Changing Classrooms & Changing Schools:

A Study of Good Practices in Using ICT in Hong Kong Schools

N. Law, H. K. Yuen, W. W. Ki, S.C. Li, Y. Lee, Y. Chow

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SITES Hong Kong Study Centre
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Preface

Prof. Tjeerd Plomp
University of Twente, The Netherlands

During the 1980's governments in many countries developed stimulation policies to introduce computers in education. Many of these policies were successful from a policy perspective to the extent that (almost) all schools started to use computers in some way or another for instructional purposes. In those years the focus was on 'teaching about computers' and on 'teaching with computers' without challenging too much our visions and beliefs about education.

In the 1990's policy makers and educators were challenged by the rapid development of telecommunication possibilities such as Internet and World Wide Web and their possibilities for teaching and learning. Besides, our societies expected education to pay attention to the development of meta-cognitive, information handling and social skills. New approaches to teaching and learning emphasised a constructivist approach viewing learning as a process of active knowledge acquisition, as a social activity and not just an individual one, as a process not bound to specific content and context.

It is in this mondial context that the HKG government decided in 1998 on a 5-year plan to incorporate IT into the school curriculum for enhancing the quality of education (Ch.1, p.3). The authors of this study report that "the response from schools and teachers to this plan was on the whole positive, though varied. Schools embarked with different degrees of enthusiasm and determination in their efforts to integrate ICT into the daily milieu of the school. Schools also differed in their visions and understanding of the contribution of the contribution of ICT to education as well as their implementation plans and strategies, in addition to the inevitable differences differences in student demographic characteristics existing among schools." (Ch.1, p.6).

In such a context, the question can be stated what type of research can support the implementation of IT in education the best. Here the researchers took an interesting starting point. Recognising that "Hong Kong is a late starter in terms of the establishment and implementation of its ICT policies" they decided that HKG education is best served with a careful and in-depth study of schools in their own country that are making the most efforts and progress in integrating ICT in classroom practices, in stead of studying the most innovative practices on the use of ICT in education that can be found 'world wide'. So they decided to study 'good practices' of the use of ICT in Hong Kong schools.

The result is an interesting report not only of a variety of uses of ICT in Hong Kong schools and classrooms. But the book also provides some intriguing conceptual approaches to the use of ICT in classrooms and schools that undoubtedly will inspire and invite readers to reflect on the 'why' and the 'how' of using ICT to enhance education.

Section II of the book focuses on 'ICT usage in the classroom'. In line with what we know from other research on implementation of change, it was found that the pedagogical approach adopted by the teacher is the key determinant for the way ICT is used in the lessons. Fullan (1991) indicated that there may be three dimensions at stake in processes of change: materials, methods and beliefs. The easiest change is the introduction of just new materials, the most complex change pertains all three dimensions. If the pedagogical beliefs of the teacher is not changing, then the use of ICT will be just a 'substitution' of certain functions until then fulfilled by the teacher. But when teachers are willing to reflect on their pedagogical approach, then ICT can become a powerful means or instrument in realising more student-oriented or process-oriented teaching-learning environments.

The researchers have identified five pedagogical approaches among the 'good' practices of ICT use: expository approach, inductive approach, tasks based approach, problem-base approach and social constructivist approach. They present these approaches as being 'found' in the lessons; they emerged from the data. But one may state the question whether these approaches can be looked at as consecutive stages of development of pedagogical beliefs. Further reflection and research may reveal this, which then may help policy makers, teacher educators and school and curriculum developers to develop strategies in which the introduction of ICT can be combined with discussions and reflections on pedagogical approaches.

Also section III of the book on 'ICT implementation at the school level' is a rich source for reflection. The researchers distinguish three models of change: the technological adoption model, the catalytic integration model and the cultural integration model. Coming back to Fullan's (1991) possible dimensions of education changes, materials, methods and beliefs, one can begin to describe the processes of change in the three models in terms of these dimensions. For example, in the technological adoption model there is only a change in materials and maybe in teaching methods, but certainly not in the beliefs of what education should be, while in the catalytic integration model there is clearly also a change in these beliefs. On the contrary, in the cultural integration model, the 'beliefs' about what is good education is already different from the 'traditional' beliefs, so one can say that in those schools the beliefs are already such that they can easily absorb ICT to enhance curriculum materials and teaching methods. This example illustrates not only the richness of the

data collected by the researchers, but also the way they have conceptualised the results clearly provides a starting point for further reflection and research.

But also some of the case studies are generating important questions. For example, it is interesting to see in chapter 10 (about the catalytic integration model) that two schools have decided to work at first via students to introduce IT and then expect the teachers to follow. This example raises questions about the strategy followed by these schools: Will teachers really follow? Or will they show a behaviour of avoiding IT, because they don't want to make themselves vulnerable towards their students? It would be interesting to follow these schools over time and study their developments. Longitudinal case studies of this type may result in a better understanding of how processes of change may evolve.

In conclusion, this book presents a rich set of case studies and the authors have provided us with some interesting and intriguing conceptual frameworks that forces us to reflect on strategies of implementation of ICT in schools and classrooms. I want to congratulate them with this research and I encourage them to follow up on it so that our understanding of processes of change in education will be deepened.

Reference

Fullan, M. (1991). *The New Meaning of Educational Change.* (2nd ed.). London: Cassell.

Part one:

Studying ICT Supported Pedagogical Practices in Schools

Chapter 1 Introduction

N Law

Background to the Study

During the past decade there has been an exponential growth in the use of information and communication technology (ICT) and this has made pervasive impacts both on the society and on our daily lives. It is thus not surprising to find increasing interest, attention and investment being put into the use of ICT in education all over the world. In addition to efforts in employing ICT to improve learning, the emergence of the knowledge economy has also brought about in recent years a much greater emphasis on education and a number of masterplans on ICT in education has been produced in many countries. Such masterplans detailed not only strategies for ICT implementation, but more significantly they are embedded within a broader framework of education reforms that aimed to develop students' capacities for self-learning, problem-solving, information seeking and analysis, critical thinking as well as the ability to communicate, collaborate and learn, abilities that figured much less importantly in the school curricula before.

Until 1997, as far as information technology is concerned, the use of computers in the schools of Hong Kong was only limited to the few computer-related subjects(e.g. Computer Studies, Computer Literacy) at the secondary school level. In 1997, the Chief Executive of the newly established HKSAR government expressed in his first policy address a much broader vision and a stronger concern for IT in education. Since then a series of initiatives to encourage and support the integration of IT across the school curriculum have been launched in primary and secondary schools. A year later, a five-year plan to incorporate information technology into the school curriculum for enhancing the quality of education was drawn up by the HK government. This marked a significant milestone in the development of a clear vision and implementation strategy for promoting IT application in education.

Thus, as in many other education systems, there is increasing pressure on Hong Kong not only to employ ICT in schools, but also to develop and implement educational reforms and programs that generate new ways of learning in order to equip citizens for the information society. At this juncture, major questions confronting policy-makers, principals, teachers, teacher educators, education related professionals as well as parents are: To what extent has progress been made in realizing these reforms? Are there gaps between objectives and educational reality? What innovations exist

and what evidence there is of their effectiveness? How does our education measure up to other countries with regard to its innovative potential? Is there anything we can learn from other countries in this regard? SITES (Second International Information Technology in Education Study) was commissioned to seek answers to such questions (Anderson, 1997). The first stage (SITES M-1, 1997-1999) of the Study was a survey of principals and technology coordinators in primary, lower secondary and upper secondary schools. The objective was to furnish initial indicators for various aspects of ICT use in schools (Pelgrum, 1999). Hong Kong was amongst the twenty-six educational systems that participated in SITES M-1, the results of which helped to reflect the status of ICT implementation in Hong Kong schools within an international context. Details of the Hong Kong Study were reported in (Law et al, 1999).

Law et al. (1999) pointed out that "... Hong Kong is a late starter in terms of the establishment and implementation of its ICT policies...", and the Study "exposes how ICT has widened the gap between schools." Given the short history in the deployment and integration of ICT to support and enhance teaching and learning in Hong Kong schools, these are not surprising findings. In fact, during the planning stage of SITES M-1, one of the main concerns was how findings from the Study could best inform policy and practice in this area. While large-scale survey studies provide valuable information on present status and trends, such information is not rich enough to inform schools and policy makers about the possibilities and contextual considerations for moving forward to enhance the quality of education through integrating IT in the teaching and learning process. To achieve this educational goal demands an active process of innovation, which would require not only financial and training support to schools, but also that teachers and school leadership work together to experiment, to explore possibilities and to overcome limitations and difficulties to create success.

Case studies have been widely used in studies on educational change at institutional levels (Fullan, 1991, 1993, 1999) as well as in studies on pedagogical practices in classrooms (Stigler & Stevenson,1992; Stigler & Hiebert, 1999) Case studies reports have also been found to be powerful means of dissemination (Merriam,1998). The research team thus decided to conduct a set of case studies in conjunction with the SITES M-1 study. The focus of which was to identify cases of good practices on the use of ICT in Hong Kong schools, with the aim to build up a rich research database of successful local experience and to construct analytic models of such practices. The findings of the present study has been used in the production of a professional development package for teachers on models of ICT use in classrooms (Law et al., 2000).

Emergent Practices of ICT in Education

Rapid technological developments have catapulted us into an 'information age' and exerted a variety of significant impacts on modern life. It is widely believed that students of this age will require not just the possession of a larger set of data or repertoire of specific skills, but also the capacity to readily acquire new knowledge, and to employ creativity and critical thinking in the development of novel approaches to solve existing and unprecedented problems. In response to this, schools are shouldered with the responsibility to help students develop life-long learning abilities and equip them to cope with the challenges of the 21st century. Thus, the emphasis and promotion of ICT application in schools has become an integral part of educational reforms in many countries around the world. In this context, a new term, "emerging pedagogical practice", was adopted in SITES to highlight the changing pedagogical goals and practices that has resulted from the use of ICT in education, as opposed to those uses of ICT that just aimed at enhancing the effectiveness of "traditionally important pedagogical practices".

Pelgrum et al. (1997) characterized the "emerging paradigm" by making explicit the "emerging" characteristics of its different stakeholders: the schools, the teachers, the students and the parents. The school, being integrated into the society, is having its information accessible to the public. The teacher emphasizes communication skills, guides independent learning, helps students find the appropriate instructional path and evaluate their own progress. The student is actively involved in self-learning, asking questions, seeking answers, engaging in teamwork and learning both in and outside of the school. The parent actively participates in and co-steers the child's learning process. Within this framework of emergent characteristics, it is inevitable that the description of "emerging paradigm" will carry different meanings and interpretations for pedagogical practices found in different educational systems.

Purpose of the Study

With the launch of the government five-year plan on ICT implementation in schools in late 1998, Hong Kong has entered a very exciting period of rapid expansion and development in this area. The challenge involved is not simply a case of technological adoption, but rather a process of innovation, which would require both financial and training support for schools, as well as cooperation between teachers and school leadership to ensure success. While Hong Kong can learn from the valuable experiences of many western countries that have already had ICT integration in the school curriculum for a decade or more, there are certain contextual factors and constraints which are unique to the Hong Kong situation. Consequently, Hong Kong schools

need to tap on their own resources and innovative power when embarking on their new endeavors.

When the HKSAR government announced the 5-year strategy on IT in education, the response from schools and teachers though varied, was on the whole positive, as confirmed by the SITES-M1 survey results. Subsequently, schools embarked with different degrees of enthusiasm and determination in their efforts to integrate ICT into the daily milieu of the school. Schools also differed in their visions and understanding of the contribution of ICT to education as well as their implementation plans and strategies, in addition to the inevitable differences in student demographic characteristics existing among schools. In parallel with the 5-year strategy on IT in education, Hong Kong is embarking on major curriculum and system wide education reforms led by the Education Commission (1998). Would schools view the implementation of ICT as a mere technological application or as an integral part of their overall response to education reform? What kinds of classroom interactions take place when ICT is introduced into the classroom and what potential impact do these bring to learning? What is the relationship between the various ICT supported classroom practices[1] and the different contextual factors of the schools? What are the crucial factors and implementation strategies necessary for schools to adopt particular kinds of ICT supported classroom practices? How could ICT be successfully implemented in an economically advanced and Chinese dominant community? The research team wants to seek answers to these questions by conducting in-depth case studies *among schools that are making the most efforts and progress in integrating ICT in classroom practices.* It is hoped that the findings from such case studies would be helpful to teachers, schools as well as policy-makers regarding the implementation and future development of ICT in education.

It is notable that the focus of the case studies is on ICT-supported classroom practices found in schools that are making significant efforts in this area, while the focus of SITES-M1 was clearly on exploring emergent pedagogical practices. Since the implementation of ICT in school education is just commencing in Hong Kong, it is appropriate to adopt a more naturalistic approach to study the "ecology" of classroom practices among fervent practitioners. This would provide valuable information and insight on the current situation as well as possibilities and difficulties in ICT implementation. In other words, this is a study on "good practices" of using ICT in schools, a term which will be discussed in greater depth in a later chapter. In addition, it is expected that the study would yield valuable comparison between the best practices

[1] Here classroom practices refer broadly to teaching and learning activities that are part of the school formal curriculum. There is no need for the activity to take place entirely within the confines of a physical classroom.

found in Hong Kong with the emergent practices reported by other countries in the SITES-M1 questionnaire.

To summarize, the objectives of the case studies are four-fold: (1) to provide teachers and related practitioners with new ideas on using ICT to improve classroom practices; (2) to deepen our understanding of the impacts of implementing ICT on pedagogical practices in classrooms; (3) to describe and examine the factors contributing to successful implementation of good practices identified and (4) to explore the similarities and differences between the "good practices" identified in Hong Kong and "emergent practices" as interpreted in other countries.

Structure of the Report

This report comprises three sections. Section I, titled "Studying ICT Supported Pedagogical Practices in Schools" and consisting of this present chapter as well as two other chapters, provides the international context, research framework and methodology for the study. Chapter 2 reports on the findings from an open-ended question in the SITES M1 questionnaire that aims to find out the kind of classroom practices that school-principals in general find to be most satisfactory. The question was designed to shed light on the kinds of characteristics that are found in pedagogical practices that were considered to be most satisfying by the school principals. This chapter also introduces the concept of emergent pedagogical practice, a concept that was key for the SITES M1 study. Chapter 3 then goes on to introduce the research framework and methodology for this study.

Section II, titled "ICT Usage in the Classroom", reports on the results of the analysis on data collected on lessons that made use of information and communication technology. An important source of data for this part of the study is the videos taken of the classroom interactions during the 40+ lessons observed. The analysis focused on delineating the key characteristics of the roles and interactions of the three actors, teachers, students and technology, in ICT supported pedagogical practices. The research team decided, on the basis of the analysis, that the key determinant of the characteristics of lessons is the pedagogical approach adopted by the teacher. Altogether five pedagogical approaches were found in the lessons observed: expository approach, inductive approach, tasks based approach, problem-based approach and social constructivist approach. Each of the five chapters in this section reports on the findings related to one of these five pedagogical approaches.

Section III, titled "ICT Implementation at the School Level", reports on the results of the analysis on models of change implemented at the school level in the 18 schools studied (the study collected data in 19 schools, one of which was a special school that

was not included in this analysis). The study found that the implementation strategy and the resulting variety of pedagogical practices using ICT found in a school is strongly dependent on the general vision and mission of the school, the school leadership's expectation of the specific goals and objectives that should be associated with the implementation of ICT for teaching and learning, as well as the history, culture and background of the school. Each of the three models of change implementation observed at the school level is reported in one of the three chapters in this section.

Finally, this report ends with a concluding chapter that summarizes the key findings from the study as well as the key recommendations to policy makers, school leaders, classroom teachers and the general public.

References

Anderson, R.E. Haider, G., Pelgrum, W.J. & Watanabe, R. (1997). *Second Information Technology in Education Study: Revised Proposal to the IEA General Assembly 1997.* Amsterdam: IEA.

Education and Manpower Bureau, Hong Kong Government (1998). *Information Technology for Quality Education: Five-Year Strategy 1998/99 to 2002/03.*

Fullan, M.(1991). *The New Meaning of Educational Change.* London: Cassell.

Fullan, M. (1993). *Change Forces : Probing the Depth of Educational Reform.* London : Falmer Press.

Fullan, M. (1999). *Change Forces : the Sequel.* London ; Philadelphia, Pa.: Falmer Press.

Law, N., Yuen, H.K., Ki, W.W., Li, S.C, & Lee, Y. (1999). *Second International Information Technology in Education Study: Hong Kong SAR Report.* Hong Kong: CITE, HKU.

Law, N., Yuen, H.K., Ki, W.W., Li, S.C, Lee, Y. & Chow, Y. (2000). *Case Studies on Good Practices in the Use of ICT for Teaching and Learning. (教學上應用資訊科技優秀案例剖析)* CITE, Faculty of Education, The University of Hong Kong..

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education.* San Francisco, Calif.: Jossey-Bass Publishers,

Pelgrum, W. J., Ten Brummelhuis, A. C. A., Collis, B.A., Plomp, Tj., Janssen Reinen, I.A.M.(1997). *The Application of Multimedia Technologies in Schools: Technology Assessment of Multimedia Systems for Pre-primary and Primary Schools.* Luxembourg, European Parliament, Directorate General for Research.

Pelgrum, W.J. & Anderson, R.E. (1999). *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and Practices.* Amsterdam: IEA & Enschede: University of Twente.

Stigler, J.W. & Stevenson, H.W. (1992). *The Learning Gap : Why Our Schools Are Failing and What We Can Learn from Japanese and Chinese Education.* New York : Summit Books.

Stigler, J.W. & Hiebert, J. (1999). *The Teaching Gap : Best Ideas from the World's Teachers for Improving Education in the Classroom.* New York : Free Press.

Chapter 2 Emerging Pedagogical Practices: Hong Kong in an International Context

N Law and Y. Lee

As mentioned in the Introduction, the widespread interest in many countries to promote the use of ICT in education has arisen in a broader curriculum context that aim to bring about new goals for teaching and learning that arise from the demands of an information society. The term "emerging paradigm" was construed in SITES to capture the changing views and practices in education.

As part of the SITES-M1 survey[1], there was an open-ended question that asked principals to provide *"an example of the most satisfying experience of a learning activity in your school in which students use computer-related technology, which gives students the most useful, effective and advanced learning experiences with technology"*. One of the main purposes of this question was to collect additional, qualitative information that can shed light on forms and characteristics of educational practices indicative of "emerging pedagogical practices" related to the use of ICT in schools. While the data collected through this item is necessarily brief and limited, it does allow the researcher to explore and gather insight into the possible characteristics of likely candidates qualifying as "emerging pedagogical practices" without going into difficult theoretical clarifications. This aim is thus very similar to a key aim of the current study, which focuses on "good practices" in the use of ICT in schools.

This chapter will begin with a description of the results for this question for Hong Kong and to contrast this with results collected internationally. It will then elaborate on the definition for "good practices" used in this study, highlighting the significance of this study in a local as well as an international context.

Most Satisfying Experiences with ICT

While all respondents to the Principal Questionnaire were asked to respond to the open-ended question on most satisfying experiences with ICT as detailed above, not all of them responded. Countries were asked to indicate those questionnaires which included a response to the question as well as to provide translations of 10 responses

[1] For details about SITES-M1, please refer to Law et al. (1999) and Pelgrum et al. (1999).

from each of the three populations[1]: primary, lower secondary and upper secondary levels. For Hong Kong, as lower and upper secondary schools are often found in the same premise with the same principal and the same set of teachers for both school sections, the principal questionnaire was modified so that principals were only asked to give one example of satisfying experience rather than separate examples for each population. The number of responses received on this item is as follows:

Table 2.1 The number of completions for question. 14 in the SITES-M1 Principal Questionnaire.

	Number of respondents	Number of completions[2]
Primary level	207	27(28)
Secondary level	298	85 (87)

As Table 2.1 indicates, only 13% of the primary school principals responding to the questionnaire provided examples of satisfying experiences of students using ICT, as opposed to nearly 30% for the responding secondary school principals. This is not surprising given the short history of ICT use in primary schools.

Kinds of Activities Reported

There were a variety of activities in the examples reported. It is clear from Table 2.2 that there was generally a heavy emphasis on information processing and production activities, except for Hong Kong at the primary level. In fact, the results indicate that the profile of activities reported by primary schools in Hong Kong differs from the international pattern in significant ways: a high percentage of the activities were focussed on basic ICT skills (23%) and remediation practice (26%). Communication and collaboration activities accounted for 16-18% of all activities except for Hong Kong at the primary level where it only accounts for 10% of the activities.

