss social impacts and ethical considerations that are raised when IT systems are used in a range of scenarios. The use of IT is likely to bring both advantages and disadvantages, and students should be able to discuss the effects of IT in a critical way as well as evaluating possible solutions. It is important that examples are drawn from the local, national and global level from recently published articles. Some examples of scenarios for consideration are listed later in this section.

### Analysing social impacts and ethical considerations

Throughout the course, students must analyse and evaluate the social impacts of IT on individuals and society, and consider the ethical issues raised by these impacts.

Social impacts and ethical considerations need to be analysed from both a local and a global perspective, recognizing that attitudes and opinions are diverse within and between different cultures.

### Key questions

The discussion of **social impacts and ethical considerations** can be guided by answering the following key questions.

Social impacts	Ethical issues
<p>What are the social impacts associated with a particular IT development?</p> <ul style="list-style-type: none"> <li>• How did the IT development emerge?</li> <li>• Who are the stakeholders—individuals, institutions and societies who initiate and control the IT developments and are affected by them?</li> <li>• What are the advantages and disadvantages for the stakeholders?</li> <li>• What are the social impacts of the IT development on human life? These may include some or all of the following areas: economic, political, cultural, legal, environmental, ergonomic, health and psychological.</li> <li>• What feasible solutions can be applied to overcome problems?</li> </ul>	<p>What are the ethical issues associated with a particular IT development?</p> <ul style="list-style-type: none"> <li>• Who is responsible?</li> <li>• Who is accountable?</li> <li>• What policies, rules or laws apply to the scenario?</li> <li>• What are the alternative ethical decisions?</li> <li>• What are the consequences of these decisions?</li> </ul>

## Definitions and examples of social impacts and ethical considerations

The following definitions may be assessed.

It is expected that other appropriate examples would be used to reinforce the understanding of the topic. These would not be assessed.

### 1.1 Reliability and integrity

**Reliability** refers to the operation of hardware, the design of software, the accuracy of data or the correspondence of data with the real world. Data may be unreliable if it has been entered incorrectly or if it becomes outdated. The reliability of machines, software and data determines our confidence in their value.

**Integrity** refers to safeguarding the accuracy and completeness of stored data. Data lacks integrity when it has been changed accidentally or tampered with. Examples of data losing integrity are where information is duplicated in a relational database and only one copy is updated or where data entries have been maliciously altered.

### 1.2 Security

**Security** refers to the protection of hardware, software, machines and networks from unauthorized access. Security measures include restricted access to machines and networks for certain employees or to prevent access by hackers. The degree of security of information systems largely determines society's confidence in the information contained in the systems.

### 1.3 Privacy and anonymity

**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. At its extreme, privacy becomes **anonymity** when, for instance, a person uses it to conceal his or her true identity in order to cyber-bully someone else. Conversely, excessive privacy could also conceal the perpetrators of criminal, terrorist or computer hacking acts from law enforcement agencies.

### 1.4 Intellectual property

**Intellectual property** includes ideas, discoveries, writings, works of art, software, collections and presentations of data. Copyright, trademarks and patents exist to protect intellectual property. However, the easy and accurate duplication methods made available through IT can undermine such protection.

### 1.5 Authenticity

**Authenticity** means establishing a user's identity beyond reasonable doubt. Authenticating the user is crucial in many scenarios, particularly in business and legal matters. A simple example of authentication is a user login to a network. A more advanced example would be the use of encrypted digital signatures in a business transaction or the use of watermarking on digital photographs.

### 1.6 The digital divide and equality of access

The growth of the use of IT systems has led to disparities in the use of, and access to, information technologies. Disparities exist not only internationally between countries, but also within countries between different socio-economic groups as well as within what may appear to be relatively homogenous groups. This may lead to groups or individuals without access to IT being disadvantaged. For example, while telelearning may bring previously unavailable opportunities to everyone's doorstep, factors such as the cost and availability of hardware, software or access to the internet may create a "digital divide".

### 1.7 Surveillance

**Surveillance** is the use of IT to monitor the actions of people. For example, monitoring may be used to track, record and assess employees' performance. It can be used to support claims for promotion or to ensure that employees follow the organization's internet policy appropriately.

## 1.8 Globalization and cultural diversity

**Globalization** means the diminishing importance of geographical, political, economic and cultural boundaries. IT has played a major role in reducing these boundaries. For example, any dramatic event anywhere in the world can be broadcast almost instantly by television or on the internet. However, the new “global village” may lead to the extinction of minority languages.

## 1.9 Policies

**Policies** are enforceable measures intended to promote appropriate and discourage inappropriate use relating to information technologies. They can be developed by governments, businesses, private groups or individuals. They normally consist of rules governing access to, or use of, information, hardware, software and networks. For example, a school policy on the use of IT would consist of each user signing an acceptable-use policy. It would also address unlawful access to the network through, for example, identity theft or using hacking software, and how these transgressions would be treated. Many websites also require users to agree to specific policies before allowing access to their services.

