

(Final Version)

# Technology Education Key Learning Area

## **Information and Communication Technology** Curriculum and Assessment Guide (Secondary 4 - 6)

Jointly prepared by the Curriculum Development Council and  
the Hong Kong Examinations and Assessment Authority

Recommended for use in schools by the Education and Manpower Bureau  
HKSARG  
2007



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**Membership of the CDC-HKEAA Committee on Information and  
Communication Technology (Senior Secondary)**

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## Preamble

The Education and Manpower Bureau (EMB) stated in its report<sup>1</sup> in 2005 that the implementation of a three-year senior secondary academic structure would commence at Secondary 4 in September 2009. The senior secondary academic structure is supported by a flexible, coherent and diversified senior secondary curriculum aimed at catering for students' varied interests, needs and abilities. This Curriculum and Assessment (C&A) Guide is one of the series of documents prepared for the senior secondary curriculum. It is based on the goals of senior secondary education and on other official documents related to the curriculum and assessment reform since 2000, including the *Basic Education Curriculum Guide* (2002) and the *Senior Secondary Curriculum Guide* (2007). To gain a full understanding of the connection between education at the senior secondary level and the basic education level, and how effective learning, teaching and assessment can be achieved, it is strongly recommended that reference should be made to all related documents.

This C&A Guide is designed to provide the rationale and aims of the subject curriculum, followed by chapters on the curriculum framework, curriculum planning, pedagogy, assessment and use of learning and teaching resources. One key concept underlying the senior secondary curriculum is that curriculum, pedagogy and assessment should be well aligned. While learning and teaching strategies form an integral part of the curriculum and are conducive to promoting learning to learn and whole-person development, assessment should also be recognised not only as a means to gauge performance but also to improve learning. To understand the interplay between these three key components, all chapters in the C&A Guide should be read in a holistic manner.

The C&A Guide is jointly prepared by the Curriculum Development Council (CDC) and the Hong Kong Examinations and Assessment Authority (HKEAA). The CDC is an advisory body that gives recommendations to the Hong Kong Special Administrative Region Government on all matters relating to curriculum development for the school system from kindergarten to senior secondary level. Its membership includes heads of schools, practising teachers, parents, employers, academics from tertiary institutions, professionals from related fields/bodies, representatives from the HKEAA and the Vocational Training Council, as well as officers from the EMB. The HKEAA is an independent statutory body responsible for the conduct of public assessment, including the assessment for the Hong Kong Diploma of Secondary Education (HKDSE). Its governing council includes members drawn from the school sector, tertiary institutions and government bodies, as well as professionals and members of the business community.

The C&A Guide is recommended by the EMB for use in secondary schools. The subject curriculum forms the basis of the assessment designed and administered by the HKEAA. In this connection, the HKEAA will issue a handbook to provide information on the rules and regulations of the HKDSE examination as well as the structure and format of public assessment for each subject.

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<sup>1</sup> The report is *The New Academic Structure for Senior Secondary Education and Higher Education – Action Plan for Investing in the Future of Hong Kong*.

The CDC and HKEAA will keep the subject curriculum under constant review and evaluation in the light of classroom experiences, students' performance in the public assessment, and the changing needs of students and society. All comments and suggestions on this C&A Guide may be sent to:

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## Acronym

C&A	Curriculum and Assessment
CDC	Curriculum Development Council
EMB	Education and Manpower Bureau
HKDSE	Hong Kong Diploma of Secondary Education
HKEAA	Hong Kong Examinations and Assessment Authority
HKSAR	Hong Kong Special Administrative Region
ICT	Information and Communication Technology
IT	Information Technology
KLA	Key Learning Area
S1/2/3/4/5/6/7	Secondary 1/2/3/4/5/6/7
SBA	School-based Assessment

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# Chapter 1 Introduction

This chapter provides the background, rationale and aims of Information and Communication Technology (ICT) as an elective subject in the three-year senior secondary curriculum, and highlights how it articulates with the junior secondary curriculum, post-secondary education, and future career pathways.

## 1.1 Background

Technology Education (TE) in the Hong Kong school curriculum focuses on how human beings solve their daily problems and how the processes involved can be replicated and transferred to solve new problems. It is an essential area of study for all students in Hong Kong.

In the 21st century, technology has become an integral part of our life. Citizens of today require much more than a basic ability to read, write, and do simple mathematics. To live in the modern world, we must understand how technology affects us. In this regard, we must be equipped to use technology effectively and flexibly to solve daily problems with positive attitude at home, in the community, and around the world; and to create new solutions, products, and services for the well-being of humankind.

By studying the related subjects developed in TE Key Learning Area (KLA), our students will be better prepared to meet the uncertainties and challenges of the future with regard to social, economic, ecological, scientific and technological changes, both locally and globally. Their studies in this area will help them to lead a healthy lifestyle in adulthood and to contribute to building a caring and harmonious society.

Building on the strengths of the existing TE curriculum and catering for social, economic and technological development, ICT is one of the five elective subjects developed under TE KLA in the senior secondary curriculum.

The *Senior Secondary Information and Communication Technology Curriculum and Assessment Guide* (2007) incorporates the key recommendations made in the Education and Manpower Bureau's *Senior Secondary Curriculum Guide* (2007), *Technology Education Key Learning Area Curriculum Guide (Primary 1–Secondary 3)* (2002) and the final report on its Holistic Review of the School Curriculum *Learning to Learn – The Way Forward in Curriculum Development* (2001). The latter three documents outline the overall direction for both education and curriculum development in Hong Kong and seek to promote the educational aims of lifelong learning and whole-person development.

## 1.2 Rationale

ICT is the technology required for information processing, i.e. for the creation, manipulation, storage, retrieval and communication of information. They are of immense value in a world in which there is an “information explosion”, and where knowledge is complex, ever-changing and cross-disciplinary in nature.

Many of the skills of ICT are important aspects of Information Literacy, which relates to the ability to select, organise, analyse and use information effectively. Quick and effective access to information is regarded as essential for everyone in contemporary society; and the ability to construct knowledge from the information gathered has become crucial in Hong Kong’s knowledge-based society. Citizens in the 21st century need to understand and be able to use ICT in order to function efficiently in modern society. To maintain the competitiveness of Hong Kong in the world economy, we need to develop interest and nurture talent in our students in this area.

The importance of ICT does not lie in the technology as such, but in its enabling function for access to knowledge and for communication with others. Rapid advances in ICT have continued to drive economic change, restructure businesses, affect education and employment, and contribute significantly to growth and wealth creation.

The senior secondary ICT curriculum should prove especially relevant to students since it will equip them with the knowledge, skills and attitudes necessary to address rapid change. It should also be a means to develop students’ intellectual capacity and lifelong learning skills.

The senior secondary ICT curriculum provides students with knowledge, practical skills and an understanding of the processes involved in problem-solving using technology. It encompasses problem identification, solution and design, and the applications of ICT knowledge and skills in these processes.

The senior secondary ICT curriculum relates to many aspects of modern life and to diverse fields of study within and beyond senior secondary education. Students will be exposed to a variety of intellectual challenges involving problem-solving, communication and a range of associated practical skills and concepts. Studying this course will contribute significantly to the education of students by providing pathways into the workforce or preparing them for further studies in ICT-related fields. The course also provides opportunities for the development of key generic skills such as critical thinking, communication, creativity and problem-solving, in contexts that derive naturally from the learning objectives, outcomes and experiences.

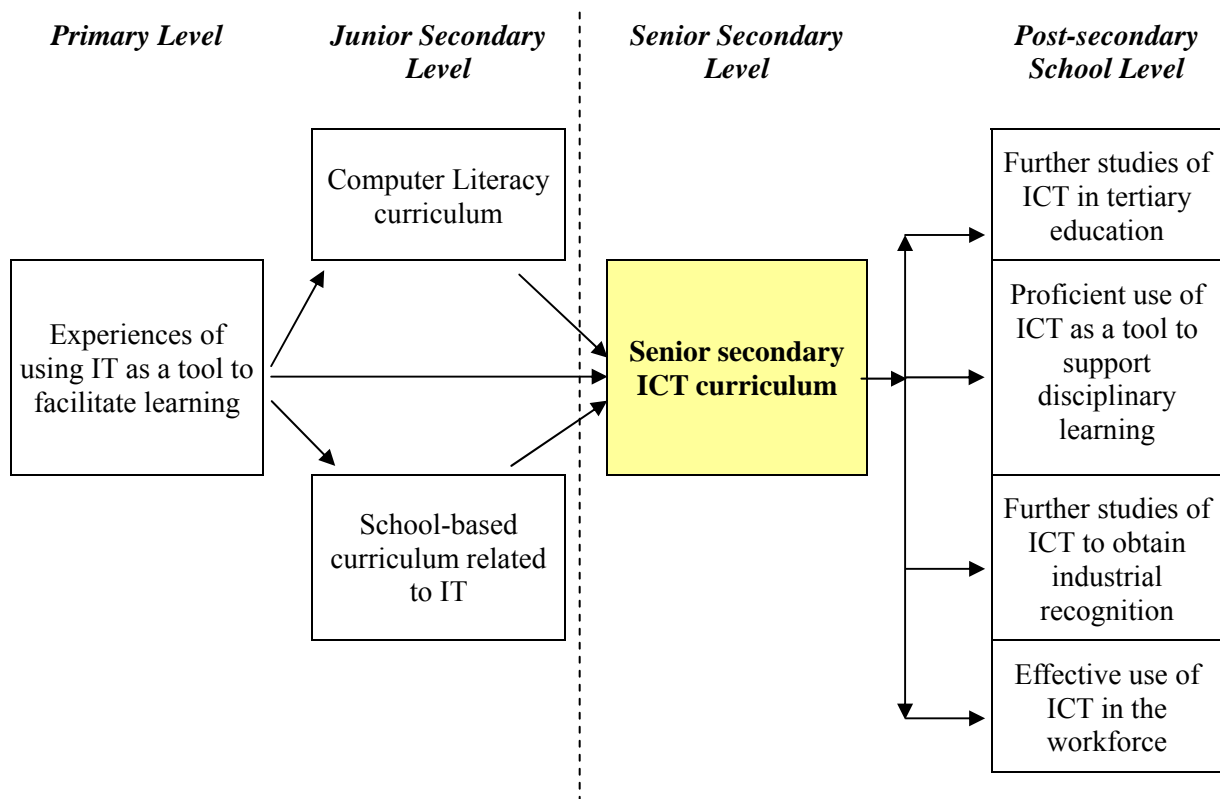
### 1.3 Curriculum Aims

The senior secondary ICT curriculum aims to

- provide students with a body of essential knowledge, concepts and applications of information, communication and computer systems;
- equip students with problem-solving and communication skills, and encourage them to think critically and creatively;
- develop students into competent, effective, discriminating, ethical and confident users of ICT, so as to support their lifelong learning; and
- provide students with opportunities to appreciate the impact of ICT on our knowledge-based society, so as to nurture in them positive values and attitudes towards this area.

### 1.4 Interface with the Junior Secondary Curriculum and Post-secondary Pathways

The linkage of the curriculum with students' various ICT learning experiences at school levels and beyond is depicted in the diagram below:



Information Technology (IT) Learning Targets at Key Stage 3

**Figure 1.1** *The continuum of learning for students in ICT*

## 1.5 Cross-Curricular Links

One of the learning goals in the senior secondary curriculum is to ensure that students can apply IT skills to learning across all KLAs. In planning the senior secondary ICT curriculum, schools should ensure that they will provide students with rich learning experiences to enable them to learn to use ICT effectively, develop generic skills, and connect this curriculum with learning elements in other KLAs. The following examples illustrate some activities that may enhance students' learning in ICT and other KLAs:

<i>Key Learning Area</i>	<i>Examples of Activities</i>
English Language Education	<ul style="list-style-type: none"><li>• Use WebQuest to locate useful information on the web to learn "Pride and Prejudice" in an interesting way.</li></ul>
Chinese Language Education	<ul style="list-style-type: none"><li>• Produce formatted texts of practical writings such as minutes and projects using word-processing software.</li></ul>
Mathematics Education	<ul style="list-style-type: none"><li>• Use WinGeom to learn geometric theories of circles.</li></ul>
Personal, Social and Humanities Education	<ul style="list-style-type: none"><li>• Use Geographic Information System to learn advanced map reading skills.</li></ul>
Science Education	<ul style="list-style-type: none"><li>• Use data-loggers to carry out data-logging experiments on Neutralization of Acids and Alkalis, then use computers to analyse the experimental results.</li></ul>
Arts Education	<ul style="list-style-type: none"><li>• Produce music materials with consideration to intellectual property right of songs and music on the net.</li></ul>
Physical Education	<ul style="list-style-type: none"><li>• Propose appropriate physical exercises when using computers to reduce injuries arising from Repetitive Strain Injuries (RSI).</li></ul>

## Chapter 2 Curriculum Framework

The curriculum framework for ICT embodies the key knowledge, skills, values and attitudes that students are to develop at senior secondary level. It forms the basis on which schools and teachers plan their school-based curriculum, and design appropriate learning, teaching and assessment activities.

### 2.1 Design Principles

The design of the senior secondary ICT curriculum is founded on the following principles, which are in line with those recommended in the *Senior Secondary Curriculum Guide* (2007).

The design:

- Builds on prior knowledge, experiences, skills and positive values and attitudes that students have acquired through the Computer Literacy curriculum and/or school-based curricula related to computer and IT in basic education;
- Achieves a balance between breadth and depth in ICT learning to facilitate students' further studies and career development;
- Emphasises the significance of both theoretical and applied learning through the use of common applications of ICT in daily life;
- Achieves a balance between essential learning and a diversified curriculum by introducing Compulsory and Elective Parts to cater for students' varied needs, interests and abilities;
- Promotes independent learning through developing students' skills in learning how to learn;
- Ensures a close alignment between curriculum, pedagogy and assessment;
- Provides suggestions for progression across the three years of the course;
- Provides articulation to a range of pathways leading to further studies and to work in different ICT-related fields;
- Fosters coherence between ICT and other KLAs through sample activities that encourage cross-curricular collaboration; and
- Takes into account the feasibility of curriculum implementation in the local education context.

### 2.2 Learning Targets

During the three-year senior secondary ICT curriculum, students work towards the following learning targets in the categories of "Knowledge and Understanding", "Skills" and "Values and Attitudes".

#### **Knowledge and Understanding**

- Develop knowledge and understanding of the range and organisation of computer systems, and the interrelationships between hardware, software and data; and
- Realise the social, ethical and legal issues pertaining to the use of ICT.

## Skills

- Use a range of applications software effectively, ethically and with discrimination to support information processing and problem-solving; and
- Demonstrate an understanding of methods for analysing problems, and planning and implementing solutions using ICT.

## Values and Attitudes

- Appreciate how information literacy and the sharing of knowledge using ICT influence decision-making and shape our society; and
- Develop responsible and positive attitudes towards the use of ICT.

## 2.3 Curriculum Structure and Organisation

The senior secondary ICT curriculum is based on the S4–5 Computer and Information Technology curriculum introduced in 2003, and the revision of the two sixth form computer curricula – Advanced-level Computer Studies and Advanced Supplementary-level Computer Applications – in 2005. It is a three-year course targeted at students with IT skills at Level 3 stated in *Information Technology Learning Targets*, or S3 Computer Literacy level (Education Department, 2000).

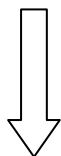
The curriculum is organised into a Compulsory Part and an Elective Part, as shown in the diagram on page 7.

The Compulsory Part of the curriculum occupies 165 hours and spans approximately one and a half school years. It comprises a number of topics involving the fundamental principles in information and communication technologies and provides students with a solid foundation and broad area of study in ICT. The Compulsory Part consists of five modules, namely *Information Processing*, *Computer System Fundamentals*, *Internet and Its Applications*, *Basic Programming Concepts* and *Social Implications*. The details of the topics and learning outcomes of the Compulsory Part are shown on pages 10–35.

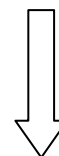
The Elective Part takes up about 75 hours of curriculum time and spans about one school year. Four options, drawn from distinctive fields of computing and information science and their applications, are offered in the Elective Part. Based on their abilities, interests and needs, students are required to choose a specialised area for in-depth study. The options in the Elective Part can be broadly categorised as those illustrating applications of computers in specific areas, and those intended for students who will pursue further studies in ICT as a discipline in tertiary education, but the two are not mutually exclusive. The options are *Databases*, *Data Communications and Networking*, *Multimedia Production and Web Site Development* and *Software Development*. Details of the options are covered on pages 36–68.

## Curriculum Framework of senior secondary ICT

<b>The Compulsory Part</b> (165 hours)			
A. Information Processing	(64 hours)	B. Computer System Fundamentals	(25 hours)
C. Internet and its Applications	(28 hours)	D. Basic Programming Concepts	(20 hours)
E. Social Implications	(28 hours)		



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<b>The Elective Part</b> (75 hours) (Choose one only)			
A. <i>Databases</i>	B. <i>Data Communications and Networking</i>	C. <i>Multimedia Production and Web Site Development</i>	D. <i>Software Development</i>

<b>School-based Assessment</b> (30 hours)
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The recommended number of hours for each module and option are noted below:

<b>Module / Option</b>	<b>No. of hours allocated</b>	
<b>The Compulsory Part</b>	<b>165</b>	
A. Information Processing	64	
<i>a. Introduction to Information Processing</i>		5
<i>b. Data Organisation and Data Control</i>		4
<i>c. Data Representation</i>		10
<i>d. The Use of Office Automation Software</i>		40
<i>e. Presentation of Information</i>		5
B. Computer System Fundamentals	25	
<i>a. Basic Machine Organisation</i>		15
<i>b. System Software</i>		4
<i>c. Computer Systems</i>		6
C. Internet and its Applications	28	
<i>a. The Networking and Internet Basics</i>		9
<i>b. Internet Services and Applications</i>		7
<i>c. Elementary Web Authoring</i>		12
D. Basic Programming Concepts	20	
<i>a. Problem-Solving Procedures</i>		4
<i>b. Algorithm Design</i>		13
<i>c. Algorithm Testing</i>		3
E. Social Implications	28	
<i>a. Equity of Access</i>		2
<i>b. Work and Health Issues</i>		2
<i>c. Intellectual Property</i>		9
<i>d. Threats and Security on the Internet</i>		15
<b>The Elective Part (Choose one only)</b>	<b>75</b>	
A. Databases	75	
<i>a. Introduction to Databases</i>		8
<i>b. Relational Databases</i>		28
<i>c. Introduction to Database Design Methodology</i>		22
<i>d. Database Applications, Development and Society</i>		17
B. Data Communications and Networking	75	
<i>a. Data Communications and Networking Basics</i>		38
<i>b. Network Design and Implementation</i>		26
<i>c. Network Management and Security</i>		11
C. Multimedia Production and Web Site Development	75	
<i>a. Multimedia Production</i>		25
<i>b. Web Site Development</i>		50
D. Software Development	75	
<i>a. Programming</i>		47
<i>b. Programming Languages</i>		12
<i>c. Systems Development</i>		16
<b>School-based Assessment</b>	<b>30</b>	
<b>Total Curriculum Time</b>	<b>270 hours</b>	

Details of the curriculum are set out on pages 10–68. The order of the modules and options, however, is not fixed. The organisation of individual modules or options represents just one possible way of organising the curriculum content. Teachers may structure and design teaching schemes in their own way according to their school situation and student needs, interests and abilities.

The ICT curriculum presents the overall aims, major targets and content of the curriculum. For each module or option, the following information is also provided:

- The Introduction provides an overview of how the module or option is approached in the curriculum;
- Learning Objectives specify what students will learn in the module or option and to what extent/level they will be learnt;
- Topics are included within each module or option. They are numbered and sub-topics are included where necessary. A suggested time allocation for each topic is also given;
- Learning Outcomes embody the essential content of each learning topic in detail; and
- Remarks are written in small print, where appropriate, to serve three purposes. They
  - provide further information such as the depth and breadth of the learning elements;
  - alert teachers to the opportunities for fostering the most dominant generic skills associated with a particular topic/sub-topic; and
  - serve as teaching notes.

Each module or option is written with learning outcomes that use action verbs to indicate the thinking or practical skills that students should exhibit during the course of study:

<b>Examples of action verbs</b>	<b>Students need to demonstrate</b>
Be aware of, know, define, write, list, relate, recognise, state	The recall and understanding of specific terms or facts and simple concepts.
Discuss, describe, explain, identify, demonstrate, apply, convert	The application of declarative knowledge and practical skills in particular contexts.
Distinguish, analyse, compare, evaluate, organise, prepare, test	The analysis of materials or systems into their constituent parts and the recognition of relationships between parts.
Develop, plan, design, construct, process, integrate, implement	The synthesis of concepts and skills from different areas into a plan for solving a problem or reaching a conclusion, and the transfer of learnt concepts and skills to new scenarios / situations.

### 2.3.1 The Compulsory Part

The Compulsory Part comprises five modules:

#### **A. Information Processing**

##### **Introduction**

This module provides students with a fundamental understanding of what information systems and information processing entail, and how data are represented inside a computer. Students will learn that different software is used to process different types of data. They will be given practical tasks to process and present information. Built on the basic knowledge, understanding and skills of word processing, spreadsheet, database and multimedia presentation acquired by students in junior secondary, this module will increase understanding of the terminology, advanced concepts and skills in using integrated software. This will enhance students' personal productivity in their work or study, and enable them to apply their learning effectively to problem-solving, data analysis and information presentation.

##### **Learning Objectives**

Students will learn about:

- information systems and processes in real-life contexts;
- the difference between information and data;
- how data are organised and represented inside a computer;
- the integrated use of office automation software, and the appropriate processing and presentation of different types of information; and
- how advances in ICT foster the development of the Information Age and its impact on society.

