Contents

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

(since December 2003)

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Preamble

This Curriculum and Assessment Guide is one of the series prepared jointly by the Hong Kong Curriculum Development Council (CDC) and the Hong Kong Examinations and Assessment Authority (HKEAA). It forms the basis for learning and teaching of the subject curriculum as well as that for setting public assessment. The issue of this single document on curriculum and assessment aims at conveying a clear message to the public that assessment is an integral part of the school curriculum and at promoting the culture of "assessment for learning" to improve learning and teaching.

The CDC is an advisory body giving recommendations to the Hong Kong Special Administrative Region Government on all matters relating to curriculum development for the school system from kindergarten to sixth form. Its membership includes heads of schools, practicing teachers, parents, employers, academics from tertiary institutions, professionals from related fields or related bodies, representatives from the HKEAA and the Vocational Training Council, as well as officers from the Education and Manpower Bureau.

The HKEAA is an independent statutory body responsible for the conduct of the Hong Kong Certificate of Education Examination and the Hong Kong Advanced Level Examination. The governing council of the HKEAA includes members who are mainly drawn from the school sector, tertiary institutions and government bodies, professionals and persons experienced in commerce and industry.

This Curriculum and Assessment Guide is recommended by the Education and Manpower Bureau for use in secondary schools. The subject curriculum developed leads to the appropriate examination provided by the HKEAA. To this connection, the HKEAA has issued a handbook to provide information on the format of the public examination of the subject and the related rules and regulations.

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 society and students. All comments and suggestions on this Curriculum and Assessment Guide should be sent to:

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I. Introduction

Advanced Supplementary Level Computer Applications (the Curriculum hereafter) is recommended for use in Hong Kong secondary schools at S6-S7. It is a two-year course leading to the Hong Kong Advanced Level Examination and is targeted at all students with information technology skills at Level 3 of the IT Learning Targets (or S3 Computer Literacy level).

This is a revised edition of the previous curriculum published in 1998. The revision is overseen and monitored by the CDC-HKEAA Committee on Information and Communication Technology (Senior Secondary) which was established in 2003. There are three purposes behind the revision of the Curriculum:

i. Computer technologies are changing rapidly. The Curriculum should be updated and strengthened regarding the applications of computer systems, in order to facilitate students in future studies and/or to equip them with skills for migration into the workforce.

ii. As a result of the widespread implementation of the IT in Education Project in junior secondary education, the cognitive levels required in Computer Applications have, to some extent, become lower than those which are expected of a subject at Advanced Supplementary Level. Therefore, there is an urgent need to review the Curriculum and to reconsider the learning and teaching intended.

iii. With the newly developed S4-S5 Computer and Information Technology curriculum in 2003, there is a strong need to develop a curriculum which forms a part of the continuum in the learning of computer and related technologies from junior secondary through to university or work, and blends eventually into the Information and Communication Technology (ICT) curriculum in the New Senior Secondary Education.

In view of the latest developments of computer technologies and the purposes of the revision, the Curriculum has been reorganised, updated and revised with new modules on computer applications such as SOHO Networking added and obsolete topics such as Operating a Microcomputer deleted. The Curriculum is designed to be non-vocational and to provide as broad and as deep a study as possible, with intellectual standards suitable for students at Advanced Supplementary Level.

This Curriculum and Assessment Guide serves as a framework to guide teachers on the contents and learning objectives which the Curriculum entails. It is presented with the overall aims and broad objectives, together with specific aims and objectives for each module of the Curriculum. The topics are accompanied by learning outcomes, which serve to further elaborate and clarify the learning experiences and the scope of the knowledge that students should attain. It also includes essential learning elements suggested for effective learning, which teachers may incorporate when designing learning and teaching activities. The scheme of assessment is included as supplementary information for teachers, paying particular attention to the area of School-based Assessment.

II. Aims and Objectives

Aims

The Curriculum is designed to provide students with

- knowledge, understanding and skills in the development and use of computer systems over a range of applications;
- an understanding of the organisation of computer systems;
- an appreciation of the impact on society arising from the rapid development of computer technologies; and
- an opportunity to develop skills in problem solving, communication, creativity and critical thinking, and learning to learn capabilities.

Objectives

Upon completion of this Curriculum, students should have developed

- knowledge and understanding of the basic operations of computer systems and the inter-relationship among hardware, software and data;
- knowledge and skills in using a range of applications software effectively, ethically and in a discriminatory manner to support information processing and problem solving;
- an understanding and experience in the ways that information is logically and sensibly organized, processed and manipulated by a computer;
- knowledge and skills in data communications and network development; and
- an understanding and appraisal of the social and ethical issues pertaining to computer technologies.

III. The Curriculum Framework

Organisation of the Curriculum

The curriculum is organised around four mandatory modules that relate to concepts of computer systems and networking, and information processing using some common applications software. Together with School-based Assessment, the entire curriculum comprises these modules: Computer Systems, Office and Internet Applications, Databases and SOHO Networking. For each module, the following time allocation is recommended:

	Module	No. of hours allocated	No. of lessons allocated (40 minutes/lesson)
1	Computer Systems	7	11
2	Office & Internet Applications	34	51
3	Databases	32	48
4	SOHO Networking	32	48
	School-based Assessment	12	18
Total Curriculum Time		**117 hours**	**176 lessons**

It is recommended that schools should allocate 4 lessons (40 minutes per lesson) per week, or 5 lessons per 6-day cycle, for the Curriculum. In addition, 18 lessons should be made available for School-based Assessment. A total of 176 lessons (117 hours) is recommended for the implementation of the Curriculum.

