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A Preliminary Study on the Impact of IT on Curriculum with Reference to the Primary Mathematics Curriculum in Hong Kong

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This paper begins with a discussion about the nature of curriculum in the new century with special reference to the implementation of IT in education. The benefits of IT in education are presented with relevant research findings. Next, the development of the school curriculum and the primary mathematics curriculum in Hong Kong are described. It is worth noting that due emphasis is laid on the development of higher order thinking skills in the curriculum, which is a major concern of the present research. This paper reports the first-stage findings of the research based on a questionnaire survey targeted at 276 schools, 100 school heads and 180 mathematics panel heads. The questionnaire seeks views on possible benefits of IT in education, its impact on the school curricu-

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lum and the teacher and mathematics teaching. Based on the results of the study, several recommendations are made for the implementation of IT in education.

Key words: information technology; school curriculum; primary mathematics curriculum

Introduction

In view of the significant social, economic, and political changes, and rapid developments in information technology in the past few decades, there has been increasing public concern over many education issues. It was agreed that there was a need to conduct a comprehensive review which would aim to enhance the overall quality of education and meet the new challenges in the twenty-first century. As a result, the Education Commission (2000) put forward the aim of education as:

> To enable every person to attain all-round development in the domains of ethics, intellect, physique, social skills and aesthetics according to his/her own attributes so that he/she is capable of life-long learning, critical and exploratory thinking, innovating and adapting to change; filled with self-confidence and a team spirit; willing to put forward continuing effort for the prosperity, progress, freedom and democracy of their society, and contribute to the future well-being of the nation and the world at large. (p. 30)

In his Inaugural Policy Address, The Chief Executive of Hong Kong, Mr. Tung Chee Hwa, pledged to make Hong Kong " a leader, not a follower, in the information world of tomorrow" (Education and Manpower Bureau, 1998). One key implication is to empower people with skills to use information technology (abbreviated as IT hereafter) and this relies on the successful application of IT to enhance the effectiveness of the school curriculum to equip students with the knowledge, skills and attitudes they need to meet the challenges of the information era.

Clearly, the use of IT in teaching and learning must be accompanied by a corresponding change in the curriculum. A five-year strategy has been

drawn up to implement IT in education (Education and Manpower Bureau, 1998). One of the missions of the Five-Year Strategy is to integrate IT into school education meaningfully through necessary curriculum and resource support. It is expected that 25% of the school curriculum should be taught with the support of IT.

Information is not yet knowledge. How information could be transformed into knowledge becomes the major task for learning. Students should learn how to process information, interpret and transform it. They need to develop higher order thinking skills more than anything else. Quality education should be targeted at helping students acquire these skills. Furthermore, The United Nations Educational, Scientific and Cultural Organisation (UNESCO) Report (1996) points out that education should be organised around four fundamental types of learning which will be the pillars of knowledge: learning to know, learning to do, learning to live together, learning to be. Hong Kong is undergoing a major education reform, the theme of which is *Learning to Learn*. IT in education is seen as the most powerful tool to achieve all these learning targets.

Potentials of IT in Education

Papert and LOGO

A lot of research has been conducted to investigate the benefits of using the computer in schools in the past decades. Probably the most well known computer-based application of constructivism is LOGO. It is a computer language developed by Papert which was designed to reflect and promote Piagetian learning (Papert, 1980). LOGO is a primary example of an application of constructivism based on "microworlds" in which one can go to learn about a specific domain through personal discovery and exploration.

Papert (1980) suggested that microworlds should fulfil four criteria. They should be simple, general, useful and syntonic. Syntonic learning indicates moving from the known to the unknown. Computers, with appropriate softwares, could promote syntonic learning by providing children with ex-

tended opportunities to explore aspects of the world previously unavailable to them.

Two major themes have shaped Papert's research agenda on computers and education. He argues "that children can learn to use computers in a masterful way, and that learning to use computers can change the way they learn everything else" (Papert, 1980). Papert believes that computers can allow us to shift the boundary separating the concrete and the formal. Knowledge that was accessible only through formal processes can now be approached concretely.

Computers in the educative processes offer instructors unique opportunities to individualise instruction, place learners in open-ended student-centred investigations, and for instructors to shift from their traditional instructor role to those of mentor and co-learner. The development of softwares that supports this mode of instruction is growing popular.

Constructivism and IT in Education

According to constructivists, thinking is grounded in perception of physical and social experiences, which can only be comprehended by the mind. The mind, in effect, filters input from the world to make interpretations which then form a knowledge base that is personal and individualistic. We all conceive of the external reality somewhat differently, based on our unique set of experiences with the world and our beliefs about them.

Constructivism asserts that we learn through a continual process of constructing, interpreting, and modifying our own representations of reality based on our experiences with reality (Jonasssen, 1994). Perkins (1991) considers constructivism has important implications for education in our technological age. He argues that:

> Constructivism has multiple roots in the psychology of this century: the developmental perspective of Jean Piaget, the emergence of cognitive psychology under the guidance of such figures as Jerome Bruner and Ulrick Neisser, the constructivist perspective of philosophers such as Nelson Goodman. Central to the vision of constructivism is the notion of the organism as "active"-not

just responding to stimuli, as in the behaviourist rubric, but engaging, grappling, and seeking to make sense of things.