The time allocation for the module is about 64 hours.

##### **Details**

This module comprises five topics: "Introduction to Information Processing", "Organisation and Data Control", "Data Representation", "The Use of Office Automation Software" and "Presentation of Information". Details of the five topics are summarised below:

Topic	Learning Outcomes	Remarks
<p><b>a. Introduction to Information Processing</b> (5 hours)</p>	<ul style="list-style-type: none"> <li>• Describe the basic concepts of the Input-Process-Output cycle and the use of a stored program in a processing system.</li> <li>• Identify and examine the components of an information system.</li> <li>• Distinguish between various information processes.</li> <li>• Realise the difference between data and information, and identify different types of data as image, audio, video and text.</li> <li>• Define Information Age and discuss the importance of information literacy in a knowledge-based society.</li> </ul>	<p>The components include the purposes, data, processes, technologies and personnel.</p> <p>Information processes include data collection, organisation, analysis, storage, processing, transmission and presentation. Examples from daily life, both computer and non-computer-based processes, should be used to consolidate and enhance students' understanding of the activities involved.</p> <p>How the development of technologies leads to the emergence of the Information Age, and how information can be flexibly and analytically converted into knowledge in modern society should be discussed.</p>

Topic	Learning Outcomes	Remarks
<b>b. Data Organisation and Data Control</b> (4 hours)	<ul style="list-style-type: none"> <li>• Identify data, records, fields, files and databases in the hierarchical organisation of data.</li> <li>• Explain how records can be organised, stored and retrieved. State the advantages, disadvantages and applications of the two types of file access: direct access and sequential access.</li> <li>• Discuss the needs of data control.</li> <li>• Describe how errors can be detected by using validation and parity checking, and prevented by verification and validation.</li> </ul>	
<b>c. Data Representation</b> (10 hours)	<ul style="list-style-type: none"> <li>• Distinguish between analog and digital data. State applications or situations where conversion of analog to digital data is required, or vice versa.</li> <li>• Explain why IT uses digital data</li> </ul>	<p>The relationship between the number of bits and number of patterns/combinations available should be mentioned (e.g. three bits can be used to represent eight colours).</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Convert integers from denary numbers to binary numbers or hexadecimal numbers, or vice versa.</li> <li>• Perform simple calculations (addition and subtraction only) on binary numbers and analyse overflow errors.</li> <li>• Know how characters are represented by using common international standards such as American Standard Code for Information Interchange (ASCII), the Big-5 code, the Guobiao (GB) code and the Unicode.</li> <li>• Know briefly how different multimedia elements are digitised. Convert them into different file formats and compare them for storing the same data.</li> </ul>	<p>Adopt two's complement for the representation of negative integers.</p> <p>In understanding errors, minimum and maximum numbers an n-bit can hold (maximum 2 bytes) should be considered.</p> <p>The relationship between the size of the character set and the representation should be explained. Recall of specific codes is not required.</p> <p>Elementary file conversion is required but not the editing of a file. Students should be given the experience in creating various file formats such as wav vs. mp3, bmp vs. jpg, and avi vs. mpeg2.</p>

Topic	Learning Outcomes	Remarks
<p><b>d. The Use of Office Automation Software</b> (40 hours)</p>	<ul style="list-style-type: none"> <li>• Design and create formatted documents or reports effectively and suitably using a word-processing tool.</li>   <li>• Convert between various document / text formats and justify their usage.</li>   <li>• Describe and use basic features of spreadsheets to solve problems.</li>   <li>• Demonstrate data manipulation techniques in spreadsheets.</li> </ul>	<p>Through meaningful tasks related to the real world, such as advertisements fliers, newsletters and reports, students are expected to apply formatting features such as tables, columns, text frames and graphics, with consideration of the use of colour, size and positioning in presenting their documents.</p> <p>Other features such as table of contents, indexes, footnotes, hyperlinks and checkers (e.g. Spelling checker) should be introduced to students to facilitate the writing of a report and to enhance the readability and accuracy of documents.</p> <p>Examples of text formats are rich text format, hypertext document format, portable document format and word document format.</p> <p>The use of cell references in formulas, and standard functions, together with mathematical, logical and relational operators should form part of the content.</p> <p>This includes filtering, searching and sorting data using single or multiple criteria. The manipulation of data dynamically in multiple worksheets should also be introduced.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Apply spreadsheets as a data analysis tool by using a pivot table (and pivot chart), and “what-if” scenarios.</li>   <li>• Apply the concepts of data organisation to create and maintain a simple database using a Database Management Systems (DBMS) tool.</li>   <li>• Create and use a form for data entry.</li>   <li>• Practise data extraction and manipulation by querying a database and create reports.</li> </ul>	<p>Through task-based activities, apart from the basic features and functions (sum, sub-total and average) of a pivot table, students should be led to observe and analyse the interdependency of data by varying the fields in a pivot table.</p> <p>Together with charting, simulating real-life situations and “what-if” scenarios, students should learn to identify trends, to make informed judgments, and to produce meaningful predictions which are required as critical thinkers throughout their careers.</p> <p>This includes the selection, filtering and sorting of data using query. Students should be able to trace and interpret simple Structured Query Language (SQL) statements. Though sophisticated reports are not required, they should create and format reports for intended users / audience.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Understand concepts of Object Linking and Embedding (OLE) and its applications.</li> <li>• Use a software suite in an integrated and effective manner.</li> </ul>	<p>Students should be given experience of the integrated use of different programs in the software suite (e.g. spreadsheet / databases with word documents in mail merging).</p>
<p><b>e. Presentation of Information</b> (5 hours)</p>	<ul style="list-style-type: none"> <li>• Construct and design a presentation incorporating multimedia elements.</li> </ul>	<p>The focus is on the planning of the storyboard and presentation, not the means of presentation. Students may choose a web-based presentation, a slide show, a multimedia document or other means of presentation.</p> <p>The presentation should be supplemented with verbal annotation, to develop students' communication skills and encourage them to articulate ideas / thoughts.</p>

## **B. Computer System Fundamentals**

### **Introduction**

This module provides students with a basic understanding of how the different components of a computer system work together to perform computational tasks. This includes the learning of the functional units of a computer, the system software, and the different types of computer systems for different applications.

### **Learning Objectives**

Students will learn about:

- the functions and properties of the major components of a computer system and how these components interact together to perform tasks;
- the functions and properties of major peripheral devices, and their uses in specific situations;
- the use of different utility programs in managing systems and files; and
- the capabilities of different operating systems, and the basic concepts of a computer network and its applications.

The time allocation for the module is about 25 hours.

### **Details**

This module comprises three topics: “Basic Machine Organisation”, “System Software” and “Computer Systems”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
<p><b>a. Basic Machine Organisation (15 hours)</b></p>	<ul style="list-style-type: none"> <li>• Explain the functions of hardware within a computer system, namely input and output devices, the central processing unit, bus system and storage devices (both primary and secondary).</li> <li>• Explain the structure and functions of a central processing unit (CPU) and its components.</li> <li>• Outline the steps in the fetch-decode-execute cycle and store using a single processor, and describe the roles of and the interdependence among components, registers and buses in the machine cycle.</li> </ul>	<p>Students should know how CPU is measured in terms of frequency. Units such as microsecond, nanosecond and picosecond should also be introduced.</p> <p>The functions of the program counter, accumulator, instruction register, memory address register and memory data register should be briefly introduced to students. No assembly language is involved but instructions requiring LOAD, ADD, STORE and STOP may be used to illustrate how data and instructions are processed in the machine cycle.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li data-bbox="819 264 1417 520">• Describe the functions and characteristics of Random Access Memory (RAM), Read Only Memory (ROM) and memory cache. Realise the relationship among the size of the memory, the memory address, word length and the performance of the computer.</li> <li data-bbox="819 743 1417 959">• Describe the features, advantages, disadvantages and applications of the input and output devices. Select and justify the use of appropriate devices for collecting and displaying information in a given context.</li> <li data-bbox="819 1007 1417 1142">• Describe the functional characteristics of storage devices in terms of random or sequential access, volatile or non-volatile, data transfer rate and storage capacity.</li> </ul>	<p data-bbox="1440 264 2033 408">Students' understanding of main memory should be extended to the current version / technologies in RAM and ROM in terms of capacity and data access rate.</p> <p data-bbox="1440 448 2045 703">The meanings of units such as terabytes, gigabytes, megabytes and kilobytes should be introduced. Also, the distinction between prefixes used in computer and the Syst�me International (SI) notation should also be made (e.g. 1KB = 1024 Bytes, not 1000 Bytes).</p> <p data-bbox="1440 743 2045 927">Students should know the various hardware devices used for collecting and displaying different types of data such as image, audio, video and text. The technical details on how each device operates are not required.</p> <p data-bbox="1440 1007 2045 1262">Examples of storage devices are magnetic disk, optical disk, flash memory, magnetic tape and network storage. In understanding the characteristics of storage devices, students should be made aware of the trend to faster and greater storage capacity but smaller physical size over time.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Outline the latest developments in computer systems including processor capabilities, primary memory technologies, secondary storage devices and data communications.</li> </ul>	Technical details are not required.
<b>b. System Software (4 hours)</b>	<ul style="list-style-type: none"> <li>• Know the functions of system software and applications software, and the relationship between hardware, system software, applications software and users.</li> <li>• Outline the basic functions of an operating system and describe some common operating systems, and their differences and applications.</li> <li>• State the functions and needs of utility programs and driver programs.</li> </ul>	<p>Examples of the utilities are data compressors, virus checkers, file managers, defragmentation software and system monitoring software. Technical details of these programs are not required but demonstration or practice on their use should be given.</p>

Topic	Learning Outcomes	Remarks
<p><b>c. Computer Systems (6 hours)</b></p>	<ul style="list-style-type: none"> <li>• Compare the characteristics of different types of computers.</li>   <li>• Distinguish the characteristics and applications of various computer systems.</li> </ul>	<p>Types of computers include personal computers, mainframes, supercomputers, network computers, etc. Comparison should be made with respect to physical size, memory size, backing store capacity, input/output devices, processors, number of user supported, cost and applications.</p> <p>Computers systems to be considered are batch processing systems, on-line interactive systems and real-time systems, single-user systems and multi-user systems, parallel processing systems and distributed processing systems, and network systems.</p>

## **C. Internet and its Applications**

### **Introduction**

This module is designed to acquaint students with Internet fundamentals. It encompasses the concepts of Internet access, services and applications of the Internet, and elementary web page design. Students will also be given the opportunity to critically analyse the reliability of the information retrieved from the Web and appreciate the impact of the Internet on various activities in society.

### **Learning Objectives**

Students will learn about:

- how to connect to the Internet, and the hardware, software and Internet Service Provider (ISP) involved in accessing the Internet;
- the personal, social and commercial activities that are available on the Internet;
- how to participate in various Internet activities such as searching for information, sharing opinions, and exchanging messages and files;
- the technologies involved in transmitting and displaying multimedia elements on the Internet; and
- the design and construction of simple web pages for an intended audience.

The time allocation for the module is about 28 hours.

### **Details**

This module comprises three topics: “The Networking and Internet Basics”, “Internet Services and Applications” and “Elementary Web Authoring”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
<p><b>a. The Networking and Internet Basics</b> (9 hours)</p>	<ul style="list-style-type: none"> <li>• Define and compare Local Area Network (LAN) and Wide Area Network (WAN).</li> <li>• Discuss the common services available in a networked environment.</li> <li>• Explain the functions of the hardware required for a network.</li> <li>• Compare common methods for Internet access in terms of speed, cost, security and availability.</li> <li>• Understand the need for communications software and communication protocols.</li> </ul>	<p>Services include internal communications, conferencing and resources sharing.</p> <p>This includes communication links (phone line, coaxial cable, fibre optics, microwave, satellite, etc.), modem (including cable modem), network interface card, network connecting devices (hub, switch and router, etc.).</p> <p>This includes connections in wireless, leased line and broadband etc.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Describe how data is transmitted over the Internet and understand concepts of Internet Protocol (IP), Uniform Resource Locator (URL), Domain Name System (DNS) and Hypertext Transfer Protocol (HTTP).</li> </ul>	
<b>b. Internet Services and Applications</b> (7 hours)	<ul style="list-style-type: none"> <li>• Formulate an effective strategy for searching for specific information on the Web by using search-engines, and critically analyse the sources of information.</li> <li>• Identify various graphics, audio, video file formats suitable for web pages. Use plug-ins and players for the multimedia elements found on the Internet.</li> <li>• Apply various services such as File Transfer Protocol (FTP), remote logon, online chat, discussion forum, newsgroup and email on the Internet.</li> </ul>	Email protocols such as Post Office Protocol (POP), Internet Message Access Protocol (IMAP), Simple Mail Transfer Protocol (SMTP) and their functions should be included.

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Describe the concepts of streaming technology and its applications in voice mail, videoconferencing, and webcasting etc. on the Internet.</li> <li>• Value and appraise the significance of the development of the Internet for various activities in society.</li> </ul>	<p>Technical details of streaming technology are not required.</p> <p>The benefits and limitations of various activities, such as e-commerce, e-government, e-learning and e-entertainment, as compared to the traditional methods, should be discussed. In e-commerce, for instance, this may range from activities such as Electronic Fund Transfer (EFT) to current practices in corporate / organisation web portals in the digital economy.</p> <p>Appreciation of technology advancement as a change agent for the betterment of humanity should be fostered among students.</p>
<p><b>c. Elementary Web Authoring</b> (12 hours)</p>	<ul style="list-style-type: none"> <li>• Practise the basic constructs of Hypertext Markup Language (HTML) which is a means to address cross-platform issues.</li> </ul>	

<b>Topic</b>	<b>Learning Outcomes</b>	<b>Remarks</b>
	<ul style="list-style-type: none"> <li>• Design and construct web pages, by writing HTML or by using a web authoring tool, for an intended audience and upload them onto the World Wide Web.</li> </ul>	<p>The organisation of information includes ease of navigation, appropriate placement of links, tables, frames and multimedia elements, colour combinations, background design, font size and style, for an intended audience.</p> <p>Although students may use a tool to write HTML codes for the creation of web pages, understanding and interpretation of HTML codes are essential.</p>

## **D. Basic Programming Concepts**

### **Introduction**

This module is designed to provide students with a basic understanding of the steps and strategies involved in solving a problem systematically. It emphasises the design of a solution, the algorithm, which is essential in computer programming, and with which students need to be equipped to manage complex problems they may encounter in their lives. The realisation of the algorithm in a syntactic language is introduced in *Software Development*. Students should learn to solve problems analytically and logically, not just to write computer programs.

### **Learning Objectives**

Students will learn about:

- the systematic approach to problem-solving;
- the application of concepts of systematic problem-solving to real-life problems;
- the use of pseudocode and/or a program flowchart to represent the algorithm;
- how to identify the objectives of an algorithm, trace the logical flow and examine values of variables during execution; and
- various ways of solving the same problem, and the differences between them.

The time allocation for the module is about 20 hours.

### **Details**

This module comprises three topics: “Problem-Solving Procedures”, “Algorithm Design” and “Algorithm Testing”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
<b>a. Problem-Solving Procedures (4 hours)</b>	<ul style="list-style-type: none"> <li>• Outline the major stages in problem-solving and explain the needs of each stage.</li> <li>• Use real-life examples to illustrate the various stages in problem-solving procedures.</li> <li>• Explain the importance of formulating and defining the scope of a problem precisely.</li> <li>• Solve a problem by breaking it down into sub-problems or modules.</li> </ul>	<p>The sub-problems, for instance, may represent the input, process and output of the solution to the problem.</p>
<b>b. Algorithm Design (13 hours)</b>	<ul style="list-style-type: none"> <li>• Define algorithm. Use pseudocode and program flowchart as methods for representing algorithms.</li> <li>• Outline and discuss the input and output requirements of a problem, and design an appropriate user interface.</li> <li>• Recognise the uses and nature of simple data types and data structures in solving a problem.</li> </ul>	<p>Simple data types are restricted to integer, real, character and Boolean while simple data structures are limited to string and one-dimensional array. Boolean logic (AND, OR, NOT) and truth tables should be introduced.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Select appropriate data types for the solution to a particular problem and discuss the merit of the chosen types.</li> <li>• Design and construct standard algorithms involving basic control structures.</li> <li>• Create and examine algorithms such as to load and print an array, and to add or delete an item from an array.</li> <li>• Describe the advantages of modularity in designing computer solutions.</li> </ul>	<p>The control structures are sequence, selection (binary and multi-way) and iteration (pre-test, post-test and for loops).</p> <p>When designing a solution to a complex problem, students should be encouraged habitually to use the modular approach to structure the algorithm.</p>
<p><b>c. Algorithm Testing</b> (3 hours)</p>	<ul style="list-style-type: none"> <li>• Trace and test algorithms.</li> <li>• Compare different solutions to the same problem.</li> </ul>	<p>Students need to identify boundary cases and generate appropriate test data.</p> <p>Comparison of the steps of operation and resource usage of different algorithms to solve the same problem should be encouraged.</p>

## **E. Social Implications**

### **Introduction**

This module provides students with an understanding, and ethical analysis, of various issues arising from the use of ICT. These issues have economic, legal, social, ethical and security consequences. Students should be given experience in discussing and debating these issues to develop the analytical and interpretive skills required to construct their own normative practices in the use of ICT. With the pervasiveness of the Internet, students should be made fully aware of the potential threats associated with its use, and the possible measures to safeguard their data and information. This module encourages students to act in a socially responsible, ethical and legal way in using the technologies throughout their studies, careers and other areas of their lives.

Although these issues are introduced specifically in this module, they should also be re-considered and re-addressed in various other parts of the course as a means to strengthen students' awareness of them. For instance, security measures on networks will be considered again in more detail in *Data Communications and Networking*.

### **Learning Objectives**

Students will learn about:

- equity issues relating to access to ICT;
- health hazards and preventive measures in using ICT;
- major issues regarding intellectual property and privacy;
- the potential threats on the Internet and measures to reduce them; and
- the need to use ICT safely, sensibly, legally and ethically.

The time allocation for the module is about 28 hours.

### **Details**

This module comprises four topics: “Equity of Access”, “Work and Health Issues”, “Intellectual Property” and “Threats and Security on the Internet”. Details of the four topics are summarised below:

Topic	Learning Outcomes	Remarks
<b>a. Equity of Access (2 hours)</b>	<ul style="list-style-type: none"> <li>• Discuss the pros and cons of freedom of information on the Internet.</li> <li>• Discuss equity issues in terms of the digital divide, gender equity and access for the disabled from local and global perspectives.</li> </ul>	<p>In explaining the digital divide, the rise of a knowledge-based society as a result of the development of ICT should also be discussed.</p>
<b>b. Work and Health Issues (2 hours)</b>	<ul style="list-style-type: none"> <li>• Realise that technological innovations can bring major benefits to society if they are used properly, but damage society when they are misused.</li> <li>• Discuss change in the nature of work in areas such as work monitoring, telecommuting, working hours, virtual organisations and the removal of national and international barriers to business.</li> <li>• Identify health hazards associated with the use of ICT, and propose good ergonomic practices when using them.</li> </ul>	<p>In ergonomics, consideration includes the reduction of injuries which arise from RSI and electromagnetic radiation, the suitable design and placement of the furniture, the design of the software (with user-friendliness features such as ease of use and a consistent user interface) and work environment.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Be aware of the consequences of indulgence in Internet activities for individuals.</li> </ul>	<p>Examples of Internet activities are online games, Internet chat and web surfing.</p>
<p><b>c. Intellectual Property (9 hours)</b></p>	<ul style="list-style-type: none"> <li>• Understand the basic ideas of intellectual property and copyright.</li> <li>• Know the difference between open source and non-open source software.</li> <li>• Debate the benefits and risks of different licensing schemes such as freeware, shareware, open source software and copyrighted software from the perspectives of users and software developers.</li> <li>• Relate acts of possible infringement of copyright in software and Internet piracy.</li> </ul>	<p>Students should discuss the social, legal and economic implications of acts of infringement of copyright. They should also develop the habit of acknowledging the source of information and be aware of the appropriate use of multimedia materials, and the possible crimes and consequences of illegal uses and broadcasting of these materials (e.g. Bit Torrent -- BT)</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Be aware of ways to reduce intellectual property theft on digital property.</li> <li>• Know some of the legal consequences, especially in education, related to the infringement of copyright in Hong Kong.</li> </ul>	<p>Examples of measures are the use of a digital watermark and digital signature.</p> <p>Teachers can quote some of the legal consequences related to infringement of copyright (e.g. Copyright Ordinance: Chapter 528, Section 4, 29, 60 and 61).</p>
<p><b>d. Threats and Security on the Internet</b> (15 hours)</p>	<ul style="list-style-type: none"> <li>• Know, from the users' perspective, possible security threats on the Internet.</li> <li>• Demonstrate the control of intrusion using security applications on a computer.</li> </ul>	<p>Supported by crimes reported in the news, students should know about the security threats such as malware, spyware and adware from the automatic intrusion via dynamic web pages, peer-to-peer (p2p) and files download.</p> <p>Examples of security applications are browsers, firewalls and anti-virus software.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li data-bbox="817 263 1420 375">• Discuss the possible privacy threats on the Internet, and suggest ways to maintain privacy.</li>   <li data-bbox="817 853 1420 965">• Be aware of information encryption technologies so as to prevent eavesdropping and interception.</li>   <li data-bbox="817 1117 1420 1228">• Explain authentication and authorisation as a means to control access of information on the Internet.</li> </ul>	<p data-bbox="1444 263 2036 438">Supported by crimes reported in the news, violation of the secrecy of data as a result of eavesdropping, hacking, phishing, spamming and junk mails etc. should all be considered and discussed with students.</p> <p data-bbox="1444 486 1937 590">The ways to maintain privacy, such as anonymity and passwords, should be stressed.</p> <p data-bbox="1444 630 2022 813">Teachers can quote some of the legal consequences related to unauthorised access to computers (e.g. Crimes Ordinance: Chapter 106, Section 27A; Chapter 200, Section 59, 60 and 161).</p> <p data-bbox="1444 853 1993 1069">This includes the basic concepts of data encryption, public and private key encryption systems, and the relationship between the size of the key used and the degree of security, e.g. Hong Kong Public Key Infrastructure (PKI).</p> <p data-bbox="1444 1109 2018 1292">Basic concepts include the authentication methods for individuals, types of tokens used in authentication processes, and digital certificates and the procedures involved in obtaining a certificate.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Know about security used in electronic transactions.</li>   <li>• Be aware of the latest developments in security measures.</li> </ul>	<p>The concepts of Secure Sockets Layer (SSL) in secured transmission in e-commerce should be introduced.</p> <p>Other security measures in online transaction such as smart cards, security tokens, digital certificates and mobile Short Message Service (SMS) should also be introduced.</p>

### 2.3.2 The Elective Part

The Elective Part comprises four options.