It is noteworthy that a sizeable proportion of activities reported by Hong Kong schools belonged to the "other" category. Under this category, more than half of these were related to the organization of seminars/exhibitions/extra curriculum activities but the responses did not give clear indications of the exact nature of the activities involved.

[1] For details about population definition in SITES-M1, please refer to Pelgrum et al. (1999) p.11-12 and Law et al. (1999) p. 13.

[2] There were 28 and 87 principals at the primary and secondary levels respectively who indicated that they had an example of the most satisfying experience of a learning activity in their school in which students use computer-related technology. However, only 27 and 85 of these respective primary and secondary principals provided descriptions of their examples.

Table 2.2 Different types of students' learning activities reported as a percentage of the total.

Students' learning activities	Primary Level		Secondary Level		
				International	
	Hong Kong	International	Hong Kong	lower secondary	upper secondary
Information processing activities	10	31	30	26	23
Production activities	19	28	28	35	38
Communication/ collaboration activities	10	16	16	17	18
Computer programming	0	1	0	1	3
Basics ICT skills	23	10	2	6	4
Remediation, practice	26	11	9	11	9
Other	13	4	15	4	5
N[1]=	31	248	96	359	299

[1] N represents the total number of activities recorded. In this case multiple coding was used to record number of activities reported, thus if an activity had two codes it will count as two incidents.

Computer-Related Technology Used

Table 2.3 Reported usage of different kinds of technology in different activities as a percentage of the total.

Computer-related technology used	Primary Level		Secondary Level		
				International	
	Hong Kong	International	Hong Kong	lower secondary	upper secondary
Information processing	**9**	**29**	**32**	**30**	**34**
Information retrieval[1]	6	24	23	21	18
Simulation	0	0	0	1	6
Spreadsheets	3	4	7	4	5
Database design	0	1	0	2	3
Microcomputer based laboratories	0	0	2	2	2
Production	**27**	**38**	**33**	**39**	**42**
Word processing	9	20	8	19	17
Presentation	9	5	13	5	6
Web design	0	4	5	6	7
Drawing & graphics	9	9	7	9	12
Communication/ collaboration (email/ICQ)	**0**	**11**	**6**	**13**	**11**
System software and languages	**25**	**5**	**8**	**4**	**5**
Operating system[2]	22	4	5	3	2
Programming languages	3	1	3	1	3
Drill and practice software	**16**	**8**	**5**	**9**	**3**
Other	**22**	**8**	**19**	**5**	**6**
N[3]=	32	247	107	387	333

[1] This includes web browsers/search engines/CDROM/ electronic encyclopedia & dictionaries
[2] This includes system software and applications, as well as network management software
[3] N represents the total number of activities recorded. In this case multiple coding was used to record number of activities reported, thus if an activity had two codes it will count as two incidents.

Table 2.3 shows the kind of computer-related technology used in the reported activities. Production tools formed the most popular category of technology used at all levels internationally and in Hong Kong. The second most popular category was information processing tools except for the primary level in Hong Kong where the next most popular categories were system software and drill and practice software. Information processing tools were used in less than 10% of the primary level reports. This is consistent with the profile of activities reported. In fact the range of technologies used at the primary level was generally narrower than at the secondary level, and this was more so in Hong Kong than was observed internationally. A notable absence was the use of communication technology, which may be due to the low presence of Internet connectivity in Hong Kong primary schools at the time of the survey.

Readers may be curious about the high percentage of the technology used in Hong Kong that are categorized under "other". Most of these were equipment and peripherals such as LCD projectors, multimedia computers and scanners. This is probably indicative of the more popular use of technology for expository purposes and the relatively higher concern for and better provision of computing peripherals in Hong Kong schools.

Curriculum Domains

There are several notable observations in relations to the distribution in subject domains for the reported examples of satisfying experiences. First all, computer literacy or computer science did not make up the most dominant subject domain except for primary schools in Hong Kong (36%). Further, internationally, more of the satisfying experience in this area was being reported at higher school levels, which was quite opposite to the trend observed in Hong Kong. Another observation is that the distribution of reports across subject domains was similar for all school levels except for a higher percentage of reported usage for mother tongue education at the primary level both internationally and in Hong Kong. It is observed that the range of curriculum domains in the primary level reports in Hong Kong was rather narrow and none was related to cross-curricular or extra-curricular applications. On the other hand, cross-curricular and extra-curricular examples comprised 13% each for Hong Kong secondary schools, much more than their presence in the international reports.

Table 2.4 Different types of curricular activities reported as a percentage of the total.

Subject domains	Primary Level		Secondary Level		
				International	
	Hong Kong	International	Hong Kong	lower secondary	upper secondary
Mathematics	16	11	11	11	10
Science	8	15	17	17	16
Mother tongue	20	28	5	17	13
Foreign languages	0	4	7	11	12
Computer literacy/ computer sciences	36	6	8	10	16
Social studies	4	16	11	18	17
Arts	12	11	10	8	6
Cross-curricula	0	4	13	3	3
Extra-curricula	0	2	13	2	2
Other	4	2	5	3	7
N[1]=	25	299	77	477	328

Perceived Changes in Teachers

The questionnaire item also asked about the impact of the satisfying experience in teachers. It is interesting to note that the greatest change reported relates to changes in the teaching and learning practice by all groups, except for primary schools in Hong Kong. Examples of such are:

> *"Teachers can provide a more interesting and vivid learning environment for students. The teaching contents will be more lively and are not confined to the textbook."*
>
> *"Teachers use the Internet more often in their lesson preparation."*

[1] N represents the total number of activities recorded. In this case multiple coding was used to record number of activities reported, thus if an activity had two codes it will count as two incidents.

"Teachers are able to pay more attention to individual students as they are generally participating attentively on the computer-based learning activities, thus reducing the pressure on teachers in relation to classroom management."

"To prepare and disseminate information to students via the Internet.'

A significant proportion of the reports in Hong Kong was about changes in teachers' attitude towards using computers and towards students' ability. It is noteworthy that, 12% of the reported cases from primary schools in Hong Kong were about changes in the perceived role of the teacher. This indicates that while the satisfying experiences per se may not have induced overall changes in teaching and learning practice for teachers in Hong Kong to the same extent as their international counterparts, there has been positive attitudinal changes in teachers which would in time lead to changes in practice. The reports on changes in the perceived roles of the teacher is especially heartening in this respect as such change would be a big step forward towards establishing emerging pedagogical practices in the school. For example, one of the reports mentioned the impact as:

"teacher's role have been changed from a transmission role to one of a facilitator that encourage students' self learning and exploration".

Another important observation is that the increase in collaboration amongst teachers was reported in about 10% of all cases internationally, while this category only comprised 3-4% of the reports from Hong Kong. This may also be a result of the shorter history of such experiences in schools.

Table 2.5 Impact on teachers as a percentage of the reported total.

Impact on teachers	Primary Level		Secondary Level		
				International	
	Hong Kong	International	Hong Kong	lower secondary	upper secondary
Changes in the teaching and learning practice	24	35	41.3	50	50
Increase ICT skills/knowledge	16	27	17.3	22	24
Increase collaboration	4	10	2.7	12	9
Changes in the perceived role of the teacher	12	N/A	2.7	N/A	N/A
Changes in teacher's attitude in using computer	24	N/A	18.7	N/A	N/A
Changes in teacher's attitude toward students' ability	8	N/A	10.7	N/A	N/A
Other	12	28	6.7	16	17
N[1]=	25	176	75	256	214

Perceived Changes in Students

It is apparent from the results presented in Table 2.6 that improved knowledge and skills was the most frequently reported gain for the students at the primary and secondary levels. Such gains were reported even more frequently by Hong Kong school principals than their international counterparts. The next most frequently reported gain was increases in concentration, interest or motivation, and again more frequently reported in Hong Kong than internationally. No negative impact on students was reported in any of the reports, whether local or international.

An important category of gain reported internationally (15 - 17%) was the observed increase in studentsí sense of responsibility, self-esteem or independence. However, this category was not reported at all by primary schools in Hong Kong and was only reported in 8% of the secondary school reports. Increased collaboration among students was not reported by primary schools in Hong Kong while this was reported in around 8% of the other reports

[1] N represents the total number of activities recorded. In this case multiple coding was used to record number of activities reported, thus if an activity had two codes it will count as two incidents.

Table 2.6 Students' gain as a percentage of the reported total.

Impact on students	Primary Level		Secondary Level		
				International	
	Hong Kong	International	Hong Kong	lower secondary	upper secondary
Increases motivation/ interest/concentration	30	23	26	17	16
Increase active participation/creativity	6.7	7	3.9	6	9
Improves knowledge/skills	60	41	53.2	44	40
Increase responsibility/self esteem independence	0	15	7.8	17	15
Increases collaboration	0	9	7.8	7	9
Negative impact	0	0	0	0	0
Other	3.3	5	1.3	8	11
N[1]=	30	241	77	342	296

Principals' Reflections

The principal questionnaire also asked the respondent to provide any other comment they had on the satisfying experience reported. Most of these were positive comments and no negative comments were reported in the cases from Hong Kong and in less than 3% of the international reports. It is noteworthy that some of the reports from Hong Kong contained deep reflections on models of teaching and learning as well as curriculum change by the principals. Examples of such reflection are:

> *"Future models of teaching and learning will be transformed from apprenticeship to partnership."*

> *"Only changes in teaching technique is not enough to improve the educational system in Hong Kong. In order to motivate students' learning, there should be a curriculum reform and a change in the assessment method."*

[1] N represents the total number of activities recorded. In this case multiple coding was used to record number of activities reported, thus if an activity had two codes it will count as two incidents.

"Time is an important element in IT implementation. The current curriculum is too tight. To accommodate changes, some parts should be cut out.'

Most Satisfying Experiences in Using ICT and Emerging Pedagogical Practices

From the preceding discussion, it is evident that the range of satisfying experiences reported in Hong Kong tended to be narrower, especially at the primary level, in terms of the kinds of activities and the kinds of learning gains reported. The focus at the primary level in Hong Kong tended to focus more on computer-related skills and technology and the resulted increases in collaboration whether for teachers or students were minimal. These were all indications consistent with the fact that the use of ICT across the curriculum to improve teaching and learning has a very short history in Hong Kong, especially at the primary level. It is also evident that the features of the satisfying experiences were less indicative of the emerging pedagogical paradigm than the overall picture gathered from examples gathered internationally. On the other hand, there are some heartening observations that point to the possibility of further developments along the direction of the emerging paradigm: the fact that more than 30% of all reports from Hong Kong pointed to changes in teachers' perception of their roles and their attitudes towards computers and the ability of students. Further, 13% of the secondary school reports were on cross-curricular applications, indicating that many schools were experimenting with changes in the broader school curriculum in conjunction with their explorations in using ICT for teaching and learning.

Definition of Good Practices in this Study

As the foregoing discussion indicates, the reports on the most satisfying experiences in using ICT confirmed the expectation of the research team in that there is a variety of positive experiences accumulated in the short period of ICT implementation across the curriculum in Hong Kong schools (the 5-yr IT in education strategic plan was released in November 1998). However, such experiences are still limited and characteristics indicative of emerging practices were not prominently represented at all. On the other hand, it is evident that at the awareness and attitude level, there is a stronger inclination towards emerging practices than current practices forebode. A key aim of the present study is to study and disseminate the experiences of schools that has made advances in the use of ICT so that schools interested in progressing in this direction can learn from such experiences. In consideration of the time when the case studies were to be conducted (April 1999 to March 2000) it was decided that the

best way to learn from practice is to do a naturalistic study of how teachers teach with ICT and how schools implement change, irrespective of whether those practices exhibit features of the "emerging" or the "traditionally important" paradigm. Thus the research team decided to distinguish good practices from emerging practices and not to set up any conceptual criteria for case selection. Good practices were thus cases of ICT use in school education that have been perceived to be positive experiences by the schools involved and by members of the wider education community.

In order to identify "good practices" as defined, the research team solicited widely through various knowledgeable contacts such as Education Department officials working in the area of ICT in education, and members of various education organizations for nominations of schools or teachers they know to be actively integrating the use of ICT in teaching and learning and may act as good role models for others. It is expected that the "good practices" so identified will capture some of the most advanced experiences found in Hong Kong schools, including some that will exhibit characteristics of emerging pedagogical practices. In studying a spectrum of pedagogical practices, it is hoped that the findings will help schools in understanding the factors and strategies influencing ICT implementation in schools.

Chapter 3 Research Framework and Design

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Conceptual Framework for Studying the Use of ICT in Education

Roles and Interactions of the Learners, the Teacher and the Technology

Much of the existing literature on educational uses of ICT categorizes the modes of usage according to the function played by technology, e.g. as tutor, tool or tutee (Taylor, 1980), as cognitive tools (Solomon, 1986) or mindtools (Jonassen, 2000). Such categorizations are very useful when one is conceptualizing the role that technology plays in the teaching and learning process or when designing or selecting technology tools for education. However, as Jonassen (1999) eloquently pointed out, educational uses of technology that strive to be "teacher-proof" or "learner-proof" do not exploit the capabilities of the technologies or the students. In designing effective learning experiences supported by technology, it is important not only to choose the appropriate technological tool, but also to have a clear understanding of the roles played by the teacher, the learner and the technology. In fact, the fundamental assumption underlying the concept of "emerging pedagogical paradigm" is that with the introduction of technology into the teaching and learning process, the roles played by the teacher and the learner should and need to change. Thus, for the purpose of understanding the impacts made by the use of ICT on pedagogical practices at the classroom level, the focus should not be on the functional characteristics of the technology used but rather the roles played by the three actors, the teacher, the learner and the technology used, as well as the interactions between them.

A Broad Curriculum Context: Intended, Implemented and Achieved

Another important consideration in arriving at a conceptual framework for the research is the curriculum context for the study. While it is important to recognize that significant learning does take place outside of the school curriculum and that the use of ICT in such learning situations is an important area of study in its own right, the focus in this study is on ICT supported pedagogical practices that are integral to the organized teaching and learning situations in schools as part of the formal school curriculum, even though the learning can be extended to situations outside of the classroom. It is

thus appropriate and important that this study be conducted within a broad curriculum framework. In fact, pedagogical practices can be interpreted as synonymous to the "implemented curriculum" within a broad framework which distinguishes three dimensions of curriculum description: the intended, the implemented and the achieved curriculum (e.g. Robitaille, 1996). The intended curriculum refers to the curriculum that schools intend to realize, which is generally described in terms of achievement targets and educational processes defined at the national/school system level. At the classroom level, the intended curriculum refers to the learning goals or objectives of a lesson. The second dimension, the implemented curriculum, refers to the educational processes happening at the school and classroom levels. It can be described in terms of learning opportunities offered to students. The third dimension, the achieved curriculum, refers to students' learning outcomes achieved through the learning experiences at the school or classroom levels.

Three Levels of Context: Classroom, School and Community

While the description of any pedagogical practice is essentially concerned with the relationship between the teacher and the learners, such practices take place in the complex milieu of the school context, which is also influenced by external forces at district/regional/national levels. Thus the entire curriculum context for studying ICT supported pedagogical practices has to be examined within the three levels of context: classroom, school and community (which may include regional/national influences). These three levels are mutually interacting and the boundaries between them are not distinct. Pedagogical practices as an implementation of the school curriculum are necessarily affected by educational policies at the national/regional level, which normally provides the framework for the intended curriculum. The school leadership and aspirations affect the intended curriculum at the school level. Instantiations of the intended curriculum as actual pedagogical practices depend not only on the classroom level factors but also on the school culture, which encompasses values, approaches and relationships amongst teachers and students. The local community, often represented by stakeholders such as parents and old students' associations may also contribute to the formulation of school policies and aspirations as well as to the provision of enriched technology infrastructure and support.

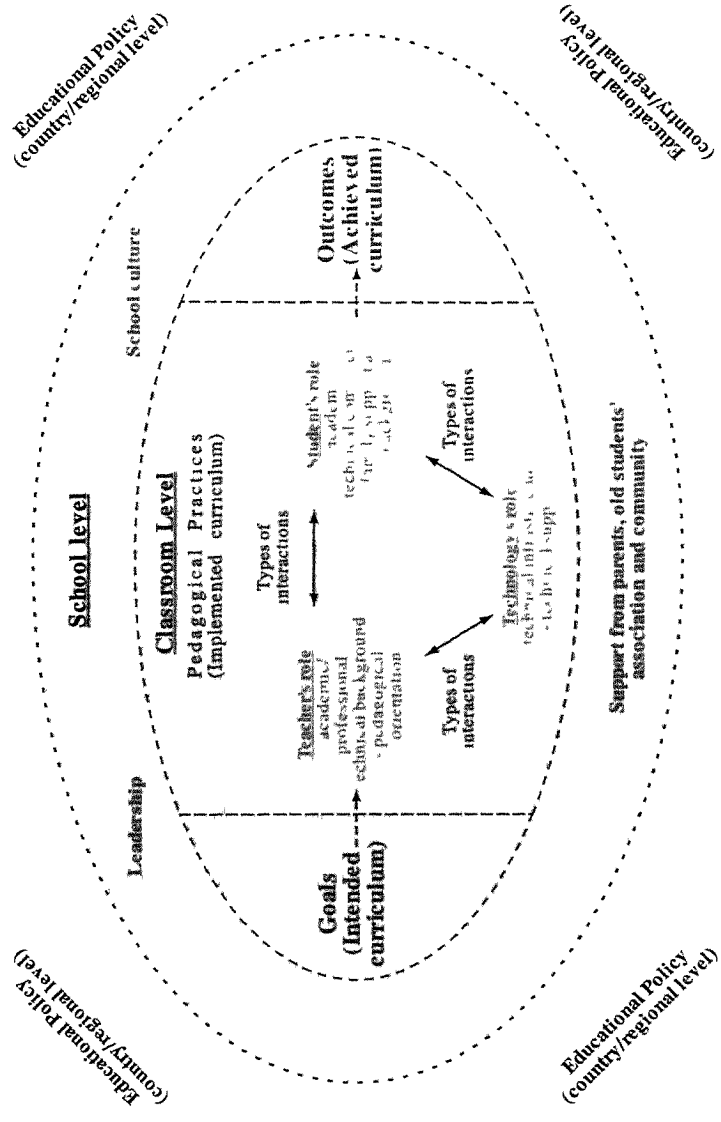

Figure 3.1 Diagrammatic representation of the framework for conceptualizing and analyzing ICT-supported pedagogical practices in school settings.

Changing Pedagogical Practice in an Institutional Change Context

As depicted in Figure 3.1, the implemented curriculum is necessarily affected by the idiosyncratic factors associated with each of the three actors present in any specific pedagogical situation, such as: the academic, professional and technological background and the pedagogical orientation of the teacher; the academic and technical competence of the learners as well as their family background and support therefrom; and the technological infrastructure and technical support available in the school. The presence/availability and orchestration of such factors often rely heavily on the institutional leadership and vision and not simply on the efforts of the specific teacher involved. In fact, the educational orientation and competence of the teachers are often also related to the vision and leadership of the principal in their schools.

The integration of ICT supported pedagogical practices into the school curriculum is thus by nature not a simple case of technology adoption but must be understood within the context of educational change. As Fullan (1991) pointed out, successful implementation of educational change is a complex process with no clear solution. The conceptual framework presented in Fig. 3.1 can also be used to capture the specific change strategies adopted in different school settings. Change leadership at the school level involves the provision and manipulation of different factors associated with the entire curriculum process from intended to implemented to achieved curriculum. Such factors include school-based curriculum goals and resource development, ICT infrastructure, staff development, staff appraisal and incentives policies, assessment goals, methods and policies. Obviously, the change strategy is very much influenced by the school leadership as this determines the change priorities, thus influencing the choice of factors to designate as key change factors. In order that this study can also throw light on whether particular models of pedagogical practice is linked with specific school implementation and change strategies, it will also collect and analyze school level data.

Case Study Design

Case studies are intensive descriptions and analysis of bounded systems or units (Smith, 1978) for the purpose of gaining an in-depth understanding of the situation and meaning for those involved. The research interest is generally in studying the process rather than the outcome, in describing and analyzing the context rather than specific variables, in discovery rather than confirmation (Merriam, 1998). Case studies are particularly suited for uncovering the interaction of significant factors and characteristic of situations or phenomena where it is impossible to delineate the variables involved

from their context (Yin, 1994). These have been found to be useful in providing heuristic insight to the problems or situations studied as the knowledge resulting from them are concrete and contextual, as opposed to the generally abstract and formal knowledge derived from other research designs (Stake, 1981).