A potential benefit of computer education is that it is better suited for interactive learner responding (Pollock & Sullivan, 1990). Students can have the opportunity to participate actively in the learning process. Moreover, the integration of holistic, videodisc images and the more serial structuring of computer-based material provide an ideal platform for learning tasks designed to encourage transfer of knowledge and skills to novel and authentic contexts (Atkins & Blissett, 1992).

Multimedia softwares can be extremely responsive to individual users and allow them to view materials at their own pace. Moreover, feedback can be given instantly which can reinforce learning. Learners can be offered hints and clues when errors occur. Learning tasks are organised in terms of difficulty. Learners can tackle the tasks at different levels. Hence, IT in education can cater for learner differences. Multimedia gives learners the power to explore and manipulate information and enable individuals to construct their own "knowledge base". It provides constructivist learning environments (Collins Hammond & Wellington, 1997).

A lot of research gives evidence of the effect of using computers in the classroom on the motivation of students. Since the early days of using small microcomputers, there have been reports of students staying longer on task, increasing their commitment to learning, achieving more through the use of computers and of being enthusiastic about using computers in their lessons. The use of IT has been demonstrated to enhance motivation (Cox, 1997).

Findings of the National Council for Educational Technology

The National Council for Educational Technology (NCET), the body advising the government on the use of technology in education in the United Kingdom, published a compendium of research findings entitled Information *Technology Works!* (NCET, 1994). This report made 27 assertions with supporting references focusing on how the application of IT enhances pupils' learning. They are as follows:

1. Children who use a computer at home are more enthusiastic and confident than using one in school.
2. Video games can be educational if they are well managed.
3. IT can provide a safe and non-threatening environment for learning.
4. IT has the flexibility to meet the individual needs and abilities of each student.
5. Students who have not enjoyed learning can be encouraged by the use of IT.
6. Computers give students the chance to achieve where they have previously failed.
7. Computers can reduce the risk of failure at school.
8. IT allows students to reflect on what they have written and to change it easily.
9. Using a computer to produce a successful piece of writing can motivate students to acquire basic literacy skills.
10. IT gives students immediate access to richer source materials.
11. IT can present information in new ways which help students to understand, assimilate and use it more easily.
12. IT removes the chore of processing data manually and frees students to concentrate on its interpretation and use.
13. Difficult ideas are made more understandable when information technology makes them visible.
14. Interactive technology motivates and stimulates learning.
15. Computing programmes which use digitised speech can help students to read and spell.
16. IT gives students the power to try out different ideas and to take risks.
17. Computer simulations encourage analytical and divergent thinking.
18. IT is particularly successful in holding the attention of pupils with emotional and behavioural difficulties.
19. IT can often compensate for the communication and learning difficulties of students with physical and sensory impairments.
20. Pupils with profound and multiple learning difficulties can be encour-

aged to purposeful activity and self-awareness by IT.

21. Using IT enables teachers take a fresh look at how they teach and the ways in which students learn.
22. Computers help students to learn when used in well-designed, meaningful tasks and activities.
23. Students make more effective use of computers if teachers know how and when to intervene.
24. IT offers potential for effective group working.
25. Giving teachers easy access to computers encourages and improves the use of IT in the curriculum.
26. Head teachers who use computers raise the profile of IT in their schools.
27. Management Information Systems can help save money and time in schools.

In the latter part of this paper, the findings of the questionnaire issued to schools will be compared with some of the assertions made by the NCET.

Informatics and Vygotsky

Vygotsky (1978) advocates a school of thought of educational psychology known as social interactionism, which adds the importance of the location of human learning within a social-cultural environment to the idea of learners constructing their own knowledge and understanding. Learning takes place through engagement with contextualised and situationalised socio-cultural environments and through "contact with a culture of material and social resources that everywhere supports cognitive activity". Learners are helped to select and shape the learning experiences presented to them and move into and through the next layer of knowledge or understanding called the zone of proximal development. IT can be seen to have mediatory potential in the Vygotskyan sense.

Vygotsky's influence is further related to informatics capability (Ridgway & Passey, 1993). Informatics is a new tool which promises new sorts of cognitive development, and has produced a good set of cultural change. Vygotsky has a number of important ideas for educationists:

> Informatics will change thinking, and the ways that individuals see the world; informatics will take on a role of defining cultures; learning can begin in piecemeal ways, but informatics capability needs to be integrated with other intellectual tools before it becomes a higher order skill; teaching should focus on the power the new ideas give the users over situations.

Teachers face a difficult challenge — to help adults learn to think in new ways, and to inculcate IT in school communities which already have stable cultural practices which work quite well for teachers.