#### **A. Databases**

##### **Introduction**

This option is designed to provide students with the fundamental concepts of databases and relational database design. It covers the application, management and design aspects of databases. Students will learn how to construct simple data models using Entity Relationship (ER) diagrams and to appreciate the importance of good database design. They will also learn to use SQL to construct, manipulate and retrieve information from a relational database. In addition, students will be exposed to database security, integrity, and data privacy issues, and be aware of the impact of database development on society. Through studying this option, students will acquire a basic understanding of the concepts, skills and applications of databases, and elementary data modelling concepts.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module *A Information Processing* before progressing to this option.

The sub-topics under topic (b) “Relational Databases” in the present option are designed as extensions of topic (b) “Data Organisation and Data Control” in the Compulsory Part – module *A Information Processing*.

##### **Learning Objectives**

Students will learn about:

- concepts and applications related to databases and the DBMS;
- the basic concepts of a relational database, and the construction, manipulation and extraction of information from a relational database using SQL;
- how to identify and perform an analysis of the data requirements of simple scenarios in different applications;
- the construction of simple data models using the ER diagrams methodology;
- the importance of good database design as a blueprint for the development of a database management system;
- the importance of data privacy and measures for its improvement;
- the database application development lifecycle and the main activities associated with the development stages; and
- database development and its impact on society.

The time allocation for the option is about 75 hours.

## **Details**

The option *Databases* comprises four topics: “Introduction to Databases”, “Relational Databases”, “Introduction to Database Design Methodology” and “Database Applications, Development and Society”. Details of the four topics are summarised below:

Topic	Learning Outcomes	Remarks
<b>a. Introduction to Databases (8 hours)</b>	<ul style="list-style-type: none"> <li>• Be aware of the uses and applications of databases in our everyday life, such as database usage in education, public services, and business and commerce.</li>   <li>• Discuss the importance of databases in an organisation and how it improves the operations of an organisation.</li>   <li>• Know database models, such as relational model and hierarchical model, and list examples of their usage.</li>   <li>• Explain the use of database instance and schema in database modelling.</li>   <li>• Describe the purposes and functions of DBMS.</li>   <li>• Explain the concepts of data definition language, data manipulation language, and data dictionary, and construct a simple data dictionary.</li>   <li>• Describe and explain the relationship of fields, records, tables, files and databases.</li> </ul>	

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Describe common data types such as integer, real, character, string, Boolean, and date.</li> </ul>	
<b>b. Relational Databases (28 hours)</b>	<ul style="list-style-type: none"> <li>• Explain the concept of program-data independence.</li> <li>• Describe the basic concepts of relational databases.</li> <li>• Create a simple relational database.</li> </ul>	<p>It includes entity, relationship, attribute, domain, index, key (such as primary key, foreign key and candidate key), and integrity (such as entity integrity, referential integrity and domain integrity). Students should be able to identify these basic elements in examples taken from everyday applications.</p> <p>Students should know how to organise data differently but sensibly in a relational database and be able to establish the required relationships among the tables.</p>









Topic	Learning Outcomes	Remarks
<p>c. <b>Introduction to Database Design Methodology</b> (22 hours)</p>	<ul style="list-style-type: none"> <li>• Use SQL to maintain a simple relational database, and manipulate its data or retrieve the required information in at most three tables.</li>   <li>• Be aware of and appreciate the importance of a good database design in effective database management.</li> </ul>	<p>Skills involved include:</p> <ul style="list-style-type: none"> <li>• modify the structure of the tables</li> <li>• add, delete and modify the data in the tables</li> <li>• view, sort, and select contents by filtering, and create different views</li> <li>• use appropriate operators and expressions such as arithmetic operators and expressions, comparison operators, logical operators and the in, between and like operators. to perform specific operations</li> <li>• use simple built-in functions such as aggregate and string functions</li> <li>• perform queries on multiple tables, including the use of equi-join, natural join and outer join</li> <li>• perform sub-queries (for one sub-level only)</li> <li>• export query results to, for example, text, HTML or spreadsheet format</li> </ul>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Describe the needs of the three levels of data abstraction, namely conceptual level, physical level and view level.</li> <li>• Be aware of the different types of relationships among entities in a relational database.</li> <li>• Analyse simple scenarios in business, education or other fields and create simple ER diagrams involving binary relationship only in designing databases.</li> <li>• Explain the concepts of data redundancy and discuss the methods or measures used to reduce data redundancy.</li> <li>• Transform the ER diagrams to tables in relational databases.</li> </ul>	<p>The resolution of many-to-many relationship into multiple one-to-many relationships should also be introduced.</p> <p>Students should be able to reduce data redundancy through normalisation up to Third Normal Form (3NF).</p>

Topic	Learning Outcomes	Remarks
<p><b>d. Database Applications, Development and Society (17 hours)</b></p>	<ul style="list-style-type: none"> <li>• Understand the stages involved in the database application development lifecycle and the links between them.</li>   <li>• Practise the main activities associated with the stages of the database application development lifecycle in an educational or commercial scenario.</li>   <li>• Be aware of the uses and applications of data mining in daily life and explain how data mining can improve the quality of living.</li> </ul>	<p>The main stages involved in the database application development lifecycle include requirements collection and analysis, system definition, application and database design, DBMS selection, form and report design, prototyping, implementation, data migration, conversion and loading, testing, and operational maintenance.</p> <p>Students should recognise that the stages of the database application development lifecycle often involve review and repetition of previous stages through feedback loops.</p> <p>Students should be able to apply simple Computer Aided Software Engineering (CASE) tools to automate, manage and simplify the database design process. CASE supports may include tools for data dictionary construction, and those for facilitating data models development, etc.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Discuss the needs and trends of future database development and the corresponding applications.</li>   <li>• Identify different database personnel such as database administrators, designers, developers and data entry operators, and describe their roles and responsibilities in database development and maintenance.</li>   <li>• Discuss the importance of data privacy and develop proper attitudes to be an ethical user of database to respect data privacy.</li>   <li>• Appreciate how effective use of database applications changes people's lives.</li> </ul>	<p>Students should be able to discuss the impact of technologies such as mobile and wireless technologies, and dynamic web pages on database development.</p> <p>In considering the need for different database applications, factors such as volume of data, variety of data and variety of users should be discussed.</p> <p>Trends in database models, including distributed, parallel, and multimedia, etc. and their impact, should be introduced.</p> <p>The responsibilities and ethics of different database personnel should be stressed.</p> <p>Ways to achieve data privacy in database applications using access rights should be discussed.</p>

### Symbols used in ER diagrams

Meaning	Symbol
Entity	
Attribute	
Key Attribute	
Relationship	
One-to-One Relationship	
One-to-Many Relationship	
Many-to-Many Relationship	
Participation constraints: <ul style="list-style-type: none"> <li>- Use   on Mandatory side</li> <li>- Use ○ on Optional side</li> </ul>	

## **B. Data Communications and Networking**

### **Introduction**

This option is designed to give students an understanding of the basic principles of data communications and networking, and the knowledge and skills associated with the design, implementation and maintenance of a simple network. Students will also be made aware of the common security threats to networks and of measures to improve network security. This option gives students a solid foundation on data communications and networking. Students will find it valuable and practical, whether they continue to study in this area in tertiary education or join the workforce.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module C *Internet and its Applications* and module E *Social Implications* before progressing to this option.

The sub-topics “Network components”, “Protocols”, “Types of network”, and “Network applications” under topic (a) “Data Communications and Networking Basics”, and the sub-topic “Network security” under topic (c) “Network Management and Security” in the present option are designed as extensions of topic (a) “The Networking and Internet Basics” in the Compulsory Part – module C *Internet and its Applications*, and topic (d) “Threats and Security on the Internet” in the Compulsory Part – module E *Social Implications*.

### **Learning Objectives**

Students will learn about:

- the basic concepts and technologies behind data communications and networking;
- the components involved in computer networks and their functions;
- the uses and applications of a computer network;
- the design and implementation of a simple computer network;
- the performance monitoring of a computer network and measures to improve it;
- the importance of computer network security and measures to improve it; and
- the latest developments and future trends in networking technology.

The time allocation for the option is about 75 hours.

### **Details**

The option *Data Communications and Networking* comprises three topics: “Data Communications and Networking Basics”, “Network Design and Implementation” and “Network Management and Security”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
<b>a. Data Communications and Networking Basics (38 hours)</b>		
<b>i. Communications model and data encoding</b>	<ul style="list-style-type: none"> <li>• Understand the simple model of communications.</li> <li>• Know the basic concepts of data encoding.</li> <li>• Understand some error detection methods.</li> </ul>	<p>Components of the model include agent, input device, transmitter, transmission medium, receiver, and output device.</p> <p>Distinction between data and signals should be known.</p> <p>Students should know that either form of digital and analog data can be encoded into either form of digital and analog signal.</p> <p>The error detection methods include parity check, checksum and cyclic redundancy check (CRC). Implementation arithmetic for parity check and checksum should be known.</p>
<b>ii. Network components</b>	<ul style="list-style-type: none"> <li>• Know the roles of client and server as two basic network devices in a network.</li> <li>• Describe the functions of network adapters.</li> </ul>	

Topic	Learning Outcomes	Remarks
<b>iii. TCP/IP protocol suites</b>	<ul style="list-style-type: none"> <li>• Compare different data transmission media.</li> <li>• Compare the functions of the various network connecting devices.</li> <li>• Know the simple concept of layering in a Transmission Control Protocol/Internet Protocol (TCP/IP) reference model.</li> <li>• Know the basic concepts of IP addressing including the scheme and classes of IP addresses.</li> <li>• Explain the functions of TCP/IP.</li> </ul>	<p>The transmission media include copper wires, glass fibers, radio, microwave, and infrared, etc. They are compared in terms of types of signal transmitted, levels of resistance to transmission impairments caused by attenuation and noise, capacity, transfer distance, cost, and security considerations.</p> <p>The network connecting devices include hub, switch, router, and access point, etc.</p> <p>The basic concept of data encapsulation across layers should be introduced.</p>
	<ul style="list-style-type: none"> <li>• Compare TCP/IP protocol suites such as Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) from an evolutionary perspective.</li> </ul>	<p>Different versions of TCP/IP protocol suites are compared in terms of address size and their support for audio and video.</p>

Topic	Learning Outcomes	Remarks
<b>iv. Basic concepts of data transmission</b>	<ul style="list-style-type: none"> <li>• Identify and describe the three communication modes: simplex, half-duplex and duplex.</li> <li>• Compare asynchronous and synchronous transmission in terms of timing and overhead.</li> <li>• Know the simple concept of multiplexing and its function in sharing the capacity of data transmission media.</li> <li>• Explain briefly the mechanism used to co-ordinate data transmission in Ethernet and wireless networks.</li> <li>• Understand the simple concepts of circuit switching and packet switching.</li> </ul>	<p>Knowledge of both Carrier Sense Multiple Access with Collision Detection (CSMA/CD) and Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is required.</p> <p>The basic function of each component of a packet including header, data and trailer should be known.</p>
<b>v. Types of network</b>	<ul style="list-style-type: none"> <li>• Describe the characteristics of the different types of network, including the LAN, WAN and Personal Area Network (PAN).</li> </ul>	

Topic	Learning Outcomes	Remarks
<b>vi. Network applications</b>	<ul style="list-style-type: none"> <li>• Describe the characteristics of basic network topology such as bus, ring and star.</li> <li>• Describe the characteristics of a client-server network and a peer-to-peer network, and explain the factors that need to be considered in choosing between them as a network solution.</li> <li>• Understand the basic features of a wireless computer network in terms of its underlying technologies and the hardware used.</li> <li>• Explain the factors that need to be considered in choosing between wired and wireless computer networks.</li> <li>• Describe the services provided by common network servers.</li> </ul>	<p>The factors include the network services required, set-up and maintenance costs, and the workload of the network administrators, etc.</p> <p>The common industry standards for wireless computer networks should be introduced to students. Relevant concepts including frequency, bandwidth, interference and roaming, etc. are required.</p> <p>The strengths and weaknesses of both network solutions should be considered. The possibility of a hybrid solution should also be introduced to students.</p> <p>The common network servers include the Dynamic Host Configuration Protocol (DHCP) server, domain controller, file server, proxy server, and gateway, etc.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Describe and appreciate the applications of various networks.</li>   <li>• Describe the different personnel involved in a networking environment.</li> </ul>	<p>The applications include resources sharing, web serving, and telecommuting, etc. Simple knowledge of the latest mobile computing applications and their role in supporting the mobile business, mobile government services and mobile life initiatives should be discussed.</p> <p>The types of personnel should include network engineers and network administrators.</p>
<b>b. Network Design and Implementation (26 hours)</b>		
	<ul style="list-style-type: none"> <li>• Conduct a simple needs analysis on a proposed network and translate the needs identified into requirements and specifications.</li>   <li>• Design a network to meet the requirements generated in the needs analysis and represent it in a diagram.</li>   <li>• Justify their designs based on technical, cost-effectiveness and other considerations.</li> </ul>	

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Set up simple Ethernet and wireless networks.</li> <li>• Share various resources among the networked computers/stations.</li> <li>• Set folder/ file-sharing permissions, including read, write and execute rights, etc.</li> <li>• Design a simple test plan based on the requirements and specifications to validate a network system.</li> <li>• Document the user requirements, a schematic diagram for the network and specifications of the network.</li> <li>• Be aware of the importance of adequate end-user support and training for the attainment of the benefits sought.</li> <li>• Appreciate and value the use of various networking technologies in meeting different user requirements.</li> </ul>	<p>Students should know the use of a subnet and know which subnet an IP address belongs to from a simple subnet mask.</p> <p>The resources include files, printers and Internet connection, etc.</p> <p>Documentation of industry standards is not required.</p>

Topic	Learning Outcomes	Remarks
<b>c. Network Management and Security (11 hours)</b>		
<b>i. Network management</b>	<ul style="list-style-type: none"> <li>• Develop the basic skills of monitoring and fine-tuning the performance of a simple network.</li> <li>• Develop the basic skills of analysing problems of a networked environment and performing troubleshooting for it.</li> <li>• Be aware of the importance of backup in disaster planning and recovery measures.</li> <li>• Know the common hardware and software components of a network backup solution.</li> </ul>	<p>Students should be able to use some simple network monitoring software to interrogate devices to determine their status and to obtain statistics about the networks for monitoring and fine-tuning purposes.</p> <p>The problems may involve cabling, Network Interface Card (NIC), driver, Network Operating System (NOS), and configuration of a network, etc.</p> <p>Students should be introduced to the different components/technologies of a network backup solution including network backup servers, network backup and recovery software, Uninterruptible Power Supply (UPS), and Redundant Array of Independent Disks (RAID), etc.</p>

Topic	Learning Outcomes	Remarks
<b>ii. Network security</b>	<ul style="list-style-type: none"> <li>• Describe the potential risks caused by the common network security threats.</li>   <li>• Propose effective measures to improve network security for both wired and wireless networks.</li> </ul>	<p>The threats include virus, worm and Trojan programs, spyware, unauthorised access, interception, and Denial of Service (DoS) attack, etc.</p> <p>The measures include anti-virus software, authentication, access and user right control, packet filtering, firewall, public and private key encryption, Wired Equivalent Privacy (WEP), and IPsec used in Virtual Private Network (VPN), etc.</p> <p>Encryption mechanisms to guarantee a message is both authentic and private should be known. Detailed implementation algorithms of public and private key encryption are not required. Technical details on how a VPN is constructed are not required.</p>

## **C. Multimedia Production and Web Site Development**

### **Introduction**

This option is designed to equip students with the basic concepts, technologies and tools in developing multimedia products. It provides them with useful and practical knowledge related to web page design and web site development. This includes the learning of the incorporation of multimedia elements in web pages, and the fundamentals of designing, developing and publishing dynamic web pages on the Internet.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module A *Information Processing* and module C *Internet and its Applications* before progressing to this option.

All the sub-topics under topics (a) “Multimedia production” and (b) “Web site development” in the present option are designed as extensions of topic (e) “Presentation of information” in the Compulsory Part – module A *Information Processing*, and topics (b) “Internet Services and Applications” and (c) “Elementary Web Authoring” in the Compulsory Part – module C *Internet and its Applications*.

### **Learning Objectives**

Students will learn about:

- the benefits of multimedia applications;
- the different kinds of multimedia elements;
- the integrated use of multimedia elements in a simple multimedia application;
- design factors for presenting information effectively on the Internet;
- web authoring and web site publishing; and
- dynamic and interactive web pages.

The time allocation for the option is about 75 hours.

### **Details**

The option *Multimedia Production and Web Site Development* comprises two topics: “Multimedia Production” and “Web Site Development”. Details of the two topics are summarised below:



Topic	Learning Outcomes	Remarks
<b>iii. Multimedia products</b>	<p><b>(1) Preparing multimedia elements</b></p> <ul style="list-style-type: none"> <li>• Prepare multimedia elements.</li> </ul> <p><b>(2) Multimedia editing and processing</b></p> <ul style="list-style-type: none"> <li>• Perform simple editing and processing on multimedia elements.</li> <li>• Convert multimedia elements from one file format to another and know the potential information loss.</li> </ul> <p><b>(3) Finalising multimedia products</b></p> <ul style="list-style-type: none"> <li>• Examine how multimedia elements of a multimedia product function together to produce meaning for an audience.</li> </ul>	<p>Students should be able to prepare multimedia elements by capturing audio information, digital images and video with various devices, importing and converting from ready-made files, constructing from scratch and by using various media authoring tools.</p> <p>For example, changing the sharpness and brightness of graphical images, applying filters to give special effects, mixing of wave files, and adding a simple transition effect / text / image on video clips.</p>

Topic	Learning Outcomes	Remarks
	<ul style="list-style-type: none"> <li>• Export a multimedia product to different file formats.</li> <li>• Compress a multimedia product.</li> </ul> <p><b>(4) Multimedia design factors</b></p> <ul style="list-style-type: none"> <li>• Recognise the essential design factors.</li> <li>• Integrate multimedia elements into a cohesive multimedia product in a given context.</li> <li>• Understand the need to strike a balance between qualities and constraints in processing multimedia elements.</li> </ul>	<p>By demonstrating some multimedia applications, students should understand that the essential design factors are audience awareness and content purpose.</p> <p>The required multimedia elements are texts, digital images/photos, sound clips, video clips, and frame-by-frame animations with shape/motion tweening and morphing.</p>

Topic	Learning Outcomes	Remarks
<b>b. Web Site Development (50 hours)</b>		
<b>i. Presenting information on the Internet</b>	<ul style="list-style-type: none"> <li>Outline and discuss the various factors to be considered in the construction of web pages.</li> </ul>	<p>By demonstrating some web sites, students should discuss successful design factors such as the web site structure, audience awareness, content purpose, site map, use of the workspace available on each page, arrangement of elements on screen, appropriateness of embedded graphics/sound/animations, use of frames and meaningful contextual links, grouping related information into tables/lists, providing channels for feedback, providing details in downloadable files, and structuring contents for easy printing.</p> <p>Students should also discuss the hardware constraint and platform compatibility factors such as computer processing power, bandwidth limitation, browser and plug-in compatibility, viewing environment, and language and colour compatibility.</p> <p>They should analyse and judge the use of the right resolution and file format for images and photos in order to keep download time low.</p>

Topic	Learning Outcomes	Remarks
<b>ii. Web authoring tools</b>	<ul style="list-style-type: none"> <li>• Know that there are guidelines to cater for web accessibility by people with special needs.</li> <li>• Construct simple web pages.</li> <li>• Create and manipulate browser windows.</li> <li>• Perform special effects.</li> </ul>	<p>For example, providing an additional text-only version, and including brief descriptions and text links in existing websites to make the web pages more accessible to the visually-impaired.</p> <p>Students should be able to use different features (e.g. links, anchors, lists, tables, frames, Mailto and Fill-out Forms) in constructing the web page. They should also be able to embed multimedia elements in the web page and apply a consistent look and style across a set of web pages.</p> <p>Students should be able to create pop-up windows, manipulate window location, and window size, and allow scrollbars to appear when necessary. They should also be able to embed messages in browser window's status bar such as displaying the current date, time, URL and its description.</p> <p>Students should be able to create special effects such as scrolling messages, rotating image banners, mouse over effect, blinking text and changing colours.</p>

Topic	Learning Outcomes	Remarks
<b>iii. Dynamic and interactive web pages</b>	<ul style="list-style-type: none"> <li>• Publish web site.</li> <li>• Understand the difference between server-side and client-side technologies.</li> <li>• Describe the characteristics of client-side scripting.</li> <li>• Create interactive menus upon user selection.</li> <li>• Validate and manipulate input data.</li> <li>• Retrieve and save client information.</li> </ul>	<p>Students should know the basics of getting a domain name and web hosting. They should also be able to transfer web pages onto web sites on the Internet.</p> <p>Students should be able to create interactive user selection, such as the 2-level interdependent select list, pull down menu and click-to-expand menu.</p> <p>Students should be able to check text data, numeric data, required input, length of input, manipulate radio buttons and check boxes and valid values for all input data. They should also be able to perform simple computations to create quizzes and simple mathematics games.</p> <p>For example, the use of Cookies for collection of user information.</p>

## **D. Software Development**

### **Introduction**

This option is designed to provide students with the basic concepts of systems development, and further programming concepts and programming languages, to develop their problem-solving skills through a systematic approach to algorithm design and programming, as well as to improve their logical thinking and critical thinking skills. By studying this option, students will understand the whole process of software development. They will be able to design and develop computer programs independently for solving problems. Students will also be exposed to various principles and techniques of algorithm design, and different programming paradigms and phases of systems development. This will develop students' creativity and broaden their views on software development. This understanding will offer students a wider choice from which to think and select an appropriate approach to solve a specific problem in future.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module D *Basic Programming Concepts* before progressing to this option.