In studying good practices in the use of ICT in school education, the purpose was two-fold: to describe and possibly categorize the roles and interactions of the learners, the teacher and the technology in the school curriculum context and to describe and analyze the contextual factors that have contributed to the successful implementation of ICT as change and innovation. Given that the purpose of the study is to explore and learn from the experience of schools that were considered to have generated good practices by members of the education community and the research team does not have apriori expectations or theories of ICT implementation to work from, case study was considered to be the most appropriate research method to use. As Sanders, (1981) pointed out, case studies are useful in education to identify and explain issues and problems of practice. In particular, case studies have been found to be useful for studying educational innovations and evaluating programs to inform policy (Merriam, 1998).

The nature of the present study is both descriptive and interpretive. The strength of case studies is the richness of the data and the ability for this method to uncover the complex relations among the various contextual factors involved in a situation or phenomena under study. It is hoped that the rich descriptions of the good practices can be used for further analyzing, interpreting and theorizing to arrive at some tentative typology for conceptualizing the classroom[1] interactions and the school change strategies.

Unit of Study - Defining the Case

Having a clearly identifiable boundary for the object of study is arguably the single most definitive characteristic of case study research (Merriam, 1998). Such boundaries often have a commonsense obviousness (Adelman, 1983). Miles (1994) suggested that a case can be represented graphically as a circle with a heart in the centre, with the circle defining the edge of the case, what would not be studied and the heart representing the focus of the study.

In our present study, the focus of the study is the ***lesson***, which is defined as the enactment of a small intact curriculum theme/topic at the classroom level (a pedagogical practice), which may take up one or a small number of class periods (the school day is normally divided into class periods of 35 to 40 minutes in Hong Kong) with clearly stated lesson objectives. Here, the "classroom" is interpreted in a loose

sense such that it defines a group of students learning the topic together, but may involve activities that go beyond the physical classroom as well as individuals/groups outside of the school.

While the key focus of a case is a pedagogical practice, a complete case study includes studying the contextual factors at the ***school*** level. The concept used in the definition of a case is that of "zooming out": in order to really understand the conditions for emergence, sustainability and transferability for these practices, one needs to find out about important aspects of the school context - the goals and vision of the school, the ICT implementation history and strategy including infrastructure, funding, staffing provisions, staff development and other related initiatives in the school.

Multiple Comparative Case Studies

While there are significant research studies conducted as an in-depth single-case study, multiple case studies provide opportunities for looking at a range of similar and contrasting cases, so that we can *"understand a single-case finding, grounding it by specifying how and where and , if possible, why it carries on as it does. We can strengthen the precision, the validity, and the stability of the findings"* (Miles,1994, p.29). In the context of the present study, the choice of specific cases was not theoretically driven and the interest was in looking for possible patterns of classroom interactions in ICT-supported classrooms and in identifying strategies of ICT implementations in schools. Thus multi-site comparative case studies was considered to be the most appropriate research method. The initial plan was to conduct 15 case studies, 10 in secondary schools and 5 in primary schools. The low number of cases at the primary level was based on the consideration that only a small number of primary schools would have started teaching with computers at the time of the study and it would not be realistic to aim for a high number. As the study progressed, the research team was directed to more schools that satisfied our criteria (see section on sampling below) and we completed the study for 11 secondary schools, 7 primary schools and one special school.

Sampling

Since the purpose of the study was not hypothesis testing or confirmation and the number of case studies that could be conducted was necessarily small compared to the total number of classrooms, probability sampling would not be appropriate. Instead, purposeful sampling (Patton, 1990) was used in this study. This method of sampling selects a number of information-rich cases for in-depth study so as to maximize the probability for the researcher to discover, understand and gain insight on issues of

central importance to the purpose of the research.

Purposeful sampling requires that a set of selection criteria be determined for case or site selection. The selection criteria is a list of attributes essential to the study which is then used to find or locate units matching the list (Le Compte, 1993). In accordance with the nature of the study being not a theoretically driven one but rather focuses on the in-depth study of "good practices" in using ICT in teaching and learning as perceived by the education community, a common form of purposeful sampling, network sampling, was used. This strategy involves identifying participants or cases of interest from people who know people who know what cases are information-rich and are good examples for study (Merriam, 1998).

Considerable effort was devoted to the selection of cases that would provide a range of worthwhile examples reflecting the widest range of teaching approaches present in Hong Kong schools as well as providing examples across different grade levels and school subject areas. However, as the teaching approach used can only be determined after the actual observation of the classroom interactions, the actual case selection was initially made at the school level. The entire list of selected schools was not determined all at one go at the start of the research but rather slowly evolved throughout the period of the study. This was necessitated by the very fluid situation in schools in terms of technology implementation at the time and the need for some extended contact and negotiation with potential schools before the formal data collection can start. The study finally included primary and secondary, pilot and non-pilot schools, grammar and prevocational schools, Chinese medium and English medium schools as well as special schools. This diversity in the type of school is important as different school backgrounds have different levels of access to ICT and different academic and socio-economic backgrounds of students, which would necessarily affect the implementation of technology in the school curriculum.

In order to arrive at a list of potential schools for the study, the research team consulted members of the Steering Committee and Education Department officials who have good contacts with schools, as well as used publicly available information and events like newspaper features and Quality Education Fund exhibitions to identify schools that were actively engaged in some form of integrating ICT in their school curriculum. The research team then contacted each of the school principals and asked if they would be willing to allow the team to conduct the research in their school. The key criterion for selection at this stage was that the team should be allowed to observe some classrooms (at least one) where ICT was used and that the team could videotape the lesson when it was being conducted. The specific lesson(s) to be observed was generally arrived at after discussion and negotiation with the school principal. Sometimes, the research team might have heard specific recommendations pertaining

to a specific teacher or a specific subject area in that school and thus asked for the permission to observe those classrooms. However, in most circumstances, the research team would consult the principal and asked about the kinds of ICT supported teaching and learning that were going on in the school and specific requests would then be made to the principal upon considering the information given in order to provide the widest range of diversity in the classroom data collected.

Instrumentation and Data Collection

While case studies can use both qualitative and quantitative methods for data collection, the present study was conducted as a qualitative study. As mentioned earlier, each case can be considered at two different levels with the prime focus on the lesson at the classroom level and as a case of technology implementation at the school level. A key advantage of the case study approach is that it can get as close to the subject of interest as is possible, partly by means of direct observation in natural settings, partly by their access to subjective factors (thoughts, feelings and desires) (Bromley, 1986). This study was designed to collect direct observation data, documentary information as well as subjective reports at both levels.

Procedures in Data Collection

Generally, two to three researchers participated in the data collection for each case. After confirming a school's participation in the study, the research team would inform the school the list of school documents the team needed to collect. Before actual visits were made, the research team would also read up some general information to gain as much background information about the school as possible. Normally, school visits after the lesson(s) to be observed were agreed upon with the school principal and teacher(s) concerned. School visits were made for two purposes: data collection pertaining to lesson observations and for understanding the school context and ICT implementation. Each lesson observation was conducted by a team of two researchers, one responsible for taking field notes and the other for video recording. Details of the data collection and instrumentation are described in a later section. Often, more than one lesson would be observed in a school. As far as possible, the research team will try to conduct document collection and interviews pertaining to school context and implementation before or after the lesson observation in order to maximize the effective use of time. To complete a case study, the research team often have to spend two to five days in the school.

Data Collection Pertaining to the Lesson

Lesson observations, interviews with students and teachers and the collection of relevant curriculum documents were conducted to study the implementation of IT at the classroom level.

Lesson Observations

Lesson observation is a primary source of data in the present study. In order to capture as much as possible the physical setting within which the lesson was conducted (some of the lessons included activities outside of the school premise), the atmosphere of the classroom as well as the details of the interactions that took place, two kinds of data collection was used:

1. Field notes - a researcher stayed at the back of the classroom throughout the lesson and took notes to describe the settings, the transactions that took place as well as comments on the observations made.

2. Video recording - this is a record of what went on during the lesson independent of the researcher who made the field notes.

A video recording of the lesson is arguably more "objective" than field notes or self-report questionnaires in that it allows for different observers to view, code and analyze the same piece of "first hand evidence" from different perspectives. It also acts a valuable resource for communicating the result of the research to both practitioner and researchers alike (Stigler et. al., 1999). However, as Stigler et al.(1999) also pointed out, the tape recording is a record of the classroom interactions according to the perceived priorities and interactions of the videographer. It is thus important that the videographer is clear about what is important to capture as data and be trained to do so. As the focus of the present study was to examine the roles and interactions between the teacher, the students and the technology in the implementation of the designed learning experiences for the student, the videographer was instructed to capture as much as possible the interactions between these three actors. In particular, the research team was interested to find out whether the use of technology enhances the communication between the teacher and the students and/or the interactions among the students. When the teacher was talking to the entire class as in whole class instruction, the focus would be centered on the activities of the teacher and that was relatively easy to capture. When the teacher moved around during group work to talk to students individually or in groups, it became more difficult to capture, especially in picking up the discourse. The most interesting and yet most challenging to capture was the interactions between students as they engage in group work using technology. The videographer, with the help of the researcher, attempted to identify groups actively engaged in discussion and move close to the group to capture both their activities and

their discourse. When opportunities permit, the videographer would try to capture a variety of student interactions that took place during the lesson.

As the classroom interactions were videotaped, the purpose of the field notes was to supplement the video. A variety of information about the lesson would be recorded: the subject area and topic being addressed, classroom context (grade level, time, setting of the classroom,), number of students in the class and the ICT infrastructure available to the class. It also captured more "subjective" observations like the mood and the peripheral activities in the classroom in the form of a kind of time-sequenced commentary recording the researcher's perception of the pertinent features and changes in the classroom interactions.

Lesson Materials Collected

In order to understand the curriculum context and the detailed design of the implemented curriculum, the researcher would request from the teacher copies of the curriculum materials related to the lesson observed: the lesson plan, worksheets, hand-outs and other printed curriculum materials used as well as the names and brief information about the technology (hardware and software) used. This study also attempts to gauge the learning outcomes of the lesson by collecting samples of students' work arising from the lesson, e.g. assignments, project reports, web-pages, etc. Sometimes, when there is classwork or homework that has to be completed after the lesson, the researcher will request the teacher to provide copies of the students' work that reflect the diversity in form and quality in the resulting work from the class.

Interviews

Interviewing was used as another important means of data collection in this study to find out about the intended lesson objectives, clarifications on the lesson plan as well as the teacher's and students' evaluation of the lesson and the learning outcomes.

Teacher Interviews

As far as possible, a brief interview would be conducted with the teacher before the lesson took place to find out about the lesson objectives, the planned activities and the rationale for the planning. The researcher will also use this opportunity to collect the lesson plan and the curriculum documents pertaining to the lesson as detailed above from the teacher. A second interview will be conducted with the teacher when the lesson was completed to seek the teacherís perception of how far the lesson plan was successfully implemented and whether there were any factors that caused the lesson to deviate from the plan, if applicable. The teacher would also be asked to comment on how far he/she felt the targeted learning objectives were achieved.

Table 3.1 Semi-structured questions used for the interviews with teachers.

Occasion & focus of the interview	Questions used
Before the lesson	1. What are the learning objectives outcomes for this lesson? 2. Why do you want to use IT in teaching this topic? 3. What is the role of IT in reaching these objectives? 4. Is this the first time that use of IT is integrated into your lessons? 5. If not, how often did you conduct this kind of lessons? 6. Whose idea was it? 7. Would it be possible to reach the same objectives outcomes without IT?
After the lesson *About the lesson*	1. What do you think of this lesson? Do you feel that you have conducted your lesson as you planned? If not, how and why was it different? 2. Do you think that the students behave differently when IT is used in the lesson? If so, how? 3. What do you see as the main gains from using IT in this lesson? 4. What are the key differences for the teacher in teaching this lesson with or without the use of IT in this lesson? 5. What difference does it make, if any, to your role as a teacher when IT is being used in the lesson? 6. Do you experience any constraints in integrating IT in this lesson? If there was any extension work derived from the lesson, the following questions would be ask: 1. How long would the assignment last? 2. What would you expect students to do in completing the assignment? (what is the role of IT in this aspect)
About preparation work	1. What kind of preparation did you have to make for this lesson? 2. Are there any difficulties in preparing for the lesson? If yes, what are 3. they? How did you solve it? Did you get any help from colleagues or friends? 4. If so, who are they and what help did they give? Did the use of IT make any difference to your lesson preparation, performance and follow-up? If it has caused you to spend more time and 5. effort, do you consider this worthwhile? 6. Do many of your fellow teachers also use IT in their teaching? 7. Did the use of IT cause any change to your mode of work? Has the use of IT in this and other similar lessons had effects on the co-operation and communication between teachers?
About the teacher's background and educational belief	1. How long have you been using IT in your teaching practice? 2. How often did you use IT in teaching this subject? 3. Have you used IT in teaching other subjects? If yes, how often? 4. What stimulated you to use IT in your teaching? 5. What do you think is the most important contribution of IT to 6. education? 7. What support did you receive in your efforts? Do you collaborate with other teachers in making use of IT? If so, what 8. sort of collaborations are these? Do you feel that you are supported by your school management 9. colleagues in your efforts? 10. Do you think the use of IT in your teaching changed you in any way? 11. Who would you turn to when you meet difficulties in using IT? 12. What further plans do you have in using IT in your teaching? Do you have computers at home? If so, what other peripherals do you 13. have at home? What kind of training/professional development related to IT have you received? What further professional development would you need, if any

Group Interview of Students

Before the commencement of the lesson, the research team would seek the permission and help from the teacher to invite a group of 4-6 students to stay behind at the end of the lesson to conduct a focus-group interview. The purpose of the interview was to seek students' views on the attractiveness and effectiveness of the lesson activities and the particular uses of technology during the lesson.

Table 3.2 Semi-structured questions used for the focus group interviews with students.

Occasion & focus of the interview	Questions used
After the lesson *About the lesson*	1. What did you learn in this lesson? 2. Was the use of the computer helpful in any way for your learning? 3. What difference does the use of IT make to this lesson? 4. Is it possible to do the same kind of learning without using IT? 5. (Applicable only if students were able to use the computers on their own during the lesson.) Were you able to do the work on the computer? Was it difficult? Have you done similar work before? Do you always work on your own or work in a group with the computer? 6. Did you enjoy this lesson? Why? 7. How often have you been using IT in learning this subject?
General information	If there was an assignment set for the lesson that requires the use of IT, the following questions would be asked: 1. Do you like this assignment? 2. What uses of IT would you need to make in completing this 3. assignment? Do you think that by using IT to do this assignment would make it 4. different in any way from assignments that don't use IT? 5. Do you think you can do this assignment? (In the event that the assignment is a group task) When and how would 6. you communicate and consult each other? Who would you turn to when you meet difficulties in your assignment? 7. Have you used computers during lessons before? If yes, how long have you been using it and how have you been using it in your learning? 8. Have you used computers in learning other subjects? 9. Which subject(s) do you think benefits more from using IT? 10. Where and when can you access computing facilities in your school? 11. Do you have computer at home? 12. If yes, what peripherals do you have at home? What do you use computers for at home? 13. Do you think IT skill is important? Why? 14. Do you think your IT skill is adequate? If not, which ones do you think you need to improve on? 15. Where and how did you get your IT knowledge? 16. What are the major obstacles in learning with IT?

Data Collection Pertaining to the School Context and IT Implementation Strategy

In order to explore the sustainability and transferability of the good practices studied and to understand better the conditions for these practices to be implemented in schools, it is necessary to study the school contexts within which such practices occur. Further, as discussed earlier, the implementation of ICT in teaching and learning should be studied within the school context as an implementation of educational innovation. Thus it is important to study the vision and mission of the school, the general perception by the school principal and staff of the roles and functions of ICT in education and the school's ICT implementation strategy and plan. For this purpose, the research team requested each of the schools where classroom observations of good practices were conducted to provide specific documentation about the school as well as the opportunity to conduct interviews with the principal and the IT team members, including the IT coordinator. In addition, the research team would request a tour of the school premises to learn about the ICT infrastructure and setting of the school.

Documentary Information

Before conducting the interviews detailed below, the researcher would contact the school to request the following documents:

1. School goals and missions
2. School development plan and/or year plan
3. School annual report
4. School vision and policy relating to IT in the school and the IT implementation plan
5. The school ICT infrastructure, including the number and kinds of computers and peripherals, network, configurations etc.
6. Staff development plan in support of IT implementation in the school

School Tour

The team would normally be shown around the school either by the principal or one of the IT team members on a tour of the school premises highlighting the ICT infrastructure and setting. This allowed the research team an opportunity not only to have a first hand knowledge of the technology set up in the school but also an opportunity to find out about the intended modes of usage for the different facilities. Field notes would be made of the observations made during these visits.

Interview with the School Principal

An interview with the school principal was normally arranged after the general school documents listed above have been gathered and read. The interview provides an opportunity to hear from the principal his/her visions about the school and about IT developments in the school, the school's IT implementation plan and the major challenges and difficulties met in the implementation. The school documents provide good background preparation for the interviewing team so that special features or issues gathered from these documents can be followed up in the interview.

The interviews were conducted as semi-structured interviews and the following list of questions was used to guide the interviews.

Table 3.3 Semi-structured questions used for the interview with school principals.

History and background of the school	1. How long has the school been established? 2. Which district does most of the students come from? What kind of socio-economic background does most of your students belong to? 3. (For secondary schools only) What is the banding of the students admitted ? 4. How long has the school been using IT for teaching and learning? 5. How many students are there in your school? 6. How many teachers are there in your school?
Vision of education and role of IT	1. What are the key values and aspirations of your school? 2. How is this vision on education manifested in your school? 3. Can you describe any key development that the school has planned for the coming one or two years? 4. What plan does the school have in relation to the use of IT in education? 5. What do you think are the key contribution and roles of IT in education? 6. Does the use of IT affect the roles of teachers and learners and the interaction between them? If so, describe either the expected or observed impacts. 7. Does the use of IT in the school relate in any major way to the realization of the broader school vision? 8. What is the influence that IT can have on education? (Specifically try to elicit if there is expected impact on the roles of teachers and learners and the interaction between them.)
Implementing and institutionalizing use of IT in the school	1. To what extent is your school engaged in school-based curriculum development? Is it common for teachers to develop their own teaching materials? If so, describe these efforts. 2. What are the main benefits or satisfaction that has resulted from the use of IT in the school curriculum? 3. What key measures has been put in place to support IT education development? 4. Is there somebody in the teaching staff newly appointed as a result of IT implementation? 5. What are the sources of funding for supporting IT developments in the school, both for the equipment set-up and staffing? 6. What part of the recurrent school budget, if any, is allocated to the purchase and maintenance of IT equipment? 7. Is IT used in the whole school or is it only for some special subjects or purposes? 8. What strategies approaches are used in implementing IT in teaching and learning? 9. Does the introduction of IT in the school caused any changes in the relationship amongst teachers, especially in terms of collaborations? 10. What opportunities are available for professional development in relation to using IT in education for teachers in the school? 11. Are parents involved in the implementation of IT? 12. Are parents concerned about the use of IT in the school? 13. What is the biggest challenge in implementing IT use in education in your school? 14. In your opinion is there any change in the role of the principal resulting from the introduction of IT into the school curriculum?

[1] All primary school leavers are placed into five bands of academic aptitude and students are allocated placement in secondary schools according to their school selection list and academic banding.

Interview with the IT Team

As revealed by the SITES M1 survey (Law et al., 1999), most schools have established an IT team consisting of several teachers to look after IT developments in the school. A focus group interview would be arranged with the IT team to find out about the structure of the team, the key functions of the IT team, the roles of the various team members, the history of IT developments in the school, the perceived achievement and general level of IT usage by teachers and students, their plans for further development and their perceived key obstacles to the team's work. This interview would also provide an opportunity for the research team to seek clarifications about the existing technological infrastructure of the school if this has not be totally clear through the school tour and the school documents collected. Often, it was not easy to get all members of the IT team together for the interview and thus a meeting would be held with the IT coordinator and as many other members as is available at a time determined by the school to be the most suitable. The list of semi-structured questions for this interview is as follows:

Table 3.4 Semi-structured questions used for the interview with school IT teams.