The Post-modern Curriculum

Doll (1993) asserts that modernism as an all-encompassing intellectual movement has outlived its usefulness, yet its influence on curriculum practice is still profound. We are in a new stage of intellectual, political and social development. It is time to do more than reform our methods and practices. It is time to question the modernist assumptions and develop a new prospective that simultaneously rejects, transforms and preserves that which has been. In curriculum terms, the managed, mechanistic, large-scale, predictable, behavioristic, objectives-driven and dehumanized modernistic bureaucratic curriculum is characterized by the Tylerian rationale (Tyler, 1949).

Post-modernity

We are moving from a modernist world and a modernist conception of the world to a postmodern world and a postmodernist conception of the world. Major changes have taken place in recent times.

Doll (1993) argues that the educational views of Dewey, Piaget and Bruner are better understood from a post-modern perspective. Dewey's concepts of experience and transaction, Piaget's of development and reequilibration, and Bruner's of learning and thought blossom more fully and richly in a post-modern milieu.

Because change is exponential, it is not possible to say with certainty

what the citizens of the twenty-first century will need from their schools. The aims, objectives, content, pedagogy, evaluation and direction of the curriculum are not fixed, but fluid. One of the educational challenges in the post-modern mode is to design a curriculum that both accommodates and stretches, a curriculum that has the essential tension between disequilibrium and equilibrium so that a new, more comprehensive and transformative re-equilibrium emerges.

The Shift of Paradigm in the Curriculum

The implications of a post-modern perspective for education and curriculum are enormous. The linear, sequential and easily quantifiable system dominating education today should give way to a more flexible, open and transformative network. Curriculum will be viewed not as a set, a priori "course to be run" but as a passage of personal transformation. The shift from the modernist paradigm to the post-modern paradigm in the curriculum is desirable. The curriculum needs to be modified to accommodate the technological functions. Technology allows students to gain control of information which was formerly the domain of the teacher, forcing teachers to relinquish absolute authority in the classroom. Students are respected as independent learners and teachers as managers of learning.

The following section discusses recent developments of school curriculum in Hong Kong.

The Development of School Curriculum in Hong Kong

The Target Oriented Curriculum

The Target Oriented Curriculum (TOC) Initiative has been implemented since 1992. More and more schools have adopted the initiative and in the year 1999/2000, more than 90% of the primary schools in Hong Kong have adopted it. Programmes of Study are initially prepared for the three core subjects: Chinese, English and Mathematics. TOC adopts a lot of sound educational principles. For the first time, stress is laid on five fundamental,

intertwining ways of learning and using knowledge across the curriculum, namely, communicating, inquiring, conceptualising, reasoning and problem solving (Curriculum Development Council,1995). Obviously, these belong to the category of higher order thinking skills. They are embodied in learning targets, tasks and assessments for each subject and permeate the entire curriculum. They will be discussed in detail later in the paper.

The new curriculum adopts target-oriented assessment based on criterion-referencing principles, with emphasis placed on judging and describing student performance in relation to targets or criteria, rather than rank ordering students relative to one another. Formative assessment which evaluates students' work in progress and provides regular feedback is emphasised.

Although TOC is generally accepted by teachers and educationalists because of the sound principles of teaching and learning, its implementation has met with considerable resistance. First, teachers find it difficult to promote the five skills, perhaps due to their lack of professional knowledge. Second, it is difficult to cater for learner difference due to the lack of suitable graded tasks and learning materials and large class size. Third and the greatest problem lies in the criterion-referencing assessment which creates unmanageable workload for teachers (Faculty of Education, The University of Hong Kong,1996).

TOC shows a marked improvement over the curriculum in the past. It is moving towards the direction of a postmodern curriculum as evidenced by the following features:

- the curriculum is process-oriented rather than focusing on the product only;
- it lays emphasis on the development of higher order thinking skills and fosters creativity;
- the teacher is no longer the authority in the classroom. Instead, he/she acts mainly as a facilitator, helping children construct knowledge. Knowledge is not simply transmitted;
- curriculum strategies address learner differences. Graded tasks were used to cater for students with different abilities.

However, the curriculum is handicapped by its inherent modernist nature in that

- it is still prescriptive and system-driven. The linear sequence of the Tyler Model is followed: chosen targets, selected experiences, effective organisation and evaluation;
- its degree of openness is limited, since there is prediction and control;
- it assumes development based on stability; the concept of order emerging from chaos is lacking, and
- it is not transformative enough and there is limited self-organisation.

Although TOC has met with obstacles and problems, it is an important milestone in the development of the school curriculum in Hong Kong. The emphasis on higher order thinking skills lays foundation for the development of a new curriculum in the new millennium.