Details of the modules are given in subsequent pages in the following order:

i. Computer Systems
ii. Office and Internet Applications
iii. Databases
iv. Small Office / Home Office (SOHO) Networking

The order of the modules does not in any way dictate how the curriculum is to be implemented. The organisation of topics in each module represents one possible way of arranging the curriculum content. Teachers may structure and design teaching schemes according to their school situations, student needs, interests and abilities.

Computer Systems

This module is intended to introduce the basic terminology, concepts and operations of hardware and software components of a computer system. It covers different parts of a computer system including the system unit, peripherals and software, and how they interact together to perform computational tasks.

Overall Expectations

Students should

- apply computing terminology accurately and appropriately;
- understand the basic components of a computer system;
- describe the functions of specific hardware components and be able to choose with justification the most appropriate combination of peripherals in a given scenario or situation;
- understand the characteristics of systems software and functions of an operating system; and
- understand the interaction between hardware and software components of a computer system in order to perform a task.

The time allocation for the module is about 7 hours (11 lessons).

Details of the Module

Topics	Remarks
• System units	• Students should be able to explain the functions of the Central Processing Unit (CPU), the Control Unit (CU) and the Arithmetic and Logic Unit (ALU). • Students should be able to describe and compare the two kinds of memory units, namely RAM and ROM, in the main memory in terms of speed and capacity. • Students should understand the function and use of cache memory.
• Peripheral devices	• Students should be able to describe the operations of a variety of peripheral devices and their functional characteristics such as speed and capacity, where appropriate. Examples of peripheral devices are ➢ input devices: keyboard, pointing devices, scanning devices, voice-input devices, video-capturing devices and Chinese handwriting recognition devices, etc. ➢ output devices: visual display units, printers, plotters and voice-output devices, etc. ➢ secondary storage devices: magnetic disks and tapes, optical disks, flash memories, mini disks and DVDs etc. • Students should be aware of the current trends to faster and greater storage capacity over time in peripherals. • Students should be able to understand hardware specifications written for a simple computer system. They should be able to compare and contrast the performances of computer systems based on their specifications.
• Systems software	• Students should understand the different types of systems software and their functions. • Students should be able to give a brief account of the basic functions of an operating system and be aware of the common types of operating system. • Students should demonstrate a basic understanding on what utility programs are and how they are used.
• Applications software	• Students should understand the functions of applications software, and the various types of applications software such as software package / software suite and custom-made software, and their uses.

Office and Internet Applications

This module builds on the basic knowledge, understanding and skills of word processing, spreadsheet, multimedia presentation and Internet basics acquired by students at junior secondary or at S4-5 level. The aim of this module is to further develop students' understanding of terminology and advanced skills in using integrated software and the Internet, so as to enhance their personal productivity in work or study, and to apply them in problem solving. Emphasis is on the proficient use of software applications as well as the ability to use those applications as tools in enhancing document production, data analysis, decision-making, information management, communication and effective information presentation.

Overall Expectations

Students should

- understand the advanced features available in common word processing, spreadsheets and presentation software, and be able to integrate these features in a given context for problem solving;
- select appropriate tools to process different types of information;
- understand the technology, applications and services of the Internet;
- have a basic understanding of some common multimedia file formats and be able to select the appropriate formats when presenting information; and
- be ethical and discriminating users of the Internet.

The time allocation for the module is approximately 34 hours (51 lessons).

Details of the Module

The module *'Office and Internet Applications'* comprises four topics; namely *'Using Word Processing in Desktop Publishing', 'Using Spreadsheet in Data Analysis', 'Multimedia Presentation of Information' and 'Internet Applications'*. Further information on the four topics is summarised as follows:

Topics	Remarks
A. Using Word Processing in Desktop Publishing *(7 hours)*	
• The design and production of formatted document / publication	• Students should demonstrate the ability to present information in a document suitably and effectively with features such as text frames, tables, multi-columns, section breaks, borders and graphics, etc., with due consideration on the use of colour, size and positioning of text and graphics. • Students should be able to create a document or a report proficiently with features such as table of contents, index, footnote / endnote, headers / footers, bookmarks and hyperlinks. They should be able to use tools to track changes and to enhance the readability and accuracy of documents using spelling checker, grammar checker and thesaurus. • Students should develop an understanding of the concepts of Object Linking and Embedding (OLE) and be able to compare the integration of graphics and data into the document by linking, embedding and copy/paste. • Students should recognise the different document / text formats such as plain text format, rich text format, hypertext document format, portable document format, and word document format. They should be able to do conversions among them, appreciate their uses and justify the choice of file formats in a given context. • Students should have experience of mail merging.
B. Using Spreadsheet in Data Analysis *(12 hours)*	
• The basic structure of a spreadsheet	• Students should have a clear understanding of the basic features of spreadsheets such as rows, columns, cell addresses and cell references, values, labels, formulas and charts, etc., and be able to apply them effectively in data analysis and data manipulation. They should demonstrate the ability to format or edit a worksheet efficiently.

Topics	Remarks
• Data manipulation	• Students should be able to use formulas, standard functions[1] and nested functions, together with mathematical, logical and relational operators, to solve problems. • Students should be able to arrange data in order, filter data using single or multiple criteria, link and manipulate data dynamically in multiple worksheets.
• "What-if" analysis	• Students should understand the use of spreadsheet in "what-if" analysis and appreciate how it is used to simulate some real world situations. They should be able to analyse and identify changes and trends so as to make informed judgment, decision and prediction when some values on the simulation are changed.
• Pivot tables	• Students should be able to create, edit and format a pivot table and a pivot chart efficiently using defined field names and appreciate the use of a pivot table as a powerful and interactive tool for data analysis. • Students should be able to use functions such as sum, sub-total and average, etc., and know how to group and manipulate data within pivot tables for problem solving. • By varying different fields, students should be able to observe and analyse the inter-dependency of data so as to enhance their decision-making and to produce meaningful predictions.