Background and roles of the IT coordinator and team members	1. (For the IT coordinator) What roles and functions are you required to serve in your current position at this school? 2. How many members are there in the IT team in your school? 3. How are the team members selected? What roles and functions do they play? 4. What subjects do the IT coordinator and team members also teach? 5. Are the computing facilities accessible to students after regular school hours and during holidays?
ICT infrastructure in the school	1. How many computers are there in your school? What are their hardware and software configurations like? 2. How many computer rooms are there in your school? How are the computers and other equipment physically located 3. What proportion of the computers in the school are networked? Where are these located? 4. What proportion of the computers in the school are connected to the Internet? Where are these located? 5. What kinds of software are available for use in the school? Are any of these specifically designed for educational purposes? If so, what kinds of educational software are available?
Embedding in curriculum	1. How widespread is ICT being used in teaching and learning in this school? What percentage of teachers incorporates the use ICT in their teaching activities? 2. For which subjects is ICT being used to support teaching and learning? Which subjects use ICT in teaching and learning more often? 3. What modes of usage has ICT been put to in the school for teaching and learning? 4. What strategies approaches are used in implementing ICT in teaching and learning in your school? 5. What staff development and supports are available for teachers in the school to support their use of ICT in their work? 6. How does the IT team relate to other teachers in the school? What collaborations, if any, exist between team members and the other teachers? 7. What do the IT team members see as the key roles of IT in education? 8. What major difficulties and challenges exist for the IT team? 9. What further developments are being planned for future?

Interview with Students on the General Use of Computers in the School

As mentioned earlier, student interviews are generally not found to be necessary for studying the school context, except when the research team found significant use of technology by the student body in non-formal, often student-led extra-curricular activities that form an important part of the total learning experience of the student body. Under such circumstances, we found that understanding these student-led activities was crucial to an understanding of the school context for the classroom practices studied.

Table 3.5 Semi-structured questions used for the general focus group interview with students actively involved in student-led ICT-related extra-curricular activities.

Background information	1. When did you join this club/activity? 2. Can you explain the nature of this club/activity? 3. Can you explain how this club/activity is planned/led/organized? What is the role played by the individual students present in the interview? 4. What kinds of ICT resources are available for the students' use for this club/activity? 5. Is there any support given by the teachers or school to this club/activity?
Learning gains	1. Can you tell me what motivated you to join this club/activity? 2. What do you think you have gained from participating in this club/activity? 3. What is your most satisfactory experience in this club/activity? 4. What uses of ICT is made in the organization of this club/activity? 5. What is the benefit of using ICT in this? Is the role of ICT important in this club/activity? 6. Are there any difficulties that you have encountered?

Data Analysis

In this study, all audio and video data collected were fully transcribed. This includes all videos captured during lesson observations as well as all interviews conducted. These transcriptions were used together with the videos and other forms of data in the analysis.

Analyzing the Lessons

Altogether more than 40 lessons from 19 schools were observed. For the analysis of the classroom data, the goal was to arrive at a categorization of the lessons and the key features observed within each category. We did not want to start with any apriori categorization of lessons or even specific theories about lessons. The analysis employed the grounded theory approach (Strauss & Corbin, 1990) and used the constant comparative method (Glaser and Strauss, 1967) to arrive at a set of categories and properties for describing the lessons.

While there were no pre-determined categories of lessons, the analysis begun with open coding of the lesson videos and field notes, based on a pre-determined set of dimensions:

1. role of teacher
2. role of student
3. role of technology

4. interactions between teacher , student and technology
5. interactions between students
6. exhibited subject matter competence
7. exhibited subject matter incompetence
8. exhibited IT competence
9. exhibited IT incompetence
10. exhibited competence unrelated to IT or subject matter.

This set of dimensions was derived directly from the conceptual framework as depicted in Fig. 3.1. These dimensions were concerned with analyzing aspects of the lessons pertaining to the implementation as well as to examine the exhibited competence/ incompetence of the students as a reflection of the learning outcomes from the lesson. It has to be pointed out here that in focussing on exhibited competence, the interest is not really on the direct learning outcome from the lesson but in finding out whether the lesson as planned and implemented allowed the teacher and/or the students to know what kind of competence the students had in relation to the lesson objectives, and whether the technology played any role in this respect.

This analysis began with an analysis of the lesson video data and field notes. Before coding can take place we need to divide the data into meaningful units or segments. A unit can be as short as a word and there is no definitive upper limit to its maximum length. Generally, a unit of analysis should be the smallest heuristic unit of data (Lincoln and Guba, 1985). The heuristic criterion requires that the unit reveals information relevant to the study. The size of the data chosen has to be the smallest piece of information that can be interpretable without additional information other than the general context of the data collected.

After some exploration and discussion, we found that regardless of the pedagogical approach adopted, the teacher played a central part in determining the objective and activities in the classroom. Further, where there was no change in the activities, there would not be any change in the role of the teacher. The research team thus decided to define as a unit of analysis for the lesson video the episode, which is a segment of the classroom transactions where there is no change in either the content or the activity focus. This essentially means that the segment deals with the same content topic and within the segment there is no change in the teacherís role.

Table 3.6 The coding scheme used in coding the lesson videos.

Role of the teacher	1. ***Inform:*** Provide information with no explicit demand for performance. 2. ***Set Task:*** Give instruction in connection with a task to be performed by students (the tasks set were open-ended ones to be coded in this sub-category). 3. ***Set problem:*** Give instruction in connection with a task to be performed by students (the tasks set were close-ended ones with a known set of right answers to be coded in this sub-category). 4. ***Challenge A:*** Demand an answer that requires immediate reflection and/or evaluation. 5. ***Challenge B:*** Demand an answer that does not require immediate reflection and/or evaluation. 6. ***Elicit:*** Check or assess students' understanding against a known set of right answers. 7. ***Respond:*** Teacher gives verbal answers to student(s). 8. ***Showcase:*** Display students' work as having commendable features. 9. ***Monitor:*** Check the progress of students' work. 10. ***Extend:*** Build on progress exhibited in students' work to set further extension tasks. 11. ***Focus and stimulate:*** Set context and provide stimulation to arouse students' interest in the topic of discussion. 12. ***Set instrument :*** Teacher set up the instrument by himself or herself.
Role of the students	1. ***Plan:*** Deliberately setting goals, objectives, foci or strategies to perform tasks. 2. ***Respond:*** Making use of their knowledge and providing answers when their teacher is evaluating their understanding. 3. ***Appraise:*** Considering own work or others' work carefully and forming own judgement. 4. ***Discuss:*** Sharing ideas with others in relation to the presented problems. 5. ***Perform:*** Doing a task/ Producing tangible work (on papers/computer files). 6. ***Present:*** Showing own work to the whole class. 7. ***Inquire:*** Ask questions. 8. ***Inform:*** Offer some information to teachers or peers.
Role of ICT	1. ***Teacher's Presentation Tool:*** ICT is used to support teacher to show his/her information. 2. ***Student's Productivity Tool:*** ICT is used to support students to complete a task. 3. ***Student's Presentation Tool:*** ICT is used to support students to show their information. 4. ***Presentation Tool for Sharing Students' Work:*** ICT is used to show students' work. 5. ***Tool for Evaluating Students' Subject Learning:*** ICT is used to check students' answers (for instance, using a software to find the pH value of a solution). 6. ***Instructional tool:*** ICT is used for self-access learning. 7. ***Assessment tool:*** ICT is used for providing exercises and providing feedback to students on performance.
Interaction between teacher, students and technology	1. ***Teacher dominated:*** Teacher is controlling the use of ICT and determines the details of the interactions. 2. ***Student dominated:*** Student is controlling the use of ICT and determines the details of the interaction. 3. ***ICT dominated:*** The flow of the lesson is predetermined by the software. For example the use of some self access learning programe.
Interaction mode between students	1. ***Mediated by teacher:*** Students interacting each other only through the teacher. 2. ***Not mediated:*** Students interacting directly with each other.

The analysis of the lesson videos and transcripts allowed us to map out the flow of the lesson and the different roles and interactions between the teacher, the students and the technology. The other data collected for each lesson would also be reviewed and coded, where appropriate, when the data pertains to any of the above 10 dimensions. A video-analyzer 1was developed to support the analysis of the video data.

The collection of lessons, after such coding and analysis, was reviewed to look for patterns of similarity. The study resulted in the identification of five key approaches. A multimedia report of the findings including video segments presenting the video coding using the video-analyzer was published in Law et al (2000). A more in-depth and theoretical report on the findings is presented in section II of this report.

Analyzing the Models of ICT Implementation

Before embarking on a cross-case analysis of ICT implementation at the school level, it was necessary for us to write up a case report for each of the schools studied. While the data collection related to lesson observations were clearly delineated with the lesson videos as undoubtedly the most important data set, the kinds of data collected at the school level were much more varied and diverse. The case reports were in fact collated descriptions of the schools based on the various collected documents and other forms of data along a set of pre-determined dimensions. The various data sources were scrutinized to identify and code information pertaining to the dimensions listed in Table 3.7. As expected, there were often several data sources providing relevant information for the same dimension. These were triangulated and then collated into a case report.

Table 3.7 Structure of the school case reports

1. School backgroung - History of the school - Vision and mission of the school - The demographic characteristics of the school
2. ICT implementation in the school - History of ICT use and status of development in the school - Vision about the role of ICT in education and future impact of ICT on the school - ICT infrastructure available, development plan and access policies - ICT-related staff development and implementation strategy - ICT-related management and administrative infrastructure, insluding composition, role and function of the IT coordinating team
3. Curriculum examples of ICT implementation in the school - Major projects/examples involving ICT use in the formal school curriculum - Examples of out-of-school activities using ICT
4. Summary of lesson observations For each of the lessons observed in the school, a brief description would be included, based on the analysis of the lesson. Each lesson summary includes: - Level and subject taught - Lessson objectives - Lesson approach, insluding roles of the teacher, student and technology - Teacher background - Technological infrastructure required - Support provide by the school in implementing the lesson

The completed case reports then provide a clearly and comparably structured narrative for comparison and further analysis. The 19 completed case reports were reviewed to look for patterns in the model of change adopted by the schools. The review looked for similarities along three major dimensions: achievements in terms of ICT implementation in the curriculum, the change strategies employed and the vision about the role of ICT in education. This review resulted in the identification of three models of change. The findings are presented in section III of this report.

References

Adelman, C., Jenkins, D. & Kemmis, S. (Ed.). (1983). *Rethinking Case Study: Notes from the Second Cambridge Conference.* Victoria, Australia: Deakin University Press.

Bromley B. D. (1986). *The Case-Study Method in Psychology and Related Disciplines.* New York: Wiley.

Fullan, M. (1991). *The New Meaning of Educational Change.* (2nd ed.). London: Cassell.

Fullan, M. (1999). *Change Forces: The Sequel.* London: Falmer Press.

Jonassen, D. H., Peck, K.L. & Wilson, B.G. (1999). *Learning with Technology.* Upper Saddle River, New Jersey: Merrill.

Jonassen, D. H. (2000). *Computers as Mindtools for Schools.* (2nd ed.). Upper Saddle River, New Jersey: Merrill.

Law, N., Yuen, H.K., Ki, W.W., Li, S.C., Lee, Y. (1999) *Second International Information Technology in Education Study Hong Kong SAR Report.* CITE, Faculty of Education, The University of Hong Kong.

Law, N., Yuen, H.K., Ki, W.W., Li, S.C., Lee, Y., Chow, Y. (2000) *Case Studies on Good Practices in the Use of ICT for Teaching and Learning. (教學上應用資訊科技優秀案例剖析)* CITE, Faculty of Education, The University of Hong Kong.

Le Compte, M. D. P., J. with Tesch, R. (1993). *Ethnography and Qualitative Design in Educational Research.* (2 ed.). Orlando, Fla.: Academic Press.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education.* San Francisco: Jossey-Bass.

Miles, M. B., & Huberman, A.M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* (2 ed.). Thousand Oaks, Calif.: Sage.

Patton, M. Q. (1990). *Qualitative Evaluation Methods.* Thousand Oaks, Calif.: Sage.

Robitaille, D. G., R.A. (1996). *TIMSS Monograph No 2: Research Questions & Study Design.* Vancouver: Pacific Education Press.

Sanders, J. R. (1981). *Case Study Methodology: A Critique.* Paper presented at the Minnesota Evaluation Conference, Minneapolis.

Smith, L. M. (Ed.). (1978). *An Evolving Logic of Participant Observation, Educational Ethnography and other Case Studies.* Itasca, Ill.: Peacock.

Solomon, C. (1986). *Computer Environments for Children: A Reflection on Theories of Learning and Education.* Cambridge, Mass.: MIT Press.

Stake, R. E. (1981). *Case Study Methodology: An Epistemological Advocacy.* Paper presented at the Minnesota Evaluation Conference, Minneapolis.

Stigler, J. W., Gonzales, P., Kawanaka, T., Knoll, S. & Serrano, A. (1999). *The TIMSS Videotape Classroom Study: Methods and Findings from an Exploratory Research Project on Eigth-grade Mathematics Instruction in Germany, Japan and the United States* (Research and Development Report). Washington D.C.: U.S. Department of Education, National Center for Education Statistics.

Taylor, R. P. (1980). *The Computer in the School: Tutor, Tool, Tutee.* New York: Teachers College Press.

Yin., R. K. (1994). *Case Study Research: Design and Methods.* (2 ed.). Thousand Oaks, Calif.: Sage.

Part two:

ICT Usage in Classrooms

Part two: ICT Usage in Classrooms

Introduction

W.W. Ki

Pedagogical Approaches in ICT Supported Classrooms

One of the aims of this study is to examine and disseminate the experiences of schools that have made advances in the use of ICT in classrooms. It was decided that the best way to learn from practice is to do a naturalistic study on how teachers use ICT in classrooms in the way they think desirable. The research team hence solicited widely for good practices as seen by practising teachers and schools. In the end, the team observed a total of 46 lessons conducted in the selected schools.

There were great variations among the lessons observed in terms of how the technology was used and what the specific roles of the teachers and students were in the teaching and learning process analysis. Based on the grounded theory approach, it was found that the most notable variations were closely related to the kinds of pedagogical approach adopted in the lessons. In view of this, the lessons were subsequently categorized under five different pedagogical approaches, namely:

- Expository approach: An approach that relies mainly on the teacher presenting information to the students. The teacher acts as a subject matter expert, an expert presenter and evaluator who presents appropriate information in clear, well-organized formats for students to learn in the lessons. The desired learning outcome is the students' assimilation of knowledge and skills related to the subject matter, such that they can retrieve and apply the learned concepts and skills to tackle subject-based questions within the same domain.

- Inductive approach: Students are encouraged to explore properties and relations of concepts associated with the subject matter based on the materials given. Learning ideally takes place when students generate and test hypothesis/concepts by themselves. Teachers provide different opportunities for students to acquire a variety of learning experiences. Teachers may elicit the prior concepts that students hold, design learning experiences and pose questions that will direct the students' attention and stimulate their thinking to achieve the desired conceptual

understanding. Students, on the other hand, are expected to generate and explore concepts in the learning process.

- Task-based approach: Learning is achieved through students' engagement on creative production tasks. The teacher sets open-ended tasks for the students, the accomplishment of which requires students to internalize the key concepts or skills taught in the subject domain as well as in the context of a productive task that requires the creative use of the targeted knowledge and skills with a broader range of abilities already acquired. It is perceived that deep and significant learning is attained through students' active participation in purposeful constructional activities and in reflecting on their experiences in the process.

- Problem-based approach: The focus is on students' learning through investigating and solving authentic problems. It often demands students to apply knowledge derived from various disciplines to solve a single problem and to monitor and reflect on their own learning through the process. Students have to refine problems, decide on strategies, search for relevant information, analyze data and draw conclusions etc. Problem-based learning approach places the teacher in a position whereby he/she exercises his/her expertise through asking probing questions to stimulate thinking and highlight issues, facilitating discussion on plausible approaches to tackle the problem, monitoring progress, supporting development of self-regulation and providing feedback to students.

- Social-constructivist approach: The students have to formulate and present their views on an issue, and debate with their peers on the different views presented. Learning is achieved by sharing, discussing and critically reviewing one's own and others' ideas/products among students. Learning takes place through classroom activities in which students can experience the process of knowledge co-construction & exploration. The teacher does not see his/her primary role as an expert, but rather as someone who poses challenges to the students and interacts with them during discussions.

Chapter 4 to 8 report the findings from our study on a selected number of lessons grouped under the five different approaches. Each chapter includes a general introduction to the pedagogical approach, a description of the ICT adoption in the selected lessons, general findings concerning the roles of teachers and students in the lessons, as well as discussions about prominent issues concerning the use of ICT for the particular teaching and learning approach. Detailed descriptions of some or part of the lessons are provided to illuminate the key features and issues related to each approach.

Distribution of Lessons among the Five Approaches

Before going into the following chapters that report on the use of ICT with regard to the individual pedagogical approach, it is useful first to look at the remarkable variation in the distribution of the observed lessons among the five approaches. The total number of observed lessons in each category is classified as follows:

Table II The distribution of the observed lessons across the five pedagogical approaches

Expository approach	Inductive approach	Task-based approach	Problem-based approach	Social-constructivist approach
Primary level: 16 lessons Secondary level: 7 lessons	Primary level: 2 lessons Secondary level: 5 lessons	Primary level: 2 lessons Secondary level 10 lessons	Secondary level: 2 lessons	Secondary level: 2 lessons

From the above table it is obvious that among the lessons cited by schools and teachers as good examples of ICT application, the majority have adopted the expository approach which is also the most common teaching approach in Hong Kong schools. Next are the inductive and task-based approaches. The less common ones are the problem-based and social-constructivist learning approaches, which share similar focus and concern with the current local curriculum reform as well as many of the features of the emergent pedagogical paradigm. This profile suggests that the development of ICT application in education is likely to be an evolutionary process building on existing pedagogical practices. The impact of ICT implementation in education has to be understood in the context of the general educational culture in Hong Kong.

Chapter Highlights

Chapter 4 reports findings on the use of ICT in expository teaching. It highlights that ICT is a two-edged sword. ICT allows teachers to bring rich presentation materials into the classroom, including text, pictures, diagrams, sound, animation, and visualization programs. This, on the positive side, can help illuminate difficult concepts and ideas. On the negative side, it can also be used as a tool for the teacher to push large quantities of information to the students, hence leaving them little room for thinking or digestion. The more successful lessons were typically those where ICT was not applied as one-way transmission. Instead, learning materials presented were

jointly interpreted and discussed *with the students*. The better lessons were logical and well structured, and ample room was given to students to contribute their ideas during each step of the instruction. The chapter also discusses critical issues concerning the use of visualization programs.

Chapter 5 reports findings on the use of ICT in inductive lessons. It highlights the use of exploratory software in the selected lessons, including a dynamic geometric program, a geographic information system (GIS) and others. The dynamic geometric program provides a virtual laboratory that allows students to create objects and explore relationships among them before the formulation of formal mathematical theories. With the use of GIS, students are guided to explore rich authentic data, and to test their ideas against the data. In the lessons, some time was usually allocated for students to do hands on explorations. It was observed that the teacher often took a strong directive role to maintain the quality and depth of the discussion. The teacher had to constantly decide when to bring in divergent views and when to narrow the focus down to the most relevant issues. This poses a great challenge to the teacher.

Chapter 6 reports findings on using ICT in lessons that adopted the task-based approach. In most of the lessons selected, ICT was used as a tool by the students. The students usually worked in-groups to complete tasks relevant to the topic of learning. While ICT could add fun and open new possibilities, it also demands additional time and effort in mastering technical skills, apart from the curriculum matters. Good practices are typically those lessons in which the use of technology is kept simple and directly relevant to the purpose of the tasks. It is also important that students are reminded of the important learning aspects of the tasks, so that they would not digress to focus on the superficial technical complexity and presentation of their products. Moreover, initial, mid-way and follow-up discussions to engage students in evaluating their work is also crucial. It ensures that the students are learning through doing. ICT can also used as a handy means for students to access and review the work of their peers.

Chapter 7 reports findings on the use of ICT in problem-based learning. It describes a series of lesson periods during which the students had to solve an authentic problem: comparing the efficiency of two fast food shops. The problem posed to the students was not a well-defined one. The students worked in groups to interpret the problem and develop their own scheme of data collection and analysis. ICT was used as a tool for data organization and analysis. It enabled the students to deal with a large volume of authentic data efficiently, and allowed them to explore among different data analysis methods. The teacher taught the students the use of spreadsheets, and relevant statistical concepts in the process. The students were then given the opportunity to undertake

research and through that process to appreciate the nature of research and problem solving.