Learning to Learn

The Education Commission started the review of education system in Hong Kong in 1998 and formulated a blueprint for the development of education in the 21st century according to the latest trends of development and the needs of society in the future (Education Commission, 2000). The overall aim is to offer all-round and balanced learning opportunities, and to lay the foundation for lifelong learning. In parallel with the Education Commission' review, a holistic review of the school curriculum was conducted during 1998-2000. *Learning to Learn* is chosen to be the theme of the holistic review. The focus of the review is to examine the experiences of curriculum development in Hong Kong, find out what is worth learning to achieve the aims of education for the 21st century and how to facilitate effective teaching and learning. The Curriculum Development Council (2000a) a stresses that "a quality curriculum for the 21st century should therefore set the directions for teaching/learning through a coherent and flexible framework which could be adaptable to changes and different needs of students and schools." (p. 17)

Five learning experiences are identified fundamental as follows: moral

and civic education, intellectual development, community service, physical and aesthetic development and lastly, career-related experiences. One noteworthy component is that of generic skills which is fundamental to help students learn how to learn in the curriculum framework. They refer to collaborative skills, communication skills, creativity, critical thinking skills, information technology skills, numerarcy skills, problem solving skills, self-management skills and study skills. In the new curriculum, information technology skills are highlighted. They help students to seek, absorb, analyse, manage and present information critically and intelligently in an information age and a digitised world. The new curriculum with emphasis on student-centred learning and the development of generic skills shares the features of a post-modern curriculum to a certain extent.

Mathematics in the Target Oriented Curriculum

The learning dimensions for mathematics are: numbers, measures, algebra, shapes and space, and data handling. The subject learning target for mathematics is stated in the Programme of Study for Mathematics (Curriculum Development Council, 1995) as follows:

> To develop an ever-improving capability to conceptualise, inquire, communicate, and reason mathematically, formulate and solve mathematical problems, appreciate the beauty of mathematics and apply mathematics to different contexts through the learning of the knowledge, concepts and skills/ procedures in number, measures, algebra, shape & space and data handling. (p. 6)

The five ways of learning and using knowledge have been stressed in mathematical education. It is expected that children can develop them as they acquire mathematical knowledge. It is useful to give an interpretation of them before going further.

Communicating

Children learn to understand and use the spoken word before learning to write. The spoken language is a chief means of communication. It is impor-

tant that when children learn mathematics, teachers should help them develop their ability to talk about mathematical ideas and to write about them. In learning mathematics, children engage in a lot of written work in tasks and exercises. Explaining a result, describing the methods used in solving a problem or carrying out an enquiry and interpreting a graph are among the written tasks which provide opportunities for children to develop their writing skills in mathematics. As communication skills can be enhanced by visual presentation, teachers should make use of models, diagrams, charts and graphs in mathematics teaching as far as possible. They should also provide opportunities for children to extract, appraise and use mathematical information from a range of other sources such as topic books, reference books, advertisements, newspaper, radio and television (Curriculum Development Council,1995).

Conceptualising

In order to develop a concept, children need a variety of experiences in which the concept is present in some form. These experiences need to be carefully planned and provided for the children in order to promote their understanding of the concepts. Furthermore, mathematical concepts are often inter-related. For example, multiplication is linked with addition and percentages are linked with fractions and decimals. It is important that children learn the relationship between relevant concepts. Teachers should place due emphasis on helping children grasp such concepts.

Reasoning

Reasoning is a fundamental ability which children need to develop at all stages of mathematics learning (Curriculum Development Council, 1995). Very often, it is of the form "if p then q". In the classroom, children often learn through observations to induce concepts and patterns. It is important that reasoning should not be taught formally at this level, but it is necessary that reasoning should involve informal thinking, making hypothesis and validating them. Children should learn to justify their answers and solution processes.

Problem Solving

The essence of mathematical education is to help children to learn and apply mathematical knowledge and techniques to tackle and solve problems. In the course of problem solving, four processes are identified (Polya, 1945). Firstly, children have to understand the problem in terms of the vocabulary and concepts involved and the requirements of the problem. Secondly, they have to choose an appropriate strategy and have to process data in carrying out the strategy. Thirdly, they have to communicate the solution or conclusions of the problem. Finally, they have to evaluate the solution or conclusions.

Inquiring

The various ways of learning and using knowledge need not be isolated form each other but may all be part of the same activity. There are no clear distinctions between problem solving and inquiring. Nevertheless, in broad terms it is useful to think of problem solving as an activity where children have to reach a solution to a given problem. In an enquiry, children are encouraged to adopt alternative strategies to arrive at reasonable conclusions. In particular, inquiring is involved in discovering and constructing knowledge through questioning or testing a hypothesis (Curriculum Development Council, 1995).

The 2002 Mathematics Curriculum

Research studies conducted in 1998 for supporting a holistic review of the Hong Kong mathematics curriculum, revealed that the existing mathematics curriculum was generally content-oriented, rather packed and difficult (Curriculum Development Council, 2000b). The primary mathematics syllabus has been revised consequently. Changes include a reduction of subject content especially the more difficult content, such as the area of circle (about 15% has been trimmed down) and the introduction of the new topic probability. There is a more evident shift of emphasis from rote procedures

and meaningless drilling to the development of thinking abilities. The CDC Committee on Mathematics Education (Curriculum Development Council, 2000b) holds the following view:

> High technology like computers and calculators has profoundly changed the world of mathematics education. Students should master information technology to become more adaptive to the dynamically changing environment. Mechanical drilling and impracticable topics are no longer essential and relevant in mathematics learning.
>
> It is important for our students to gain experience and acquire foundation knowledge and skills, develop capabilities to learn how to learn, think logically and creatively, develop and use knowledge, analyse and solve problems, access and process information, make sound judgements and communicate with others effectively. (p. 3)

The use of IT is encouraged in the teaching and learning of mathematics. Computers and calculators will be tools for learning mathematics in the classroom. Similar to TOC, higher-order thinking skills are emphasised in the new curriculum. Examples showing how the nine generic skills can be experienced through the course of mathematics learning are provided in the new curriculum. The new curriculum is based on a sound rationale, but to implement it effectively, teachers need to be equipped with technological skills and appropriate pedagogical approaches.