[1] Examples of functions are

Logical functions:	AND, OR, NOT, IF
Statistical functions:	AVG, MAX, MIN, LARGE, SMALL, SUM, SUMIF, COUNT, COUNTIF, RANK, FREQUENCY
Time:	DATE, NOW
Text functions:	CHAR, LEFT, LEN, LOWER, MID, RIGHT, UPPER, VALUE, CONCATENATE
Mathematical functions:	INT, MOD, ROUND, ROUNDUP, ROUNDDOWN, SQRT
Reference functions:	CHOOSE, HLOOKUP, VLOOKUP, LOOKUP

The list is by no means exhaustive. In essence, students should understand the basic construct of a function and know the parameters to be filled in for a function. They may need to use functions which are not on the list by referring to the HELP menu of the software when required.

Topics	Remarks
C. Multimedia Presentation of Information *(4 hours)*	
• Multimedia elements	• Students should have a basic understanding of the features of the different multimedia elements comprising video, audio, text and graphics. They should be able to use them, justify their usages, perform simple file conversions and compare the different file formats in terms of resolution, file size and applications.
• Multimedia presentation	• Students should be able to apply concepts for effective communication and presentation, and to enhance information presentation using multimedia elements.
D. Internet Applications *(11 hours)*	
• Internet Basics	• Students should be able to describe the hardware and software requirements for Internet access. • Students should know 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).
• Internet services and resources	• Students should be able to formulate an effective strategy for searching for specific information on the World Wide Web by using search-engines, and be able to critically analyse the sources of information. • Students should have experience of the use of the Internet for file transfer by using file transfer protocol (FTP), remote logon, locating and using an online chat, joining discussion forums and newsgroups. • Students should be able to use plug-ins or players for multimedia elements found on the Internet. • Students should understand the differences between a mail client and web mail, and the protocols (POP, IMAP, SMTP, etc.) used in sending and retrieving emails.
• Ethical and social issues on the use of the Internet	• Students should be able to discuss critically issues arising from the digital divide, the emergence of a knowledge-based society and globalisation. • Students should be keenly aware of the issues of intellectual property, and be familiar with measures to safeguard themselves and their information on computers, by various means such as the installation of a firewall, filtering software, anti-spyware and anti-virus software. They should understand the use of cookies and the impact on user tracking. • Students should understand the measures which ensure Internet security in data transmission, such as the use of a digital certificates and data encryption.

Databases

With the widespread use of databases within our society, everyone now needs knowledge and skills in database management in order to make meaningful use of this tool. This module introduces students to the fundamentals of databases and relational database design. It entails the application, management and design aspects of databases. Students will learn how to construct simple data models using entity-relationship diagrams and to appreciate the importance of good database design. They will also learn to use Structured Query Language (SQL) to construct, manipulate and retrieve information from a relational database. Through the completion of this module, students will acquire a basic understanding of the concepts, skills and applications of databases, and elementary data modeling concepts.

Overall Expectations

Students should

- explain concepts and applications related to databases and the database management system (DBMS);
- understand the basic concepts of a relational database and be able to construct, manipulate and extract information from a relational database using Structured Query Language;
- identify and perform analysis of the data requirements of simple business systems;
- construct simple data models using methodologies such as entity-relationship (ER) diagrams; and
- appreciate the importance of a good database design as a blueprint for the development of a database system.

The time allocation for the module is about 32 hours (48 lessons).

Details of the Module

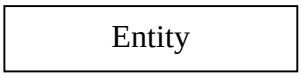
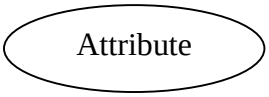
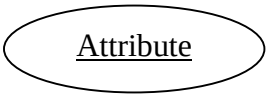
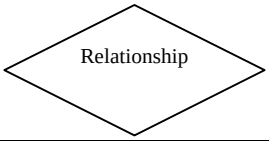
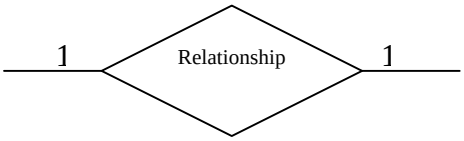
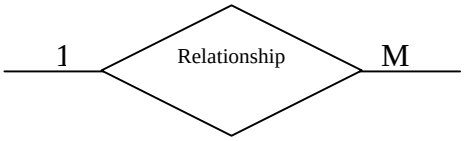
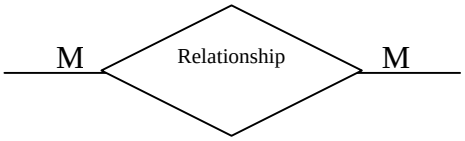
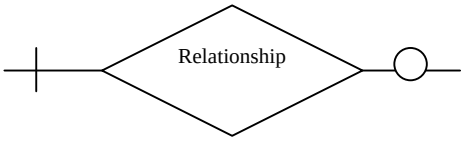
The module *'Databases'* comprises three topics; namely *'Introduction to Databases'*, *'Relational Databases and Working with Structured Query Language (SQL)'* and *'Introduction to Database Design Methodology'*. Further information on the three topics is summarised as follows:

Topics	Remarks
A. Introduction to Databases	*(3 hours)*
• Applications of databases in society	• Students should be aware of the uses and applications of databases in everyday life (e.g. the library system, inventory system in a supermarket, credit card system, etc.). • Students should be given opportunities to discuss the importance of databases in business environments and how they are related to the success of a business.
• Concepts and terminology	• Students should understand the following terminology and concepts: ➢ data and information ➢ data, fields, records, tables, files and databases ➢ common data types such as integer, real, character, string, Boolean, date, etc. ➢ indexes and keys ➢ database management systems (e.g. data definition language, data manipulation language, data dictionary, transaction processing and access control, etc.) ➢ program-data independence ➢ data redundancy and data integrity
B. Relational Databases and Working with Structured Query Language	*(18 hours)*
• Basic concepts of a relational database	• Students should know the basic concepts underpinning relational databases such as entity, relation, attribute, domain, primary key, foreign key, candidate key, entity integrity, referential integrity, domain integrity, etc. Students should be able to identify these basic elements in examples taken from everyday applications. • Students should know how to organise data differently but sensibly in a relational database and be able to establish the required relationships to link up the tables.
• Creating a relational database	• Students should be able to create a simple relational database[2] based on specified requirements using SQL.