The sub-topics “Problem definition and analysis”, “Design of solutions”, “Implementation” and “Testing and evaluation” under topic (a) “Programming” in the present option are designed as extensions of sub-topics “Problem-solving Procedures”, “Algorithm design” and “Algorithm testing” in module D *Basic Programming Concepts*.

### **Learning Objectives**

Students will learn about:

- how to define and analyse problems;
- the importance of good programming skills and good programming styles;
- the importance of formulating appropriate algorithms in solving problems;
- creative design and development of computer programs;
- how to illustrate different programming paradigms with appropriate programming languages;
- how to choose different languages to meet different needs;
- the importance of a systematic approach to software development; and
- how to apply concepts underlying software development in a systematic way.

The time allocation for the option is about 75 hours.

### **Details**

The option *Software Development* comprises three topics: “Programming”, “Programming Languages” and “Systems Development”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
<b>a. Programming (47 hours)</b>		
<b>i. Problem definition and analysis</b>	<ul style="list-style-type: none"> <li>• Define problems.</li> <li>• Identify the inputs and outputs involved in solving a problem.</li> <li>• Plan solutions by choosing an appropriate problem-solving approach.</li> <li>• Describe the concept of stepwise refinement.</li> <li>• Apply structured programming to program writing.</li> </ul>	<p>The problem-solving approaches included are the top-down approach and the bottom-up approach.</p> <p>Modularity has been discussed in the Compulsory Part.</p>
<b>ii. Design of solution</b>	<ul style="list-style-type: none"> <li>• Select appropriate data types for a solution.</li> <li>• Represent algorithms with flowcharts or block diagrams.</li> </ul>	<p>The data types included are simple data types, structured data types and user-defined data types. Simple data types have been discussed in the Compulsory Part.</p>

Topic	Learning Outcomes	Remarks
<b>iii. Implementation</b>	<ul style="list-style-type: none"> <li>• Apply algorithms of counting, accumulating, swapping, searching, sorting and merging in writing programs.</li>   <li>• Choose an appropriate algorithm for a task.</li>   <li>• Apply various basic constructs in a solution.</li>   <li>• Apply control structures in a solution.</li> </ul>	<p>The search algorithms included are linear search and binary search. The sorting algorithms included are bubble sort, insertion sort and merge sort. Merging involves only two arrays of data at one time. Students should realise that there are some other sorting algorithms, say quick sort, other than the three stated above.</p> <p>Students should be aware that a problem may be solved by several different algorithms. The selection of algorithms sometimes depends on their complexities and data structures as well as their trade-off. Students should evaluate the algorithm with respect to efficiency, correctness and appropriateness for a task.</p> <p>Students should be able to use global variables, local variables, constants, assignment statements, input statements, output statements, arithmetic operators, string operators, Boolean operators and Boolean logic, and operations of the operators including precedence and association.</p> <p>Sequence, selection and iteration have been introduced in the Compulsory Part.</p>

Topic	Learning Outcomes	Remarks
<p><b>iv. Testing and evaluation</b></p>	<ul style="list-style-type: none"> <li>• Construct lists, stacks and queues in terms of arrays.</li> <li>• Manipulate text files through file-handling statements.</li> <li>• Implement parameters passing in manipulating sub-programs.</li> <li>• Realise the importance of good programming styles.</li> <li>• Appraise the use of structured programming to design, implement, and debug errors.</li> <li>• Interpret errors.</li> <li>• Apply both manual methods and software debugging tools to program debugging.</li> </ul>	<p>Students should be able to create and manipulate linear linked lists, stacks and queues in terms of arrays.</p> <p>The manipulation involves file updating statements to delete, insert, append and amend records.</p> <p>The sub-programs are called by two parameters passing methods: call by value and call by reference.</p> <p>Students should develop the habit of using meaningful variable names, comments, annotations, space and indentation.</p> <p>The numerical errors included are rounding errors, truncation errors, overflow errors and underflow errors. Other errors are syntax errors, logical errors and run-time errors.</p> <p>Use stubs, flags, break points and program traces for debugging.</p>





Topic	Learning Outcomes	Remarks
<b>iii. Systems design</b>	<ul style="list-style-type: none"> <li>• Examine the pros and cons of alternative proposals.</li> <li>• Write requirement specifications.</li> <li>• Describe the functions of each part of a computer-based system and the related issues.</li> <li>• Design and appraise an effective interface between the user and the system.</li> <li>• Know system flowcharts, structure charts, data flow diagrams and data dictionaries to design and document a proposed system.</li> <li>• Use Gantt Charts for project management.</li> </ul>	<p>This covers the hardware platform, software, inputs, outputs, user interfaces, database structures, data processing, data control, data security and system security.</p> <p>Different types of human-machine interfaces are compared.</p>
<b>iv. Systems implementation</b>	<ul style="list-style-type: none"> <li>• Design and prepare computer-based solutions.</li> <li>• Explain different types of testing and their uses.</li> </ul>	<p>The types included are unit testing, system testing and acceptance testing.</p>

Topic	Learning Outcomes	Remarks
<b>v. Systems conversion and maintenance</b>	<ul style="list-style-type: none"> <li>• Design a simple test plan for functionality of parts of a system.</li> <li>• Compare different strategies of systems conversion.</li> <li>• Explain the need for ongoing maintenance, upgrading and training.</li> </ul>	<p>The strategies included are pilot conversion, phased conversion, parallel conversion and direct cutover conversion.</p>
<b>vi. Systems documentation</b>	<ul style="list-style-type: none"> <li>• Differentiate different types of documentation and their purposes.</li> <li>• Document the processes and specifications.</li> </ul>	<p>The types included are system documentation, technical documentation and user manuals.</p> <p>The examples of documentation are requirement statements, project plans and design plans.</p>
<b>vii. Alternative approaches</b>	<ul style="list-style-type: none"> <li>• Explore the limitations and shortcomings of the Waterfall Model.</li> <li>• Recognise the benefits and limitations of other approaches.</li> </ul>	<p>Other approaches include Prototyping and Rapid Application Development (RAD).</p>
<b>viii. The personnel</b>	<ul style="list-style-type: none"> <li>• Identify various job titles for different stages of systems development.</li> </ul>	

## Chapter 3 Curriculum Planning

This chapter provides guidelines to help schools and teachers to develop a flexible and balanced curriculum that suits the needs, interests and abilities of their students, and the contexts of their school in accordance with the central framework provided in Chapter 2.

### 3.1 Guiding Principles

One aim of the senior secondary curriculum is to widen the knowledge base of every student while at the same time enabling learning in depth in some subjects to prepare for further study. Schools should develop and provide a broad and balanced school-based curriculum. Careful curriculum planning not only facilitates student learning, but also cultivates generic skills and positive values and attitudes. TE is one of the eight KLAs that each student is entitled to study in the senior secondary curriculum.

In the modern world, our personal and social values are shaped through interaction with technology, and the effects appear to be multiplying rapidly as new and more powerful technologies become part of our lives. Students who choose to study TE elective subjects in the senior secondary curriculum will acquire the ability to intervene creatively in the man-made world by designing and making artefacts (either tools, products or services) and by assessing their social impact. The study of TE KLA is an effective platform for nurturing students' skills in collaboration, communication, creativity, critical thinking, problem-solving, and IT.

Most TE KLA electives require equipment, software, storage, and material. In most schools, the existing facilities are considered adequate for offering the electives. Schools should focus on the interests, needs, and abilities of their students in planning their school-based curricula. Where schools anticipate problems associated with low enrolment, they may consider collaborating with other schools to form networked classes for the electives.

Careful curriculum planning not only facilitates student learning, but should also aim to cultivate generic skills and positive values and attitudes. In planning the senior secondary ICT curriculum, teachers need to understand students' prior knowledge in ICT, their needs and interests in addition to the requirements of the Compulsory Part, and the differences among the elective options. Noted below are some guiding principles that teachers should take into account in the curriculum planning process:

- Curriculum planning starts at the junior secondary level where teachers will have ample opportunities to know what students have achieved in the area of ICT and help them to identify their interests so that they choose the appropriate elective options to further their study in specific areas of ICT;
- Learning is made more meaningful by introducing authentic tasks and scenarios; and appropriate life-wide learning experiences;
- Topics are not to be taught in isolation. Appropriate integration of curriculum areas is encouraged;
- Learning is not confined to time-tabled lessons. Schools should make use of learning opportunities beyond the classroom to maximise learning effectiveness;
- Teachers are encouraged to work together as a team to plan the senior secondary ICT curriculum, to develop learning materials, activities and tasks, and to collaborate with

- teachers of other KLAs on cross-curricular projects;
- Teachers are encouraged to make flexible use of class time to facilitate learning (e.g. single periods for theoretical topics, and double or triple periods for practical tasks.); and
  - Teachers are encouraged to make use of both formative assessment (e.g. portfolios and projects) and summative assessment to inform learning and teaching.

## 3.2 Progression

The senior secondary ICT curriculum is designed to enable students to explore their interests, potential and aspirations for further studies and careers. It is built upon students' prior knowledge and skills in their computer literacy studies from primary through junior secondary. By including a variety of different topics in the teaching of ICT in S4, students will have a "taster" year to make informed decisions on suitable combinations of elective subjects to be studied from S5 onwards.

To help students achieve the curriculum aims and objectives, schools should feel free to vary the organisation and teaching sequence of learning elements. In practice, most schools will teach the core modules prior to the options. However, some schools may start teaching the options immediately after the related core module is covered. Experience in handling students with very different ICT knowledge and skills in transition from Primary 6 to S1, and from S3 to S4, indicates that the transition does not cause any major problems where planning has allowed for different levels of achievement. Students who wish to start studying ICT in S5 will need to spend some extra time on the subject during the first few months of S5 to develop the fundamental knowledge and skills they missed in S4. In considering curriculum planning for ICT, the prior concern is to put in place something that will benefit students as much as possible.

The following examples give some suggestions as to how to organise the learning elements and teaching sequence of the ICT curriculum. The examples are for reference only. Schools should develop their own school-based curriculum plan.

## Case 1 ICT Curriculum Planning in ABC Secondary School

### **Background**

This school plans to offer four core subjects – Chinese, English, Mathematics and Liberal Studies, and three elective subjects, including ICT, to their senior secondary students. The total curriculum time for ICT is 270 hours. For illustrative purposes, 105, 105 and 60 hours are allocated to the teaching of ICT in S4, S5 and S6 respectively.

### **Rationale**

- 1) Learning office automation software, web authoring tools and Internet services in the *Information Processing* and *Internet and its Applications* modules at an early stage of the ICT curriculum can equip students with the necessary knowledge and skill sets to complete the project work. Also, these practical skills are essential enabling skills to facilitate students' self-directed learning. In addition, the *Computer System Fundamentals* module provides the foundation knowledge on computers necessary for students to study the more in-depth topics in the ICT curriculum.
- 2) Related modules in the Compulsory Part are taught in S4 to give students more understanding of the nature and contents of the options in the Elective Part. This will help students in choosing one of the options as they progress to S5 and S6.
- 3) Curriculum time for SBA should be allocated flexibly and appropriately in S5 and S6, to provide continuous feedback to students to enhance learning effectiveness.
- 4) Since the Elective Part is taught in the second half of S5, this arrangement has the shortcoming of giving students a shorter time span to focus on their project work.

### Teaching Sequence and Time Allocation

Curriculum Time	Level	Compulsory Part	Elective Part	SBA
105 hours	S4	IP (64 hours)		
		CSF (25 hours)		
		I & A (28 hours)		
105 hours	S5			↑
		BPC (20 hours)		
		SI (28 hours)		SBA (30 hours)
60 hours	S6		One of the four options (75 hours)	↓

Notes :

IP	Information Processing
CSF	Computer System Fundamentals
I&A	Internet and its Applications
BPC	Basic Programming Concept
SI	Social Implications
SBA	School-based Assessment

## Case 2 ICT Curriculum Planning in DEF Secondary School

### Background

As in ABC Secondary School in Case 1, DEF Secondary School plans to offer four core subjects – Chinese, English, Mathematics and Liberal Studies, and three elective subjects, including ICT, to the senior secondary students. The total curriculum time for ICT is 270 hours. For illustrative purposes, 105, 105 and 60 hours are allocated to the teaching of ICT in S4, S5 and S6 respectively. However, this school introduces a variation in the teaching sequence. The option *Databases* is taught immediately after the related compulsory modules have been completed.


### Rationale

- 1) The main advantage of this teaching sequence is that students learn related knowledge and skills in a sequential and structured manner instead of in separate parts. Mapping of related modules in the Compulsory Part and in the options in the Elective Part is shown below.

<u>Compulsory Modules</u>		<u>Related Options</u>
<i>Information Processing</i>	→	<i>Databases</i>
<i>Internet and its Applications</i>	→	<i>Data Communication and Networking</i>
	→	<i>Multimedia Production and Web Site Development</i>
<i>Basic Programming Concepts</i>	→	<i>Software Development</i>

- 2) Since the Elective Part is taught at an early stage of the curriculum, students will have a longer time span for their project work in S5 and S6.
- 3) Curriculum time for SBA should be allocated flexibly and appropriately in S5 and S6, to provide continuous feedback to students to enhance learning effectiveness.
- 4) Only a portion of the Compulsory Part of the curriculum is taught in S4. Students may not have a sufficient overview of the whole curriculum to enable them to choose an appropriate option in the Elective Part.

### Teaching Sequence and Time Allocation

Curriculum Time	Level	Compulsory Part	Elective Part	SBA
105 hours	S4	IP (64 hours)		
			Databases (75 hours)	
105 hours	S5			 SBA (30 hours)
		CSF (25 hours)		
		I & A (28 hours)		
60 hours	S6	BPC (20 hours)		
		SI (28 hours)		

Notes :

IP	Information Processing
CSF	Computer System Fundamentals
I&A	Internet and its Applications
BPC	Basic Programming Concept
SI	Social Implications
SBA	School-based Assessment

## Case 3 ICT Curriculum Planning in GHI Secondary School

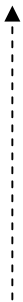

### **Background**

- 1) This school plans to offer four core subjects – Chinese, English, Mathematics and Liberal Studies, and four elective subjects, including ICT, to the senior secondary students to give them a taste of various subjects. Students may choose three elective subjects from S5 onwards.
- 2) The total curriculum time for ICT is 270 hours. For illustrative purposes, 80, 130 and 60 hours are allocated to the teaching of ICT in S4, S5 and S6 respectively.
- 3) Students have completed their junior secondary Computer Literacy course and most of them are inclined to further their studies in the area of multimedia and web authoring.

### **Rationale**

- 1) The topics taught in S4 should be interesting and practical enough to arouse students' interest. To this end, topics such as "Introduction to Information Processing", "The Use of Office Automation Software" and "Presentation of Information" from the *Information Processing* module are chosen. (The *Internet and its Applications* module is also a good choice for teaching in S4.)
- 2) The knowledge and skills of ICT taught in S4 are transferable to other subjects even if students opt not to study ICT from S5 onwards.
- 3) The related modules from the Compulsory Part are taught in S4 to give students more understanding of the nature and content of the options in the Elective Part. This will help students in choosing one of the options as they progress to S5 and S6.
- 4) Curriculum time for SBA should be allocated flexibly and appropriately in S5 and S6, to provide continuous feedback to students to enhance learning effectiveness.
- 5) As fewer topics are covered in S4, schools need to allocate more time to cover the whole curriculum in S5 and S6.

### Teaching Sequence and Time Allocation

Curriculum Time	Level	Compulsory Part	Elective Part	SBA
80 hours	S4	IP (52 hours)		
		I & A (28 hours)		
130 hours	S5	IP (12 hours)		 SBA (30 hours)
		CSF (25 hours)		
		BPC (20 hours)		
		SI (28 hours)		
60 hours	S6		One of the four options (75 hours)	

Notes :

IP	Information Processing
CSF	Computer System Fundamentals
I&A	Internet and its Applications
BPC	Basic Programming Concept
SI	Social Implications
SBA	School-based Assessment

## 3.3 Curriculum Planning Strategies

### 3.3.1 For Students of Different Abilities and Inclinations

In junior secondary, the emphasis of TE is on “Exploration, Experiences and Familiarisation”. After completing the Computer Literacy course, students should have a broad and balanced knowledge of computer technologies; and a basis on which to make informed decisions as to their choice of options in their senior secondary ICT studies.

In senior secondary, the emphasis of TE is on “Exploring Orientations for Lifelong Learning and Specialisation”. To cater for the varied abilities and inclinations of students, the senior secondary ICT curriculum provides four options in the Elective Part:

- *Databases*
- *Data Communications and Networking*
- *Multimedia Production and Web Site Development*
- *Software Development*

The design of the Elective Part aims to provide students with a range of choices. Students are encouraged to choose the option that matches their interests, their intended post-secondary studies or career aspirations. Teachers should refer to Section 2.3 for more details on the structure and organisation of the senior secondary ICT curriculum.

Students have a variety of learning styles: some learn best by reading, or by watching others perform, while some prefer “learning by doing” The Elective Part in the senior secondary ICT curriculum provides students with a choice of more in-depth theoretical or more in-depth applied learning.

For instance, *Multimedia Production and Web Site Development* has a heavier emphasis on applied learning and is suited to students who learn better in a practical way.

Students who are interested in studying information retrieval in a systematic way, may find the option *Databases* interesting, as they can learn how to apply database theories in daily-life situations

Those who are problem-solvers and are keen on carrying out projects using computers may consider selecting *Software Development* which focuses on solving problems and developing solutions.

Students who are interested in equipping themselves with networking knowledge and practical skills to meet the challenging demands of the future Internet-based business environment and economy may wish to choose the *Data Communication and Networking* option.

Overall, students are advised to choose options in their areas of strength, so that they will be more motivated and confident learners. Schools can decide on the number of options to be offered, based on the needs of their students and consideration of practical constraints such as the teachers’ capacities and time-tabling.

### 3.3.2 Making Student Learning More Meaningful

Technology is best learnt within a context that includes application. Activities, problems and projects that replicate real-life situations are effective in helping students to make sense of why they need to learn technology. To enhance students' learning of ICT, teachers and schools are encouraged to consider adopting the following strategies in curriculum planning:

#### (a) Designing Authentic Experiences

Knowledge is constructed through rich and authentic learning experiences. The use of authentic situations not only provides meaningful contexts for students to develop their potential for creativity and problem-solving, but also gives them opportunities to reflect on the values they hold, and to express their own views and have them challenged in real situations. Two examples to illustrate how authentic situations can be integrated into learning and teaching are provided below.

#### **Example 1: Community service project**

To make students' ICT learning more meaningful, schools can involve them in community service, such as repairing computers for the elderly and disadvantaged groups. In addition to being authentic tasks in which they can practise the IT skills they have learnt, serving others helps to develop personal values. In the process, students engage in learning how to see the needs of others, experience empathy and sympathy, and take appropriate action to help to improve the quality of life. Students also develop a sense of responsibility, commitment, and sometimes perseverance or resilience, when there are barriers to be overcome. On completing a community service project, students gain satisfaction from what they have achieved, and develop confidence for further service and more challenging tasks in the future. In this way, authentic tasks foster values education.

Other authentic tasks may include designing class web pages and setting up a database for the alumni association.

#### **Example 2: Reading authentic materials**

Everyday authentic materials outside the classroom, such as newspapers, magazines and websites, can be used to make the learning of relevant topics more meaningful. For example, students may be asked to take turns in posting news / journal articles about current network security issues on bulletin boards or display booths; and they may also post their views about the articles and propose improvements. To promote discussion, teachers may also host forums for students, e.g. at the end of a school term, students might debate and then vote for the top three network security threats. "Reading to learn" activities can make students more aware of recent trends and developments. Also, in the process of evaluating various network security risks and their solutions, students' critical thinking skills will be nurtured.

## **(b) Engaging in Life-wide Learning**

Life-wide learning refers to student learning in settings outside the classroom. As a subject that emphasises both theoretical and applied learning, the study of ICT should not be confined to the classroom. There are many possible ways in which students can “learn by doing” in real contexts and through interactions with people from different sectors.

### **Example 1: Visits to different IT organisations**

When teaching the multimedia-related elements, schools can arrange for their students to visit different ICT organisations, such as Cyberport. This kind of activity can help students to understand the application of technology in their daily lives. Professionals and experts from ICT fields can also be invited to give talks and conduct activities in schools.