Implementing IT in Education in Primary Schools in Hong Kong

Hong Kong is lagging behind many advanced countries in the implementation of IT in education, for example, US, UK and Singapore. In UK, a government circular, New Technology for Better Schools (Department of Education and Science,1987), clearly spelled out the need for schools to use IT to enhance the quality of teaching and learning. This was reinforced in the *Curriculum Matters 15: IT from 5 to 16* (Her Majesty Inspectorate, 1989). IT has been incorporated into all subjects in the National Curriculum as well as having an Attainment Target dedicated to it in the subject of

Technology (Department of Education and Science, 1990). In Hong Kong, the document *Information Technology for Learning in a New Era Five-Year Strategy 1998/99-2002/03* (Education and Manpower Bureau,1998) was released to promote and implement IT in education. In 2000, the document *Information Technology Learning Targets* (Curriculum Development Council, 2000c) was finalised to serve as a guideline for schools to organise teaching and learning activities to develop IT capabilities of students. The research study conducted by the author seeks to investigate the following:

1. Is there a paradigm shift from a modernist view of the curriculum to a post-modern view of the curriculum with the application of IT in education?
2. Can IT in education promote TOC and the development of higher order thinking skills?
3. What is the impact of the application of IT in education on the primary mathematics curriculum in Hong Kong?

Research Instruments

In the research, quantitative as well as qualitative techniques are employed. Questionnaires are used to collect the view of the different sectors of people involved including school heads, curriculum coordinators and mathematics panels. Interviews are conducted to collect relevant data. The target interviewees include school heads, teachers, students, parents and officers in the Education Department. Case studies are conducted to investigate the actual phenomenon of implementation of IT in schools. Three schools at different levels of implementation are identified. They are visited at various stages of the research to investigate the whole process.

This article focuses on the analysis of the questionnaire issued to schools in the early months of 2000. It reveals important findings that address the objectives of the research. The second stage of case studies including interviews and school visits is being conducted. The findings will be disclosed in another article.

The questionnaire was first constructed in English and then translated

into Chinese. The Chinese version was pilot tested in 1998 with four primary school heads and a class of 25 students who were serving teachers and taking the B.Ed degree course in the Hong Kong Baptist University. A short discussion on the questionnaire was held after they had completed the questionnaire. The participants found it comprehensive and relevant to the research. A few ambiguous questions were amended subsequently.

The method of stratified random sampling is adopted. More than 100 primary schools including school heads, curriculum coordinators and mathematics panels completed and returned the questionnaires. 276 primary school teachers and curriculum co-ordinators and 180 mathematics panels responded to the questionnaires.

Findings and Discussion

The questionnaire consists of 4 parts(see Appendix). Participants were requested to rate each item on a five-point scale, ranging from "Strongly agree" (5) to "Strongly disagree (1), or "A great deal" (5) to "Not at all" (1), or "Yes" or "No", depending on the nature of the items.

Table 1 Mean ratings/percentages of responses to the items assessing Information Technology and the School Curriculum

Items	Mean	SD
• an open and flexible curriculum(2)	4.28	.54
• a new school curriculum needed(1)	4.20	.61
• emphasis on higher order thinking skills(5)	3.72	.69
• facilitating assessment(7)	3.42	1.94
• change in the content of learning and its nature(3)	3.36	.69
• catering for learner differences(6)	3.16	.76
• promoting the Target Oriented Curriculum(8)	2.96	.70
• softwares available to facilitate IT in education(4)	2.50	.68
	Frequency	Percent
• The school where I work has drawn up a school-based policy of implementation of IT in education.(9)		
Yes	169	61.3
No	92	33.3
Missing	15	5.4

Note: Numbers in parentheses refer to item numbers in the questionnaire.

It can be seen from Table 1 that participants strongly agree that a new curriculum is needed and that the curriculum should be open and flexible. More than half of the schools have already drawn up a school-based plan of implementation of IT in education.

Teachers and school heads hold a positive view on the possible benefits of using IT in education. They believe that IT can be used to facilitate assessment. However, they find that there is insufficient softwares for use in education.

The general agreement that IT can cater for learner differences is in concord with assertion 4 made by the NCET that "IT has the flexibility to meet the individual needs and abilities of each student" (NCET, 1994). They strongly believe that the new curriculum using IT in education should lay emphasis on the development of higher order thinking skills. This again is in agreement with several assertions made by NCET on the benefits of IT, for example, No. 17: "Computer simulations encourage analytical and divergent thinking." and No. 12 "IT removes the chore of processing data manually and frees students to concentrate on its interpretation and use." (NCET)

Table 2 Mean ratings of responses to the items assessing Information Technology and the Student

Items	Mean	SD
• should learn to use IT (10)	4.08	.78
• motivating them to learn (14)	3.64	.60
• encouraging them to become independent learners (15)	3.48	.70
• promoting higher order thinking skills (16)	3.35	.72
• skills of using IT for learning too difficult to master (11)	2.96	.97
• diverting attention and effort from their studies (12)	2.39	.74
• finding information through the Internet for learning (13)	2.21	.69

Note: Numbers in parentheses refer to item numbers in the questionnaire.