Policies also affect the exchange of information, for example, by making it subject to copyright laws and raising people’s awareness of plagiarism. In general, policies can promote or restrict access, guide behaviour, require the fulfillment of certain conditions prior to or during use, or need to be developed to address unforeseen issues such as cyber-bullying.

## 1.10 Standards and protocols

**Standards and protocols** are technical rules and conventions that enable compatibility and therefore facilitate communication or interoperability between different IT systems and their components. They might govern the design and use of hardware, software and information. For example, the communication protocols used on the internet, the ASCII representations for characters, or the design of the printer port on a personal computer are all governed by standards.

## 1.11 People and machines

The use of IT systems brings significant advantages, for instance in ease of use, being available 24/7, or through its use rather than exposing humans to a potentially hazardous environment. However, this can raise concerns about the rate at which technology is being introduced and issues that may arise from insufficient testing in critical situations such as air traffic control. The ultimate fear of many people is that future systems will be programmed to make decisions that would be better taken by humans, such as the decision to deploy nuclear weapons.

There are also social impacts such as internet addiction, where people feel that they can never get away from IT and are trapped on a “digital treadmill”.

## 1.12 Digital citizenship

**Digital citizenship** can be defined as appropriate behaviour that represents the responsible, ethical and legal approach that individuals take in any situation with respect to the use of IT. Digital citizenship permeates, in one way or another, all of the preceding social and ethical considerations.

## Other specific social and ethical considerations

Other social and ethical considerations may emerge during different scenarios discussed in class. These may be related to changes in attitudes towards the use of IT systems, or new developments in IT such as social networking or e-assessment.

## HL extension

In discussing the social and ethical issues linked to the case study, additional considerations may emerge.

## Strand 2: Application to specific scenarios

The scenarios listed here are divided into themes as an organizational tool. Examination papers assess scenarios related to these themes. Individual examination questions may address one, some, or all of the themes.

- Every theme must be studied.
- Every topic within each theme must be studied.
- Each topic must be taught using real examples. Some of the examples shown in the tables suggest possible approaches for study.
- Students will be expected to apply their knowledge from the topics taught in class or researched independently to the stimulus material in the externally assessed components. This may include discussing ethical issues and social impacts as well as demonstrating an understanding of the IT systems involved.
- For each of the scenarios addressed, students will be expected to identify relevant stakeholders and to discuss, where relevant, potential stakeholder conflict.

### 2.1 Business and employment

Topic	Examples
Traditional businesses	Banks, including ATM (automatic teller machines), EFT (electronic funds transfer), hotels, supermarkets, travel agencies.
Online businesses (e-commerce)	Working practices such as teleworking and home working.
Transportation	Airline reservation systems, navigation, package tracking, traffic control systems, IT systems in cars.

The coverage of business and employment should address the IT systems that exist as well as the ethical issues and social impacts that arise from the increased use of information technologies for both employers and employees. Students should be aware of the range of different business environments, ranging from a traditional (offline) business to businesses that are exclusively online.

### 2.2 Education and training

Topic	Examples
Distance learning over large areas	Hospitals, prisons, retirement homes, schools.
Use of IT in teaching and learning	Educational software, online research and forums, virtual learning environments (VLE), e-books, Web 2.0 educational networks, use of mobile devices, game-based learning, fully immersive environments, filtering and monitoring of students' internet use, 1-to-1, m-learning.
Hardware and network technologies in the classroom	Laptop computers, handheld devices, interactive whiteboards.

Topic	Examples
Provision for special needs	Inclusive software, Braille keyboards, accessibility.
School administration	Record-keeping of staff and finances, libraries, student records, EDI (electronic data interchange).

The development of new IT systems is revolutionizing the delivery of education and training. Technological advances have led to an increase in the dependency of students, staff and administrators on the supporting IT systems.

### 2.3 Environment

Topic	Examples
Modelling and simulations	Climate change, forecasting natural events or demographic changes.
Data logging	Sensors, probes, real-time data collection.
Satellite communication	Remote sensing devices, satellite imagery, tagging.
Mapping, virtual globes	Geographic information systems (GIS), global positioning systems (GPS), cell/mobile phone tracking, online journey planning, online maps.
E-waste	Development, disposal and recycling of IT equipment, monitoring organizations such as the Basel Action Network.
Resource depletion	Use of non-renewable resources for manufacturing components, electrical consumption of IT systems.

The environmental theme covers a wide range of topics. The increasing processing capability of mobile devices has enabled almost universal access to information, but the increased number of devices has impacted on health and the environment.