[2] A simple relational database refers to one working with at most 3 tables.

Topics	Remarks
• Database maintenance and manipulation	• Students should be able to use SQL to maintain a simple relational database, manipulate its data or retrieve the required information. They should be able to: ➢ modify the structure of the tables ➢ add, delete and modify the data in the tables ➢ view, sort and select the contents by filtering ➢ use appropriate operators and expressions such as the *in*, *between* and *like* operators, arithmetic operators and expressions, comparison operators and logical operators etc. to perform specific operations ➢ use simple built-in functions such as aggregate and string functions, etc. ➢ perform multiple field indexing and multi-level ordering ➢ perform queries on multiple tables including the use of equi-join, natural join and outer join ➢ perform sub-queries (for 1 sub-level only) ➢ export query results to, for example, text, html or spreadsheet format, etc.
C. Introduction to Database Design Methodology *(11 hours)*	
• The conceptual data model	• Students should understand the importance of good database design in effective database management. They should be aware of the three levels of data abstraction; namely conceptual level, physical level and view level.
• Entity-Relationship modeling	• Students should be aware of the three types of relationship (one-to-one, one-to-many, many-to-many) among entities in a relational database. • Students should be able to create simple entity-relationship (ER) diagrams[3] involving binary relationships only in designing databases for simple business scenarios. This includes the resolution of many-to-many relationships into multiple one-to-many relationships in order to implement the database. • Students should be able to transform the ER diagrams to tables in relational databases and be able to create a database schema for a given set of data to describe the characteristics of the database.
• Introduction to Normalisation	• Students should be able to briefly explain the meaning and purpose of normalisation. They should be aware of the methods or measures used to reduce data redundancy.

[3] Symbols used in entity – relationship diagrams:

Meaning	Symbol
Entity	
Attribute	
Key Attribute	
Relationship	
One-to-One Relationship	
One -to-Many Relationship	
Many-to-Many Relationship	
Participation constraints: • Use | on Mandatory side • Use ○ on Optional side	

Small Office/Home Office (SOHO) Networking

This module focuses on knowledge and skills essential in constructing SOHO networks. SOHO networks are small-scale networks suitable for small-and-medium enterprises (SMEs) which make up more than 90% of businesses in Hong Kong. Building up networking capabilities and infrastructure within SMEs will increase the productivity and enhance communication internally among staff and externally to customers or clients throughout the world.

Through the study of this module, students will gain an understanding of the basic principles of networking, and the knowledge and skills associated with the design, implementation and maintenance of a SOHO network. Students will also be aware of the common security threats to SOHO networks and the methods by which network security can be improved. This module will give students a solid foundation on networking in general and SOHO networking in particular. Students will appreciate the practical nature of the module, regardless of whether they continue to pursue knowledge in this area in tertiary education or migrate to the workforce.

Overall Expectations

Students should

- understand the basic concepts and technologies behind networking, focusing specifically on SOHO networks;
- identify and describe the functions of basic components involved in a simple network;
- describe the uses and applications of a SOHO network;
- design and implement a simple SOHO network;
- assess the performance of a network and implement improvements; and
- understand the importance of network security and be able to propose measures of improvement.

The time allocation for the module is about 32 hours (48 lessons).

Details of the Module

The module *'Small Office/Home Office (SOHO) Networking'* comprises three topics; namely *'SOHO Networking Basics', 'SOHO Network Design and Implementation'* and *'SOHO Network Management and Security'*. Further information on the three topics is summarised as follows:

Topics	Remarks
A. SOHO Networking Basics	*(8 hours)*
• Basic concepts of data communications and networking	• Students should be able to identify and describe the basic function of each component of a packet: header, data and trailer. They should also be able to explain briefly the use of packets in data transfer in a packet switching network. • Students should understand the basic concepts of Internet Protocol (IP) addressing including the schemes and classification of IP addresses. They should understand the use of a subnet and know which subnet an IP address belongs to from a simple subnet mask. • Students should know the use of some common protocols including TCP/IP and DHCP, etc. • Students should be able to explain the factors that need to be considered in choosing between a client-server network and a peer-to-peer network. • Students should be able to compare and contrast the common types of communication links (e.g. modem dialup or cable modem, leased line, broadband and wireless, etc.) for Internet access in terms of data transfer rate, cost, and reliability.
• Basic network components	• Students should be able to identify and describe the functions of the various components which make up the wired and wireless networks. These include the network interface cards (NICs), cables, hubs, switches, routers, broadband routers, gateways, wireless adapters, wireless access points, wireless routers, etc. They should also be able to describe and explain briefly the services provided by a network operating system.
• SOHO network applications	• Students should be able to describe and appreciate the common applications of SOHO networking including resources sharing, Internet access, web serving, telecommuting, etc.