Table 2 shows that there is a strong agreement that all students should learn to use IT to acquire knowledge and skills and that IT in education can encourage students to become independent learners. Teachers and school heads tend to disagree that IT skills are difficult for children to master, IT in education diverts their attention and efforts from their studies and that chil-

dren can find information through the Internet for their learning to a great extent.

The strong belief that IT in education can motivate students to learn is in agreement with assertion No.14 made by the NCET: "Interactive technology motivates and stimulates learning" and No.5 "Students who have not enjoyed learning can be encouraged by the use of IT" (NCET, 1994). Teachers and school heads generally believe that IT in education can promote higher order thinking skills. This again echoes assertion No.17 and No.12 mentioned above.

Table 3 Mean ratings/percentages of responses to the items in assessing Information Technology and the Teacher

Items		Mean	SD
•	enjoying using IT in everyday life (18)	3.92	.61
•	training needed to become competent (34)	3.67	.82
•	facilitating administrative work in school (30)	3.62	2.63
•	confidence in using IT to teach students (24)	3.53	.81
•	changing teacher's role from instructor to facilitator (33)	3.52	.69
•	enhancing teaching and learning (32)	3.50	2.54
•	familiar with the use of IT (17)	3.47	.85
•	adequate knowledge of using IT in education (19)	3.25	.89
•	insufficient IT facilities in school (22)	3.14	1.08
•	using the Internet (28)	3.06	1.25
•	hindering the effective delivery of teaching (20)	2.58	.78
•	applying IT in teaching and learning in school (31)	2.54	.91
•	students will challenge the teacher's authority more than before (23)	2.30	.85
•	using computer communication with colleagues (27)	2.12	.97
•	fewer teachers needed as a result of IT use (21)	2.09	.77
•	using multimedia educational softwares in teaching (29)	2.03	.87
•	using Powerpoint presentations in classroom teaching (26)	1.96	.96
•	communicating with students through the E-mail system (25)	1.58	.81
		Frequency	Percent
•	I have read carefully the booklet entitled *Information Technology for Learning in a New Era: Five-year Strategy 1998/99 - 2002/03* published by the Education and Manpower Bureau in 1998. (35)		
	Yes	135	48.9
	No	138	50.0
	Missing	3	1.1
•	On the whole, I advocate using IT in education. (36)		
	Yes	252	91.3
	No	19	6.9
	Missing	5	1.8

Note: Numbers in parentheses refer to item numbers in the questionnaire.

It is noteworthy from Table 3 that the majority of teachers and school heads enjoy using IT in everyday life and that they advocate using IT in education. This certainly helps to promote IT in education. A bit unexpectedly, they show confidence in using IT to teach their students. However, in practice, they do not often use Powerpoint presentations in teaching or multimedia educational softwares in teaching.

The majority of teachers and school heads express the view that they need training so that they can become more competent in using IT in education. Only about half of them have carefully read the booklet *IT for Learning in a New Era.*

Teachers and school heads generally think that using IT in the classroom enhances teaching and learning. This echoes assertion No. 22 made by NCET: "Computers help students to learn when used in well-designed, meaningful tasks and activities"and No.13: "Difficult ideas are made more understandable when information technology makes them visible."(NCET, 1994)

Table 4 Mean ratings of responses to the items in assessing Information Technology and the Mathematics Teacher

Items	Mean	SD
• making mathematics learning more interesting and motivating (45)	3.80	.62
• helping children learn Data Handling more effectively (44)	3.75	.62
• training in using IT to teach mathematics needed (41)	3.58	.81
• promoting mathematics education (37)	3.52	.63
• revising the present mathematics curriculum to accommodate the use of IT (39)	3.52	.74
• helping students to grasp mathematics concepts (38)	3.41	.63
• enhancing children's problem solving ability (42)	3.31	.67
• distracting children from learning mathematics (43)	2.64	.75
• softwares available to facilitate mathematics teaching (40)	2.48	.69

Note: Numbers in parentheses refer to item numbers in the questionnaire.

Table 4 shows that the majority of mathematics teachers are of the opinion that IT in education promotes mathematics education to a great extent. They also believe that it helps students to grasp mathematics concepts. This

is in agreement with assertion No.13 made by the NCET: "Difficult ideas are made more understandable when information technology makes them visible" (NCET, 1994). They also think that it can help children learn data handling more effectively and this is in agreement with assertion No.12: "IT removes the chore of processing data manually and frees students to concentrate on its interpretation and use" (NCET). More importantly, it enhances children's problem solving ability in mathematics. Again this echoes assertion No. 17: "Computer simulations encourage analytical and divergent thinking."