### 2.4 Health

Topic	Examples
Diagnostic and therapeutic tools	Surgery, prosthetic devices, diagnostic technology, rehabilitation, patient monitoring, individualized IT solutions for disabled people, accessibility.
Medical information, administration, marketing and sales	Medical advice, e-prescriptions, telemedicine, electronic health records, international health cards.
Medical research	Global collaboration, database for the Human Genome Project, improving patient rehabilitation.
Psychological and physical considerations	Internet addiction, repetitive strain injury (RSI), ergonomics.

IT has revolutionized medicine. With the increasing size of the world's population, the effective management of health care using IT systems will become even more important.

## 2.5 Home and leisure

Topic	Examples
Homes and home networks	IT management of home systems: for example, lighting, security, entertainment centres.
Digital entertainment	Films, photographs, music, arts, online and digital games, gambling, virtual worlds.
Social networking	Chat rooms, messaging, blogging, file sharing, wikis.
Published and broadcast information	Books, newspapers, digital radio and TV, e-books, podcasts.
Digital policing	Monitoring organizations such as the Recording Industry Association of America (RIAA) and the Motion Picture Association of America (MPAA).
Hardware, software and networks	Portable digital devices and their ability to remotely control other devices, IT-enabled appliances.

The growth of the internet and the ability to transfer information globally in real time has revolutionized the way in which increasing numbers of people live. The global online society, the development of English as the dominant online language, and the constant availability of information may lead to a homogenization of peoples, with some cultures being subsumed into others or lost.

## 2.6 Politics and government

Topic	Examples
Political processes	Online campaigning, voting, lobbying, fund-raising and advertising.
Government information sites	For example, travel warnings, tourist information, environmental information and warnings, government policies, city government websites.
Access to, and updating of, personal information held on government databases	Collection, storage and updating of personal data: for example, driving licence, TV licence, tax returns, passport applications and renewals, medical records, military service records, social security information, online police records.
Government control and use of information	Censorship, data matching across agencies, archiving, biometric data, national identity cards.
Law and order	Police surveillance, terrorist monitoring, DNA data.
Military	Cyberwarfare, smart weapons, espionage, battlefield technology.

The importance of IT is becoming increasingly evident in political campaigns. With increased amounts of information available to governments, ethical issues relating to its possible misuse are becoming more and more important.

## Strand 3: IT systems

Students are required to demonstrate knowledge and understanding of the technical concepts within the IT systems strand. They are expected to demonstrate this technical knowledge by the use of correct and appropriate technical language and provide, where appropriate, a step-by-step description of how the IT system works.

Teachers must be aware that the technical knowledge should concentrate on breadth of knowledge rather than depth and should bear this in mind during the teaching of the course. In all of the topics, but particularly “Internet”, “Personal and public communications”, “Multimedia/digital media”, “Databases” and “Spreadsheets, modelling and simulations”, students are expected to carry out practical activities to reinforce their theoretical knowledge. It should also be noted that programming is not explicitly required as part of the ITGS course, although it may be used in the development of the project.

Due to the rapidly changing nature of IT systems, a list of new (additional) technical terms that will apply to future examinations will be provided for schools on the OCC.

### SL/HL core

#### 3.1 Hardware

##### Introduction

The **hardware** topic deals with a computer system consisting of input devices, output devices, a central processing unit and storage. ITGS students are required to understand the meaning of the terms and concepts listed here and, where appropriate, briefly describe how they work.

The increasing tendency to develop hardware in modular units raises a range of social impacts and ethical issues such as the use of non-renewable natural resources, the global transportation of manufactured components and their eventual disposal by individuals, organizations and governments. Students are expected to discuss possible solutions and evaluate their effectiveness.

##### Possible scenario

A computer user is planning to upgrade their current computer system to a newer model and must use their knowledge to:

- understand the specifications of the proposed new system
- evaluate other physical considerations that may influence the choice of the physical environment of the proposed new system, such as ergonomics and other health-related issues
- suggest upgrades to the computer system to take advantage of improvements in components, such as processing speed
- describe how the proper disposal of the old computer system can take place and whether the choice of computer may be affected by the manufacturer’s policies on disposal.

##### IT concepts to address in this topic

###### *The computer system*

- Types of computers: personal digital assistant (PDA), laptop, desktop computer
- MAC address
- Motherboard
- Central processing unit (CPU), microprocessor, clock speed: for example, megahertz (MHz), gigahertz (GHz), terahertz (THz)
- Primary storage: read-only memory (ROM), random-access memory (RAM)

- Secondary storage: optical, magnetic, flash memory: for example, USB (universal serial bus) flash drive
- Bit, byte, kilobyte (KB), megabyte (MB), gigabyte (GB), terabyte (TB), petabyte (PB), exabyte (EB), zettabyte (ZB), yottabyte (YB)
- Character encoding: ASCII (Unicode and American Standard Code for Information Interchange)
- Ports

### **Input and output devices**

- Keyboards, mice, touch pads
- Optical mark recognition (OMR), optical character recognition (OCR), magnetic ink character recognition (MICR), radio frequency identification (RFID), radio tag, bar code scanners, magnetic stripe readers
- Microphones
- Smart card readers
- Webcams, digital cameras, digital video cameras
- Sensors, probes, real-time data collection
- Composite devices: for example, game controllers
- Touch-sensitive devices: for example, pads
- Printers, monitors, speakers, projectors
- CD-ROM (compact disc read-only memory), DVD (digital versatile/video disk) readers and burners

## **3.2 Software**

### **Introduction**

The **software** topic deals with the software associated with a typical computer system. ITGS students are required to understand the meaning of the terms and concepts listed here and, where appropriate, briefly describe how they work or their relevance to the user.