Chapter 8 reports findings on the use of ICT in lessons employing the social constructivist approach. In the lessons selected, students were asked to use the Internet to look up information related to a government decision, and to formulate their own positions on the issue. They had to present their views and to defend their positions. The activity provided opportunities for the students to think critically. In the debate process, some students were made aware of the flaws in their own argument. Some students thought that the main role of the teacher had changed from the provision of information to guiding them to realize the different ways of seeing and the different values associated with different viewpoints.

Challenges in the Use of ICT in Classrooms

The lessons discussed in chapters 4 to 8 illustrate the beneficial use of ICT in the different kinds of lessons. Teacher interviews indicated differences in their rationale for using of ICT. Some think that the increasing importance of ICT in everyday life has made it necessary for classroom teaching to follow suit. Apart from that, the majority of the teachers express more specific educational concerns. They use ICT to undertake tasks that are difficult to accomplish using conventional means. The adoption of ICT is hence used to extend the mode of teaching and learning beyond the conventional.

From the teacher interviews, it was also evident that successful implementation of ICT in classrooms is likely to be quite challenging for most teachers. One basic problem is the confidence or lack thereof, of the teachers in using the technology. In general, teachers would choose to use technology that is relatively straightforward and powerful. However, even in such cases, technical problems may still arise in classrooms. Technical assistance and moral support among colleagues are therefore important.

The other challenges lie in the pedagogical competence of the teachers. In the first three approaches named above, which are commonly used in Hong Kong, the effective use of ICT depends heavily on the teachers' teaching and classroom management skills. In some cases, if the teacher is inadequate, the use of ICT may even worsen the quality of classroom learning. The last two approaches, besides effective teaching skills, also demand the teachers to be more adventurous in passing the control of learning back to the students, allowing spontaneous learning events to happen, and to be prepared to respond to initiatives from students.

Furthermore, the demand on teachers' time and efforts can also be very substantial. They have to develop new skills to search for and develop new materials, re-think about settings, lesson flow, student activities, classroom organization and management, in addition to developing new curriculum goals and practices if emerging pedagogical practices are to be targeted.

Chapter 4 Using ICT in Expository Teaching

W.W. Ki

The Expository Approach

According to Ausubel (1960,1963), expository teaching does not necessarily mean passive learning. During a lecture, which is typically expository, the learners' minds can be quite actively interpreting the messages heard. The learners are constantly creating meanings by relating what they heard and seen to their existing cognitive structure, and trying to organize the information received into a meaningful whole. Ausubel points out that the structure of presentation is very important for such teaching to be effective. In a well-structured lesson, information can be provided in a meaningful way, so that the students can see a continuous development of an idea (the organizing concept). The use of advanced organizers is suggested to activate relevant existing concepts from the learner that can help them to process the subsequent information given. Although expository approach has the advantage of being more straightforward and systematic in its operation, it might limit the opportunity for the learners to structure their own experience and monitor their own learning. Especially when the objective of a curriculum component is more on the development of problem solving and learning ability in the learner, then the expository approach might have the danger of being too teacher-centered and restrictive.

Expository teaching is most commonly used in curriculum components where the primary objective is the students' mastery of standardized facts, concepts, rules and procedures. It is also used in cases when the objects of learning and/or resources available are too complex to be understood by the learners. The teacher recognizes the need to subdivide, translate, and structure the information into more digestible form for the learners, and introduce the knowledge in a logical and systematic manner.

Expository approach usually involves a high degree of teacher-directedness. The whole lesson follows a pre-structured sequence of steps. At each of these steps, the teacher initiates by providing information and/or posing questions. The student responds, and the teacher will then provide evaluative feedback and follow up on the studentís response. The teacher exercises strong control over the development of the classroom discourse through such cycles of Initiation-Response-Evaluation (IRE).

Examples of ICT Adoption in Expository Teaching

Among the lessons observed in the study, six are selected for detailed analysis. The teaching topics and the use of ICT are summarized in the following table:

Table 4.1 Summary of the six examples in expository teaching

Lesson	Topic	ICT used and its functions
P4 General Studies	Choosing toys	PowerPoint slides containing notes and cartoons with voice over (an audio play) were run. Students were asked to elaborate on what they saw. The webpage of a toy company with a display of toys suitable for children of different ages was shown. The teacher guided the students to discuss why certain toys were not suitable for children.
P4 Chinese Language	Elaboration of meaning by expanding sentences	PowerPoint slides were used to project sample sentences on the white board that served as a large worksheet. The class worked together on the 'worksheet' to decide how the meaning of the sentences could be elaborated by inserting additional phrases.
P6 Chinese Language	Comprehension of study text and the writing of brief communication notes (The study text described an incident that required the writing of a note.)	PowerPoint slides were used to display the study text. There were hot spots on the text which linked to word explanations and illustrative diagrams. The teacher used it as a visual aid to supplement her explanation about the study text. A PowerPoint slide containing an example of a brief note with pop-up annotation about its major components was shown. This was used as an aid to introduce the structure of a note E-mail. students were asked to write short notes and send them to the teacher through e-mail.
P4 Music	Instruments, rhythm, melody	A music learning game was used where The user played a role in the adventure game to save the music land by accomplishing some tasks related to knowledge about musical instruments, rhythm, and melody. The class played the game together. (A student came out to perform the task on the teacher's computer and the whole class could see the result.) In the process, the teacher made use of the opportunities arising from the game to elaborate on the particular musical items encountered.
S5 Physics	Half-life in radioactivity decay, and applications of nuclear radioactivity	There was an applet on the WWW that illustrated the dynamic process of radioactive decay and the concept of half-life. The teacher used it to visualize the change in activity rate over time. Then, PowerPoint slides with notes and graphs about radioactivity were displayed; An applet on WWW was used to simulate the control mechanism of a nuclear reactor.
S6 Chemistry	Common ion effects on the dissociation of weak acids	PowerPoint slides containing notes, equations, and diagrams were shown. The teacher used them as a visual aid to supplement his explanation. A simulation program that could output resulting ionic concentration dynamically based on the input from the user was used. Students worked in groups to calculate resulting ionic concentrations and to check their answers using the program.

It is clear from Table 4.1 that these lessons were conducted mainly through the use of one teacher computer with a large screen projection. The teacher carried out presentations or held discussions with the help of technology. The functions performed by ICT during the teaching and learning process included:

1. To display notes and drawings to supplement the teacher's oral presentation
2. To locate the topic of learning in an interesting context
3. To supply stimulus materials to elicit ideas from students for discussion
4. To provide visualization for the understanding of dynamic processes

In some of the lessons, the teachers also provided the names of web sites so that the students could do follow up reading after the teachersí exposition.

It was noted that although ICT was used in the lessons, there were often also other types of activities. These included paper and pencil work, physical activities (like the whole class clapping hand according to a rhythm in the music lesson), and off-computer group work.

Roles of Teachers and Students

In these lessons the teacher was the major supplier of information. In general the teachers would prepare all the presentation materials on the computer. With the help of technology, the presentation materials included pictures, sounds, as well as interactive programs. Some teachers also named URLs and encouraged the students to visit those sites for further self-learning on the topic.

In most of the lessons observed, ICT materials were used to enhance teacher-student interaction. Although the flow of the lesson was quite tightly controlled by the teacher (each step achieving a specific goal), in each of the teaching steps, the teachers tried to solicit studentsí viewpoints. The ICT materials were used as part of the stimulation

The lessons were conducted mainly through the use of one teacher computer with large screen projection. Despite the fact that there was only one computer in the classroom, some teachers found ways to allow the students to play a more active role. Some asked the class to make collective decisions and then input these into the computer and tested how the computer responded (some even invited students to come out and do the input themselves.)

In the post-lesson interviews, the teachers were asked whether they thought the roles of teachers and students had changed due to the use of ICT. Following are highlights of their responses:

- *I think there is change in the teacher's role, the teacher now guides the students to learn. It is not the kind of teacher talks and students listen.*
- *Not much at the moment. We've just begun using ICT. In this lesson, even with ICT, the participation of the students has not increased too much. I hope in the future the role of the teacher can be less on directing and more on helping.*
- *The teacher is going to be more dynamic. In the past the teacher had to tell students about all the things they needed to know. But the teacher cannot go too far, perhaps only confined to one or two books. Now the teacher has more resources available at hand, he/she can gain access to the Internet and search for information. Going one step further, the students can visit the website and report to the teacher on their gains, or consult the teacher if they have any problems.*

On the whole, the teachers are looking forward to changes that enable them to be more like a helper to the students than the provider of knowledge. However, as for their current use of ICT in the lessons concerned, they think they are doing more or less the same thing as they used to do.

Is ICT Making these Lessons More Interesting?

Teachers generally hold the opinion that the use of computer presentation can help make the lessons more understandable, interesting and efficient. Following are some of their comments in the post-lesson interviews:

Question: *What do you think is the purpose of using ICT?*

- *The students pay more attention. We can also use it to display something that is originally very abstract.*
- *I think we can save time and do things more quickly.*
- *It is handy to organize the materials. You can have sound and pictures. It is much easier than to use taper recorder. Also we can log on to the web.*

Question: Do you think you can achieve the same effect if there is no ICT?

- *I think yes, but with lower efficiency*
- *With ICT, we have one more medium, it helps to attract studentsí attention.*

Both primary and secondary students were also invited for interviews. Following are highlights of their comments (P = primary student, S = secondary student, R= researcher):

P: *The lesson becomes less boring with computer. Before it (the subject) was rather boring. It can be better if we have computers in class.*

P: *The lesson can be more interesting. Using computer is like entering a maze, you donít really want to go out. It is good that we can go out to the teacherís computer and press the button.*

S: *Without computer, we cannot do simulation of the experiment. Some experiments are difficult. It is more fun to check the answer from the software. Before, it was the teacher who worked out the answers on the board. Thatís boring.*

S: *Without PowerPoint, the teacher will have to write them out and it takes a longer time.*

(R: Besides being quicker, does the use of ICT help you understand?)

S: *I will visit them (the websites referred to by the teacher) again. Since the teacher has shown them in class, I may look at the sites again at home. . If the teacher has not shown that, I may not have the initiative. If it is a book, it is done after you finish reading it. But if it is the web, you can find out more from it.*

S: *The graphics on the computer are more interesting than the books, they catch my sight and also help me understand.*

In general, the students' feedback confirms the teachers' comments that the use of ICT does help to a certain degree arouse students' interest. Some teachers also mentioned that variation in the medium of presentation is also very important (sometimes ICT and sometimes not). However, the nature of the interest can vary from the superficial to the more intellectual, and hence it deserves careful examination by the educator on what sort of interest they are arousing. Otherwise the novel effect of ICT supported presentation can die off quite soon if it is used repeatedly for several lessons.

Is ICT Making the Students More Active?

Let us examine two teaching episodes before we discuss the issues uncovered in the case studies. The first episode is taken from a lesson for primary two students, the topic is on choosing toys (T= teacher, S= student).

T: *Please read the words on the screen. (In front of the class is a large display showing a PowerPoint slide.)*

S: *The toy is not expensive and the price is within our buying capacity.*

T: *When we buy toys, is it good to buy the very expensive ones?*

S: *No.*

T: *Suppose I have enough money to buy that expensive toy, do you think we should buy it?*

S: *No we should not.*

T: *Why? If you get a lot of pocket money during the Chinese New Year, then why not?*

S: *Mum doesn't have much money.*

T: *If Mum has the money, then can we buy it?*

T: *Tell me, even if Mum has the money, would you still not want to buy expensive toys?*

S: *It is a waste of money.*

T: *A waste of money, good. Any different opinion? Anna?*

S: *After buying the toy, there is not enough money for food.*

T: *Yes? Sandra, what do you think?*

S: .....

T: *Where do we get the money for the toy?*

S: *It is earned from very hard work.*

S: *It is given by Mum...Mum earns the money.*

T: *So the money is earned by Mum who works hard. Hence don't use it to buy expensive toys. OK?*

T: *Any more? (The teacher illustrated the next point on the PowerPoint slide).*

S: Enlightening and educational (reading the words on the slide).

T: What does that mean? .. Do you know what it means?

S: Like playing basketball, or like football.

S: Mum said we should not teach people bad things.

T: Teach people bad things, what counts as teaching people bad things? What do you think?

Obviously, during each step taken, the teacher tried hard to allow as much freedom as possible for the students to interpret and elaborate. However, the structure of the lesson has already been carefully planned and followed by the teacher. Key points were written down on the PowerPoint slide before the lesson. The focus of discussion and content of learning were all defined by the teachers. In this sense we could say that the students were playing a passive role. In a subsequent part of the lesson, the teacher used ICT to present an audio play, to solicit ideas from the students. Essentially, the teacher was doing the 'reading' and the audio play. The discussion drew upon a lot of life experience of the students beyond what was presented in the PowerPoint earlier. As a result, the students did play a role in adding meaning to the object of the lesson.

The manner of discussion described above can be contrasted with another teaching episode taken from a P6 Chinese language lesson:

T: Please read the passage. Give me a signal when you have finished.

T: OK. Close the book, and let's see whether you can remember what is in the passage.

T: So on Saturday Kin-ming went to visit his auntie with his father. What did he see on the desk? (She showed a PowerPoint slide that displayed the question.)

S: A book.

T: A book? What is the name of the book?

S: The secret of a wax figurine museum (蠟像院的秘密)

T: Let's see if it is correct. (She turned to the next PowerPoint slide which showed the answer). Right, the secret of a wax figurine museum. Kin-Ming took out a piece of paper, why?

S: He wished to borrow the book, so he wanted to leave a note.

T: OK, let's see if it is so (She turned to the next PowerPoint slide). Yes.

(She read out the model answer) 'He wanted to borrow the book home, so he left a note for his auntie. ...'.

The most contrasting feature one noticed here is that the use of PowerPoint is to draw a close to the discussion. Similar patterns could be found when the teacher used PowerPoint slides to explain the meaning of difficult words in the text. The pop up explanation, enriched with multimedia, was used to conclude the discussion on the meaning of the word.

T. Now look at the text again for one minute and see if there are words which you don't know their meaning.

T: OK, finish? You can close the book, the text is already displayed on the projector.

T: Here is a word that I wish to ask you: on the way (順路). What does it mean?

T: (She clicked on the word and a map popped up.) Here is a building, let say Kin-ming's house is here. Here is his auntie's house, on that day, her auntie drove to that building. The car would pass by Kin-ming's house (The PowerPoint showed an animation of the car). This is called on the way. If the auntie goes in other direction, then it is not on the way.

(The explanation of this word ends here, and the teacher moves on to another word)

One can argue that the use of ICT here is limiting rather than opening up discussion. First, the teacher asked the students to close their books and look at the text on the projector. With that move, the students could no longer see any pencil markings they might have made in their reading, words they might have difficulty in understanding. Second, instead of asking the students to suggest words for discussion, the teacher picked the word, because she had prepared that in her PowerPoint. Thirdly, with the well-prepared illustration, the teacher seemed to be more keen to show her illustration rather than asking students to guess or discuss about the meaning of the words. The students might have been able to guess the meaning of the word from the context of the text, or from the meaning of the constitutive words 順 and 路. But all these possibilities were pushed aside, because the teacher had already prepared a good explanation on the PowerPoint, and showing this seemed to be the most convenient and effective way to make students understand.

'With the Students' vs. 'To the Students'

The teaching episodes serve to show that the use of ICT can have both positive and negative effects on classroom discussions. Here, we can make a subtle distinction of the difference between 'to the students' and 'with the students'. In a sense it is the distinction between the transmission view and the interpretation view on classroom processes. In the transmission view, the teacher uses technology to transmit his/her thoughts **to the students**. Technology is a means to 'amplify his/her voice', hoping that the students would have a higher chance in getting the message. In the interpretation view, however, technology is used to present materials that are viewed as shared objects by both the teacher and the students. The teacher interprets and elaborates the shared object jointly **with the students**.

Suppose the teacher displays a piece of material. The "to the student" style would likely be the teacher explaining the content, followed by a class exercise to check whether the students can perform following the information given. In contrast, with the same medium, the "with the student" style would be that the teacher and the student jointly reading the material. The teacher may invite students to tell what meanings they can read from it, and why they read it that way. The teacher may reveal his/her interpretation at some points, but the role will be that of a partner working with the students in understanding the material. Though the material is created by the teacher, during the teaching episode the teacher looks at it anew, with the students, from a knowledge level slightly higher but close to that of the learner, and try to operate in the zone of proximal development of the students in interpreting the material.

This subtle difference between 'to the students' vs. 'with the students' is actually very important in considering the different effects one can expect from the use of ICT for exposition. If the teacher takes the 'to the student' view, one danger is that the technology would allow the teacher to present huge amounts of information to the students within a short time in class. As a result, the space for thinking on the students could be reduced with the use of ICT. On the other hand, taking the 'with the student' view, ICT can be seen as a very powerful vehicle for bring in useful materials for stimulating student discussion. One example of the latter variety can be found in the later part of the lesson on choosing toys. The teacher showed a PowerPoint slide containing a cartoon of Kei Kei (a popular comic figure) and her friend, with the following audio dialogue:

Kei Kei:	*Yesterday, my mother bought me a doll. At first she did not want to buy it, I cried, and then she bought it for me.*
Her friend:	*How many dolls do you have?*
Kei Kei:	*I don't know, anyway, many many. I will bring that to school tomorrow to show them to my classmates. How proud I will be!*

T: *Do you think Kei Kei has done right?*

S: *No*

T: *What is wrong? Alex?*

S: *Asking mother to buy the doll.*

T: *We have discussed a number of principles. She has broken which principle?*

S: *She has already got a lot of dolls and she still wants to buy more.*

T: *Any more?*

S: *She does not accept her mother's ... she fought with her mother.*

T: *Yes, at first the mother did not want to buy, so what did she do?*

S: *she went wild and would not leave, she cried and refused to take meals.*

T: *Should she behave like that?*

S: *No.*

T: *Any more?*

S: *Let me think... to show off your toys in front of others.*

T: *Yes, it is not a good attitude to use your toys for showing off.*

The teacher followed this discussion with another scenario: a child begged her mother to buy him the same toy gun that his elder brother had.

T: *After the begging, the mother bought the child the gun. Do you think the mother is correct?*

S: *No.*

T: *Why? Sandy?*

S: Because ... the mother (too soft)

T: Any elaboration from others?

S: Because there are some small parts in the gun.

T: Yes, the mother has not considered what?

S: Whether the toy is suitable for young children or not.

T: Right, she has not considered the age of the younger brother.

The teacher then displayed the website of a toy company. On the site, toys were classified according to the age group suitable. The teacher directed the students to look at some toys, asked them to guess the appropriate age range, and give reasons to support their assertion. The activities continued until the bell rang.

Potential Pitfalls in Using Computer Presentations

Another potential pitfall in the use of ICT presentation is the great temptation on the teacher's part to follow strictly the presentation materials prepared in advance, instead of responding spontaneously to reactions from the students. This, to a certain extent, is related to the very nature of computers. The computer is a programming device, so you can program the steps before hand, to execute complicated procedures in fractions of a second. This strength can actually become a deficiency. The materials are created with a pre-conceived sequence of the teaching and learning process (or a pre-conceptualized labor termed by some economists). However, the reality is that the actual process seldom proceed as expected. Since the presenter has invested so much effort in preparing the materials, and it is often very messy to modify at the time of the presentation, the presenter tend to stick to what was planned and become less flexible.

In the conventional classroom, teachers are used to invite inputs from students about their personal experience on the learning topic, and put down on the blackboard important points arising from the discussion. However in classrooms where computer presentation is used, it is not unusual to find that the lights of the room are turned off, and the projector screen is blocking the blackboard. The opportunity for spontaneous note taking is often reduced.

It is pleasing to note that some of the teachers in this study appear to be quite aware of this danger. It is remarkable to note that although many of them have prepared their notes and visual aids on the computer, they would still use the blackboard to write down students' views that are raised spontaneously during the lesson. One teacher

even projected the computer display onto a white board, so that marks / writing can be added freely onto the display when needed.

Issues Concerning Visualization

Visualization is among the most popular usage of ICT for expository instruction. It is particularly relevant when the learning involves an understanding of a dynamic process. The computer can bring the whole process to live, make it more accessible for close examination, and hence provide a better context for discussion among the teacher and students. However, in the teaching episodes we observed, the effectiveness of such usage also rested on whether the teacher was able to use the visualization 'with the students'.