Topics	Remarks
B. SOHO Network Design and Implementation *(16 hours)*	
• Need analysis	• Students should be able to conduct a simple need analysis on a proposed SOHO network and translate the needs identified into requirements and specifications.
• Design	• Students should be able to design a network to meet the requirements generated in the need analysis and represent it in a diagram. • Students should be able to justify their design based on technical, cost-effectiveness and other considerations.
• Setup	• Students should have experience of setting up simple Ethernet and wireless networks. • Students should have experience of sharing various resources (e.g. files, printers and Internet connection, etc.) among the networked computers/stations. • Students should have experience of setting folder/file-sharing permissions including read, write and execute rights, etc.
• Testing	• Students should have experience of validating a network system by testing it according to a simple test plan based on the requirements and specifications.
• Documentation	• Students should be able to document the user requirements, specifications, and a schematic diagram for the network.
• End-user support	• Students should be aware of the importance of adequate end-user support and training on the attainment of the benefits sought.

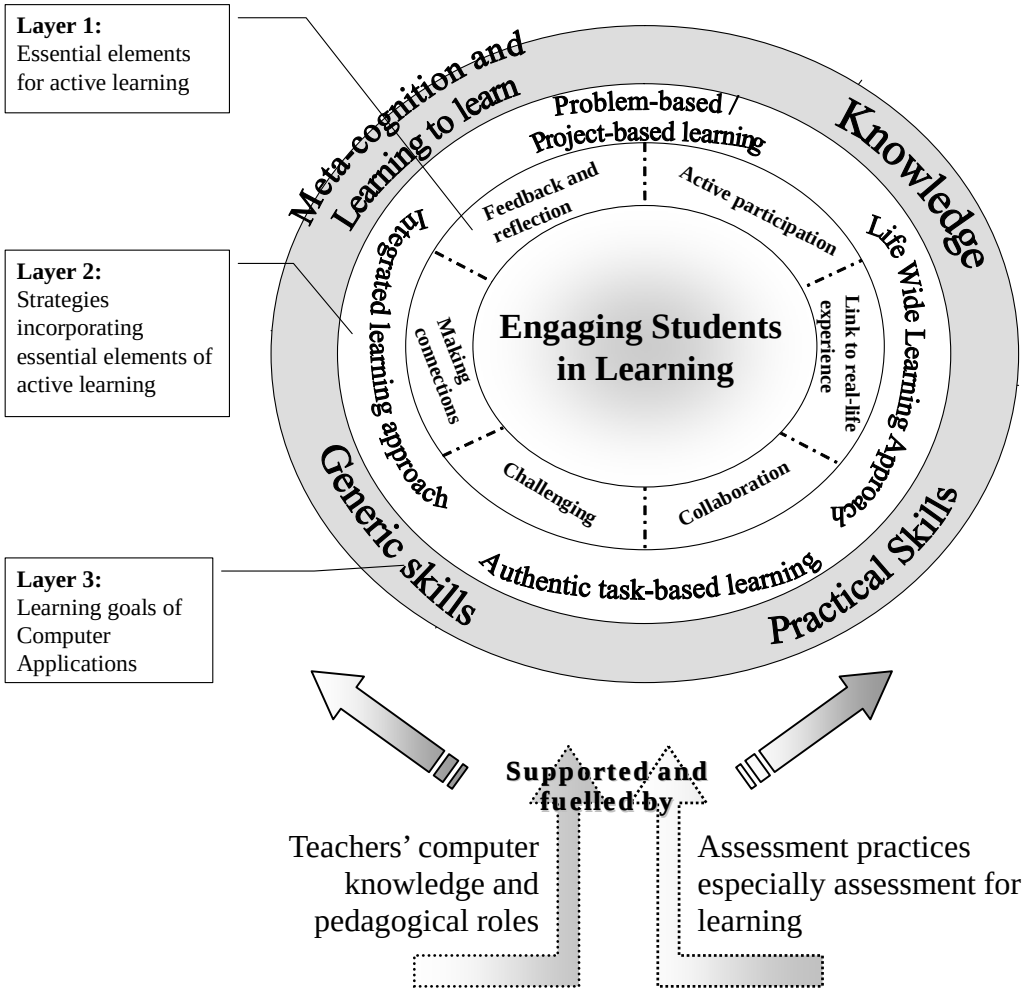
Topics	Remarks
C. SOHO Network Management and Security *(8 hours)*	
• Monitoring, fine-tuning and troubleshooting	• Students should develop the basic skills of monitoring and fine-tuning the performance of a simple network. • Students should develop the basic skills of analysing problems associated with the use of a networked environment and performing troubleshooting for it.
• Backup	• Students should be aware of the importance of backup in disaster planning and recovery measures. • Student should know the common hardware and software components of a network backup solution, such as Redundant Array of Independent Disks (RAID), Uninterruptible Power Supply (UPS), network backup servers, network backup and recovery software, etc.
• Security threats and measures	• Students should be able to describe the potential risks caused by the common network security threats including virus, worm and Trojan programs, spyware, unauthorised access, interception, etc. • Students should be able to propose effective measures to improve network security for both wired and wireless networks. These include anti-virus programs, authentication, access and user right control, packet filtering, public and private key encryption, Wired Equivalent Privacy (WEP), and IPsec used in Virtual Private Network (VPN), etc.

IV. Learning and Teaching

As the 21st Century is unfolded, there is a fundamental change in learning and teaching. The new culture of learning and teaching has shifted from transmission of knowledge to learning how to learn, from over-emphasising content study to whole person development, from compartmentalised topics / subjects to integrated learning, and from the dependence on textbooks to diversified teaching and learning materials. All these changes recognise the fact that citizens in the modern world need to be critical thinkers, problem solvers and competent in articulating ideas. Above all they need to be active learners who can construct knowledge taken from various sources and from different perspectives in a rapidly changing environment.

Every student has a capacity to learn. Students learn best when they actively seek information to accomplish a learning task. They learn effectively when they play the role of researchers and navigators rather than spectators; the role of problem solvers and thinkers rather than passive recipients of a static set of facts, as these facts may become obsolete as the rate of computer development accelerates. Students need to construct their own knowledge, learn from different perspectives and be responsible for their own learning. This paradigm of learning comes naturally and effectively if students are intrinsically motivated and engaged in their learning, i.e. they themselves become active learners.