The development of software can have social impacts such as increased access for disabled people, and ethical issues, for example, only producing packages in a limited number of languages, effectively making English the global language. Students are expected to examine the effects of these developments on stakeholders.

### **Possible scenario**

A computer user is planning to update the software on their current computer system to the most recent versions and must use their knowledge to:

- select a suitable operating system based on information such as price and ease of installation
- select suitable software for the computer and decide which source to obtain the software from
- ensure that the software is installed legally, is registered and that user support is available
- select the appropriate software to prevent viruses or malicious software from damaging the contents of the home computer.

### **IT concepts to address in this topic**

#### **Fundamentals**

- Applications: word processing, desktop publishing, presentations, photo and video editing, music and sound development, website development
- System software: operating systems and utilities

- Interfaces: graphical user interface (GUI), command line interface (CLI), menu-driven interface (MDI), voice
- Licensing: shareware, public domain, freeware, proprietary and open source software
- Licensing authorities: Business Software Alliance (BSA)
- Commercial and custom-built (bespoke) software
- Registration, serial number, warranty, copyright agreement
- Web-based software
- User support: manuals, assistants, tutorials, help systems, "Read Me" files
- Macros, templates, wizards
- File formats, for example, RTF (rich text format), TXT (text), PDF (portable document format), XLS (Excel spreadsheet), SWF (small web format), ZIP (zipped file), JPG/JPEG (Joint Photographic Experts Group bitmap), PNG (portable network graphics bitmap), CSV (comma-separated values), HTM/HTML (hypertext markup language)
- Data transfer: ASCII (American Standard Code for Information Interchange), tab-delimited text file, zipped file

### **System utilities**

- Defragmentation/optimization and disk utility software
- Backup, file management, account and accessibility management
- Monitor and keyboard settings, for example, international settings, disability settings
- Virus scan, malware detectors and removers
- Compression/decompression (lossless, lossy)
- Colour synchronization

## **3.3 Networks**

### **Introduction**

This topic addresses the role of **networks** in a range of different scenarios. Almost all businesses, institutions and organizations, and an increasing number of households, are linked by networks.

The increasing use of networks raises a range of social impacts and ethical issues such as unauthorized access, intrusive software (viruses, worms and Trojan horses), spam, phishing, pharming, spoofing and identity theft. Students are expected to discuss possible solutions and evaluate their effectiveness.

### **Possible scenario**

An organization is considering developing a network to facilitate the sharing and transfer of information. The student must use their knowledge to demonstrate an understanding of:

- the types of networks that exist and the specific scenarios where they are used
- the development of an acceptable-use policy for a network
- the protocols that exist to ensure compatibility within and between networks
- the ways in which the effectiveness of a network may be measured
- the impacts that the ineffective management and network failure can have for many organizations.

**IT concepts to address in this topic****Network technologies**

- Client, host, server
- Mainframe, supercomputers
- Grid computing, distributed processing
- Ethernet, peer-to-peer (P2P)
- Local area network (LAN), wide area network (WAN), virtual LAN (VLAN), wireless LAN (WLAN), home network
- Internet, intranet, extranet, virtual private network (VPN)
- Routers, switches, hubs
- Connection types: optical fibre, cable, wireless technologies such as wireless fidelity (WiFi), worldwide interoperability for microwave access (WiMax), Bluetooth, microwave
- Network operating systems and utility software
- Cloud computing
- Storage technologies: for example, SAN (storage area network), RAID (redundant array of inexpensive disks)

**Network functionality**

- Protocols
- Synchronous, asynchronous
- Remote access
- Bandwidth, broadband
- Bit rates

**Network administration**

- Electronic security: for example, authorized access, levels of access, biometrics, login, password, firewalls, proxy server, encryption, secure socket layer (SSL), audit trails
- Licences: single-user, multi-user, concurrent, network, site
- Physical security: for example, locks
- Monitoring: for example, keystroke monitoring, system performance, surveillance
- Network policies: for example, backup, archiving, disaster recovery, usage, redundancy, failover
- Codes of ethics and professional conduct: for example, ACM (Association for Computing Machinery)
- Data centres
- Energy usage, uninterruptable power supply (UPS)

**3.4 Internet****Introduction**

The **internet** and World Wide Web are omnipresent in contemporary society. This topic introduces ITGS students to the technology that enables access to the internet. The tools and applications that contribute to the creation of web-based resources and websites are addressed under topic 3.6, "Multimedia/digital media".