### **Example 2: Participation in IT-oriented competitions**

Schools can encourage students to participate in ICT-oriented competitions, such as the Hong Kong Olympiad in Informatics (HKOI). These competitions offer opportunities for students to apply the knowledge and skills they have acquired from learning programming and software development-related topics.

## **3.4 Curriculum Management**

### **3.4.1 Areas of Work**

In managing the school-based ICT curriculum, teachers should:

#### **(a) Understand the Curriculum and Learning Context**

- Understand the *Senior Secondary Curriculum Guide (2007)* and the *Senior Secondary Information and Communication Technology Curriculum and Assessment Guide (2007)* with a view to adapting the central curriculum in school-based curriculum development;
- Understand the school’s vision and mission, strengths and policies, as well as students’ abilities and interests; and
- Understand the community culture and the changing needs of society.

#### **(b) Plan and Implement the Curriculum**

- Design and implement schemes of work to help students achieve the curriculum aims and learning targets of the senior secondary ICT curriculum; and
- Design modes of assessment and tasks to promote assessment for learning.

#### **(c) Evaluate the Curriculum**

- Review the senior secondary ICT curriculum and teaching and learning on a regular basis through collecting data from different sources, analysing student learning, and making adjustments whenever necessary.

**(d) Develop Resources**

- Develop, collect and organise learning and teaching resources and allow students to access them whenever needed;
- Make effective use of schools and community resources to facilitate student learning of ICT; and
- Expand and share learning and teaching resources by exploiting the use of an e-learning platform.

(For more ideas on learning and teaching resources, please refer to Chapter 6 “Learning and Teaching Resources”.)

**(e) Build Capacity**

- Keep abreast of the latest curriculum development, teaching strategies, subject knowledge and advances in technology; and
- Build face to face and electronic networks with other schools, and conduct peer lesson observations to foster mutual support and share the best practices in delivering the ICT curriculum.

### 3.4.2 Roles of Different School Personnel

Managing the ICT curriculum efficiently to promote effective learning and teaching requires a clear division of duties and collaboration among ICT teachers, TE KLA co-ordinator / ICT panel chairperson and the school head, who have different roles in the planning, development and implementation of the school-based ICT curriculum.

**(a) ICT Teachers**

To help in implementing the school-based ICT curriculum, ICT teachers are encouraged to:

- acquaint themselves fully with the structure, organisation and learning targets of the curriculum;
- help students to identify their specific area(s) of interest in ICT;
- explain clearly to students the overall aims, learning targets, and expectations of the school-based ICT curriculum;
- foster an active learning environment for students, strengthen their skills in learning how to learn, and help to develop their full potential in learning ICT;
- initiate the sharing of teaching ideas, knowledge and experiences to foster peer collaboration, support and professional exchange to improve the learning and teaching of ICT;
- keep abreast of the latest developments in ICT curricula and innovations in ICT; and
- participate actively in professional development courses, workshops, seminars, etc. to enhance professionalism.

**(b) TE KLA Co-ordinator / ICT Panel Chairperson**

TE KLA co-ordinator / ICT panel chairperson steers and co-ordinates the development and management of the school-based ICT curriculum, and monitors its implementation. He/she also serves as a “bridge” between the school administration and ICT panel members. TE KLA co-ordinator / ICT panel chairperson should lead the panel to:

- set a clear direction and plan for its own school-based ICT curriculum;
- decide on which modules to offer in the Elective Part, taking into account students’ needs, interests and prior knowledge in ICT, as well as teachers’ strengths and practical constraints;
- collect and analyse evidence of students’ learning to make informed decisions in curriculum planning and instruction;
- monitor the implementation of the curriculum, and make appropriate adjustments in strategies for learning and teaching; and
- manage and use the learning and teaching resources, including hardware, software and computer rooms, systematically and effectively.

To facilitate coordination and collaboration among panel members, TE KLA co-ordinator / ICT panel chairperson is encouraged to:

- appoint level co-ordinators and work closely with them to ensure coherence in planning, instruction and collaboration among teachers;
- hold regular meetings (both formal and informal) to discuss matters such as schemes of work and choice of textbooks, and to explore curriculum strategies to enhance the quality of learning and teaching;
- promote professional exchange on subject knowledge, learning and teaching strategies by means of peer coaching and lesson observation, collaborative lesson preparation and team teaching;
- encourage panel members to participate in professional development courses, workshops, seminars, etc.; and
- make the best use of the resources available in school.

**(c) School Head**

School head takes the leading role in planning, directing and supporting school-based curriculum development. With regard to ICT, he/she must understand the needs of the students, the strength of the ICT panel and the organisational culture of the school. School head is encouraged to work closely with deputy head(s)/academic master(s) to carry out the following functions:

- Understand students' needs, strengths and interests, as well as the significance of learning ICT in their whole-person development;
- Understand the strengths of teachers, and assist the TE KLA co-ordinator / ICT panel chairperson to deploy teachers flexibly to teach the Compulsory and Elective Parts of the curriculum;
- Co-ordinate the work of KLA leaders and subject panels, and set clear targets in curriculum development and management;
- Provide support for trying out new initiatives in the learning and teaching of the ICT curriculum (e.g. flexible time-tabling to facilitate collaborative teaching and peer lesson observation among teachers; and flexible grouping of students for topics of different kinds);
- Convey a clear message to parents regarding the significance of ICT education; and
- Network with other schools to facilitate professional exchange of information and sharing of good practices.

## Chapter 4 Learning and Teaching

This chapter provides guidelines and suggestions for effective learning and teaching of the ICT curriculum. It is to be read in conjunction with Booklet 3 in the *Senior Secondary Curriculum Guide* (2007), which provides the basis for the suggestions about learning and teaching set out below.

### 4.1 Guiding Principles

The following section outlines the rationale and guiding principles for effective learning and teaching in ICT.

- **Knowledge:** Knowledge exists in different forms and contexts. Some knowledge is established while some is dynamically changing and contextualised. In order to be useful, all knowledge has to be constructed by the learners;
- **Learning:** Learning takes place in different ways. Knowledge can be acquired from instruction and reading the literature. Knowledge can also be learnt through experience followed by reflection. Finally it can be learnt through collaborative interaction with others;
- **Understanding the learning targets:** Each learning activity should be designed with learning targets which are clear to both teachers and students;
- **Teaching for understanding:** The pedagogies chosen should aim at enabling students to understand what they are learning rather than just to memorise it;
- **Building on prior knowledge and experience:** The learning activities should be planned with the prior knowledge and experience of students in mind;
- **Using a wide range of pedagogies:** A range of learning and teaching approaches and activities should be designed to suit different purposes and students' various learning styles, so that effective learning can be achieved by all;
- **Promoting interaction:** Teachers need to bring about interaction in which students can explore what they know and don't know, and try out ideas. Teachers should use open-ended questions that get students thinking and offering views, so that students can learn from each other;
- **Promoting independent learning:** Generic skills and reflection can be nurtured through learning activities in appropriate contexts of the curriculum. Students should be encouraged to take responsibility for their own learning;
- **Using formative assessment:** Assessment activities should be designed to collect and provide information to improve learning and teaching;
- **Effective use of resources:** Various types of teaching resources should be employed as tools for learning;

- **Enhancing motivation:** Learning takes place best when students are motivated to learn. Appropriate motivation strategies should be used to arouse the interest of students;
- **Maximising engagement:** In conducting learning activities, it is important for all students to be mentally engaged in each activity; and
- **Catering for learner diversity:** Learners have different characteristics and strengths. Teachers should employ various strategies to cater for such learner diversity, for example by establishing a learning community in which learners of varied ability support each other's learning.

The learning and teaching of the senior secondary ICT curriculum should aim to: enhance students' capacity for learning to learn; develop their potential to the full by using a variety of pedagogical approaches; and enhance their motivation through appropriate target-setting which enables them to improve their level of performance. Effective learning requires constructive feedback and makes assessment an integral part of learning and teaching.

## 4.2 Teacher and Student Roles

In learning and teaching activities, teachers and students take on a variety of roles to make learning more effective. Some of these roles are elaborated below.

*Teachers are the consultants/instructors on computer knowledge; and both teachers and students are learners*

Teachers need to have an in-depth understanding of the theories, principles and concepts of computer technology so that they can help students to create useful cognitive maps, construct knowledge, apply it to real-world settings, relate ideas to each other and address misconceptions. They can serve as role models by demonstrating (i) computer knowledge and insights, (ii) flexible and critical thinking, and problem-solving skills and (iii) standards to be pursued and upheld.

By acting as role models for lifelong learning through continuous self-updating and self-improvement in both computer and pedagogical knowledge and skills, they can inspire students to learn and create knowledge and become lifelong learners. However, teachers also learn if they become partners in the process of constructing knowledge.

*Teachers are knowledge facilitators and students are knowledge seekers*

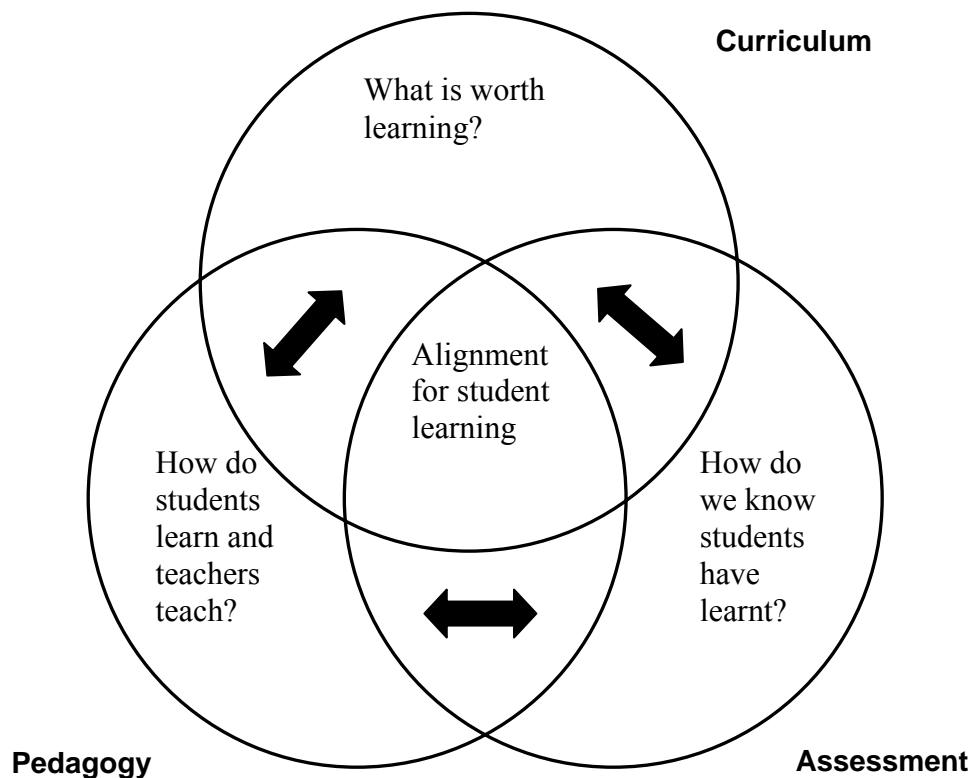
Teachers should act as facilitators of students' learning, not just dispensers of facts and information in a student-centred teaching approach. They can provide appropriate guidance and assistance in helping students to solve problems, or carry out projects in which students seek solutions, learn how to find relevant information, and make connections among concepts, skill elements and experiences.

*Teachers are resource consultants and students are resource collectors*

Teachers lead students to develop the capacity for self-directed learning by locating and securing tools and resources to support students' learning; Students engage in searching and collecting resource actively, discriminating information and understanding the materials through self-directed learning, anywhere and at any time.

*Teachers are assessors; students are assessed, but at times are also peer and self-assessors*

Teachers should assess students individually, as well as the class as a whole, by using a variety of assessments of different aspects of learning, both formative and summative. They need to judge each student's stage in learning and evaluate their practice systematically and critically. Students should receive constructive feedback and encouragement, and they can also assess themselves. In addition, students can assess other students (peer assessment) to help improve their learning.



*Figure 4.1 “Trinity” of student learning in schools*

### 4.3 Approaches and Strategies

During the three-year senior secondary ICT curriculum, students work towards the learning targets of “knowledge and understanding”, “skills” and “values and attitudes” mentioned in Chapter 2. To help teachers and to enhance the effectiveness of learning and teaching in the

context of ICT, examples of learning activities for a number of topics in the curriculum are introduced in this chapter. Teachers should note, however, that:

- the suggestions are by no means the only approaches/activities which can be used to teach the topics specified in the examples – to facilitate learning, teachers can employ a wide range of teaching strategies to suit the different needs of their students; and
- the examples in this chapter aim to illustrate the more significant learning outcomes that can be achieved in lessons but, in fact, students can achieve a number of learning targets during the same learning process.

#### 4.3.1 Acquisition of Content Knowledge

The curriculum provides students with access to vast networks of information. During their studies, students should: develop knowledge and understanding of the range and organisation of computer systems; understand the inter-relationships between hardware, software and data; and realise the social, ethical and legal issues related to the use of ICT.

##### **Example 1**

##### **Compulsory Part**

**Module:** A *Information Processing*

**Topic:** a Introduction to Information Processing

**Theme:** The input-process-output cycle of a vending machine

Students are asked to describe the working cycle of a vending machine in terms of input, process and output. Students may come to a conclusion that a stored program which follows the input–process–output cycle governs a vending machine.

In the process of getting to this conclusion, students need to identify and examine the components of an information system (the vending machine). In doing so, they may discover that many daily-life incidents – both computer-based and non-computer-based processes – are examples of information processing.

#### 4.3.2 Development of Generic Skills

The senior secondary ICT curriculum involves a variety of classroom activities, such as reading reference materials, collecting data/information, designing and processing. Generic skills, especially creativity, critical thinking and problem-solving skills, are integrated into the learning and teaching of the subject.

##### **Creativity**

Students can develop their creative abilities by, for example, generating ideas of their own, making new combinations of old elements, using different strategies to solve a programming problem and working out different database designs.

### **Example 2**

#### **Elective Part**

**Option:** *B Data Communications and Networking*

**Topic:** b Network Design and Implementation

**Theme:** Network design for a clubhouse

A teacher gives the class the task of designing a computer network model for a clubhouse. The resulting model does not have to be a working prototype but should convey the key features of the intended design ideas. In this activity, students have to use their imagination to create a new look or add new functional features to the clubhouse. They can experiment with different topologies, rearrange the cables etc. when making the prototype.

From the conceptualisation of initial ideas to the realisation of the final design, students are encouraged to generate more than one design solution and then critically appraise the aesthetic value and functional characteristics of each design.

#### ***Critical thinking skills***

Students have to reflect regularly on their ideas, designs, choices of materials and tools in relation to the task set. Students develop their critical thinking skills through such processes.

### **Example 3**

#### **Elective Part**

**Option:** *A Databases*

**Topic:** b Relational Databases

**Theme:** A database for a library book reservation system

(Note: This example focuses on the development of students' critical thinking skills. An elaborated version to illustrate the integration of generic skills is given in Appendix 1.)

Students are asked to create a simple relational database for a computerised library book reservation system for their schools. In this task, they investigate the needs of their schoolmates and provide solutions for developing such a system.

The process of developing the solutions nurtures students' critical thinking skills through the following activities: (1) analysing the requirements of a computerised book reservation system; (2) creating a simple relational database; and (3) appraising various aspects of the solutions against the design specifications.

#### ***Problem-solving skills***

In studying ICT, students are provided with many activities to develop their problem-solving skills.

#### **Example 4**

##### **Elective Part**

**Option:** C *Multimedia Production and Web Site Development*

**Topic:** a Multimedia Production

**Theme:** Presenting a report on the Sports Day

Students are asked to make use of their ICT skills to present their observations on their school's Sports Day on the Internet. They have to decide on the information to be collected and on what equipment they have to use during the Sports Day. In order to make the presentation more interesting, students have to employ different methods to produce the desired effects.

In this activity, students develop their problem-solving skills by identifying the problems, designing their own solutions, gathering the necessary information, selecting the best possible solution, and presenting and evaluating their results.

#### 4.3.3 Development of Values and Attitudes

In the senior secondary ICT curriculum, students are expected to appreciate how information literacy and the sharing of knowledge using ICT influence decision-making and shape our society. They should develop responsible and positive attitudes towards the use of ICT.

#### **Example 5**

##### **Compulsory Part**

**Module:** E *Social Implications*

**Topic:** c Intellectual Property

**Theme:** A debate on the benefits and risks of different software licensing schemes

Students have to debate the benefits and risks of different licensing schemes such as freeware, shareware, open source software and copyrighted software from the perspectives of users and software developers.

In this activity, students develop positive values and attitudes towards the idea of intellectual property and copyright, and then are more aware of the ways to reduce intellectual property theft on digital property.

#### 4.3.4 Choosing Appropriate Strategies

Learning ICT is a complex, multi-faceted, active and interactive process. Apart from the traditional lecturing approach, active learning elements should be infused into classroom activities for effective learning and teaching. Teachers should employ a repertoire of strategies to provide students with multiple ways to acquire the knowledge, concepts and skills that this curriculum encompasses; and they should help students to gain a deep understanding of content knowledge, as well as generic skills, such as problem-solving, critical thinking, creativity, communication, meta-cognition, and the capacity to learn how to learn.

Teachers must, therefore, not only be knowledgeable about ICT, but also have the pedagogical skills and knowledge to deliver the curriculum.

Teachers should also strive to develop the potential of every student to the full. For this purpose, they should adopt enquiry and problem-based learning, provide prompt support to students, interact with them as a facilitator of learning, and provide timely and useful feedback.

### ***Direct instruction***

Direct instruction involves transmitting knowledge from teacher to student, often in small steps, after which the teacher checks on student understanding through questions. In general, direct instruction has four teaching functions: presenting new material, guiding practice, correcting and providing feedback, and encouraging independent practice. This method has been shown to be particularly effective in areas which involve well-structured, straightforward tasks where teachers can provide general guidelines and students can practise independently. An example of the use of a direct instruction approach is given below.

#### **Example 6**

##### **Compulsory Part**

**Module:** *A Information Processing*

**Topic:** d The Use of Office Automation Software

**Theme:** Designing and creating effective formatted documents or reports using a word-processing tool

This class is conducted in the computer room. The teacher demonstrates how to perform various formatting features, such as tables, columns, text frames and graphics, using a computer and projector. After the demonstration, the students practise on their computers, the teacher observes them and gives feedback. Through individual practice, students learn various formatting methods and note the effects of the formatting features. This knowledge and skill gives them the background for performing more meaningful tasks such as creating advertisement fliers and newsletters in the future.

### ***Enquiry***

In an enquiry approach the students find out information by themselves. They engage in complex cognitive processes which require thoughtful discourse, and are often involved in self-directed learning. They are invited to make assumptions and predictions and debate alternatives in a meaningful context and so develop their critical thinking skills. Students are also encouraged to provide explanations/elaborations of their answers. The concept of teaching as enquiry is illustrated in the following activities which may take place inside or outside the classroom.

## **Example 7**

### **Elective Part**

**Option:** A *Databases*

**Topic:** c Introduction to Database Design Methodology

**Theme:** Analysing simple scenarios in business, education or other fields and creating simple ER diagrams involving binary relationships only in designing a database.

(Note: This example focuses on using an enquiry-based strategy. An elaborated version using multiple teaching strategies is given in Appendix 2.)

One or two weeks before the lesson, the teacher asks students to form pairs and start to investigate the data required for a school library system. Students are encouraged to go through the procedures for borrowing and returning books in a public library if the school library system has not yet computerised. They are also asked to search for related information from the Internet, and discuss the relevant issues with their classmates/a librarian/friends/parents. Students need to think critically about the data involved in such a system. They have to write down the static data (e.g. about users of the system, such as student\_number, student\_class, and about books (such as ISBN, title, author, publisher) and the dynamic data to be recorded when a book is borrowed or returned, and then design and construct the database tables for a school library system.

In the classroom, the teacher asks three to four groups of students to present their findings during lesson time. The students need to state the assumptions they have made about the functions of a school library system, and provide explanation for their designs of the table structures. Various creative designs may arise from the knowledge they have gained from self-directed learning in the previous stage. The teacher should offer hints to the students if they are unable to identify the critical data required during this stage. (e.g. that the book return/borrowing process requires data such as student\_number, ISBN, date\_borrow/date\_return). Students can compare different designs and examine critically how the information/functions (say books on loan, books not returned after the due date, the most popular books during a period of time, etc.) can be derived/performed from the suggested table structures of a database. By asking students to present their designs with explanations and allowing them to observe their peers doing the same, students learn how to make important and rational decisions about the information to convey and how to convey it. Besides learning the content of the topic, students learn to work collaboratively, and respect each other's contributions in completing the task successfully.

## **Scaffolding**

Scaffolding provides temporary task-oriented support which allows students to perform tasks or solve problems which they cannot accomplish on their own. It is an interactive process in which the student is assisted by others (teachers or peers) to acquire knowledge or skill. For learning to take place, a learner must have sufficient background knowledge to be able to start to process new information into personal knowledge. Scaffolding helps learners to make connections between what they already know and the new information being presented; and in this way, it develops mental schemas, into which the new information is integrated and becomes personal knowledge that is meaningful to them. For example, at the start, the teacher might explain what is to be learnt, to assist the learners in knowing where they are going; and in the scaffolding activities, he/she needs to pay particular attention to inconsistencies in learners' responses as they may lead to students' misconceptions later on.