Teachers and school heads strongly believe that IT in education can make mathematics learning more interesting and motivating. This is in concord with assertion No. 14 and No. 5 mentioned above. However, they also express the view that the present mathematics curriculum must be revised to accommodate the use of IT and that there is a lack of softwares to facilitate mathematics teaching. It is worth noting that the majority of them are of the opinion that a lot of training is needed to enable them to teach mathematics competently with IT.

Further Findings from the Analysis of the Questionnaires

1. The chi-square test is used to find out whether there is any relationship between gender and the confidence in using IT in teaching (Q24, see Appendix).

   The chi-square value is 3.82 and the significant value is 0.431. The result is non-significant at the level of 0.05 showing that there is no relationship between the two variables.
2. The chi-square test is also used to find out whether there is any relationship between gender and the view on using IT in education (Q36).

   The chi-square value (continuity with correction) is 0.179 and the significant value is 0.672. The result is non-significant at the level of 0.05 showing that there is no relationship between the two variables.
3. The t test is used to compare the means of two samples: the mean familiarity with use of IT of male and female teachers (Q17).

The computed t value of 0.954 and the one-tailed level of significance is 0.171. The result is non-significant at the level of 0.025. There is no significant difference in mean familiarity with the use of IT between male and female teachers.

4. Correlation studies are also conducted. From the correlation analysis, the following observations are noteworthy:
   a. Teachers' and school heads' familiarity with IT use (Q17) was highly correlated with their confidence in using IT to teach their students (Q24). (r=0.568).
   b. Their view on the need of a new school curriculum (Q1) was highly correlated with their view on students' learning to use IT (Q10). (r=0. 448)
   c. Their view on the extent IT in education can motivate students to learn (Q14) was highly correlated with their view on the extent IT in education can promote higher order thinking skills (Q16). (r=0.471)
   d. Mathematics teachers' view on the extent IT in education can promote mathematics education (Q37) was highly correlated with their view on the extent IT in education can help students grasp mathematics concepts (Q38). (r=0.691)
   e. Mathematics teachers' view on the extent IT promotes problem solving ability (Q42) was highly correlated with the extent IT can help students grasp concepts (Q38). (r=0.556)

Implications and Recommendations

The questionnaire analysis leads to the consideration of the following implications.

Curriculum Change

The survey reveals that an overwhelming majority of teachers and heads advocate the design of a new curriculum to equip students with skills to cope with the changes in the new millennium and that the curriculum should

be open and flexible. In Hong Kong, schools are now preparing for transition to a new curriculum framework and developing a school-based curriculum using the framework to suit the needs of students. The new curriculum has certain features of a post-modern curriculum. There is due emphasis on constructivism and the development of thinking skills. IT in education has been highlighted. An important strategy is to help students to acquire the skill of using and applying information technology. The fast pace of IT development creates new learning cultures and innovative pedagogical practices. Teachers should take initiative in keeping abreast of IT developments, understanding their impact on the curriculum and implementing them in schools. Schools should be the learning organisations and should work collaboratively to improve learning and teaching by implementing IT in education. They should continue to develop the curriculum that integrates the use of IT to achieve key curriculum goals of the school. It is desirable to further develop the curriculum so that it has the major qualities of a post-modern curriculum as advocated by Doll.

Hardware and Software Provision

The hardware, networking and software infrastructure provisions in Hong Kong schools are relatively poor in comparison to other countries, especially at the primary level (Law, 1999). The student computer ratio of 53:1 at the primary level compared with many other countries is low. Moreover, the provision of only one to two computer rooms in schools can only give students opportunities to use the computer for one period per week. This clearly affects learning and teaching using IT. This area clearly needs improvement. Greater resource support from the government is indispensable.

Most of the respondents are of the opinion that Hong Kong is lacking in softwares to facilitate IT in education. Moreover, the softwares that exist in the market is of low quality. One of the features of multimedia technology is that it gives a wealth of information through a wide range of special effects including animation, video and sound. But more than that, teachers

need to look beyond the special effects and consider the real educational value of the multimedia. Teachers should avoid the indiscriminate use of softwares.

Training and Professional Development

It is encouraging to find that teachers and heads generally hold a positive attitude to the implementation of IT in education and that they understand its potential benefits. At the same time, they express the need for training to help them become competent in using IT in education. At present, all teachers are obliged to take up training courses on IT but the courses focus on basic computer operation skills and general applications rather than on the more advanced IT techniques or pedagogical applications (Law, 1999). It is important that teachers learn how to use multimedia and how they can incorporate it into their teaching. Furthermore, they need to know their role in supporting learning using multimedia. The government needs to offer effective training programmes to help teachers implement IT in teaching and learning effectively.

IT and Mathematics Teaching

The survey reveals that mathematics teachers are generally aware of the benefits of using IT in mathematics teaching. However, most of them lack competence in applying IT in their teaching. They need to know how the appropriate use of IT can help achieve their teaching objectives effectively. They should assess the potentials of mathematics-specific softwares for helping them to meet teaching objectives and evaluate the success of its use in relation to teaching objectives. They should consider the impact of the use of IT on the conduct of the mathematics lesson and how this is to be managed. They should learn how to use IT to provide learning activities to explore alternatives and model relationships, consider causes and effects, predict and recognise patterns and rules and make hypotheses.