The use of the internet for activities such as e-commerce, academic research and social networking can raise ethical issues and have positive or negative social impacts. These may include exposure to undesirable materials, cyber-bullying, e-fraud, improved communication between individuals and groups, intellectual property theft, plagiarism, spamming and the global dissemination of ideas. Students are expected to discuss, where appropriate, possible solutions to a specified problem and evaluate their effectiveness.

### **Possible scenario**

A school is considering using the internet to enhance the learning opportunities of its students. Before making a final decision it intends to obtain an outline of the different facilities available. It must also consider the potential problems of opening this “window on the world”. Where appropriate, the ITGS student should investigate different environments to experience the range of available learning opportunities. This may include research using different collaborative websites, educational websites or online sources of information.

### **IT concepts to address in this topic**

#### ***Fundamentals***

- WWW (World Wide Web), URL (uniform resource locator), internet, intranet, extranet
- Internet protocols: for example, HTTP (hypertext transfer protocol), HTTPS (hypertext transfer protocol secure), FTP (file transfer protocol), TCP/IP (transmission control protocol/internet protocol)
- IP address
- Modem, browser, internet service provider (ISP), bandwidth, download, upload, streaming audio/video, compression, decompression, cache
- Domain names, domain name system (DNS)
- Features of a website: for example, hyperlinks, navigation, metatags, tags, forms
- Features of a browser: for example, bookmarks, visited links, tabs
- Web-based languages: for example, hypertext markup language (HTML), JavaScript
- Adding functionality to a browser (for example, plug-ins)
- Data-driven websites: for example, active server page extended (ASPX), personal home page (PHP)
- Site management: for example, web hosting, uploading
- Other site use: for example, bounce rate, click-through rate (CTR), avatar, profile

#### ***Tools***

- Search engines, web crawler/spider, search directories, search techniques, filtering, keyword density, keyword prominence, ranking of sites
- Social networking: for example, newsgroups, message boards, chat rooms, forums, instant messaging
- Email, email server, list server
- Web 2.0, Web 3.0 and beyond, collaborative online tools: for example, wikis, blogs, micro-blogs, RDF (resource description framework) site summary feeds, RSS (really simple syndication) feeds, mashups, forums, social bookmarking, online collaborative applications, podcasts, photcasts, vidcasts, social networking sites, templates, tagging, viral marketing, webcasts, widgets, virtual worlds and learning environments
- Web databases, encyclopedias

**Services**

- Online advertising and marketing technologies: for example, banners, pop-ups, cookies
- Push–pull technologies: for example, email newsletters
- Content management systems: for example, Moodle, Blackboard
- E-commerce technology: for example, business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C), payment services, secure transactions
- The World Wide Web Consortium (W3C)

**Internet threats and security**

- Internet security: for example, firewall, proxy server, SSL (secure sockets layer), encryption, public and private keys, digital signatures
- Internet threats: for example, global viruses, hackers, spam, phishing, pharming, spyware, adware

**Practical techniques**

- Collaborative online tools: for example, wikis, blogs, RSS feeds, mashups, forums, social bookmarking, online collaborative applications, podcasts, photocasts, vidcasts, social networking sites, templates, virtual worlds and virtual learning environments

**3.5 Personal and public communications****Introduction**

Developments in technology have allowed an increasing number of mobile devices to be developed that enable people to communicate anytime, anyplace, anywhere. There is a wealth of information available to society that can be accessed on demand and has changed the way in which people behave.

It is important that the ITGS student is able to discuss the social impacts and ethical issues related to these technologies. These may include the health implications of mobile devices, unauthorized access to wireless networks, interception of communications, storage of personal communications for security purposes, and tracking of people.

**Possible scenarios**

Students may investigate, both theoretically and practically, the plethora of devices and means of communication that exist in contemporary society, and leading on from this research discuss how they work independently and as part of a network. Further research may lead students to weigh up the benefits and drawbacks of the increasing use of these devices. The ITGS student should also evaluate the potential of existing converging technologies and their compatibility and make predictions about future developments.

**IT concepts to address in this topic****Technologies**

- Personal digital assistants (PDAs) and handheld digital devices
- Global positioning systems (GPS), navigation systems and geotagging
- Cell/mobile phones
- Digital radio and TV
- Embedded systems

**Services**

- Accessing, distributing and sharing text, photos, video, audio, television via portable and non-portable digital devices
- Synchronization of information between portable systems, desktop systems, servers and web-based services

- Videoconferencing
- Remote access: for example, teleworking, distance learning
- Telephony: voice over internet protocol (VOIP)

### 3.6 Multimedia/digital media

#### Introduction

**Multimedia/digital media** involves the use and integration of media (for example, text, images and graphic elements, animation, sound and music, and video) to create digital products that are available online or offline.