### **Example 8**

#### **Elective Part**

**Option:** A *Databases*

**Topic:** c Introduction to Database Design Methodology

**Theme:** Creating simple ER diagrams.

In creating ER diagrams, the teacher may want to see if students can identify entities and the attributes in a simple scenario (e.g. a simplified public library system); or he/she may suggest that students start by identifying entities only. If this fails, the teacher needs to point out the entities (e.g. BOOK, READER) and ask students to name the attributes for the entities in turn (e.g. Title, Author, Publisher and ISBN for BOOK; ID-number, Name, Address for READER). After entities and their attributes are identified, the teacher may ask students to discuss the possible relationships between entities; and the students will produce various designs based on the knowledge they have gained from previous experience. The teacher should prompt students that different function requirements of a system may need different database designs (e.g. keeping the current loan status of a book may require fewer tables in the database compared with keeping the book's entire loan history).

For successful scaffolding, teachers should give just enough support to enable students to carry out the task.

## **Feedback**

During the learning and teaching process, teachers can give informal feedback to help students to see what they need to do to achieve the learning objectives or enhance their learning further. Teachers should also encourage students to express themselves openly and share their work in class. The feedback provided should be constructive and supportive and avoid lowering students' self-esteem. Also, students should be encouraged to develop the skill of giving useful feedback to their peers. With the increased use of project learning, timely feedback from teachers, peers or even experts from outside the school helps students to reflect on their thinking and build up their personal knowledge.

### **Example 9**

#### **Elective Part**

**Option:** A *Databases*

**Topic:** c Introduction to Database Design Methodology

**Theme:** Understanding the concepts of data redundancy

The teacher presents samples of “Examination Results” in a table format and helps students to identify “data, records, fields and file” in the hierarchical organisation of data. He/she then asks students to present “BOOK” information in a similar format. Students can present this information in a three-column table with title, author and publisher as column headings. If students are asked to give more examples of book data using the school’s textbook list, it is likely that the same publisher will appear in the table a number of times – and the teacher should point out the possibility that the same publisher may appear differently in the table (e.g. due to typing errors). The teacher can then ask students to discuss the possible consequences of duplicated data in the table if the data are to be updated in future – and also suggest how to prevent storing duplicated data. This helps to build up students’ knowledge on database concepts and thus improves their learning of database design.

Timely feedback from teachers helps students to reflect on their thinking and enhances their understanding and retention of new content knowledge.

## **Co-construction**

Teachers can be students’ partners in the co-construction of knowledge. During the co-construction process, both teacher and students contribute ideas regarding a topic. Teachers facilitate discussion by asking open-ended questions and require students to compare and defend their own arguments. Sometimes teachers might set some constraints or counter arguments to students in order to lead them to the expected direction. By doing so students will have to generate, review and modify their ideas along with their peer and teachers. This iterative process allows teachers and students working together as facilitators and learners with changing roles which leads to knowledge creation through co-construction.

**Example 10****Compulsory Part****Module:** *E Social Implications***Topic:** c Intellectual Property**Theme:** e-forum on acts of infringement of copyright

Teachers can make use of the school intranet to allow discussion between themselves and students, and among students. They can start an e-forum on the topic “Social, legal and economic implications of acts of infringement of copyright”. Each student is required to post an item of news, a court case, a URL etc. related to the issue, and then give his/her views on the material posted by other students. The teacher should participate on a regular basis, encourage critical thinking, and prompt students to think logically and provide evidence to support their opinions. By sharing his/her thoughts through this electronic platform, each participant also gains deeper understanding of the topic being discussed.

Discussion/debate can be carried out outside the classroom. Feedback and reflection may lead to new questions and the cycle of learning moves forward. Students discuss and answer each other’s questions at any time they like. Sometimes they may include topics beyond the curriculum.

#### 4.3.5 Teaching for Understanding

Knowledge and skills learnt at the level of rote memorisation rarely transfer to other contexts. The transfer of learning occurs best when students understand the underlying principles that can be applied to problems in new situations.

To promote understanding, teachers need to know clearly what it is they want to teach. For instance, in Example 6, the teacher introduced how to design and create formatted documents or reports effectively by demonstrating various formatting features and asking students to do meaningful tasks related to the real world.

Secondly, teachers should identify what is worth understanding. Faced with the rapid advances in computer technology, students should be encouraged to read computer journals and magazines, update their computer knowledge and skills through various means such as educational newsgroups and websites available on the Internet, and attend workshops or participate in contests in order to enrich their learning experiences. All these activities help to develop students’ potential in the computer industry and nurture their capacity for being lifelong learners.

Thirdly, teachers should decide how to teach for understanding. For instance, in Example 7, the teacher should help students to understand the design methodology using ER diagrams. In pairs, students analyse simple scenarios in the school library; and by the time they present their designs with explanations, they should have developed their understanding of the content, and learnt to work collaboratively, respecting each other’s contributions in completing the task successfully.

### 4.3.6 Learning Outside Classroom

Teachers should explore opportunities for students to learn in authentic settings. Such experiential learning enables students to achieve certain learning goals that are more difficult to attain through classroom learning alone.

Libraries, government departments, public institutions and non-government organisations are all potential sources of information for studying different issues in the senior secondary ICT curriculum. In fact, opportunities for learning exist everywhere in the community. Schools can also make use of their connections to arrange cross-border exchange programmes or visits to broaden students' horizons on ICT.

There are also organisations which are willing to support student learning of the curriculum in various ways, such as providing updated information, producing curriculum resources, and organising competitions and talks. One of these competitions – the HKOI, which is co-organised by the government and a non-government organisation – requires students to learn computer programming at a level they do not usually reach in class.

## 4.4 Interaction

Interaction between the student and the teacher can motivate learning and provides support and encouragement; and interaction among peers helps students to consolidate ideas, test hypotheses and affirm opinions.

Interaction is supported when, for example:

- teachers facilitate the exchange of ideas, attitudes, and opinions;
- both students and teachers cultivate an accepting atmosphere which helps to develop creativity, open-mindedness, objectivity and respect for the views of others;
- teachers provide insightful and timely input and feedback to students;
- teachers make good use of open-ended questions to stimulate students' critical thinking;
- teachers enrich discussion without dictating its direction, and keep distractions and interruptions to a minimum;
- teachers shift from interactions which are brief and random to those which are longer and more sustained;
- teachers are sensitive to the way their expression, gesture, body language, physical stance and location in the learning environment can affect the type and quality of interaction;
- both students and teachers recognise that they are influential models during interaction; and
- students work in groups to develop their ability to communicate effectively.

The purpose for interaction must be meaningful to the students. Opportunities should be provided for students to exchange ideas and opinions; and the teacher should not dominate the discussion and conversation during such exchanges, but should encourage risk-taking and creativity.

The following example helps to illustrate how interaction can be included in a learning task.

### **Example 11**

#### **Elective Part**

**Option:** B *Data Communications and Networking*

**Topic:** b Network Design and Implementation

**Theme:** Building/upgrading a computer network

In this task, interaction can take place between teachers and students, and among students themselves to provide valuable learning opportunities.

At the beginning of the lesson, students study a networking project prepared by the teacher, which may involve building a new network or upgrading an existing one. Students are organised into small groups. Role-playing interviews are arranged in which some students play the part of network users and others of network engineers. In the process of gathering information for the proposed network, students have to negotiate with other classmates. Through actively involvement in peer-to-peer interaction in a meaningful context, students improve their communication skills: they become aware that appropriate protocols, manners and tone have to be used in verbal (e.g. face-to-face or by telephone), written (e.g. reports and letters) as well as visual communication (e.g. using graphical image models), and learn how to phrase their messages to obtain the desired responses.

In the next stage, students conduct a needs analysis, and have to translate the needs identified into specifications for the proposed network, based on the requirements gathered from the interviews. They then design a network to meet the requirements and represent it in a diagram. At this stage, the teacher plays a variety of roles – as a knowledge facilitator and resource consultant. He/she monitors students' progress and provides constructive feedback to students' enquiries to cultivate their problem-solving skills and creativity. Students act as both knowledge-seekers and resource collectors during the process.

At the end of the activity, each group gives a presentation of its work in front of the whole class, in which they have to justify their designs based on technical concerns, cost-effectiveness and other considerations. Each group also has to respond to oral questioning on its design from the teacher, as well as other groups. At this point, both the teachers and students take on the role of assessors.

During the process, students face challenges as well as receiving qualitative feedback from different parties, which offers opportunities for self-reflection and further learning.

## 4.5 Catering for Learner Diversity

### 4.5.1 Different Strategies

Catering for learner diversity should involve the use of appropriate strategies to ensure that all learners learn and perform to the best of their abilities. A multi-dimensional approach involving a variety of different strategies, such as those set out below, may be helpful:

- Enhance students' intrinsic motivation through arousing their curiosity by using contents and contexts that appeal to the relevant age-group, encouraging them to value their achievements, and controlling the level of challenge and the risk of frustration in problem-solving;
- Give recognition to students' performance, which is the most immediate means of raising their self-esteem. There is no need to try to force students to be successful at everything, every time;
- Provide encouragement whenever appropriate by giving constructive responses to students' creative work and/or by involving parents to assist student learning;
- Get students to work on different topics or units of varying levels of difficulty;
- Modify the pace of instruction according to the abilities of students, and structure activities so that students explore, explain, extend and evaluate their progress;
- Make use of a variety of resources (e.g. the Internet, newspapers, friends, parents) instead of just using textbooks;
- Encourage cooperative and collaborative learning to enrich the perspectives and experiences of students; and
- Encourage more able students to do more challenging tasks or even take part in worldwide competitions.

### 4.5.2 Different Learning Styles

Students have a variety of learning styles: some learn best by reading, or by watching others perform, while some prefer "learning by doing". Teachers therefore need to find out how individual students in their class learn best. Teachers should not be seen as the only source of support in helping students with different learning styles: they should be trained to learn by themselves and encouraged to see their fellow schoolmates as learning partners. By providing four options in the Elective Part, the senior secondary ICT curriculum aims to cater for students with different interests and post-secondary aspirations.

### 4.5.3 Learners with Special Education Needs

Based on the principle of "one curriculum framework for all", students with Special Educational Needs (SEN) follow the same school curriculum as other students.

#### ***Students with learning difficulties***

Equal opportunities should be provided for students with learning difficulties to gain essential learning experiences from activities inside and beyond the classroom. However, some adaptations to the learning materials and the teaching approaches have to be made to meet their needs. The curriculum should be balanced, with due consideration given to their intellectual, personal, emotional and social development. Teachers also need to refine the objectives and expected learning outcomes to align them more closely with the abilities of

such students, and monitor their progress closely and regularly. Teachers should use a variety of means to cater for their special needs – for example by presenting the subject content through different means, e.g. multimedia and other technologies, and allowing the students to express their ideas in their preferred form (e.g. drawings, videos, oral reports).

**Example 12 – Visually impaired children**

Teachers should choose appropriate learning materials to meet the needs of visually impaired students. For example, printed materials and diagrams may have to be adapted by using contrasting colours, tactile marks, enlarged size, and increased boldness and spacing. Also, training in operating computer access devices needs to be given, including the following skills: screen review skills in braille or in visual enlargement, printing skills with a braille printer, and the use of optical character recognition techniques for transformation. Also, depending on the degree of impairment, they have to be trained to use one, or more, of the following special adaptive devices before they can manipulate the different processes of a computer system:

- (a) screen enlargement devices or software;
- (b) voice synthesisers;
- (c) braille displays on computers.

***Gifted students***

Gifted students have educational needs that differ in nature from those of other students, and schools need to respond to these and develop their potential. The senior secondary ICT curriculum provides effective ways of nurturing giftedness. For example, writing more demanding programs can enhance gifted students' problem-solving skills, and promote their reasoning and creative abilities; and the use of a database and spreadsheet can enable them to carry out powerful data analysis. In addition, teachers may consider adopting the following strategies:

- Use an enquiry-based learning approach, with open-ended questions that have multiple solutions or multiple paths to solutions. Also, encourage them to formulate their own ways of finding the answers to complex questions;
- Use higher-level questions involving “why” and “what-if” in discussing problems;
- Use a problem-based learning approach that encourages them to define the problem and work out how best to solve it;
- Provide opportunities for them to move beyond the curriculum to study topics which are of particular interest to them and/or design activities related to current lessons that challenge them; and
- Encourage them to take part in ICT-related competitions such as the HKOI to widen their exposure and help them to fulfil their potential in specific areas of ICT.

## 4.6 Building a Learning Community

The Internet has proved to be a very effective platform for building learning communities among teachers and students. Internet technologies and services such as newsgroups, discussion forums and blogs are readily accessible, and can be easily customised to build a virtual community to serve a common learning goal. However, the technology itself does not guarantee the success of a learning community – both teachers and students need to participate actively and share their knowledge, experience and expertise in building and maintaining a successful learning community.

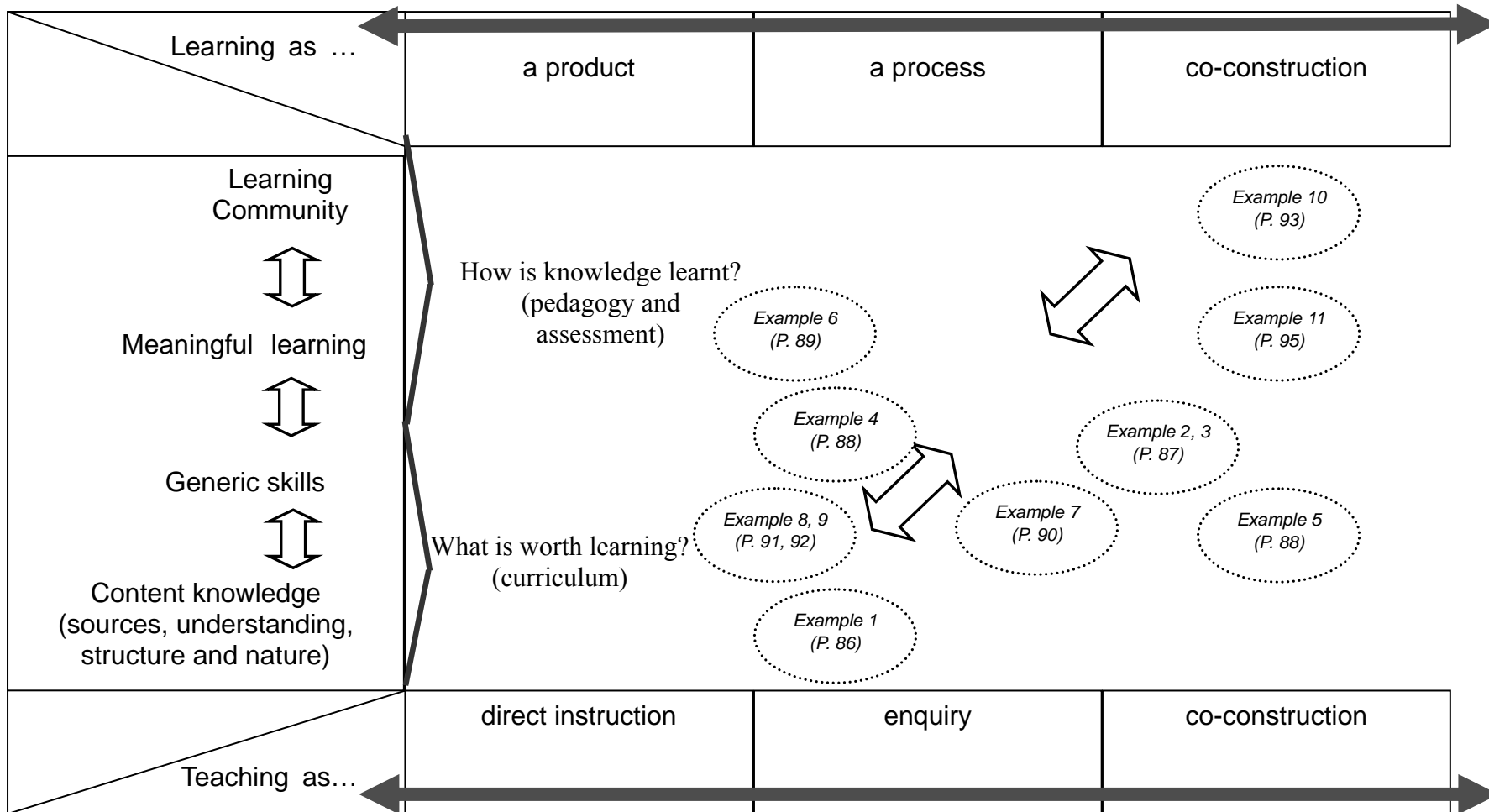
### 4.6.1 Co-construction in a Learning Community

As members of the learning community, teachers take the lead in fostering a sharing culture, learning with their students, encouraging peer learning and group work, and taking part in the co-construction of knowledge. Students come to treat their teachers and classmates as partners in learning, share views with them, interact with one another and learn to appreciate and value the views of others.

### 4.6.2 Developing Student Potential in a Learning Community

Many learning and teaching activities can be designed to provide students with ways of participating in a learning community. By taking on different responsibilities, students have a wide variety of experiences and develop different kinds of expertise. Learning and teaching activities should be organised in such a way that students are encouraged to go beyond the common knowledge base and seek to approach issues in their own ways so as to generate new ideas and perspectives.

With the help of the latest technologies such as e-forum and blog, student-student and student-teacher interaction may be extended anywhere and anytime outside the classroom. By responding to teachers' open-ended questions, students have to compare, discriminate, critique, appreciate, and defend their own or other students' argument. In this way, a learning community is created. Students are encouraged to learn independently and think carefully before responding to others.



**Figure 4.2 Approaches to Learning and Teaching**

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## Chapter 5      Assessment

This chapter discusses the roles of assessment in learning and teaching the senior secondary ICT curriculum, the principles that should guide assessment of the subject and the need for both formative assessment and summative assessment. It also provides guidance on internal assessment and details of the public assessment of ICT. Finally, information is given on how standards are established and maintained, and how results are reported with reference to these standards. General guidance on assessment can be found in the *Senior Secondary Curriculum Guide* (2007).

The assessment objectives should be aligned with the curriculum framework and broad learning outcomes presented in earlier chapters. Readers should refer to the relevant parts of Chapters 1 and 2 wherever appropriate when reading this chapter.

### 5.1    The Roles of Assessment

Assessment is the practice of collecting evidence of student learning, with the dual aim of improving learning and teaching and recognising student achievements. It is a vital and integral part of classroom instruction, and serves several purposes and audiences.

First and foremost, it gives feedback to students, teachers, schools and parents on the effectiveness of teaching and on students' strengths and weaknesses in learning.

Second, it provides information to schools, school systems, government, tertiary institutions and employers to enable them to monitor standards and to facilitate selection decisions.

The most important role of assessment is in promoting learning and monitoring students' progress. However, in the senior secondary years, the more public roles of assessment for certification and selection come to the fore. Inevitably, these imply high-stakes uses of assessment since the results are typically employed to make critical decisions about individuals.

The HKDSE provides a common end-of-school credential that gives access to university study, work and further education and training. It summarises student performance in the four core subjects and in various elective subjects, including both discipline-oriented subjects (such as ICT) and the new Applied Learning courses. It needs to be interpreted in conjunction with other information about students provided in the Student Learning Profile.

## 5.2 Formative and Summative Assessment

It is useful to distinguish between the two main purposes of assessment, namely “assessment *for* learning” (formative assessment) and “assessment *of* learning” (summative assessment).

“Assessment *for* learning” is concerned with obtaining feedback on learning and teaching, and utilising this to make learning more effective and to introduce any necessary changes to teaching strategies. We refer to this kind of assessment as “formative assessment” because it is all about forming or shaping learning and teaching. Formative assessment should take place on a daily basis and typically involves close attention to small “chunks” of learning.

“Assessment *of* learning” is concerned with determining progress in learning, and is referred to as “summative” assessment, because it is all about summarising how much learning has taken place. Summative assessment is normally undertaken at the conclusion of a significant period of instruction (e.g. at the end of the year, or of a key stage of schooling) and reviews much larger “chunks” of learning.

In practice, a sharp distinction cannot always be made between formative assessment and summative assessment, because the same assessment can in some circumstances serve both formative and summative purposes. Teachers can refer to the *Senior Secondary Curriculum Guide* (2007) for further discussion of formative assessment and summative assessment.

Formative assessment should be distinguished from continuous assessment. The former refers to the provision of feedback to improve learning and teaching based on formal or informal assessment of student performance, while the latter refers to the assessment of students’ ongoing work and may involve no provision of feedback that helps to promote better learning and teaching. For example, accumulating results in class tests carried out on a weekly basis, without giving students constructive feedback, may neither be effective formative assessment nor meaningful summative assessment.

There are good educational reasons why formative assessment should be given more attention and accorded a higher status than summative assessment, on which schools tended to place a greater emphasis in the past. There is research evidence indicating that formative assessment is beneficial when used for refining instructional decision-making in teaching and generating feedback to improve learning. For this reason, the CDC report *Learning to Learn – The Way Forward in Curriculum Development* (2001) recommended that there should be a change in assessment practices, with schools placing due emphasis on formative assessment to make assessment *for* learning an integral part of classroom teaching.

It is recognised, however, that the primary purpose of public assessment, which includes both public examinations and moderated school-based assessments (SBA), is to provide summative assessments of the learning of each student. While it is desirable that students are exposed to SBA tasks in a low-stakes context and that they benefit from practice and experience with such tasks (for formative assessment purposes) without penalty, similar tasks will need to be administered as part of the public assessment process to generate marks to summarise the learning of students (i.e. for summative assessment purposes).