Visualization is a two-edged sword. While there are the benefit in using visualization, it may also easily lead people to wrongly believe that everyone is seeing the same thing, which obviously is untrue. Yet, it is not uncommon for a teacher, after showing an animation to the students, to conclude by saying 'This is what you see happening, OK?', and move on to other part of the lesson taking for granted that the students have already captured the critical features of the process which are so obvious to the teacher.

With the increasing power of computer animation, visualizations can now be made to look very real. This can further reinforce the idea 'seeing is believing' or even 'seeing is understanding'. With that in mind, once the materials are displayed, the teaching goal seems completed. Of course that is also not true. Seeing and making sense are different things. We can see that in situation S, there is a pattern X. However, to make sense of that, we do not just accept it as a fact that X is true in S. We think and judge as well. We will relate what we see to other possibilities, such as whether a contrasting or idea or pattern X' can be applied to the same situation S, or whether the pattern X will become similar or different if the situation changes to S'. A lively computer animation/model should be the starting point for, but not the replacement of this thinking and discussion. If we are not aware of this pitfall, the myth of visualization can in fact result in an anti-intellectual reduction of teaching and learning.

In the observed lessons in which visualization was used, the teachers were seen to supplement visualization with the following significant moves:

1. Allow students to guess what would happen before the actual viewing, and discuss the reasons behind their guess. This stimulates and prepares the mindset of the students in viewing the visualization.

2. Allow students to verbalize in their own words what they see as a whole and/or the different components in the process.

3. Link what they see to other analogical or contrasting situations. This develops the students' ability to make generalization and to apply ideas and concepts in different situations.

Summary

The chapter reviews expository lessons in which ICT presentation materials are used. It highlights the importance of how one sees the role of such materials in teaching. These materials should better be seen as objects for the teacher and the students to 'read together'. The teacher should read the materials together **with the students**, inviting them to interpret and elaborate on the materials. With such thinking in mind, ICT can help enhance the exchange of views between teachers and students. On the other hand, if ICT is seen just as a means to strengthen the teacher's voice or the efficiency in the transmission of information, then the use of technology may just aggravate the down side of expository teaching.

The chapter also highlights the importance to realize the intrinsic relationship between the strengths and potential problems of ICT usage in classrooms. ICT can help the teacher to present a lot of information within a short period of time. This is a strength. Nevertheless, it can also be easily turned into a major weakness, if the teacher uses it to dump information to students without considering the time and process for them to digest. We can use ICT to visualize dynamic processes. This is a strength. However, if not careful, the teacher may fall into the trap of thinking that the students are seeing what they see, and reduce the students' construction of meaning to a simple viewing of computer animations.

References

Ausubel,D.P. (1960). The use of advanced organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology*, Vol. 51, pp.267-272.

Ausubel,D.P. (1963). *The Psychology of Meaningful Verbal Learning*. New York: Grune & Stratton.

Chapter 5 Using ICT in Inductive Teaching and Learning

S C. Li

Inductive Learning

The inductive approach to teaching and learning has a long heritage. Getting students to engage in deep learning through critical thinking, problem solving, and discovery are not new goals for education. The Socratic method, dating back to the early Greeks, emphasizes the importance of inductive reasoning and dialogue in the teaching process (Gilstrap et al. 1975). Bruner (1960, 1962, 1966) emphasizes the importance of discovery learning and how teachers could help learners become "constructivists" or "constructionists" or builders of their own knowledge. In the areas of social studies and history education, Fenton (1966) developes his own inductive approach to teaching and learning by emphasizing on the importance of encouraging students to participate in historic analysis, and to test ideas and theories against artifacts from the historical record.

The concept of an inductive pedagogical approach is often used interchangeably with discovery learning and inquiry learning in the research literature. Adoption of the inductive approach in the classroom can be classified according to the amount of guidance given by the teacher. The variation ranges from guided discovery to unguided discovery. Generally speaking, the goal of the inductive pedagogical approach is to help students learn how to ask questions, seek answers or solutions, and build their own theories and ideas about the world through exploration and discovery. Instead of giving students prior ideas or teaching theories about the world, which is what teachers are doing when they use the expository or direct instructional approach, teachers using the inductive approach would pose questions or problems to students and ask them to generate their own ideas, concepts, theorems or theories. The teacher is not merely instructing students on concepts and ideas, but is also facilitating exploration and discovery.

Exploratory learning environments which include micro-worlds, modelling tools and visualization tools are often used to support inductive learning activities. These learning environments provide discovery space and constrained simulations of real-world phenomena in which learners can control, navigate, manipulate objects and test their effects on one another. These exploratory activities also involve the formulation and testing of hypothesis/concepts through experimentation by students. They allow

students to explore phenomena and ideas about a topic presented by teachers or experts. While these tools help students visualize abstract concepts and derive meanings from the information represented, they can also be used to enable students to externalise their thoughts and formulate ideas into models or theories that they can experiment with and reflect upon. In the prelude of each teaching episode, teachers would usually present students with puzzling or problematic situations that are not self-explanatory. These puzzling situations create cognitive dissonance among students and motivate them to think. The use of ICT makes the task of expressing ideas and exploration of the consequences of those ideas easier for students. With the help of ICT, teachers can encourage students to generate theories and hypotheses to explain puzzling events, ask questions, generate data, and put their ideas to empirical and logical tests. In this type of lessons, teachers help students become more conscious about their own thinking processes and monitor and evaluate their own learning more effectively.

Examples of Technology Supported Inductive Learning

Among the lessons categorized as adopting the inductive pedagogy, four typical examples were chosen to depict the salient features of this approach. These were lessons in P2 mathematics, S4 mathematics, S6 chemistry, and S6 geography. The software applications used in these lessons included a software package for learning geometric figures, Geometer Sketchpad, a chemical visualization tool and ArcView, a geographic information system(GIS). A summary of these lessons and the functions of ICT in each lesson is presented below.

Table 5.1 Summary of the four examples in inductive teaching and learning

Lesson	Topic	ICT used and its functions
P2 Mathematics	Identifying simple properties of two-dimensional and three-dimensional geometrical figures	- A CAL quiz package for learning geometrical figures was used to help learners to visualize and explore the features of various geometrical figures
S4 Mathematics	Exploring the geometric relationship and properties of tangents to a circle	- Geometer SketchPad, a software that allowed users to construct 2D geometric figures, take measurements and compute various geometric quantities was used - Through manipulating the different parameters of a circle learners were able to explore various geometric properties and their relationships
S6 Chemistry	Studying the mechanism of hybridization	- A chemical visualization software was used This provided a 3D visualization of molecular structures according to the formulae prescribed by the user
S6 Geograph	Investigating the relationship between pollution level and geographical location in Hong Kong	- ArcView a geographic information system provided a multi-layered representation of geographical information was used - Students could make use of the huge amount of real data in the database to analyze and explore pollution levels at different locations in Hong Kong

Although some variations in teaching styles and the degree of teacher's guidance in students' exploratory activities were found in the four lessons, they did share commonality in several aspects such as the classroom interaction pattern, the lesson structure and the way technology was being used.

Roles of Teachers and Students

The lessons under this category shared certain similarities. Every lesson was made up of a series of classroom transaction cycles. Each consisted of the following episodes: introducing new subject matter knowledge, eliciting questions, responding to students' learning outcomes and monitoring student activities by the teacher. The inductive lessons observed in this study were structured in a rather teacher-centred fashion. Basically, the teachers devoted most of the time to classroom teaching with very little time reserved for students to engage in hands-on, exploratory activities. The teachers played a dominant and pivotal role in maintaining the quality and quantity of teacher-student interactions. Most of the questions raised by them were short and close-ended, and students' responses were also brief and direct. Student-student interactions were rare during the lessons. Technology was generally used as dynamic visualization tools for teachers to elicit concepts related to the subject matter. An exception to this was found in the geography lesson in which the teacher posed open-ended questions and required students to explore possible solutions. In this lesson, the class was divided into groups, and by utilizing the GIS software package and current data provided by

the government, students were required to analyze various factors contributing to environmental pollution in Hong Kong. With the aid of the software, students were able to formulate their own explanations or theories through the manipulation of data, group discussion and argumentation. However, in other inductive lessons observed, the focus was on the acquisition of subject matter knowledge. The use of technology was predominately controlled by the teachers. IT or non-subject matter competence of the students was unable to be displayed during these lessons

In addition to the software packages, some of the teachers liked to include Internet activities in their lessons. The variations in teaching philosophy were reflected in how they structured these activities. Interestingly, the teachers who adopted the inductive pedagogy tended not to encourage students to have free exploration of the Internet:

> *Now, on your desktop, you should also have another document, which is a word document. Please open that one, and in fact, that contains many of the web sites from which I downloaded the materials ... You just click on it, and hyperlink to the first web site. The last one, organic chemistry online. ...I'd like you to take a look at that, and then try out some of those. Find out the answer yourself.*

They tended to prescribe bookmarks or hyperlinks for the students and asked them to look up facts on the computer rather than allowing them to do research on their own. This kind of constraint imposed on student activities characterizes the teacher-centred nature of the inductive lessons in our study.

Exploring Concepts with Technological Tools

Generally speaking, the lessons observed were highly structured and well organized. The teachers had a clear goal and direction in mind and a specific subject content to cover. The inductive lessons, though still exhibiting strong teacher directives and control, were more student-centred than the expository lessons. The former type of lesson was usually divided into two segments: teacher demonstration followed by students' exploratory activities. In the demonstration session, the teachers employed the predict-observe-explain strategy to elicit the concepts and ICT was used as a virtual laboratory, providing simulations of real-world phenomena and visualizations of abstract ideas and concepts. In the exploratory activities following, the teachers created a climate of support and promoted success through their questioning skills. Whereas in expository lessons the concepts were stated by the teacher before examples were given, here students were required to make observations and finally arrive at a

generalization through logical reasoning. The following episode highlights some of the salient features of inductive teaching.

In this F6 Mathematics lesson, the teacher used the Sketchpad as a dynamic visualization tool to illustrate abstract mathematical concepts:

> *We are going to study the basic properties of the tangent, the relationship between tangent and the radius. Now first we will use the Sketchpad to measure angles. ...I'll run some animation for you .. You can observe the diagram, ...*

The teacher had to pose the right question at the right time, monitor students' responses and decide when to prompt and to channel divergent responses toward the goal:

T: What happens to angle ACH and the distance of IC as point I gets closer to point C?

T: You just guess the answer by observation. .

S: Angle ACH becomes larger.

T: How about the distance of IC?

S: It becomes shorter.

T: How about angle ACH if I is just right on top of point C?

S: 90 degree

T: 90 degree, usually it is 90 degree. You guess. And distance becomes zero. This is easy.

T: When point I and C coincide, the distance between I and C becomes zero. That means it just touches the circle. What do we call HCP?

S: Tangent.

T: Yes, the answer is easy to find...

After journeying through a series of questioning and guided exploration, the teacher tried to make generalization by formulating a theorem about the related geometrical property based on students' observations during the guided exploration:

> *We have the following theorem. If HCP in the diagram is a tangent, that means it represents a line, a line is tangent to a circle at C, then AC is perpendicular to HP.*

In the above example, the lesson was mainly teacher directed with the teacher as the major provider of information. The teacher used the software as a dynamic visualization tool, which was, to a certain extent, similar to a presentation tool used in expository lessons. However, instead of stating the 'tangent to a circle' theorem right at the beginning (as teachers normally do in expository lessons), the teacher used the software to create a variety of examples, asking students to observe, guess, explain and make generalizations. This contrasts with the deductive teaching strategy that is often employed in expository lessons.

Teachers' Perception of the Impact of Technology

While most of the teachers who adopted the inductive pedagogical approach felt that using technology did not change their teaching beliefs, they admitted that technology was used to support their teaching in ways they found appropriate. As they maintained, the implementation of ICT in teaching and learning had not induced any significant change in their roles.

> *In Mathematics lesson, there is not much change. This is because IT is usually used as a tool for illustration. It is hard to use IT as an interactive tool. The interaction during the lesson you just observed is barely achieved. Indeed, I have thought of doing group discussion (which is facilitated by IT), but this is too difficult to be done...*

In terms of pedagogical innovation and learning goals, teachers generally thought that ICT could not bring about any fundamental or revolutionary change:

> *For the learning goals, there is not much change. That is, we use the traditional teaching method and the same lesson structure to achieve the teaching goals. The development of information technology devices is an ongoing process. Instead of increasing the workload of teachers and making them reluctant to use IT, it is hoped that IT can make teaching more convenient and effective. ... For example, a Chinese lesson is a Chinese lesson, the teaching goals are still the same, with or without IT. Sometimes, people say we are moving into a new era. We may use a set or more than one set of texts and pictures in learning. We may use multimedia devices in learning. (After all), they are only teaching tools.*

Even though they maintained that the use of technology had not changed their teaching beliefs, some teachers indicated that technology, to a certain extent, had changed the way they taught, by making it possible to do different things in the classroom. Some teachers noticed that, with the use of ICT, they could extend the depth as well as the

breadth of the subject matter content and explore more deeply on topics that were not covered adequately in the textbook:

> *(In terms of teaching strategy), we have more choices now. There are more things that can be done with technology. It is impossible to achieve what I have just done in the lesson with only the textbook or an overhead projector.*

Teachers generally believe that ICT does provide new opportunities for teaching and learning. For instance, the Geometer Sketchpad provides a virtual laboratory for students to carry out experimentation in mathematics. Before going through the formal proofs for the mathematical theorems, students can manipulate various geometrical figures and explore the mathematical relationships among them by taking measurements, collecting data and making generalization. This inductive approach complements the traditional pedagogy of deductive teaching. It allows students to make their own sense of abstract mathematical concepts through their own investigation and exploration. In addition, the software also serves as a powerful visualization tool for teachers as well as students to express or illustrate abstract ideas.

Besides this, the geographic information system (GIS) has also made improvements possible for traditional geography lessons:

> *Without computer, if the students want to investigate the relationship between air pollution and other factors, they have to read many maps to find out the relationship between concentration and other factors. Maybe they have to investigate this by overlaying a set of transparencies. Now, this can be done just by drag and drop on the computer. Or even simpler, the software has already contained the many layers that are useful. The advantage of the software is that it can process a large amount of data. For example, I do not want to use the data collected on the 19th. I want to use today's data. I can update the data in 15 or 30 minutes by downloading the newest information from the Internet and making use of it instantly. The updating process does not take much time indeed.*

The GIS software has the capability of visualizing and processing a huge amount of geographical information in a multi-layer fashion. It therefore offers new opportunities for students to carry out investigations into complex issues such as environmental problems. Traditionally, these topics are usually discussed in a qualitative fashion during the lesson. With such a cognitive tool in hand, students are able to engage

themselves in more authentic situations in which they can manipulate and analyze real and updated information, formulate their own hypotheses and theories.

Issues and Challenges

The exploratory activities or demonstrations in inductive lessons, with their emphasis on observation, comparison and explanation, are more conducive to the development of cognitive skills than are expository approaches. However, inductive pedagogy is in fact hard to employ unless teachers and their students are skilled in employing discussion techniques, and unless norms exist in the classroom that allow open and honest exchange of ideas (Arends, 1991). One of the biggest challenges to the inductive pedagogical approach is the skills they demand of the teachers. Teachers using this approach must constantly be involved in decision making. They must decide when to channel divergent responses towards the goal, pose the right question at the right time, prompt when necessary and do all these while monitoring the students' responses in order to follow-up on questions. This requirement on the teachers' part is substantial if the class consists of students with diverse backgrounds and mixed abilities. In short, inductive lessons typically require more time, more skills and more effort in teachers' preparation work.

Another challenge to teachers adopting this approach is how to liberate and empower students to learn with technology. As mentioned earlier, the lessons under this pedagogical category were generally conducted in a teacher-directed manner. Though there were hands-on sessions reserved for students to do exploration and experimentation, the whole lesson was still dominated by the teacher's exposition. ICT was used mainly as a dynamic visualization tool for teachers to elicit content related concepts rather than as a cognitive tool to enable students to externalize their thoughts and to construct knowledge. As a result, the learning opportunities provided by the technology were not fully exploited. This poses another challenge to the teachers.

Exploiting the learning opportunities provided by software packages can be a formidable task especially when the software is not originally designed for educational purposes, for example, the GIS. It relies particularly on the teachers' experience and insight in curriculum issues, and their courage and ability to overcome various technical barriers and hurdles in the process of application. To create a reform-based classroom where curricular changes and pedagogical innovations are best coordinated, teachers need to be receptive and acquire contextual competence in meeting the new demands of teaching and learning.

In response to the impact of the fast changing environment, teachers' continuous learning and adaptation are critical elements in the pursuit of teaching effectiveness. To achieve continuous improvement and development in the teaching profession, it is important that teachers will engage themselves in lifelong learning. This does not only facilitate the acquisition of necessary knowledge and competence that will help them analyze and reflect on environmental changes and develop appropriate strategies, but also ensures the attainment of pedagogical innovations and curriculum development. For these to succeed, reframing the conception of teacher professional development is therefore essential.

Summary

The inductive pedagogical approach accompanied by the use of ICT is likely to help improve and enhance students' development of cognitive skills and processes by engaging them in exploratory and discovery activities. The inductive strategy produces a sense of excitement in students. The method allows them, to a certain extent, to move along paths best suited to their own abilities and help them strengthen their self-concept as they gain confidence through trial and error in the process of exploration. With respect to the use of technology in the classroom, teachers maintain that technology has not changed their teaching beliefs. However, some teachers indicate that integrating technology into the curriculum could extend the depth as well as the breadth of the subject matter content, and enable them to explore topics in details that are not covered adequately in the textbook.

References

Arends, R.I. (1991). *Learning to Teach.* New York: McGraw-Hill.

Bruner, J. (1960). *The Process of Education.* Cambridge: Harvard University Press.

Bruner, J. (1962). *On Knowing: Essays for the Left Hand.* Cambridge: Harvard University Press.

Bruner, J. (1966). *Towards a Theory of Instruction.* Cambridge: Harvard University Press.

Fenton, E. (1966). *Teaching the New Social Studies in Secondary Schools: An Inductive Approach.* New York: Holt, Rinehart & Winston.

Gilstrap, R.L. et al. (1975). *Current Strategies for Teachers: A Resource for Personalizing Instruction.* Pacific Palisades, Calif.:Goodyear Publishing Company, Inc.

Jonassen, D.H. (2000). *Computers as Mindtools for Schools: Engaging Critical Thinking.* Upper Saddle River, N.J. : Merrill,.

Kauchark, D.P. & Eggen, P.D (1998). *Learning and Teaching: Research-Based Methods.* Boston, Mass.: Allyn and Bacon.

Mellar, H. (1994). *Learning with Artificial Worlds: Computer Based Modelling in the Curriculum.* London: The Falmer Press.

Chapter 6 ICT Applications in Task-Based Learning

W.W. Ki

Task-Based Learning

The term 'task-based learning' mainly originates from the literature on language education (Prabhu, 1987; Nunan, 1989). It serves as a contrast to the form-focused approach. In 'task-based learning', the learning activity focuses on the meaningful use of language within a social milieu. Learning activities are organized around tasks instead of around language items. The underlying assumption is that by engaging learners on a purposeful communication task, they would be able to learn the structure of the language in a more natural and meaningful way.

Here, the concept of 'task-based learning' is used as a general idea across different subject areas. Subject knowledge is learnt in the context of its application. What differentiates between 'task' and the conventional 'exercise' is that the former carries a purpose that is understandable and inviting to the learners, while the latter is often for the sake of mastering a certain piece of knowledge and skill. A task would generally involve the learners in an active process of understanding of the purpose and the situation and to explore different ways to accomplish the task. The outcome of a 'task' is usually more open-ended than the case of an 'exercise'. In general, the task can provide some room for learners to add their own personal flavor. In the end it is hoped that they can feel a stronger sense of ownership of their products.

Ideas similar to task-based learning have also been put forward quite strongly by some educators in the field of ICT education. These include those who advocate theories of constructionism and apprenticeship learning (Kafai & Resnick, 1996; Lave & Wenger, 1991). These views raise fundamental doubts about the validity of conventional learning of declarative knowledge which is distanced from the actual physical and social context.

A number of potential advantages of the task-based approach can be summarized as follows:

- A task-based lesson can usually give the learner an active role in participation and creation and hence increase their learning motivation.