This topic introduces ITGS students to the technologies that make information accessible through different media and online services. It is important that the ITGS student is aware of the actual uses of multimedia/digital media and, bearing in mind **the emphasis on practical work in this topic**, has practised using the tools in order to be able to evaluate their effectiveness in various scenarios.

Multimedia/digital media raises questions about a range of impacts, issues and solutions that the ITGS student must investigate, including copyright, intellectual property, and current practices and policies used to grant permission for use.

#### Possible scenario

A school would like to create a print yearbook with an online version. The print version would contain only text and photos. The online version would also include audio, video and multimedia files. The yearbook team is also considering burning the website version on to a DVD and including it in the back of the printed version of the yearbook. A number of factors need to be considered in producing the print yearbook, the website and the DVD. These are:

- whether to develop the IT products in school or to use a commercial provider
- whether the necessary IT systems are available to produce a high-quality print yearbook and to create an online yearbook and DVD with audio and video files
- whether the content to be included in all three versions of the yearbook is accessible
- what professional guidelines must be followed in the design of the three products
- what copyright, intellectual property and licensing are required for three versions of the yearbook
- what can be learned from yearbooks produced by other schools in these three formats.

#### IT concepts to address in this topic

##### *Theoretical concepts*

- Design guidelines for creating multimedia/digital media
- Design methods: for example, site map, storyboard

##### *Data collection*

- Primary and secondary data
- Multimedia file formats: for example, text formats, audio formats, video formats, presentation formats, image/graphics formats
- Policies, copyright, citing sources, Creative Commons, licensing and watermarking
- Digital rights management (DRM)

##### *Product development*

- Folder and file management: importance of file and folder naming, appropriate folder structures
- Tutorials: for example, help pages, online manuals

- Templates and wizards, online and provided with software
- Importing and exporting data
- Integrating software applications and online tools: for example, embedded videos, web-based database

### **Components**

#### Text

- Text-processing software
- Formatting: for example, page layout, fonts, headers and footers
- File formats: for example, PDF, RTF, TXT
- Typography

#### Graphics, images and animations

- Software types: for example, albums, animated, 3D, bitmapped, vector, photo editing, photo casting, simulation
- Bit depth, colour depth (grayscale, shades of gray, millions of colours)
- Layers, grouping, divisions, alignment
- Resolution, pixels, dots per inch (dpi)
- File formats: for example, JPG, GIF, TIF
- Computer-generated imagery (CGI)

#### Audio

- Audio-editing software, podcasts
- Digital audio: for example, MIDI (musical instrument digital interface), MP3 (MPEG-1 audio layer 3), MP4 (MPEG-4 part 14), WAV (waveform audio format)
- File formats: for example, MP3, MP4, WAV

#### Video

- Video-editing software, vidcasts and special effects (for example, morphing, transitions)
- Digital video: for example, AVI (audio video interleave), MPEG (Moving Picture Experts Group), video CODECs (coder-decoders)
- File formats: for example, AVI, MOV

### **Integrating the components**

- Software types to house and display the multimedia components: for example, word processing, desktop publishing, presentations, web pages

#### Generic techniques

- Differences in files (for example, graphics, images, audio, video) for print and online versions
- Inserting and manipulating objects (graphics, sound or video files)
- Tables: cell merge, borders, cell padding, cell spacing, nested tables
- Layers
- Links: relative and absolute, internal and external, for example, anchors, pop-ups

Word processing and desktop publishing (DTP)

- Referencing and reviewing: for example, spellchecker, thesaurus, outliners, word count
- Inline and floating graphics

Interactive multimedia, slideshows and websites

- Applications and online tools used for creating and making available interactive multimedia, games, presentations, slideshows and websites
- Use of scripting in creating web pages (for example, HTML, JavaScript, URL links to online media)
- Integration of online tools

### 3.7 Databases

#### Introduction

**Databases** lie at the heart of most IT systems whether in businesses, organizations or other institutions. Databases enable organizations to maintain accurate and comprehensive records. In order to appreciate the role that databases play, the ITGS student must have an understanding of how they work, which can only be gained from the design and creation of basic relational databases as well as by examining how databases are used in specified scenarios (for instance, schools, retail stores, online shopping, online reservations).

The increasing use of databases raises a range of social impacts and ethical issues such as the rights of individuals with respect to the storage and potential sale of their personal data or the ease of data mining and data matching. Students are expected to discuss these issues and, where appropriate, evaluate possible solutions.

#### Possible scenario

A vet requires information about pet owners and their pets. The ITGS student must be able to develop an original IT solution to meet the vet's needs. This knowledge should be acquired through a practical activity where the student creates a (minimum) three-table relational database (first normal form only) that uses queries to interrogate the data, forms to enable the easy input and viewing of data, and reports to provide printed information as required.