Another distinction to be made is between internal assessment and public assessment. Internal assessment refers to the assessment practices that teachers and schools employ as part of the ongoing learning and teaching process during the three years of senior secondary studies. In contrast, public assessment refers to the assessment conducted as part of the assessment process in place for all schools. Within the context of the HKDSE, this means both the public examinations and the moderated SBA conducted or supervised by the HKEAA. On balance, internal assessment should be more formative, whereas public assessment tends to be more summative. Nevertheless, this need not be seen as a simple dichotomy. The inclusion of SBA in public assessment is an attempt to enhance formative assessment or assessment *for* learning within the context of the HKDSE.

### 5.3 Assessment Objectives

The assessment objectives are closely aligned with the curriculum framework and the broad learning outcomes presented in earlier chapters.

The assessment for ICT assesses candidates' ability to:

1. develop knowledge and understanding of the range and organisation of computer systems, and the interrelationships between hardware, software and data;
2. realise the social, ethical and legal issues pertaining to the use of ICT;
3. use a range of applications software effectively, ethically and with discrimination to support information processing and problem-solving;
4. demonstrate an understanding of methods for analysing problems, and planning and implementing solutions using ICT;
5. appreciate how information literacy and the sharing of knowledge using ICT influence decision-making and shape our society; and
6. develop responsible and positive attitudes towards the use of ICT.

The majority of the above assessment objectives are applicable to both internal and public assessment, while some may not be applicable to public assessment. Those objectives applicable to public assessment will be listed in the approved Regulations and Assessment Frameworks published by the HKEAA.

### 5.4 Internal Assessment

This section presents the guiding principles that can be used as the basis for designing internal assessment and some common assessment practices for ICT. Some of these principles are common to both internal and public assessment.

### 5.4.1 Guiding Principles

Internal assessment practices should be aligned with curriculum planning, teaching progression, student abilities and local school contexts. The information collected should help to motivate, promote and monitor student learning, and will also help teachers to find ways of promoting more effective learning and teaching.

#### (a) *Alignment with the learning objectives*

A range of assessment practices should be used to assess the achievement of different learning objectives for whole-person development. These include practical tasks, written tests, projects and oral questioning. The weighting given to different areas in assessment should be discussed and agreed among teachers. The assessment purposes and criteria should also be made known to students so that they have a full understanding of what is expected of them.

Different assessment methods should be employed to assess the various dimensions embedded in the curriculum design, e.g.

<b>Dimension of learning aim</b>	<b>Common assessment method</b>	<b>Example of learning objective</b>
Knowledge	Written tests	To understand how data are organised and represented inside a computer
Practical skills	Project work	To integrate the use of office automation software to process and present different types of information appropriately
Values and attitudes	Students' self-reflection/ teachers' observations/oral questioning. (Positive values and attitudes are conducive to improvement in students' performance, which can be observed through formative assessment and the end product of the learning activity.)	To appreciate how advances in ICT foster the emergence and development of the information age – and to recognise its impact on our society

#### (b) *Catering for the range of student ability*

Assessment practices incorporating different levels of difficulty and diverse modes should be used to cater for students with different aptitudes and abilities. This helps to ensure that the more able students are challenged to develop their full potential and the less able ones are encouraged to sustain their interest and succeed in learning.

#### (c) *Tracking progress over time*

As internal assessment should not be a one-off exercise, schools are encouraged to use practices that can track learning progress over time (e.g. portfolios). Assessment practices of this kind allow students to set their own incremental targets and manage their own pace of learning, which will have a positive impact on their commitment to learning.

**(d) *Timely and encouraging feedback***

Teachers should provide timely and encouraging feedback through a variety of means, such as constructive verbal comments during classroom activities and written remarks on assignments, together with an indication of where improvements should be made. Such feedback helps students to sustain their momentum in learning, and to identify their strengths and weaknesses.

**(e) *Making reference to the school's context***

As learning is more meaningful when the content or process is linked to a setting which is familiar to students, schools are encouraged to design a few assessment tasks that make reference to the school's own context (e.g. its location, relationship with the community, and mission).

**(f) *Making reference to current progress in student learning***

Internal assessment tasks should be designed with reference to students' current state of knowledge, as this avoids the danger of placing impossible demands on students, which have a cumulative negative impact on learning.

**(g) *Feedback from peers and from the students themselves***

In addition to giving feedback, teachers should also provide opportunities for peer assessment and self-assessment in student learning. The former enables students to learn among themselves, and the latter promotes reflective thinking which is vital for students' lifelong learning.

**(h) *Appropriate use of assessment information to provide feedback***

Internal assessment provides a rich source of data for providing evidence-based feedback on learning in a formative manner.

#### 5.4.2 Internal Assessment Practices

A range of assessment practices suited to ICT, such as practical tasks, written tests, projects and oral questioning, should be used to promote the attainment of the various learning outcomes. However, teachers should note that these practices should be an integral part of learning and teaching, not "add-on" activities.

***Practical tasks***

The acquisition of fundamental practical skills is essential for student understanding of some of the curriculum content. These tasks are standards-referenced (i.e. students' performance is matched against pre-set standards), and teachers can assess students' performance on them, and give feedback, as often as necessary.

### ***Written tests***

As in other subjects, written tests are the most common mode of assessment in ICT. To reflect the curriculum aims and learning targets, such tests should be geared towards assessing students' understanding of concepts, creativity and higher-order thinking skills rather than just factual recall – and the inclusion of open-ended questions can help in evaluating such higher-order skills. ICT teachers can easily find ready-to-use online written tests/quizzes in various web-based learning platforms, which have a large databank of question items and can give instant feedback to students. More sophisticated systems even have test items graded in level to cater for learners' differences in ability.

### ***Projects***

A project is any piece of extended work from which the constraints of lesson time have been largely removed. Asking students to carry out project work provides an opportunity for them to study a topic of interest in depth, and teachers may wish to draw the following steps in the process to students' attention:

- Clarifying the areas of interest
- Interpretation of the question
- Analysis of the case
- Designing a solution
- Implementation of the solution
- Testing and evaluation
- Documentation
- Presenting the product

Throughout the cycle, teachers should help students to acquire the essential practical ICT skills for completing the project. To enhance the validity and reliability of internal assessment, teachers may consider offering a range of project options to accommodate the full spectrum of students' aptitudes and abilities.

### ***Oral questioning***

Oral questioning need not be seen as a form of test to be used in the language subjects only. It can be helpful in other subjects also. It allows teachers to discuss matters in depth with able students, tease out the meaning of obscure statements, and find out the reasons for students' conclusions. Teachers are encouraged to try using oral assessment, as it can be a valuable supplement to conventional assessment methods.

Regardless of the assessment activities adopted, at the heart of effective formative assessment is *feedback* since this provides constructive advice to students on how they can improve their learning.

The following is an example of a teacher using internal assessment to enhance students' performance by commenting on draft presentations:

*Module: Compulsory Part – module A “ Information Processing”*

*Learning outcome:* Students should be able to design and give a presentation incorporating multi-media elements.

*Task:* Students have to design and construct a multi-media presentation to promote Hong Kong to potential tourists. They need to decide how to incorporate different multi-media elements into the presentation to convey their ideas most effectively. They should demonstrate an understanding of the principles of effective presentation of information in both the process of learning and the final product.

*Criteria for ongoing assessment:* The teacher informs students about the criteria for a successful presentation:

- (a) It caters clearly for the background of the target audience.
- (b) It presents multi-media information to the audience in an effective way.

*Feedback for ongoing assessment:* Each group of students participates in group discussion and shares drafts of their presentations for feedback and critique. They also submit a first draft to the teacher for comment. The teacher discusses the draft with students to check their understanding of the principles of effective presentation of information. The final drafts are submitted with self-evaluations that the teacher includes as part of the final grades.

## 5.5 Public Assessment

### 5.5.1 Guiding Principles

Some principles guiding public assessment are outlined below for teachers' reference.

#### (a) *Alignment with the curriculum*

The outcomes that are assessed and examined through the HKDSE should be aligned with the aims, objectives and intended learning outcomes of the ICT curriculum. To enhance the validity of public assessment, the assessment procedures should address the range of valued learning outcomes, and not just those that are assessable through external written examinations.

#### (b) *Fairness, objectivity and reliability*

Students should be assessed in ways that are fair and are not biased against particular groups of students. A characteristic of fair assessment is that it is objective and under the control of an independent examining authority that is impartial and open to public scrutiny. Fairness also implies that assessments provide a reliable measure of each student's performance in a given subject so that, if they were to be repeated, very similar results would be obtained.

**(c) Inclusiveness**

The Hong Kong Advanced Level Examination (HKALE) is designed for a relatively elite group of students, most of whom aspire to university study. However, the new assessments and examinations will accommodate the full spectrum of student aptitude and ability. In the Elective Part of ICT, there are four options for an in-depth SBA study, from which students choose one depending on their abilities, interests and needs.

**(d) Standards-referencing**

The new system will be “standards-referenced”, i.e. student performance will be matched against standards, which indicate what students have to know and are able to do to merit a certain level of performance.

**(e) Informativeness**

The new qualification and the associated assessment and examinations system should provide useful information to all parties. First, it should provide feedback to students on their performance and to teachers and schools on the quality of the teaching provided. Second, it should communicate to parents, tertiary institutions, employers and the public at large what it is that students know and are able to do, in terms of how their performance matches the standards. Third, it needs to facilitate selection decisions that are fair and defensible.

**5.5.2 Assessment Design**

Table 5.1 below outlines the assessment design – but this is subject to continual refinement in the light of feedback. Full details will be provided in other supplementary documents, in particular the approved Regulations and Assessment Frameworks for the year of the examination.

Component		Weighting	Duration	
Public examination	Paper 1	Compulsory Part	55%	2 hours
	Paper 2	Elective Part (choose one only)	25%	1 hour 30 minutes
	2A	<i>Databases</i> elective		
	2B	<i>Data Communications and Networking</i> elective		
	2C	<i>Multimedia Production and Web Site Development</i> elective		
2D	<i>Software Development</i> elective			
School-based assessment		20%		

**Table 5.1 Outline of the assessment design**

### 5.5.3 Public Examinations

In the public examination for the ICT curriculum, a standards-referenced approach will be adopted for grading and reporting student performance.

Various kinds of items, including multiple-choice and structured data-response questions, will be used to assess students' performance in a broad range of skills and abilities. Item types will be similar to those adopted in the Hong Kong Certificate of Education (HKCE) and Hong Kong Advanced Level examinations. Specimen papers will be provided to schools by the HKEAA to illustrate the format of the examination and the standards at which the questions are pitched. Examples 1 to 3 below illustrate the purposed formats for the questions.

<b>Example 1</b>
<i>Module: Internet and its Applications</i>
<i>Topic: The Networking and Internet Basics</i>
<i>Knowledge to be assessed:</i> The basic concept of URL
<p>Uniform Resources Locator (URL) is to locate</p> <ul style="list-style-type: none"><li>A. a particular web page or file existing in a web site.</li><li>B. a leased line reserved for related users.</li><li>C. a remote line for connecting users to the Internet.</li><li>D. a data line that provides unlimited access time.</li></ul> <p><i>(2005 HKCE Computer and Information Technology Examination Paper)</i></p>
<i>Note</i>
This question requires students' understanding of fundamental ICT knowledge and concepts.

## Example 2

*Module: Information Processing*

*Topic: The Use of Office Automation Software*

*Knowledge/generic skills to be assessed:*

- i) Word-processing – “search and replace” function<sup>1</sup>
- ii) Problem-solving skill.<sup>2</sup>

Part of a passage written by Alan describing John Lee and John Woo is shown in the following box:

*Mr. Lee and John are working in ABC University. Mr. Lee is a professor while John is a research assistant. They have been working together for more than two years.*

Now Alan wants to make some changes in the passage:

- change ‘Mr. Lee’ into ‘John Lee’
- change ‘John’ into ‘John Woo’

Describe briefly how Alan can do it by only using the “search and replace” function.

*(2004 Hong Kong Advanced Supplementary Level Computer Applications Examination Paper)*

## Note

<sup>1</sup> For this question, students need to understand the operation of the “search and replace” function. The word-processing tool will simply find the pattern of word(s) being searched and replace it with other word(s) – it will not consider the content. So, students should predict the result after changes to avoid mistakes.

<sup>2</sup> To complete the task, students should notice the priority between the two operations of the “search and replace” function. Students who simply use the “search and replace” function in the order described in the question will generate a wrong result – instead, it should be done in reverse order. In this way, students’ problem-solving skills are evaluated.

**Example 3**

*Module:* Social Implications

*Topic:* Threats and Security on the Internet

*Knowledge/generic skills to be assessed:*

- i) Knowledge of data privacy<sup>1</sup>
- ii) Critical thinking skills<sup>2</sup>

The Internet Fashion Design (IFD) is a web-based fashion retail company which has accumulated a large number of customers during the past two years. Last month, the whole IFD business was sold to a property development company, and the development company screened the customers' IFD profiles to select likely property-buyers and mailed its property catalogue to these selected customers.

- (a) Is it legal for IFD to sell its whole business, including its customer information, to another company? Explain your answer.
- (b) Is it legal for the development company to use the customer information from IFD to screen for likely property-buyers? Explain your answer.

*(2001 Hong Kong Advanced Supplementary Level Computer Applications Examination Paper)*

**Note**

<sup>1</sup> In this question, students should know about the issue of data privacy.

<sup>2</sup> This kind of question assesses students' critical thinking skills. They have to support their point of view with convincing arguments; and, to a certain extent, students' values and attitudes on controversial issues can also be evaluated.

#### 5.5.4 School-based Assessment

In the context of public assessment, SBA refers to assessments administered in schools and marked by the students' own teachers. The primary rationale for SBA in ICT is to enhance the validity of the assessment by including the whole range of dimensions of learning in the curriculum: knowledge and understanding, generic skills and practical skills.

There are, however, some additional reasons for SBA. For example, it reduces dependence on the results of public examinations, which may not always provide the most reliable indication of the actual abilities of candidates. Obtaining assessments based on student performance over an extended period of time and developed by those who know the students best – their subject teachers – provides a more reliable assessment of each student can be obtained.

Another reason for including SBA is to promote a positive “backwash effect” on students, teachers and school staff. Within ICT, SBA can serve to motivate students by requiring them to engage in meaningful activities, and for teacher, it can reinforce curriculum aims and good teaching practice, and provide structure and significance to an activity in which they are already involved on a daily basis, namely assessing their own students.

In the SBA, students are required to complete a project, with teacher guidance. The context of the project is related to both the Compulsory Part and the Elective Part chosen by individual students. Teachers are encouraged to inform students of the assessment criteria/guidelines before they start the project, and to provide regular feedback to them on ways to improve their learning. It is suggested that the project should be assessed on the following aspects:

- Objectives and analysis
- Design and implementation
- Practical ICT skills
- Testing and evaluation
- Conclusion and discussion
- Documentation
- Creativity
- Project management.

Very often, skills for completing SBA can be integrated into daily learning and teaching activities without imposing much extra workload on students and teachers. The following example is intended to illustrate this point.

**Example 4 – Project skills incorporated into lessons**

*Module:* Basic Programming Concepts

*Topic:* Algorithm Design

*Knowledge/generic skills to be assessed:*

- i) Outline the input and output requirements of a problem
- ii) Design and construct standard algorithms involving basic control structures

*Activity description:*

In a timed learning task, students are required to design an examination score calculator program to fulfil the following requirements.

It should:

- let students input their examination scores by subject
- assign a grade based on the score of each subject
- calculate the average examination score
- output the above results on screen.

**Note**

Upon completion of the task, students should document the solution for presentation to the class later. In solving the problem, students will go through the following steps, with teacher guidance:

- Problem identification
- Problem analysis
- Algorithm design
- Implementation
- Testing and debugging
- Documentation.

During the process, students are actually acquiring the essential project skills for completing their ICT coursework assessment, which include:

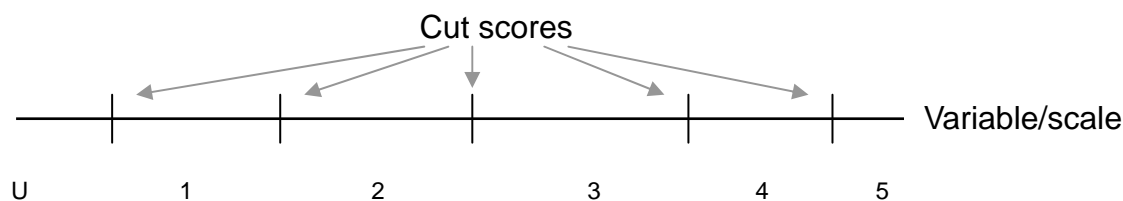
- Problem-solving skills
- Time-management skills
- Documentation skills
- Presentation skills.

Thirty hours of curriculum time have been allocated for SBA. While teachers should give students advice and guidance on their work, it is essential that each piece of work is clearly that of individual students.

It should be noted that SBA is not an “add-on” element in the curriculum. The modes of SBA above are normal in-class and out-of-class activities suggested in the curriculum. The requirement to implement SBA will take into consideration the wide range of student ability and efforts will be made to avoid unduly increasing the workload of both teachers and students. Detailed information on the requirements and implementation of SBA and samples of assessment tasks will be provided to teachers by the HKEAA.

### 5.5.5 Standards and Reporting of Results

The HKDSE will make use of standards-referenced reporting of assessments. What this means is that candidates' levels of performance will be reported with reference to a set of standards as defined by cut scores on the variable or scale for a given subject. Standards referencing relates to the way in which results are reported and does not involve any changes in how teachers or examiners mark student work. The set of standards for a given subject can be represented diagrammatically as shown in Figure 5.1.



**Figure 5.1** *Defining levels of performance via cut scores on the variable or scale for a given subject*

Within the context of the HKDSE there will be five cut scores, which will be used to distinguish five levels of performance (1–5), with 5 being the highest. A performance below the threshold cut score for Level 1 will be labelled as “Unclassified” (U).

For each of the five levels, a set of written descriptors will be developed that describe what the typical candidate performing at this level is able to do. The principle behind these descriptors is that they describe what typical candidates *can* do, not what they *cannot* do. In other words, they describe performance in positive rather than negative terms. These descriptors will necessarily represent “on-average” statements and may not apply precisely to individuals, whose performance within a subject may be variable and span two or more levels. Samples of students' work at various levels of attainment may be used to illustrate the standards expected of them. These samples, when used together with the level descriptors, will clarify the standards expected at the various levels of attainment.

In setting standards for the HKDSE, Levels 4 and 5 will be set with reference to the standards achieved by students awarded grades A–D in the HKALE. It needs to be stressed, however, that the intention is that the standards will remain constant over time – not the percentages awarded different levels, as these are free to vary in line with variations in overall student performance. Referencing Levels 4 and 5 to the standards associated with the old grades A–D is important for ensuring a degree of continuity with past practice, for facilitating tertiary selection and for maintaining international recognition.

The overall level awarded to each candidate will be made up of results in both the public examination and the SBA. SBA results for ICT will be statistically moderated to adjust for differences among schools in marking standards, while preserving the rank ordering of students as determined by the school.

To maintain current levels of discrimination for selection purposes, the Level 5 candidates with the best performance will have their results annotated with the symbols \*\* and the next top group with the symbol \*. The level awarded to each candidate will be recorded on the Diploma. There will also be a Statement of Results which will in addition provide level descriptors.

## Chapter 6 Learning and Teaching Resources

This chapter discusses the importance of flexible and effective use of learning and teaching resources, including textbooks, to enhance student learning. Schools need to select, adapt and, where appropriate, develop relevant resources to support student learning.

### 6.1 Purpose and Function of Learning and Teaching Resources

The purpose of learning and teaching resources is to provide a basis for students' learning experiences. They include not only textbooks, workbooks and audio-visual teaching aids produced by the EMB or other organisations but also web-based learning materials, computer software, the Internet, the media, libraries, resources in the natural environment, and people. All of these should be drawn upon to broaden students' learning experiences and meet their different learning needs. If used effectively, they will help them to: consolidate what they have learnt; extend and construct knowledge for themselves; and develop the learning strategies, generic skills, values and attitudes they need – and thus lay a solid foundation for lifelong learning.

School-based learning and teaching materials are also effective and need to cater for students' needs. Used with appropriate teaching strategies, textbooks and school-based materials can complement each other well to support the teaching and learning of ICT.

### 6.2 Guiding Principles

The basic considerations in the selection of learning and teaching resources, including textbooks, for ICT are as follows. They should:

- be in line with the curriculum aims and contain core elements of the curriculum;
- arouse students' interest and engage them actively in learning tasks;
- provide access to knowledge, as well as scaffolding, to help students progress in their learning;
- cater for students' individual differences by providing a variety of learning activities at different levels of difficulty;
- be well expressed, and present information and ideas accurately and effectively;
- support independent learning by complementing and extending what students have learnt in class; and
- support a variety of approaches and strategies such as inquiry, discussion, co-construction and reflection.

### 6.3 Types of Resources

This section considers how teachers can make use of textbooks, reference materials, the Internet and technology, and the community to bring about effective student learning of ICT.

### 6.3.1 Textbooks

Teachers still rely on textbooks as an important source of information to support their teaching. Textbooks will be recommended only for the Compulsory Part of the ICT curriculum. The recommended list will be available in early July 2008 for schools' information.

Despite the fast-changing nature of technologies, much of the knowledge and many of the fundamental principles of ICT can be suitably presented in textbooks. Teachers can advise students to adopt the following practices to use textbooks effectively. First, go through the required parts of the textbooks quickly to get an overview of the material, without making notes (as students are likely to take down too much information and simply copy without understanding); after the first reading, review the material and locate the main ideas and important points; then try to paraphrase the ideas and points in note form. By using this approach, students will become actively involved with the material and can arrange the information from textbooks in ways which aid their understanding and allow them to compare it with information from other sources. It will also help them to develop their skills in "Reading to Learn".