It is also strongly agreed that IT in education can enhance the development of higher order thinking skills such as those advocated by TOC. Further

research is needed to investigate how these skills can be enhanced through teaching and learning.

Conclusion

IT has the potential for exciting changes in education in terms of what children learn and how they learn. Clearly, it has a great impact on the school curriculum. The shift of paradigm in the curriculum is inevitable. The post-modern curriculum is desirable in this new millennium. Moreover, teachers need to know how to use technologies to support teaching and learning. Making the connection between the art of teaching and the children's experience of IT lies at the heart of the development of IT capability for teachers. The impact on the development of higher order thinking skills will be a topic of great interest in educational research. Finally, when schools are implementing IT in education, it is important to conduct a systematic evaluation of the impact of IT on children's standards of achievement and quality of learning.

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Appendix

Questionnaire

Part 1: Information Technology and the School Curriculum

This part consists of 9 statements/questions.

Q1 – Q3 (Strongly agree to Strongly disagree)

Q4 – Q8 (A great deal to Not at all)

Q9 (Yes/No)

Q1 In the twenty-first century, a new school curriculum needs to be designed to equip students with skills to cope with the changes.

Q2 An IT-embedded curriculum should be open and flexible.

Q3 To what extent does an IT-embedded curriculum change the content of learning and its nature?

Q4 At present, how many softwares are available to facilitate IT in education?

Q5 To what extent should the new curriculum using IT lay emphasis on

the development of higher order thinking skills?

Q6 To what extent can the use of IT in education cater for learner differences?

Q7 To what extent can the use of IT facilitate assessment?

Q8 To what extent can the use of IT promote the Target Oriented Curriculum (TOC) in Hong Kong?

Q9 The school where I work has drawn up a school-based policy of implementation of IT in education.

Part 2: Information Technology and the Student

This part consists of 7 statements/questions.

Q10 – Q12 (Strongly agree to Strongly disagree)

Q13 – Q16 (A great deal to Not at all)

Q10 In the twenty-first century, all students should learn to use IT to acquire knowledge and skills.

Q11 Skills of using IT for learning are too difficult for students to master.

Q12 The use of IT in education diverts students' attention and effort from their studies.

Q13 To what extent can your students find information through the Internet for their learning?

Q14 To what extent can the use of IT in education motivate students to learn?

Q15 To what extent can the use of IT in education encourage students to become independent learners?

Q16 To what extent can the use of IT in education promote higher order thinking skills such as evaluating, reasoning, enquiring and problem solving?

Part 3: Information Technology and the Teacher

This part consists of 20 statements/questions.

Q17 – Q24 (Strongly agree to Strongly disagree)

Q25 – Q34 (A great deal to Not at all)

Q35 – Q36 (Yes/No)

Q17 I am familiar with the use of IT.

Q18 I enjoy using IT in my everyday life.

Q19 I have adequate knowledge of using IT in education.

Q20 IT hinders the effective delivery of teaching in the classroom.

Q21 Fewer teachers will be needed as a result of the implementation of IT in education.

Q22 There are insufficient IT facilities in my school.

Q23 Using IT in learning, my students will challenge my authority as teacher more than before.

Q24 I have confidence in using IT to teach my students.

Q25 How often do you communicate with your students through the E-mail system?

Q26 How often do you use Powerpoint presentations in classroom teaching ?

Q27 How often do you use computer communication with your colleagues to share materials and ideas?

Q28 How often do you use the Internet on the computer?

Q29 How often do you use multimedia educational softwares in teaching?

Q30 To what extent does IT facilitate administrative work in your school?

Q31 To what extent has IT been applied in teaching and learning in your school?

Q32 To what extent does using IT in your classroom enhance teaching and learning?

Q33 To what extent has IT in education changed the role of teacher from instructor to facilitator?

Q34 How much training do you need so that you can become competent in using IT in education?

Q35 I have read carefully the booklet entitled *Information Technology for Learning in a New Era: Five-year Strategy 1998/99-2002/03* published by the Education and Manpower Bureau in 1998.

Q36 On the whole, I advocate using IT in education.

Part 4: Information Technology and the Mathematics Teacher

All items (Strongly agree to Strongly disagree)

Q37 To what extent does IT in education promote mathematics education?

Q38 To what extent does IT in education help students to grasp mathematics concepts?

Q39 To what extent must the present mathematics curriculum be revised to accommodate the use of IT?

Q40 How many softwares are available to facilitate the teaching of mathematics?

Q41 How much training do you need to enable you to teach mathematics competently with IT?

Q42 To what extent does IT in education enhance children's problem solving ability in mathematics?

Q43 To what extent does IT in education distract children from learning mathematics?

Q44 To what extent does IT in education help children learn the dimension of Data Handling in mathematics more effectively?

Q45 To what extent can IT in education make mathematics learning more interesting and motivating?