#### IT concepts to address in this topic

##### **Database organization**

- Table
- Field, data types, key field/primary key, secondary key
- Record
- Flat-file database, relational database, normalization
- Database management system
- Specialized databases: for example, web databases, online encyclopedias

##### **Functions**

- Data validation: data types, range check, check digit, field size, input mask, drop-down list
- Queries: for example, searching, sorting, filtering, use of Boolean operators (AND, NOT, OR)
- Data entry form
- Report generation
- Macros
- Transfer of data between databases and other applications

**Data storage and access**

- Data integrity, reliability, redundancy
- Data matching, data mining
- Database security

**Practical database techniques**

- Table
- Field, data types, key field/primary key, secondary key
- Record
- Linking tables to create a relational database
- Data maintenance: changing, editing, deleting records
- Queries: for example, searching, sorting, filtering, use of Boolean operators (AND, NOT, OR)
- Data entry form
- Report generation
- Creating and editing simple macros
- Mail merge

**3.8 Spreadsheets, modelling and simulations****Introduction**

The increasing capabilities of computers have allowed individuals and organizations to develop software that can be used to test “what-if” scenarios and create simulations and models of real-world events.

**Spreadsheets**, through the use of worksheets and graphs, can be used to manage, predict using a series of “what-if” scenarios, and display financial details of businesses.

**Modelling and simulations** can be used to recreate or predict the conditions that may result from an event, for example, the areas that will be affected by coastal flooding as a result of different levels of global warming.

It is important that the ITGS student is aware of the benefits of creating accurate spreadsheets, models and simulations as well as the social impacts that could result from simulations being unable to replicate the real world, and the ethical issues that may arise during the development of the model.

**Possible scenarios**

Students are expected to carry out practical activities using spreadsheets, for example, the development of a spreadsheet that allows a teacher to add marks from a class test so as to generate information such as the grade for the test.

Students are expected to use modelling and simulations to reinforce their theoretical knowledge, and to apply the ITGS triangle to a range of real-life scenarios.

**IT concepts to address in this topic****Theoretical and practical concepts for spreadsheets**

- Cell types: for example, text, number, date, currency, hyperlinks
- Formulas: relative and absolute cell references
- Sorting, filtering and replicating data
- Types of charts
- Formatting and presentation: for example, text (fonts), background, paragraphs, pages

- Data validation, verification and testing
- Functions: maths, text, logic, date
- Protection for sheets and workbooks, cell locking
- Advanced functions: for example, lookup, pivot tables, macros
- Worksheet modelling: “what-if” analysis (scenarios, goal seek tool)

***Modelling and simulation technologies and considerations***

- Model
- Simulation
- Types of simulations and models
- Virtual reality, augmented reality, gaming: for example, MMORPG (massively multiplayer online role-playing game)
- Graphics and animations (2D, 3D)
- Visualization of data
- Feedback loop

***Developing and using models and simulations***

- The validity of the model and verification of the results of a simulation, reproducibility of results
- Relationship of model to reality
- Relationship between a model and a simulation

**3.9 Introduction to project management**

**Introduction**

All IT development requires a management method. Knowledge and understanding of the **product development life cycle (PDLC)** should be used as a framework to develop an IT solution for the internal assessment. It is recommended that this topic is covered before students start work on the project.

**IT concepts to address in this topic**

***Theoretical fundamentals***

- Client, end-user, developer
- Data collection techniques for content and product design, citing of sources
- Role of testing and processes used
- Technical and end-user documentation (manuals)
- End-user training

***The product development life cycle (PDLC)***

- Investigation of existing system(s)
- Feasibility study
- Requirements specification
- Project schedule
- Product design
- Product development and technical documentation
- Client and end-user evaluation

**Practical techniques**

- Appropriate design techniques
- Data capture
- Product testing and debugging

**HL extension****3.10 IT systems in organizations****Introduction**

This topic builds on the concepts introduced in “Introduction to project management” and provides students with a more in-depth understanding of the development of IT systems.

Most organizations, at some stage in their development, require the introduction of a new IT system as well as the maintenance and eventual retirement of their current systems. The ability of the organization to manage this change can determine the future viability of the organization.

Students should consider the interrelationship between stakeholders, IT systems, data, processes and policies, which provides the framework for the different project management approaches needed in order to accomplish the specified task. For example, students should research real examples of the role of IT professionals who maintain legacy or develop new IT systems, to reinforce the theoretical concepts addressed in this topic.

**Possible scenarios**

Students may take the development of their internal assessment as a starting point for the application of the theoretical and practical aspects of this topic. This may take the form of producing a Gantt chart to indicate the stages in the development of the solution, on the agreed date, or how differing methodologies may lead to variations in the completion of tasks.