Teachers should not assume that the sequence of content presented in textbooks is necessarily the teaching sequence required for the ICT curriculum. They should structure and design teaching schemes according to their school situation, and their students' needs, interests and abilities.

### 6.3.2 Reference Materials

As there will be no textbooks for the Elective Part of the ICT curriculum, and some of the information in textbooks may be too academic, lacking in real-life learning experiences, students will need to use other sources. Printed materials such as reference books, newspapers, journals, periodicals and magazines can provide a rich source of relevant information to supplement textbooks. By reading such materials, students can develop their reading and self-directed learning skills, and become more sensitive to recent trends and developments in the ICT field.

In today's information age, news comes from a wide range of sources that may conflict with each other. Students should therefore be reminded to examine these sources critically and evaluate them from various perspectives. Teachers should encourage their students to discuss issues related to ICT, so that they can gain experience in presenting their own views and responding to others, and in the process develop their communication skills.

Lists of useful reference books and websites for ICT can be found in the EMB TE KLA website.

### 6.3.3 The Internet and Technology

The massive increase in the quantity of information available today has led to new approaches to teaching and learning. Teachers can act as facilitators of learning by helping students to search for information and to work on it to turn it into personal knowledge.

The Internet and technology help learning by:

- providing audio-visual aids for understanding difficult concepts;
- providing access to information from a wide range of sources;
- allowing students to work at their own pace, including the use of specially designed software;
- promoting interaction between the students, resources and teachers;
- promoting collaboration between students and teachers; and
- facilitating the acquisition of information, the development of critical thinking, and knowledge-building.

The Internet serves as a good context for teachers to nurture in students proper attitudes and values related to various topics in the curriculum, including the ethical use of ICT, and copyright and privacy issues. The key to effective use of the Internet and technology in teaching is to maximise students' engagement, enhance the quality of interaction by providing timely feedback, and cater for learners' differences by allowing self-directed and self-paced learning. However, teachers should always caution their students to assess the accuracy of information obtained from the Internet.

Given the multi-faceted nature of the curriculum and the ever-advancing technologies, materials in print form cannot fully support the learning and teaching of the curriculum. Some Internet and technology resources which the EMB plans to develop for use by ICT teachers, or which are already available, are outlined below.

### ***Web-based e-learning platform***

Individuals with similar needs and interests are increasingly forming virtual communities through, for example, discussion forums, newsgroups and blogs. These communities are sources of a vast amount of information and knowledge, and provide participants with opportunities for real collaboration in learning. With the aim of promoting collaboration and co-construction of knowledge among ICT teachers, the EMB developed an e-learning platform to support the revised Advanced Supplementary Level Computer Applications and Advanced Level Computer Studies in 2005. The platform, which will be maintained to provide continuous support for the ICT curriculum, can provide very effective support to teachers and schools. With teachers' active participation, a resources database can be set up for different learning topics in the curriculum for convenient retrieval, and teachers can make use of the materials on the e-learning platform for teaching ICT. However, they are encouraged to modify them to suit their students' needs, upload them on the schools' Intranet, and make hard copies or allow students to download the materials for self-directed learning. Teachers are encouraged to share not just learning and teaching materials, but also their teaching experience, teaching sequences and any difficulties they have faced in teaching particular topics.

### ***E-learning and teaching resources packages***

As there will be no textbooks for the Elective Part of the ICT curriculum, a series of learning and teaching resources packages for specific topics in this Part (e.g. Database Design Methodology in the *Databases* option, and Definition and Analysis in the *Software Development* option) will be developed by the EMB for use in schools before 2009. Teachers may like to use these packages with their students.

### ***Glossary of computer terms***

As discrepancies exist in some Chinese ICT terminology used in Hong Kong, China and nearby areas such as Taiwan and Singapore, the CDC has prepared a glossary of computer terms which can be downloaded from the EMB website. It provides Chinese translations of English terms and English translations of Chinese terms commonly used in teaching computer subjects in secondary schools. The glossary is particularly valuable for teachers since many useful references and resources for ICT on the Internet are in English. Teachers can use it to aid the translation process in schools where Chinese is the medium of instruction. The glossary will be reviewed periodically and updated as necessary.

### ***Multimedia packages in Kowloon Tong Education Services Centre***

A list of software developed by the Centre to support learning and teaching in various subjects can be found on the EMB website. Many of these multimedia packages are relevant to the ICT curriculum and can be useful teaching aids for demonstrations (e.g. the packages on Pascal Symbolic Programming Editors, and modules on Multimedia Presentation with Animation and Areas of Computer Applications, and Computer Education: Creative Approach, Looping Structures and Animation Workshop). Teachers can visit the Centre to preview the packages and make a copy of those they find useful for the learning and teaching of ICT in their schools. Students can also use some of the software packages (e.g. Dreamweaver MX, and Pascal Symbolic Programming Editors) for self-directed learning.

#### **6.3.4 Community Resources**

A spirit of partnership is necessary among the many parties in the community who can contribute in different ways to helping our students learn effectively. Some examples of the specific roles they can play in relation to ICT are given below, but the list is by no means exhaustive.

#### ***Professional organisations***

The Hong Kong Association for Computer Education (HKACE) (<http://www.hkace.org.hk/>) was founded in 1981, in response to the planning of a pilot scheme to introduce S4–5 Computer Studies as a subject in secondary schools by the then Education Department. The formation of the HKACE aimed to promote computer education in schools through collaboration. Its core members were actively involved in the design and revision of various ICT-related curricula. The HKACE has mounted various sharing activities to support ICT teachers, and has organised student competitions such as the HKOI to raise interest in learning the subject. The HKACE has established a professional membership system, with members classified according to their academic qualifications, professional development, experience and contributions to IT education in Hong Kong.

The Association of IT Leaders in Education (AiTLE) (<http://www.aitle.org.hk/>) is a local non-profitable educational association organised by a group of enthusiastic voluntary IT co-ordinators and IT-related people who are working mainly in primary or secondary schools. Its overall aim is to improve the quality of ICT education, and it does so by, for example: holding lectures, exhibitions, meetings, classes and conferences; sharing experience and resources in education; and supporting studies and development programmes. Guest speakers/consultants are frequently invited to conduct free seminars/workshops for ICT teachers. All IT-related teachers in local primary or secondary schools are eligible to apply for free Associate membership of AiTLE, and members can use the resources on its website freely.

### ***Parents***

Parental involvement in schools is important for the community and students. When parents are involved in their sons'/daughters' schools (e.g. in helping to choose curriculum materials), they feel more committed to their education, more responsible for encouraging them, and more supportive of the teaching staff. Parents should be encouraged to play a support or advisory role in curriculum development to provide a community perspective. In the context of ICT, schools can invite parents with a relevant background to, for instance: help and monitor students using IT facilities during and outside normal school hours; be consultants for school computer/ICT clubs; share their working experience of using ICT; and be a speaker at computer/ICT club activities.

### ***Alumni***

Schools should establish close links with alumni to draw on their resources and professional knowledge for improving schools' "hardware" and "software" and strengthen their sense of belonging to the school. Many alumni are likely to be involved in ICT-related fields, including education and ICT professions, and their knowledge and practical experience can be a valuable source of authentic daily-life examples for students.

### ***Government bureaux and departments***

Various government bureaux and departments, including the Hong Kong Police Force (HKPF) and the Television and Entertainment Licensing Authority (TELA), have been involved in public education on information security and the prevention of computer-related crime. The InfoSec website (<http://www.infosec.gov.hk/>) – co-developed by the HKPF, TELA and the Office of the Government Chief Information Officer – serves as a portal for the general public on these issues. The materials in this website are particularly useful for teaching the topic "Threats and Security on the Internet" in the compulsory module *Social Implications*.

The web site Cyber Ethics for Students and Youth (<http://cesy.qed.hkedcity.net/>) is an inter-departmental and community-wide project jointly developed by the EMB, HKPF, TELA and other experts. This website provides guidelines and suggested learning activities for teachers and students on the social, ethical and legal issues related to cyber ethics. These materials are very helpful for teaching most of the topics in the compulsory module *Social Implications*, and it is worthwhile for teachers to introduce this website to students.

The Intellectual Property Department website (<http://www.ipd.gov.hk/>) consists of materials to educate students to respect intellectual property rights and the proper use of works protected by copyright. There are interesting, interactive materials that are useful for students' independent study, and they are particularly relevant for the Intellectual Property topic in the compulsory module *Social Implications*.

### ***Government-funded organisations***

Hong Kong Education City (HKEdCity) is a large-scale project launched by the EMB, and funded by the government's Quality Education Fund (QEF). The website has been built collaboratively by the government and the education, social services, and business sectors to provide high-quality information. It collates education resources and provides them online for use by schools, teachers, students, parents and the general public; and its website includes webpages on computer learning and teaching resources and an e-forum to support the teaching and learning of computer education in Hong Kong.

### ***Industry partners***

With the common goal of empowering students and teachers with IT, the EMB has collaborated with Microsoft to implement a five-year "Partners in Learning (PiL)" programme for the benefit of students and schools. The PiL program offers schools a spectrum of IT and training resources and teachers can update their ICT knowledge through participating in the PiL programme.

To support the learning and teaching of databases in schools, the EMB worked with Oracle HK to launch the "Oracle Academy: Education Support for Hong Kong" programme in July 2005. The programme provides participating schools with a range of free learning and teaching resources, including access to database curriculum materials via "Oracle iLearning" (an online learning environment) and online access to a development environment for SQL programming via the "Oracle HTML DB". Training courses are also provided for teachers from the schools involved, and teachers can use the database provided to teach the *Databases* option in the Elective Part of the ICT curriculum.

## 6.4 Flexible Use of Learning and Teaching Resources

Schools are encouraged to develop their own school-based learning and teaching resources according to the needs, interests and abilities of their students whenever appropriate and feasible. In developing school-based learning and teaching resources, members of the ICT panel should hold collaborative lesson-planning meetings. For example, teachers working at the same level can meet, say, once a term to plan/design a unit in the scheme of work and subsequently use the materials and activities developed with their classes. Also, peer observation of lessons, followed by discussion among the teachers, can improve the quality of learning and teaching materials.

School-based learning and teaching resources should be specially prepared for students who have difficulty in understanding particular topics, even after reading their textbooks. Also, as there will be no textbooks for the Elective Part of the ICT curriculum, teachers need to develop resources for the options they offer to students. They can refer to the resources developed by the EMB and customise them to provide suitable learning tasks for less able students. Also, to fulfil the potential of students gifted in ICT, extension activities should be provided in which they investigate topics of interest in depth outside the classroom (e.g. by compiling a different resource/reference list, or providing more Internet websites to promote a global perspective on topics in ICT).

## 6.5 Resource Management

Effective management of resources, including the use of computer rooms and other IT resources, is important for successful implementation of this curriculum. Schools should co-ordinate and maximise the use of computer rooms and/or the multi-media learning centres within and across all subjects. Also, IT resources such as hardware, software and network resources need to be managed and maintained systematically.

### 6.5.1 Developing a School-based Resource Bank

Good use should be made of schools' Intranets as teaching, learning and management tools. Teachers should be encouraged to upload materials there and classify them in a systematic way for effective retrieval by ICT teachers and students – for example, teachers may structure the hierarchy of resources with reference to the curriculum framework. By refining it regularly, the resource bank can become a comprehensive platform to support a variety of learning and teaching activities, including homework submission, discussion forums and collaborative project work.

### 6.5.2 Sharing Resources

A culture of sharing is the key to the success of knowledge management. Schools should make arrangements for:

- teachers and students to share learning and teaching resources through the Intranet or other means within the school; and
- ICT teachers to form professional development groups for the exchange of experience.

### 6.5.3 Accessing Resources

It is important for teachers to be fully aware of where to access relevant resources to support their teaching; and they must foster in themselves and in their students the habit of looking for relevant new resources, and update the school website/Intranet regularly. Students should be encouraged to read ICT-related news and magazines and share their findings with their peers in class.

### 6.5.4 Inventories of Computer Equipment

Teachers need to know what computer equipment is available for use in school. For this purpose, ICT panel chairpersons should maintain the following three inventory records:

- a hardware inventory of the number and location of the major items, such as personal computers, monitors, notebook computers, printers and other external peripherals;
- a software inventory of the software installed in each computer/server; and
- a license inventory, including the number of licenses for each piece of software the school possesses, together with the relevant license documents (such as the storage boxes of Microsoft full pack products and the whole-school license agreement).

Schools are advised to verify fully or randomly check the stocks of computer equipment at least once a year.

## 6.6 Funding

To assist schools in the implementation of senior secondary curriculum in 2009, the EMB will continue to provide them with additional funding and to allow greater flexibility in the use of resources to cater for their diverse needs. Schools are advised to refer to the relevant and latest circulars issued by the EMB from time to time.

## An Elaborated Version of Example 3 in Chapter 4 - Integration of Generic Skills

**Elective Part****Option:** A *Databases***Topic:** b Relational Databases**Theme:** Integration of generic skills

(Note: This example is an elaboration of Example 3 in Chapter 4, with the integration of creativity, critical thinking skills and problem-solving skills discussed here.)

Students are asked to create a simple relational database for a computerised library book reservation system for their schools. In this task, students investigate their schoolmates' needs and provide solutions for the relational database.

In the process of developing the solutions, students may interview their schoolmates, the library helpers and the librarian to collect information. After that, they filter the information and identify the attributes; and they also have to use their intuition/imagination to create some relevant attributes. Creativity is cultivated when students design a prototype of the database.

Students then analyse critically the relationship among all the attributes, and have to formulate the relational database to serve this purpose. They appraise the various aspects of the relational database against the design specifications. Students' critical thinking skills are nurtured through the whole process – from the conceptualising of initial ideas to the realisation of the final design.

Finally, students create a relational database for the book reservation system. In doing so, they have developed their problem-solving skills by gathering the necessary information, identifying the attributes and formulating the database.

## An Elaborated Version of Example 7 in Chapter 4 - the Use of Multiple Teaching Strategies

### Elective Part

**Option:** A *Databases*

**Topic:** c Introduction to Database Design Methodology

**Theme:** Analyse simple scenarios in business, education or other fields and create simple ER diagrams involving binary relationship only in designing a database.

(Note: This example is an elaboration of Example 7 in Chapter 4, with the integrated use of enquiry, scaffolding and feedback discussed here.)

One or two weeks before the lesson, the teacher asks students to form pairs and start self-directed learning to investigate the data required in a school library system. Students need to think critically about the data involved in such a system. The teacher asks them to write down static data and dynamic data to be recorded when a book is borrowed or returned, then design and construct the database tables for a school library system.

The teacher asks three or four groups of students to present their findings, in which they need to state the assumptions they have made about the functions of a school library system, and explain the designs of their table structures. The teacher should offer hints to students if they are not able to identify the critical data required during this stage. By asking students to present their designs with explanation and allowing them to observe their peers doing the same, students learn how to make important and rational decisions on what information to convey and how to convey it. At this point, the teacher should give formal and timely feedback to students during lesson time, as this will help students to reflect on their thinking and build up their understanding of content knowledge.

In creating an ER diagram, the teacher may want to see if students can identify entities and their attributes; and, if not, he/she may suggest that they start by identifying entities only. If this fails, teacher needs to point out the entities (e.g. BOOK, READER) and ask students to name the attributes for the respective entities in turn (e.g. Title, Author, Publisher and ISBN for BOOK). After they have done so, the teacher may ask students to discuss the possible relationships between entities. The teacher should prompt students to the fact that different function requirements of a system may require a different database design. To make scaffolding successful, students should be given just enough support to enable them to carry out the task.

## **Programming Languages Used in Public Examination**

As of now, it is agreed that the programming languages C, Java, Pascal, and Visual Basic will be used in parallel in the public examination for the elective option “*Software Development*”. The programming languages used will be reviewed from time to time on a needs basis.

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## Glossary

<b><u>Term</u></b>	<b><u>Description</u></b>
<b>Applied Learning (ApL, formerly known as Career-oriented Studies)</b>	Applied Learning (ApL, formerly known as Career-oriented Studies) is an essential component of the three-year senior secondary curriculum. ApL uses broad professional and vocational fields as the learning platform, developing students' foundation skills, thinking skills, people skills, values and attitudes and career-related competencies, to prepare them for further studies and/or for work as well as lifelong learning. ApL courses complement 24 senior secondary subjects, diversifying the senior secondary curriculum.
<b>Assessment objectives</b>	The outcomes of the curriculum to be assessed in the public assessment.
<b>Co-construction</b>	Different from the direct instruction and construction approaches to learning and teaching, the co-construction approach emphasises the class as a community of learners who contribute collectively to the creation of knowledge and the building of criteria for judging such knowledge.
<b>Core subjects</b>	Core subjects recommended to all students to take: Chinese Language, English Language, Mathematics and Liberal Studies
<b>Curriculum and Assessment (C&amp;A) Guide</b>	A guide prepared by the CDC-HKEAA Committee. It comprises curriculum aims/objectives/contents and learning outcomes, and assessment guidelines.
<b>Elective subjects</b>	A total of 20 subjects in the proposed new system from which students may choose according to their interests, abilities and aptitudes.
<b>Generic skills</b>	Generic skills are skills, abilities and attributes which are fundamental in helping students to acquire, construct and apply knowledge. They are developed through the learning and teaching that take place in the different subjects or KLAs, and are transferable to different learning situations. Nine types of generic skills are identified in the Hong Kong school curriculum, i.e. collaboration skills, communication skills, creativity, critical thinking skills, IT skills, numeracy skills, problem-solving skills, self-management skills and study skills.
<b>Hong Kong Diploma of Secondary Education (HKDSE)</b>	The qualification to be awarded to students after completing the three-year senior secondary curriculum and taking the public assessment.

<b><u>Term</u></b>	<b><u>Description</u></b>
<b>Internal assessment</b>	This refers to the assessment activities that are conducted regularly in school to assess students' performance in learning. Internal assessment is an inseparable part of the learning and teaching process, and it aims to make learning more effective. With the information that internal assessment provides, teachers will be able to understand students' progress in learning, provide them with appropriate feedback and make any adjustments to the learning objectives and teaching strategies they deem necessary.
<b>Key Learning Areas (KLA)</b>	Organisation of the school curriculum structured around fundamental concepts of major knowledge domains. It aims at providing a broad, balanced and coherent curriculum for all students in the essential learning experiences. The Hong Kong curriculum has eight KLAs, namely, Chinese Language Education, English Language Education, Mathematics Education, Personal, Social and Humanities Education, Science Education, Technology Education, Arts Education and Physical Education
<b>Learner diversity</b>	Learners are individuals with varied family, social, economic and cultural backgrounds and learning experience and have different talents, personalities, intelligence and interests. Their learning abilities, interests and styles are, therefore, diverse.
<b>Learning community</b>	A learning community refers to a group of people who have shared values and goals, and who work closely together to generate knowledge and create new ways of learning through active participation, collaboration and reflection. Such a learning community involves not only students and teachers, but also parents and other parties in the community.
<b>Learning outcomes</b>	Learning outcomes refer to what learners should be able to do by the end of a particular key stage of learning. Learning outcomes are developed based on the learning targets and objectives of the curriculum for the purpose of evaluating learning effectiveness. Learning outcomes also describe the levels of performance that learners should attain after completing a particular key stage of learning and serve as a tool for promoting learning and teaching.
<b>Learning targets and Learning objectives</b>	<p>Learning targets set out broadly the knowledge/concepts, skills, values and attitudes that students need to learn and develop.</p> <p>Learning objectives define specifically what students should know, value and be able to do in each strand of the subject in accordance with the broad subject targets at each key stage of schooling. They are to be used by teachers as a source list for curriculum, lesson and activity planning.</p>

<b><u>Term</u></b>	<b><u>Description</u></b>
<b>Level descriptors</b>	A set of written descriptions that describes what the typical candidates performing a certain level is able to do in public assessments.
<b>Public assessment</b>	The associated assessment and examination system for the HKDSE.
<b>SBA moderation mechanism</b>	The mechanism adopted by HKEAA to adjust SBA marks submitted by schools to iron out possible differences across schools in marking standards and without affecting the rank order determined by the school.
<b>School-based Assessment (SBA)</b>	Assessments administered in schools as part of the teaching and learning process, with students being assessed by their subject teachers. Marks awarded will count towards students' public assessment results.
<b>School-based curriculum</b>	Schools and teachers are encouraged to adapt the central curriculum to develop their school-based curriculum to help their students achieve the subject targets and overall aims of education. Measures may include readjusting the learning targets, varying the organisation of contents, adding optional studies and adapting learning, teaching and assessment strategies. A school-based curriculum is therefore the outcome of a balance between official recommendations and the autonomy of the schools and teachers.
<b>Standards-referenced Reporting</b>	Candidates' performance in public assessment is reported in terms of levels of performance matched against a set of standards.
<b>Student learning profile</b>	Its purpose is to provide supplementary information on the secondary school leavers' participation and specialities during senior secondary years, in addition to their academic performance as reported in the HKDSE, including the assessment results for ApL courses, thus giving a fuller picture of their whole-person development.
<b>Values and attitudes</b>	Values constitute the foundation of the attitudes and beliefs that influence one's behaviour and way of life. They help form the principles underlying human conduct and critical judgment, and are qualities that learners should develop. Some examples of values are rights and responsibilities, commitment, honesty and national identity. Closely associated with values are attitudes. The latter supports motivation and cognitive functioning, and affects one's way of reacting to events or situations. Since both values and attitudes significantly affect the way a student learns, they form an important part of the school curriculum.

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