- A task-based lesson can provide more opportunities for the students to externalize their thinking through their actions. This can help them to reflect on their thinking. The teacher can also be more responsive to the needs of the students.

- It allows students to use the knowledge they have learnt and apply it productively in the task context (procedural knowledge). It can also link cognitive learning to the affective or value dimension engendered in the task situation.

- The practical experience can help learners to appreciate why certain academic questions are important and provide an experiential substrate for the development of a further academic discourse.

- The task usually requires the creation of some objects as outcome. This can provide a shared focus where students can work together. In the process, different participants, including peer learners in the team and the tutor, can project different views on the same situation and develop meaningful discussion on the matter.

- The task will usually generate objects that are also amenable to cross-group evaluation. The students can present their own products and/or evaluate others'. Everyone can take part in evaluating the strengths and weaknesses of the work generated within the classroom community. This will induce reflection as well as the development of critical awareness in the students.

However, the idea that children would naturally learn important knowledge structures simply by being on-task has been challenged. In the area of language education, some educators doubt that children will be able to naturally internalize certain language structures without instructional intervention, and raise questions about how one should sequence different tasks (Long and Crookes,1992). Some language educators actually adopt a mixed approach where form-focused consolidation components are added as complementary to the task-based learning units. Similarly, in the lessons we observed, 'task-based learning' approach was used in the classrooms mostly as one teaching and learning approach among / or integrated with many others.

Examples of ICT Adoption in Task-Based Lessons

In this study, we have selected four task-based lessons from our observations for detailed analysis. The topics and tasks of these lessons are tabulated as follows:

Table 6.1 Summary of four selected lesson in task-based approach.

Lesson	Topic	The task and technology used
P3 Chinese	Descriptive writing	To describe scenes of thunderstorm, rain and rainbow in a few sentences, so as to portray major features in the scenes, and add that description to the PowerPoint slides together with the pictures.
P4 Art	Egyptian art	To create models of stone crafting similar to the Egyptian hieroglyphs.
S1 English	Story writing	To produce an electronic version of a story: arrange a piece of test to 6 paragraph story and put in voice-over and visual elements to make it more interesting.
S2 Chinese	Use of associations in writing	To search somefor an animal picture fromon the iInternet and write aboutdown the associated thoughts students can draw from the characteristics of the animalsassociate with those pictures.

All these lessons, except the second one, took place in the computer laboratory. In general, the structure of the lessons is as follows:

1. The teacher highlights relevant previous learning.
2. The teacher assigns the task, explains the purpose and key expectations.
3. The teacher explains how students can make use of the IT tools to carry out the task.
4. The students work on the task in small groups, and the teacher gives individual help to the groups.
5. The class reviews and discusses about the work of the groups.

In the art lesson, only one computer was used. It had a large projection display which was mainly used as a medium to show stimulus materials to the class. Subsequent work was done using conventional art and craft materials.

According to our observation, the students were on the whole quite actively involved in the tasks given, and the amount of student-student, and teacher-student interaction was quite intensive during the group work period. Some of the strength of using IT can be identified. There were also issues arising due to the use of IT. These are discussed in the following sections

Roles of Teachers and Students

At the beginning of the lessons, the teachers usually take an active role in providing the background of the task (reviewing related knowledge, introducing the purpose of the task and so on) and in teaching the students the use of the technology.

In task based lessons, a substantial part of the time is allocated for students to work on the task, either individually or in groups. In the process, the students are playing an active role in their work. Here, the teacher's control is exercised indirectly through definition of the task goal, and directly through discussion with students during their work.

It is observed that most of the tasks were very clearly defined. What was required was very specific. This might be due to the tight schedule. The teachers had to ensure that the students could complete the tasks within a relatively short period of time (usually half of a lesson or the whole lesson, but seldom over weeks). Furthermore, the task were often designed to be simple and very focused, so that they were accomplished within the general capability of the students, and could fit in closely with the other parts of the teaching.

In the individual discussion between the teacher and the students, the teachers typically play a less prescriptive role. They often coach reactively, in the sense that their directions or assistance are given based on what the students' want. They give their advice only after they have solicited and understood the ideas of the students, and try as much as possible to follow the line of thinking of the students. In some cases, the teacher works as a technical support person for the students. The students tell the teacher what they want to do (but cannot do), and the teacher tell them what technical steps could be taken.

Some teachers would conduct an interim or final review of the task products by the whole class. In these review sessions, the teachers would play a facilitating role. They highlight key questions and invite comments from the students.

Above are descriptions of the roles of students and teachers in general. However, our observation indicates some important variations. While it is quite common that teachers may like to work jointly with the whole class in exploring some phases of the task so that the students can appreciate/understand the task and the procedures better, some teachers tend to overdo this part and tend to spend long time to demonstrate in details how one might accomplish the task. In so doing, the amount of time for the actual work by the students is reduced and the task become more like an exercise in the end.

Many students enjoy working independently from the teacher. However, some of them would like to call for teachers' reassurance from time to time during their work. Apparently, they need more teacher encouragement before they are fully prepared to take the risk of exercising their original ideas.

Successful Implementation of ICT Supported Task-Based Lessons

In the following sections we focus on a primary three Chinese language lesson and use it as an example to discuss areas that deserve teacher's attention in designing technology supported task-based lessons. This lesson is chosen because it is the most illustrative among others to show the general features, benefits and potential problems of a task-based lesson.

This was a primary three Chinese language lesson about descriptive writing. The students used the PowerPoint software to carry out the task. They had watched their teachers using the software for presentation, but they had not used it before. The lesson went as follows:

Table 6.2 Outline of the primary three Chinese language lesson.

Major episodes	Detailed descriptions
The teacher began by spending about 5 minutes to let the class get their technology tools ready	The teacher led the students into the computer laboratory She asked them to turn on the computers and execute both the PowerPoint program and Chinese hand-writing program She showed the steps on her computer which got its display projected onto a large screen in front of the class She asked the students to follow her steps There was not much difficulty The students had learnt about these general procedures before She just waited to make sure everyone could do it Everything ran smoothly up to this point
The teacher told the students how to access the resources specific for this lesson Here some technical complication occurred and it took her a few minutes to fix the problem	Then she demonstrated how to access the resource materials they were going to use in the lesson She opened the directory '3b' and subdirectory 'A240' and then the file 'weather' which she had prepared before the lesson Unfortunately, the speed of the machine was very slow, the students started to murmur among themselves The teacher called the names of particular students to keep them quiet while she was trying to solve the problem at the same time She was able to handle the situation calmly, exploring other methods of accessing the file, such as creating copies of the file onto the students' computer as well as opening the file in the read-only mode Eventually she got things set up and she circulated around the groups to help them individually
The teacher explained about the task	When she was sure that the basic IT tools and resources were ready for the task, she began to introduce the learning task She switched on the control system so that the students were temporarily barred from using their computers All student computers were controlled by the teacher, and their monitors showed the same display broadcasted from the teacher's computer

The teacher started off by helping students recall from their previous lesson that a scene could be described in terms of the sound, color, and state associated.	*"Never mind what happened. There has been some complication, but we can now do what we want. Do you remember what we did last time? What did we describe? Yes, we described scenes. Do you remember what were the three kinds of things we could write about? Student A, can you say it loudly?"*. The teacher then brought the students' attention back to the curriculum matters. *"Sound."* *"Yes, sound. The second kind? Student B"* *"Colour.""Yes, colour. The third kind? Student C?"* *"Shape."* *"It should be state...*
Then she related these general concepts to the specific task that the students were going to do.	Then the teacher switched from general concepts to the particular scenes in the 'weather' file. She displayed all seven slides in the file on the screen. *"See the pictures. Someone is very noisy. I am constantly updating your 'discipline marks'. If you talk then you will not get your marks. Good, we shall do something like what we did last time. We shall describe them in the three ways. What is the colour? "*
The teacher spent 4 minutes working jointly with the class on a small part of the task, illustrating at the same time the task objectives as well as the technical operation required.	The teacher worked briefly with the whole class on one of the pictures, and showed them the method of adding text to the picture. The method was fairly straightforward: double clicked on the slide which would then pop up. On each slide, there was a picture underneath which was a text box. Just clicking on the textbox would begin the text input. Chinese characters were then input through the writing pad (the computer did the automatic character recognition.) The whole process was very smooth. It only took 4 mins for the integrative process of discussion and demonstration.
Students worked in groups for about 25 minutes. The teacher moved around to offer help to individual groups.	Then the students were allowed to work in groups to think about the textual description and entered them onto the slides.The teacher walked around to give individual guidance. Some students asked her to clarify the task, and some asked how to write individual characters. There were no technical problems except in some cases where the computer failed to recognize students' character input. In creating the text, students sometimes helped one another in recalling how to write certain characters. The students worked for about 15 minutes. The teacher ensured that all groups were now making steady progress. Most of them had completed the description on one slide. The teacher announced that they only had 10 more minutes, and continued to move around to inspect students' work. *"'The rain is falling like pearls' ... do you copy that from the book? What sound can you think of?"* The teacher asked one of the groups... A group wished to rearrange the order of the slides. The teacher told them how that could be achieved. 10 minutes passed. *"Time is up."* said the teacher.
The teacher conducted an interim review of what the students had done. She asked some of the groups to explain to others what they had done.The review took about 6 minutes.	*"Have you finished all six? or five? It does not matter, you can finish that after class. Let's first look at some of the work of our classmates. Student D? Stop doing it, or I will update the 'discipline mark' now."* The teacher asked some groups to present their work and guided other students to evaluate it according to the criteria mentioned before the task. Initially she tried to project the students' work via the LCD projector onto the large screen but failed. She then decided to just ask the students to read their sentences. She would ask questions like *"Does it include sound?" and "Is the description appropriate?"* The questions were on the whole quite well responded to. The teacher praised the groups and the review took about 6 minutes.

Based on the work of the students, the teacher asked them to use analogies to write more vivid descriptions. She also invited students to suggest useful analogies. This discussion took about 8 minutes.	Based on the students' work, the teacher posed a higher level requirement: to improve the description using analogy. *"The lightning is like what?"* A student was invited to suggest an analogy and then more were invited to suggest alternative analogies. The questions were repeated for rain.
The teacher gave directions to the students about how they could continue with the work after the lesson.	*"You see there can be many different ideas, you can go on and on. How many of you will continue after school? "* Majority of the students raised their hand. *"OK I will make the arrangement."* The bell rang and the class was dismissed.

Students' Comments on the Use of Technology and Collaboration

After the lesson, the teacher and some students were interviewed. The students expressed great pleasure about their activities on the computer.

S2: It is fun to write on the computer. Sometimes if you write too fast, the characters cannot be recognized. It is fun, if you add in one more dot...

S1: If you write it wrongly, it will generate some funny characters.

I: Do you write more when you use paper and pencil?

S1&S2: Yes, We write more.

There was the novelty effect. They liked the aloofness and interactive nature of the media. They did not have to be too anxious about making mistakes. In addition, they also enjoyed the experience of working together, partly for social reasons (boring or not) and partly for task reasons (sharing the burden/difficulty of the work).

I: Do you think it would be more fun if each of you work on one computer?

S1&S2: No.

S3: It is good to have three people on a computer... we can discuss. It is boring to work on one's own...have to think of the whole sentence by oneself.

I: But I saw you fighting among yourselves for the computer.

S2: We can ask help from others if we have difficulty.

S2&S3: It's better to be in groups.

I: I saw you referring to the book. Do you like to go to the book or to the teacher?

S3: First to the book.

S1: It is better to have two people for each computer...no need to fight for the computer.

S2: Better to have four. You can do it faster.

S1: Not single person.

S3: Two to three is fine, but not more than four.

I: Is it good to have two or three people writing joint composition in the future?

S1&S2: Yes

S3: If you don't know a word, you can ask your classmate.

Using Technology to Learn vs. Learning the Technology

Although there had been some technical problems at the beginning, the lesson was successfully completed in the end. It was also well received by the students (illustrated by their work progress, involvement in discussion, and the enthusiasm in continuing with the work after school).

It is evident from the post lesson interview that the teacher has carefully designed the task so that it is at the right level of difficulty and closely linked to the curriculum objectives.

T: Actually they have studied a descriptive text and learnt some techniques, but they don't know how to do it by themselves, so I give them some photos and ask them to think how to write about the scenes.

T: I have simplified the task of writing by breaking it down. They can concentrate on one sentence (for one scene) at a time and later rearrange the scenes into the right sequence. That is easier. I then require them to write the whole thing in one piece. I think that basically the student can master what I tell them to do.

Another remarkable feature of the lesson was that the level of technological/ operational complexity was kept to the minimal, so that it could be mastered by the primary school children who had never used the software before. The set of technical operations were all directly relevant to the performance of their learning objectives. No general training on the operation of the software was conducted. Instead, a pre-created PowerPoint file with simple and straightforward template is used. By clicking on the text area, students knew instantly what they have to do. The writing pad also allowed the children to write Chinese on the computer conveniently. This 'minimalist approach' had obviously been one of the important factors for the success of the lesson.

As far as technological adoption was concerned, one admirable feature of this lesson was that all illustration/demonstration about technology and its operation steps were done in close relation with the nature and goals of the task. The part and whole, figure and ground, action and purpose never lose each other. The technicality and task goals were introduced in an inter-woven manner: the teacher used the Power Point slides as a visual aid to arouse discussion on the elements of the scenes that one can describe. After the discussion, the teacher demonstrated the technical procedure of inputting the descriptive text.

Facilitating Learning through Doing

One further remarkable feature we noticed was the priority given to discussion, reflection and the enhancement of understanding. The time was obviously quite pressing. However, instead of hurrying the students to finish the task, the teacher had decided to take a break when students could collectively reflect on part of the work they had done, consolidated the basic ideas that they could focus on sound, color and state in their description. Furthermore, based on what the students had achieved, the teacher then tried to introduce them to a further linguistic technique: the use of analogies. The students hence followed a spiral development in their accomplishment of the task. Here learning and doing had been well integrated.

At the post-lesson interview, the teacher identified some areas where improvement could be made. She saw the limitation in the physical setting of the computer laboratory.

> *T: I shall collect their files and have a good look at them. Then I will probably ask the class to move back to the ordinary classroom, and then give them another opportunity for discussion on their work. In the computer room, the students are spaced too widely apart and it is very difficult for them to concentrate and listen.*

The Demand on Technological Infrastructure

The technical problems that appeared at the beginning of the lesson also throw light on another area in which improvement can be considered. Obviously the teacher has very good knowledge of the PowerPoint software and knows how to use it for instructional purposes. However, it is unreasonable to demand the teacher to be also knowledgeable about computer systems, in particular about network file sharing and network user administration. Nevertheless, in task-based lessons using IT, housekeeping work is inevitable. Here, some support on the system side was missing and is definitely necessary. It can help handle all aspects like giving each individual a workspace, allowing them to enroll for any particular task set by the teacher, having access to relevant resources and the flexibility to team themselves up for a task in a seamless way. Having such a system in place will save a lot of trouble for the teacher as well as the students, and avoid wasting precious class contact time on technical administrative business.

The use of ICT for task-based learning also demands the availability of hardware and software for student use beyond the normal lesson hours. During such usage, there will be less teacher supervision and hence the convenient use of technology is also very important.

Possible Benefits of Using ICT in Task-Based Learning

In what ways can IT contribute to the task-based instructional approach? Some answers can be drawn from the lessons observed as well as teachers' comments made at interviews.

1. IT is a medium novel to the students. This helps to generate some curiosity and interest among students in doing things with this new medium. For example, they found interest in being able to write Chinese characters and to compose Chinese writing on the computer.

2. IT can be used as a rich medium to stimulate students' thinking. It can provide vivid visual and sound display of events or examples.

3. The multimedia capability of IT also offers expressive power beyond the conventional paper and pencil media. Students can input their voice and animations. This allows for more room for personal creativity and the students have more pride and enthusiasm in making the products.

4. Multimedia capability also renders particular advantages to certain subjects. For example, in the English language lessons, the capability to record voice encourages students to read aloud (they are usually very shy of doing so in the class). Moreover, the convenience offered by IT in revision or modification is also very useful in writing activities. Students can easily make revisions based on feedback from their peers or teachers. This naturally helps the process of collaborative writing. When working on modification, the students look back and review and see the ideas evolve. In some cases, IT, especially the network, also provides a new platform for students to publish their finished work.

5. The network can be a rich source to provide a wide range of materials so that each group can work on something quite unique. This diversity helps generate a wider space that increases the feeling of self-initiative, originality, creativity and ownership.

6. The sharing of IT resources in a group, for example, the use of a single computer among 2 or 3 students also naturally helps the group members get together and work collaboratively. They have to discuss and reach some consensus before things can be input.

7. IT can help make the product more legible so that other members in the class can read and comment. With the network in place, the access of each other's work is also becoming very easy. At the end of the lesson, the teacher can easily take out the work of some of the groups, and have them displayed in front of the whole class for presentation and discussion. Some teachers also mention in the interviews that students are allowed to continue their work beyond lesson hours and the teachers can still keep track or follow up with their work on the network.

Issues and Potential Pitfalls

Having mentioned the advantages of using IT in task-based lessons, there are actually certain problems or issues associated with these advantages that we need to be aware of.

1. IT is a medium novel to the students and it does generate curiosity. In many cases, we observed that, the teacher had to spend a lot of effort to control the class in the computer laboratory, to keep students from playing with the computers and to concentrate on what the teacher was saying.

2. While technology can provide additional capability for the students to do the task, the teacher also gets an additional task to introduce the tool (especially when the students are not quite familiar with the tool). The teacher hence has to teach materials in the curriculum as well as IT

techniques. To handle that appropriately is not easy. Too much technology and technical procedures may overshadow the focus on the subject matter.

3. IT offers capabilities beyond conventional media. These include audio and visual presentation as well as the convenience to modify draft. It is not uncommon that students often spend time on improving the presentation rather than the content of their work. They may also waste time in endless trial and error on trivial technical matters.

4. Task-based learning is itself more time-consuming than the traditional expository lesson. Coupled with the need to handle technical matters, like assigning network workspace for different student groups, booting up the system and software, demonstrating software usage, and the solving of technical problems that arose, time is often very tight. If insufficient time is allocated, then the lesson and activities would likely be hurried through. An achieving approach (aiming just at fulfilling the output requirement) may be adopted such that the room for deep thinking can in fact be reduced. In some of the lessons observed, very little time is left for peer review of the works done, and hence many good opportunities for reflective learning is missed.

5. It was also observed that during the period of group work when the teacher approached individual groups of students, a substantial amount of time was spent on technical matters, like how to perform particular operations on the software. How to decide on the appropriate level of sophistication or complexity of technology used is an important question that the teacher should consider. Otherwise, the learning goal of the lesson will become one of operating the technology, distracting away from the subject matter.

6. It was also observed in some of the lessons that there were occasions in class when the system or the software did not perform as the teacher expected. Although the teachers we observed tackle the problems very well, but in general this sort of situation may be very stressful for teachers. Some on site technical assistance would be very important especially when the teacher has to look after more than 10 groups of students working on the computers.

Summary

From the lessons we observed, we identify some benefits in the use of IT in extending/ enhancing task-based lessons. However, in reviewing the lessons, we can also see that there are two quite challenging questions for teachers in designing a good ICT supported task-based lesson. First, how the technology can be used to support and not to crowd out the curriculum intentions; second how the teacher can operate the activity/reflection/evaluation cycle, so that learning and dong can reinforce each other.

We also see that even for the pioneering teachers who agree to spend a lot of effort in designing these IT lessons and prepare the necessary materials, there are a lot of minute-to-minute problems they have to tackle in their actual classroom implementation (classroom management problem, technical problems). They have to learn during the process and peer support is very important.

References

Kafai, Y. & Resnick, M. (Ed). (1996). *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral.* Cambridge: Cambridge University Press.

Long & Crookes (1992). Three approaches to syllabus design. *TESOL Quarterly*, Vol 26, No 1.

Nunan, D. (1989). *Designing Tasks for the Communicative Classroom.* Cambridge: Cambridge University Press.

Prabhu, N.S. (1987). *Second Language Pedagogy.* Oxford: Oxford University Press.