Other scenarios may include a city government that wishes to introduce an improved IT system to provide a more secure and effective method of record keeping in its public libraries. This would include the replacement of the storage area network (SAN) to accommodate the increased amount of data requiring archiving, along with the need to provide a disaster recovery system.

**IT concepts to address in this topic****Information systems, people and teams**

- The role and need for IT in organizations
- Organizational IT policies
- IT personnel and organizational structure: for example, information system (IS) managers, support staff, network manager, database administrator
- Development personnel: for example, manager, programmer, analyst, project manager

**The system development life cycle (SDLC)**

- Analysis of current situation
- Organizational requirements
- Methods of data collection: questionnaires, interviews, observation, literature searches
- Feasibility study
- Identification of possible IT solutions
- Requirements specification
- Justification of preferred IT solution

- Project plan (who, why, what, when and how part of the project)
- Project goals, scope and constraints, such as financial, time, technical, human-resource-related, risks, communication, procurement, quality
- Project initiation document
- Design considerations
- Inputs, data structure, processes, outputs, user interface
- Prototyping
- Development of the IT solution
- Initial testing, alpha testing
- Quality assurance and quality control
- Implementation
- Training and support of staff, documentation to support the new IT system
- Changeover methods: direct, phased and parallel running
- Beta testing
- Maintenance
- Phase out

**Project management issues**

- Need for project management
- Development methodologies: agile development and waterfall development
- Project management methodologies: for example, PRINCE2 (projects in controlled environments 2), SSADM (structured systems analysis and design method), PMBoK (project management body of knowledge), CMMI (capability maturity model integration)
- Iteration
- Time constraints, tasks, resources and milestones; Gantt and Pert charts
- Modelling systems: for example, entities, entity relationship diagrams (ERD), data flow diagrams
- Maintenance of legacy systems
- System support: for example, internal support, maintenance contract
- Incident management and escalation

**3.11 Robotics, artificial intelligence and expert systems**

**Introduction**

The increasing capability of IT systems has allowed developers to implement systems that attempt to understand and imitate human behaviour. These systems have already had profound effects on society, although their effectiveness is largely determined by the accuracy of the algorithms that underpin them.

The increasing use of robotics, artificial intelligence (AI) and expert systems raises a range of ethical issues. For example, at which point should humans hand over key decision-making to a computer? Should robots have the same rights as humans? What social impacts might arise with the replacement of human workers or the creation of smart weapons?

**Possible scenario**

A hospital administrator is considering using a computer-controlled robotic device to assist with knee surgery. The robotic system models the patient's knee area prior to surgery. During the procedure the robot is controlled by the surgeon using a joystick. The system eliminates the effects of tremors in the surgeon's hands and limits the range of movement of the cutter to areas of the knee that have been predetermined by the model. Although there are claims that the surgery is less invasive and patients have a shorter recovery time, questions may be raised about the reliability and the cost of the system.

**IT concepts to address in this topic****Robotics**

- Input devices: for example, camera, sensors, microphones
- Output devices: for example, claws, wheels, motors, relays, speakers
- Robot, android, cyborg
- Sensors: for example, heat, proximity, magnetism, light, humidity, pH

**Artificial intelligence**

- Artificial intelligence versus computational intelligence
- Man or machine: Turing test, CAPTCHA (completely automated public Turing test to tell computers and humans apart)
- Capabilities and limitations: for example, learning to identify human emotions, evaluation of living things and machines (intuition, prior knowledge, judgment)
- AI techniques: searching, pattern recognition, heuristics, machine learning
- Fuzzy logic, set theory
- Machine learning: can machines become independent?
- Natural language communication and translators
- Neural networks: similarity to biological systems
- Pattern recognition: OCR (optical character recognition), image analysis, speech recognition, speech synthesizers
- Processing and storage requirements

**Expert systems**

- Collection, creation and maintenance of knowledge base
- Creation of inference engine, inference rule ("if-then" rules), chaining, suitable domains for expert systems
- Expert systems, knowledge base, knowledge engineer, expert system shells, inference engine, domain, common-sense knowledge
- Purpose of an algorithm within expert systems: for example, fault finding, product development

**Applications of robotics, artificial intelligence and expert systems**

- Embedded systems: for example, cell/mobile phones, GPS, washing machines
- Internet search engines
- Smart systems: for example, used at home or in warfare, medicine, cars
- Use of artificial intelligence (AI): for example, language translation, chess, voice recognition, modelling, games, predictive text, business intelligence systems

- Use of expert systems: for example, medical diagnosis, fault diagnosis, flight simulators, fraud detection
- Use of robots: for example, in industry, health, warfare, airlines, space, underwater exploration

### **3.12 Information systems specific to the annually issued case study**

Additional subject content may be introduced as part of the annually issued case study. The additional terms will be listed as an appendix in the case study.