To engage students actively in learning, as shown in the diagram overleaf, teachers should put them in the centre and blend the essential elements (Layer 1) required in effective learning into classroom learning and teaching strategies which are suggested in Layer 2. In addition to the learning of the Curriculum delivered via various student-centered learning and teaching strategies, and apart from knowledge and practical skills associated with computer technologies, students will develop generic skills such as problem solving, critical thinking, creativity and communication, and metacognition and learning to learn capabilities (Layer 3). These are all beneficial to students in the complex world of work and study. This system of learning should be supported by the different and active roles played by teachers and supported by the new concept of assessment, assessment for learning, to further facilitate student learning.



The System of Active Learning in AS-level Computer Applications

Essential Elements for Active Learning

Learning occurs best

- when students create their knowledge actively using their own learning strategy, and engage in an active search for understanding of what is being learnt;
- when students make connections between concepts, skill elements and experiences;
- when it is structured in real-world problems or circumstances;
- in the context of relatively challenging tasks or problems;
- in a collaborative context that provides thought-provoking discussion, trust and supportive interaction from peers and teachers; and
- when students receive qualitative feedback, encouragement for self reflection and opportunity for practice and improvement.

Learning and Teaching Approaches

Learning in Computer Applications is a complex, multi-faceted, active and interactive process. Apart from the traditional lecturing approach, active learning elements can be infused into classroom activities for the effective learning and teaching of the Curriculum. The following approaches are suggested for teachers' reference only and are by no means the only way to deliver the Curriculum. Teachers may use an extensive repertoire of learning and teaching strategies to achieve the learning objectives of the Curriculum.

Task-based Learning: The task should be a goal-oriented activity with a clear purpose in mind. Teachers may provide learning opportunities that engage students actively in tasks that are related to real-world problems or circumstances. Students should be asked to perform, create, produce, or do something that invokes real world applications; for instance, the creation of an advertisement flier, the simulation of a tax payment, the creation of a school library database system or the setting up of a home network for shared internet access. The tasks, however, should be moderately challenging and interesting enough to increase students' motivation. Teachers need to have very clear teaching objectives. The tasks, however, are tools which serve as instruments to facilitate student acquisition of underpinning concepts and skills, not the learning objectives themselves.

Life Wide Learning Approach: To enrich students with real-life experience, activities such as visits to computer or IT companies or institutes help to widen their horizons on the applications of computer systems. Students interact with the environment with the purpose of exploring, learning and observing how problems are solved in a computer-based system. By giving students authentic experiences outside the school setting in the form of observation or problem-solving, which they may inevitably encounter in their own workplaces or study, deeper understanding and learning skills will be fostered in students. The inclusion of reflection on experience after visits can also maximize learning.

If visits or field experiences of this kind cannot be provided, case studies of real-life examples detailing how computers are employed in various contexts can be used to bring out the related concepts and methodologies and to further consolidate students' concepts, knowledge and skills.

Problem-based Learning and Project-based Learning: Most students retain and use little of what they memorise in classroom. Students learn best when they are actively and purposely seeking information.

> *"Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand." (Confucius around 450 BC)*

By engaging students in structuring solutions to real life and contextualized problems, problem-based learning or project-based learning helps to orient students towards knowledge-making over fact-collecting. Through searching for and finding solutions to problems, students develop higher levels of comprehension and cognitive strategies to research, gain more learning and knowledge-forming skills and more social skills (collaboration and handling group dynamics) if group work is involved. This kind of approach emphasizes long-term, integrated and student-centred practices. Students assume greater responsibility for their own learning due to the reduction in direct teaching.

As a result of their rich learning outcomes, problem-based learning and project work should be integrated throughout the Curriculum and embedded in learning and teaching activities, and the assessments. This kind of methodology is commonly used throughout the computer industry and students will emulate these approaches. The importance of this kind of learning is also reflected on the mandatory Project Assignment in School-based Assessment. However, problem-based or project-based learning should not be restricted to a Project Assignment only. If problem-based or project-based learning is structured and guided carefully with built-in mechanisms for self-reflection, learning in both knowledge and skills will be maximised.

Making Connections and Integrated Approach: The Curriculum should not be viewed as a collection of discrete and disconnected modules. Concepts, skill elements and experiences can be linked and integrated to make them more meaningful and achieve lasting cognitive connections. By helping students to make connections they will be able to see the interrelationships between concepts within or beyond the Curriculum. This can facilitate flexible thinking, critical thinking and transfer of knowledge from one context to another.

Approach to Sustain Computer Fluency: Faced with the rapid advancement of computer technologies, students should be encouraged to read computer journals and magazines, to update their computer knowledge and skills through knowledge networks such as educational newsgroups and websites available on the Internet, and to participate in various workshops or contests in order to enrich their learning experiences. All of these help to stretch students' potential in computer knowledge and nurtures them into lifelong learners. In this respect they are similar to personnel working in IT industries, who continually keep abreast of new developments in the field.

Collaborative Approach: Effective learning is social and interactive. In the learning of computer and related technologies, students are often required to undertake group work. It is recommended that students at various ability levels should be grouped together in small groups when solving a problem or accomplishing a project or a task. This will enhance the active exchange of ideas and multiple feedback within the small groups. This not only increases interest and retention of information by students, but also promotes critical thinking, enhances communication skills and immediate feedback from peers. The shared learning gives students an opportunity to engage in discussion and take responsibility for their own learning.

Feedback and Reflection: Feedback from peers and teachers throughout the learning process or activity, be it a project, a task or a problem to solve, is essential for effective learning and should be integrated into learning and teaching. Structured opportunity for practice should be given, for without opportunity for practice, even well-learned abilities will disappear.

Reflection is necessary to reach the point of deeper learning required for knowledge and skills to be retained for use in the future. Reflection enhances students' self-assessment skills. Through reflection students use critical thinking to examine their understanding of the concepts, application of certain computer skills and presentation of work. They take control of their own learning. In doing so, students develop their learning to learn capabilities and metacognition. Without reflection, deep learning will not occur.

Effective learning can be achieved with the active involvement of teachers who can direct and orchestrate learning and teaching activities for students, and with a clear vision of assessments (especially assessment for learning) within and beyond the classroom.

Teachers' Roles

New concepts of learning demand new concepts of teaching and different roles for teachers. To foster active learning teachers must not only be knowledgeable about computer technologies but also need to have the pedagogical skills and knowledge to deliver the Curriculum. First and foremost the teacher becomes a facilitator who may become the consultant or instructor of computer knowledge, resource guide or developer, assessor and learner in the learning community.

(i) Teachers are the *consultants* or *instructors* of computer knowledge, for they

- have a thorough understanding of the theories, principles and concepts of computer technologies and a flexible approach so that they can help students to create useful cognitive maps, construct knowledge, apply that knowledge to real-world settings, relate one idea to another and address misconceptions;
- serve as role models when they fulfill their roles as teachers. To inspire students with their computer knowledge and insights, their approaches to problem solving, their flexible and critical thinking and the values and excellence to be pursued and upheld; and
- employ a repertoire of strategies to provide students with multiple ways to acquire the knowledge, concepts and skills which the Curriculum encompasses.

(ii) Teachers are *knowledge facilitators,* for they

- are facilitators of students' learning, not dispensers of facts and information in a student-centered teaching approach. The introduction of problem-based or project-based learning highlights the need for such a role

(iii) Teachers are *resource consultants*, for they

- lead students to the art of self-learning by locating and securing tools, pools of resources and support to facilitate students' learning at anywhere and anytime.

(iv) Teachers are *assessors*, for they

- assess individual student as well as the class as a whole by using multiple assessments and multiple dimensions of learning, both formatively and summatively;
- know how to move from assessment to decisions about teaching strategies and about where each student is in the continuum of learning in order to help him/her to improve, thus increasing the prospects for successful learning; and
- evaluate and reflect on their practice systematically and critically in light of student progress and pedagogical trends, and learn from experience.

(v) Teachers are *learners*, for they

- act as a role model for life-long learning through continuous self-updating and self-improvement in both computer and pedagogical knowledge and skills.

While each of the five teachers' roles has been described briefly and separately in the system of active learning, they are often interconnected and closely related. A teacher may indeed take on several roles simultaneously.

Teachers undoubtedly play a significant role in directing student learning in a dynamic flow of classroom activities. Assessment, on the other hand, helps students to understand curriculum expectations and can be a tool to improve their own learning. In fact, the kind of assessment used significantly influences what is learned and the degree of meaningful engagement by students in the learning process throughout the course.

V. Assessment

Purposes of Assessment

The overall purpose of student assessment in Computer Applications in a school setting is to gather information and make judgments about student quality of learning and achievement throughout the course. It is done for a variety of purposes:

- to provide qualitative information suitably to make fair judgment of student achievements;
- to enable students to gain information on what the Curriculum values, on promoting their self-knowledge about performance in order to facilitate and improve their learning;
- to evaluate and improve teaching effectiveness; and
- to incorporate into external examination.

Assessment for Learning

Traditional testing or assessment has always been done by the paper-and-pencil method. This kind of assessment, however, is inadequate in assessing students' performance and has the following short-comings:

- The demands made of 21st Century citizens as active learners who can articulate ideas, adapt and continuously reconstruct knowledge with critical thinking and problem solving abilities. These attributes cannot be adequately assessed by paper-and-pencil methods.
- The concept of learning has changed. Learning is not solely the acquisition of content knowledge. In fact, the Curriculum advocates the applications of computer knowledge and concepts, the development of communication and critical thinking skills, creativity and computer capabilities, and the fostering of positive values and attitudes towards the use of computer or information technologies. Paper-and-pencil tests, however, cannot measure the broad range of abilities fostered in the Curriculum. It is, indeed, only one way of collecting information about student learning.
- Paper-and-pencil testing can only engage students with certain kinds of learning styles such as verbal-linguistic and logical, leaving other dimensions of learning or ability out of the assessment process.

In the broader concept of assessment, it includes other assessment procedures such as observing student performances and critiquing student projects and reports. This broadens the kind of information that is collected about students and the way that this information is used in the facilitation of student learning.

Assessment can be used as a tool to facilitate student learning. Assessment for learning is the practice of collecting evidence of student learning so as to provide feedback to the learners and to the learning process, as well as to examine the progress of the learners so that more appropriate strategies for the next stage of development can be planned and implemented. It

- focuses on how and what students learn;
- integrates into learning and teaching;
- advocates a shared understanding of learning objectives and the criteria by which students are assessed;
- develops student's capacity for self-assessment and reflection;
- advocates the notion that students are given constructive guidance, feedback on work and opportunity to improve on their work; and
- recognises the full range of student achievements.

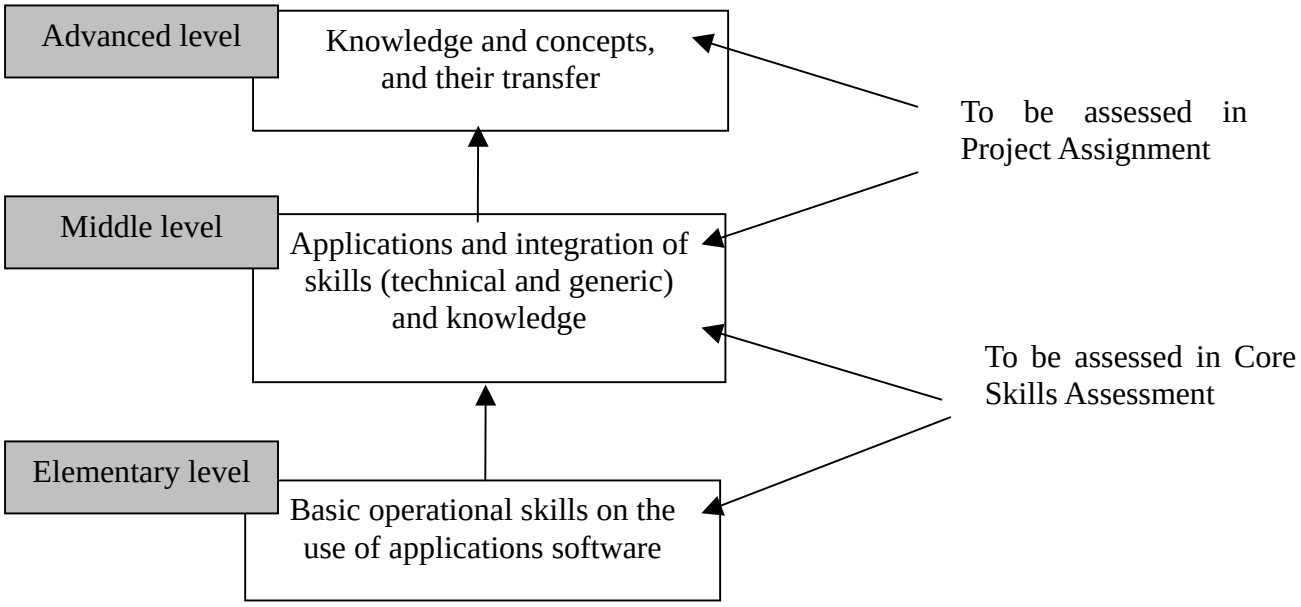
In assessment for learning, both the processes and the products of student work are equally important in student learning. Evaluation of student performance will be based on a broader concept of learning, ability and achievements. Teachers need to assess students' repertoire of learning strategies, skills in communicating with others, and knowledge and concepts as they are applied to real life and diverse contexts. This demands that teachers strive to provide new assessment techniques or procedures which are dynamic and continuous i.e. the School-based Assessment.

School-based Assessment (SBA)

In School-based Assessment teachers have the responsibility and flexibility for designing, constructing and administering assessment tasks, and for appraising student work. It recognizes teachers' professional judgments in the evaluation of student work. Based on the principles of assessment for learning, School-based Assessment should be on-going, formative, comprising multiple assessment and multidimensional with integrated / contextualised tasks.

Throughout the course of Computer Applications there are concepts and knowledge, applications of computer skills, generic skills (communication, creativity, problem solving and critical thinking) and project management skills, which students should master or develop. There should, however, be a balance between the knowledge, concepts and understanding outcomes, and skills (technical and generic) outcomes.

School-based Assessment is structured around two assessment components, comprising the Core Skills Assessment and a Project Assignment. These are used to measure the three cognitive levels prevailing in the course, as depicted in the following diagram



School-based Assessment of the three cognitive levels in AS-level Computer Applications

Core Skills Assessment

One of the assessment objectives involves practical skills that cannot be readily and adequately assessed by written examinations. The Core Skills Assessment aims at evaluating whether students can perform the required tasks, irrespective of how long it may take them to grasp the skills. In Core Skills Assessment, students are required to demonstrate their competence through various problem-solving tasks using major features of computer applications software and a wide range of abilities and skills stipulated in the Curriculum. The Core Skills Assessment is an ongoing process for the development of students' practical skills. Not only should teachers assess students' performance in Core Skills Assessment, but also analyse students' performance so as to provide formative feedback to facilitate student learning. Teachers can help students to develop a portfolio of

learning and assessment throughout the course and use feedback to inform students of their strengths and weaknesses in order to motivate and reinforce their learning.

The assessment on students' core skills, however, should not be confined within class time nor solely within the context of this Curriculum, for computer skills have now become everyday life skills. Students may demonstrate their competency in computer skills in an interdisciplinary manner.

Project Assignment

The Project Assignment is a powerful instrument to assess nearly all dimensions of learning; knowledge and concepts, technical and generic skills, and values and attitudes. It taps the power and diversity of active learning of students. In doing the Project Assignment, students should be asked to use a wide range of cognitive processes and abilities such as to perform, create, produce or do something that requires them to use higher-level problem-solving skills or thinking skills to analyze and to interpret their work and to reflect or evaluate their quality of learning. What is assessed is what is valued. So in designing the assessment criteria, teachers should include not just the knowledge aspect but also other learning dimensions or values that the Curriculum advocates.

Public Examination

The public examination consists of a written paper, Paper 1, and a School-based Assessment component, Paper 2. Paper 1 carries 70% of the overall subject mark. There will be Section A and Section B in Paper 1. Section A will consist of short questions while Section B will comprise of long questions. This paper will be a common paper to Advanced Level Computer Studies. Paper 2 is a School-based Assessment component which carries 30% of the overall subject mark. Students will be assessed internally at schools by their teachers. As mentioned previously, it will consist of the Core Skill Assessment and a Project Assignment.

The detailed assessment criteria, rules and regulations as well as assessment modes can be found in the Hong Kong Advanced Level Examination Regulations and the Advanced Supplementary Level Computer Applications School-Based Assessment Handbook published by the Hong Kong Examinations and Assessment Authority. Teachers and students should refer to these documents for further information.

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