Chapter 7 Problem-Based Learning Approach

H K Yuen & Y Lee

Problem-Based Learning

A problem usually refers to a situation where there is a goal but it is not immediately obvious how to reach the goal. Problem based learning (PBL) originated in the area of medical education to help medical students learn the basic biomedical science knowledge and skills in the context of dealing with authentic medical cases since 1950. This approach is now widely used in the education field. It requires students to learn through engagement in authentic problem solving. Using this approach, the basic unit of instruction is a project. Embedded in each project is an ill-defined problem. The problem can be fairly content-specific (Dods, 1997), or contain multiple or interdisciplinary facets (Stepien, Gallagher & Workman, 1993). PBL assumes that learning involves both knowing and doing. By their very nature, problems which are anchored in realistic and relevant situations entice students to become actively engaged in their solutions.

PBL has many characteristics that are in sharp contrast with the traditional expository instruction. While traditional instruction is often conducted in a teacher-centred mode, PBL normally occurs within small groups of students facilitated by the teacher (Aspy, Aspy & Quimby, 1993; Bridges & Hallinger, 1991). Duch points out that PBL, *"at its fundamental level, is an instructional method characterized by the use of 'real world' problems as a context for students to learn critical thinking and problem solving skills and acquire knowledge of the essential concepts of the course"* (1995, p.1).

It is clear that the PBL approach aims to develop skills of analyzing, synthesizing, critical thinking and problem solving. More importantly, through solving an authentic problem, it enhances students' ability to:

1. clearly define a problem;
2. develop alternative hypotheses and give new information;
3. access, evaluate and utilize data from a variety of sources;
4. develop clearly stated solutions that fit the problem and its inherent conditions based upon information and clearly explicated reasoning;

5. develop effective and efficient self-directed learning skills including an intrinsic motivation to learn, question and understand;

6. develop interpersonal and group skills that include giving and receiving performance feedback.

The following table summarizes some key differences between the traditional expository approach and PBL.

Table 7.1 Differences between traditional expository approach & PBL

		Traditional expository approach	Problem-based learning
1	Learning goal and activities	teacher directed	student's responsibility
2	Teacher's role	expert and dispenser of knowledge	coach, facilitator
3	Student's role as a learner	passive or reactive	active
4	Assessment	knowledge-centered assessment	project-based assessment
5	Learning outcomes/goals targeted	learning of fact and value	critical thinking, higher level thinking, metacognition
6	Nature of learning tasks	Close-ended, well-defined content, distanced from real world situation	open-ended, connected to real world situation

In short, this approach has been considered as a student-centred process that fosters the skills needed for life long learning (Jones, Rasmussen & Moffitt, 1997). In the study of ICT supported pedagogical practices at classroom level, we found that the PBL approach was very exceptional among the observed lessons. This chapter focuses on the discussion of a series of lessons observed in a secondary school in which the PBL approach was used. We begin with a brief introduction on the instructional process of PBL and a description of the observed lessons. This is followed by a discussion on some issues of using ICT in these PBL lessons based on the post-lesson interviews with teachers and students.

Example of Technology Supported Problem-based Learning

The lessons that we observed were S3 classes on statistics. The instructional unit was about "central tendency" which covered 3 lessons. The unit was taught in two different

classes by Teacher A and Teacher B. Teacher A (female) was not directly involved in the planning and design of the instructional unit. She just went through the draft proposal and gave some feedback and suggestions. The instruction guidelines were not very clearly specified. Teacher A admitted that she was not certain about the planned instructional unit in detail and sometimes was unaware of the underpinning ideas. Besides mathematics, she also taught Arts and Drawing. She had never tried using ICT in Arts lessons.

Teacher B (male) had taught mathematics for 5 years and for the past three years he has used computer in his teaching. It was him who proposed to teach students concepts on data handling, such as mean, mode and median. Teacher B believes that after the students have understood the concepts, they can then organize data by using the computer, which would act as a tool to help students to find their answers.

The teaching objectives of this unit include students' abilities to:

1. to pose question(s) and/or answer question(s) about a suitable issue intelligently by formulating strategies/plans and conducting investigation(s);
2. to collect data;
3. to apply measure of average, i.e. the mean to justify answers in relevant contexts;
4. to use computer and spreadsheet (Excel) as a tool for statistical calculation;
5. to represent data graphically using Excel;
6. to interpret data and draw conclusions.

The classroom activities and the respective instructional objectives (as perceived by the researcher) of each lesson are summarized in the following tables. In the first lesson, the teacher stated the problem: to compare the efficiency of two popular fast food shops (activity 2). Students discussed their project plans and they had to decide: (1) what is an appreciate indicator of efficiency? (2) what data do they have to collect? (3) How should they collect the data? The teacher guided the discussion and provided feedback to them. The post-lesson activity for lesson one was data collection by the students according to their plans in the two fast food shops.

Table 7.2 Lesson outline and the instructional objectives of the first lesson.

	Classroom Activities (First lesson)	Instructional Objectives
1.	Brainstorming: the teacher wrote on the blackboard the word "Statistics" and asked the students to discuss.	To motivate the students and test how much they know about statistics.
2.	Questions posed: which fast-food restaurant is more efficient in serving their customers during lunchtime, McDonald or Kentucky Fried Chicken? The class was divided into 2 blocks: one block favored the McDonald and the other the Kentucky. They had to take side and defend their claim. How do they go about convincing the other block that their view is right?	To challenge the students to design an investigation and find out the answer, i.e. data collection and analysis, presentation and interpretation, to promote group work.
3.	The teacher gave a summary of the discussion on the research question, method and procedures for the investigation and the collection of data.	To reinforce the concepts learned.
4.	The teacher reminded the students to carry out data collection over the weekend and to bring them back for the next lesson.	To ensure that the data needed for Monday's class will be ready.

The second lesson focused on the data analysis. The teacher demonstrated how to use a spreadsheet and then the students worked in groups to analyze the data collected. In the third lesson, students reported the results of their analysis and the teacher gave feedback on the projects.

Table 7.3 Lesson outline and the instructional objective of the second and third lessons.

	Classroom Activities (Second & Third lesson)	Instructional Objectives
1.	Students sat in their data collection groups around a computer.	Getting ready for data processing.
2.	The teacher demonstrated how to calculate the mean of 10 numbers using Excel.	To teach the students how to calculate the mean of a set of data using Excel.
3.	Students entered their data and calculated the mean of their data.	To familiarize students with the calculation of the mean using Excel.
4.	Students reported their findings.	To develop skills in the communication of mathematics ideas.
5.	Students calculated the mean of all the groups that belonged to the same batch.	To give the students more hands on experience using Excel and practice the techniques of copy, cut and paste.
6.	The teacher asked the students to represent the data graphically and solicited suggestions from the students to draw the graphs.	To explore possible types of graphs to represent data; to encourage students using the "help" menu; to experience the power of drawing graphs by Excel.

It is assumed that in the process of applying the knowledge and solving their problems, students would discover gaps in their understanding, the awareness of which would stimulate them to revise the conceptual materials and consolidate their understanding. The fourth lesson was planned to focus on the application of what the students had learned in the previous lessons to other situation. Nevertheless, the plan could not be implemented due to the tight schedule.

Roles of Teachers and Students

According to Stepien et al. (1993), Duch, (1995) and Edens (2000), there are several stages in PBL.

Stage 1: Encountering and defining the problem

The teacher presents a problem for students to solve or learn more about. The problem is usually framed in a scenario or case study format. The problem is designed to be "ill-structured" and imitate the complexity of real life cases. At this point, students work in-groups, they begin to organize their ideas and previous knowledge that is related to the problem. They pose additional questions, identify areas on which they need more information and try to redefine the problem.

Stage 2: Accessing and investigating

Once they have clearly defined the problem, students might plan how to solve the problem, share the work among themselves and finally carry out the investigation. At this stage, students and teacher also discuss what resources will be needed in order to solve the problem and where they would be found.

Stage 3: Synthesis and performance

At this stage, students generate a solution to the problem. Students may create a multi-media production, a presentation or a more traditional written paper which focuses on an essential question. Students are also encouraged to reflect on what they have learned and to comment on their own and other group members' work. As students articulate and reflect upon their knowledge, contribution will be made to the group's learning and collaboration.

In PBL, teacher does not act as a knowledge expert but rather a facilitator who guides students' learning (Bridges & Hallinger. 1995). The teacher serves as a cognitive coach who supports, rather than dictates, the learning process. Teacher's major tasks include asking probing question to stimulate the students' quest for information, and encouraging experimentation and discovery learning. The teacher is also responsible

for evaluating and providing feedback to students' work. He/she should also encourage students to monitor their own problem-solving processes by having them reflect on their progress and understanding.

In the PBL approach, questions or problems are used to organize and drive activities in the classroom, and these activities lead to various artifacts that culminate in a final product which addresses the driving questions (Jones et al., 1997). The core component of the PBL classroom is a project usually with a clear authentic setting. In PBL lessons, students assume major responsibility for their own learning. They have to monitor and conduct their projects in groups, including: redefining problem, deciding ways of solving problems, collecting data, analyzing data, presenting findings and giving comments to their classmates. In this approach, ICT acts as an empowering tool for the students to attain resources, organize and analyze data and present their findings effectively and efficiently. It includes general application software (such as spreadsheet, presentation software) and Internet tools (such as WWW browser, web page composing tools). These tools are meant to extend students' mental and physical capability in the processes of problem solving.

Can ICT Help Students Learn Better?

Regarding applying IT in teaching, it is Teacher A's opinion that ICT can provide convenience if students are already familiar with it; if they are not, then ICT may cause inconvenience. Therefore, she is uncertain whether ICT can really help students to learn better because she believes students can achieve the same without using ICT, such as drawing graphs. However, it is also her view that ICT is a trend in education in Hong Kong, it is worthwhile to integrate ICT into the school curriculum, but that requires careful planning and should be carried out in stages. As she said,

> *"Students need to know about ICT. Asking them to draw (by hand) is already outdated as computer can do that already, so I see ICT in education is a must and the whole process is positive. But background support is very important. If ICT is to be integrated into the curriculum, it will take a long time to prepare, to have clear planning and coordination of relevant resources within the school. [...] I spend much time to do preparation. I realize ICT cannot be taught instantly, for example, in teaching students to use a certain function, you need to guide them slowly and step by step, then they will learn better."*

Teacher B thinks that the role of ICT in these particular lessons is to help students to organize data, and he said,

> *"Students are allowed to use their own methods to collect data and bring it back to school. They can save time in finding the mean by using computers. They use Excel to plot graphs and I request them to do histograms; they can put the data for one or both of the companies into the same graph."*

Teacher B also believes that the use of IT can help promote students' motivation in learning. He said,

> *"I think computer can help promote students' initiative, or we call it active learning. That is, students are very willing to learn something new. If you are passive, then there is no way you can get any data from the computer or anything at all."*

Benefits from Using ICT: the Teachers' Perceptions

Both Teacher A and Teacher B find the students have benefited from using ICT though they hold different perspectives and attitudes towards using ICT in teaching and learning.

In these lessons, Teacher A wanted students to learn about the process of gathering data from the two fast food shops and to draw conclusions. For example, the data they gathered was not enough and might not reflect the real situation. So it was her goal to let students understand the nature and limitation of doing research, to experience the handling of questions and collection of data. Teacher A observed that students had a greater involvement and were more excited in the lessons using ICT. This is consistent with the students' reports stating that group projects have made learning mathematics more interesting and the use of computer was really helpful.

It was Teacher B's opinion that the teacher's role had a significant change after using ICT in teaching. He said,

> *"In traditional classroom teaching, the teacher takes the leading role and students are only passive followers; even in group work, teacher usually gives guidelines for the discussion. If a computer is used in teaching, the computer program can provide guidelines and the teacher only needs to explain the task. Students can use the program which will guide them through; there is no need to waste time on further explanation. If the setup of the computer system is good, then the only problem students would encounter is the acquisition of skills in using the program. In that case, the teacher may need to give further help;*

but not all groups would need that. However, the teacher may need to take some caution in the preparation work, such as considering the level of computer skills required of the students and how the computer should be used."

In the past Teacher B has used computer games as a media to teach mathematics. He found that students played with the game that incorporated mathematical concepts and after the game a conclusion is drawn. Students actively participate in the game and learn about the mathematical concepts. Regarding the students' role, he encouraged those who performed better to help students who have difficulty, and the former are mostly willing to do so.

In these lessons, using ICT helped the students to save a lot of time in drawing graphs and they could easily make changes to the diagrams, such as their size and color. As Teacher B shared his observation,

"Students can make changes at any time and this is one advantage. They are interested in handling this kind of task. They experience that if they enter the data, they will easily get the results."

In fact, according to Teacher B, although IT was not frequently used in lessons, many students would use it to do their homework with enthusiasm.

Teaching Technology vs. Teaching with Technology

In this instructional unit, Teacher A wanted to explore students' attitude in using ICT and whether they had difficulty in handling it. In doing so, she realized the need to get very familiar with certain areas in computer knowledge and it was impossible to teach all the subject matters in just four lessons. As she had spent a lot of time in helping students to use Excel, she felt that she had, to a certain degree, given up the teaching of statistics. Some students indeed reported that they had difficulties in using Excel to draw statistical graphs.

Teacher A experienced difficulties in both the technical and pedagogical aspects. She admitted that she was not too familiar with using computers and that caused her some difficulties. The IT facilities in the school was inadequate and sometimes she had to arrange the classroom with other teachers. Also, as the school did not have an in-house technician, the teacher needed to spend time on checking the setup every time before the lesson. She also had difficulty in handling all the technical questions from the students by herself alone, particularly the girls who knew nothing about computers. Moreover, she thought she did not know much about using IT in teaching either. For

example, she did not know how to present and how to help students to understand each step. In this unit, she took reference from the draft lesson plan from Teacher B and made modifications, but she believed more input was needed on her part to work out the exact execution of each step.

In this school, when teachers face difficulties in using computers, they will normally go to the computer teachers if these are technical issue. On the other hand, they will consult other subject teachers if these concern pedagogy. However, the school does not have a formal support system for teachers in matters relating to ICT use.

Regarding the challenges to teachers, Teacher B said,

> *"There are more demands on the teachers when using ICT. First of all, teachers need to know the content of the lesson well. Secondly, they need to have computer knowledge. Thirdly, they need to employ relevant software that matches each particular lesson. It is a major constraint that we don't have too much educational software that can be used for teaching. If IT is only used in one or two lessons, then students will either have problems in getting used to it, or they just find excitement in using computers because it is new to them. Either way, the effort of using computers loose as a medium of teaching will be reduced."*

Summary

The problem-based learning approach places teachers in a position whereby they exercise their expertise through discussing with students the approach to tackle the problem, intervening students' progress during class and providing feedback to them. The major functions of the teacher are: (1) to elicit students' existing knowledge, (2) to help define the problem and decide on strategies, and (3) to pose challenges to students to stimulate students to evaluate their strategies or processes in problem-solving. The variation among lessons within this approach lies in the nature of the problems, the strategies employed and the knowledge and skills required to solve the problems. PBL emphasizes the metacognitive development of the students rather than the learning of specific knowledge or skills. In PBL, students have to redefine the problem and to break it down into sub-problems. They have to rationalize their approach and apply knowledge from a variety of disciplines to solve a single problem.

In this chapter, we have reported lessons using the PBL approach to teach S3 mathematics with ICT. Results from the observations and feedback reveal that ICT is a vehicle to help students work effectively in hands-on group projects. The focus of concern reported by both teachers and students tends to be on the technical and practical

side, such as the acquisition of computer knowledge/skills, the provision of ICT infrastructure and technical support. While ICT tools provide mental and physical aids to extend students' capabilities in solving problems, teachers need to be fluent and confident with the use of technology before they can fully realized the pedagogical potential of such tools. We believe that problem-based learning is a powerful approach that offers ways for teachers and students to make learning and teaching more meaningful.

References

Aspy, D.N., Aspy, C. B., & Quimby, P.M. (1993). What doctors can teach teachers about problem-based learning. *Educational Leadership,* Vol 50(7), pp.22-24.

Bridges, E. M., & Hallinger, P. (1991). *Problem-based learning in medical and managerial education.* Paper presented at the Cognition and School Leadership Conference of the National Center for Educational Leadership and the Ontario Institute for Studies in Education, Nashville, TN.

Bridges, E. M. & Hallinger, P. (1995). Implementing Problem-Based Learning in Leadership Development. *ERIC Clearinghouse on Educational Management,* University of Oregon.

Dods, R. E. (1997). An action research study on the effectiveness of problem-based learning in promoting the acquisition and retention of knowledge. *Journal for the Education of the Gifted,* Vol 20, pp.423-437.

Duch, B. (Ed.) (1995). *What is Problem-Based Learning? In ABOUT TEACHING: A Newsletter of the Center for Teaching Effectiveness, 47. http://www.udel.edu/pbl/cte/jan95-what.html.*

Edens, K.M. (2000). Preparing problem solvers for the 21st century through problem-based learning. *College Teaching.* Vol 48 (2), pp 55-60.

Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (1997). *Real-Life Problem Solving: A Collaborative Approach to Interdisciplinary Learning.* Washington, D. C.: American Psychological Association.

Stepien, W. J. & Gallagher, S. A. (1993). Problem-based learning: as authentic as it gets. *Educational Leadership,* Vol 50 (7), pp 25-28.

Stepien, W. J., Gallagher, S. A. & Workman, D. (1993). Problem-based learning for traditional and interdisciplinary classrooms, *Journal for the Education of the Gifted.* Vol 16, pp. 338-357.

Chapter 8 Social-Constructivist Approach

H.K. Yuen & Y. Chow

Social-Constructivist Approach

While all the other 4 approaches are well documented as approaches to organizing teaching, social-constructivism is more a theory of learning than a special pedagogical approach. In fact it is often the case that teachers who believe in social-constructivism will design teaching and learning activities in such a way that students' sharing and co-construction of knowledge become an intrinsic part of the pedagogoical repertoire. We use the term "social-constructivist approach" (SCA) to refer to precisely such aspects of the pedagogical design while fully recognize that SCA would not be used independent of other pedagogical approaches. The theoretical foundation of the SCA lies in Vygotsky's constructivist learning theory, in which the importance of social context in cognitive development is emphasized. Vygotsky (1978) advocates the concept that learning occurs in the "zone of proximal development", which is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". The SCA therefore advocates that students should learn and master concepts through interaction with people who are more knowledgeable, such as teachers or peers.

SCA values the establishment of a strong collaborative culture within a knowledge-building community. Besides learning through discussion with teachers, students also learn by sharing, discussing and critically reviewing one's own and others' ideas/ products among themselves. In this way, the students can construct new knowledge and relate new knowledge to prior knowledge through interacting with others. In general, four principles are applied in a social-constructivist classroom (Chen, 1997):

1. Learning and development is a social, collaborative activity.
2. The zone of proximal development can serve as a guide for curricular and lesson planning.
3. School learning should occur in a meaningful context and should not be separated from learning and knowledge children develop in the "real world".

4. Out-of-school experiences should be related to the children's school experience.

Apart from subject matter knowledge, social-constructivist approach also aims at helping students to develop their metacognitive abilities and higher order thinking skills. These include skills on reflective thinking, critical thinking and knowledge construction through collaboration with others. In the study of ICT supported pedagogical practices at classroom level, it was found the more prominent examples of SCA were found in secondary schools. This chapter focuses on the discussion of a series of lessons observed at two secondary schools where the SCA was used in the teaching of S4/S5 GPA and S5 English Language. We begin our chapter by offering a description of the observed lessons. It then goes on to discuss issues of using ICT in these SCA lessons based on the post-lesson interviews with teachers and students.

Examples of Technology Supported Social-Constructivist Learning

S4/S5 GPA

The first example is a joint GPA lesson for S4 and S5 students. The S4 students have received training in accessing information on the web, so the teachers asked the S4 students to do a project which can provide current information to S5 students on the "dismissal of the urban & regional councils". S5 students in return had to demonstrate skills in critical thinking and posing questions to S4 students. The plan was finally implemented after confirming that the combination of both classes would not disturb the flow of teaching in either class.

The lesson was conducted by two teachers. Teacher A (male) has taught at the school for five years and Teacher B (female) has over 16 years of teaching experience. Both have experience of using computers in teaching and they learn it from their friends, spouse and students. They are familiar in using application software such as Word, PowerPoint and Excel to prepare documents and teaching materials.

ICT was not a common feature in class, except it was used for searching information by the teachers. The only technological device they used was the overhead projector. VHS and CD Rom were also employed to do presentations. Also, Teacher A would encourage and provide guidance to S5 students to do information search with computer at home. Teacher B would teach S4 student to identify useful web sites.

There were three objectives for this lesson:

1. S4 students can learn more about the "Dismissal of the Urban & Regional Councils";
2. S5 students can renew their knowledge about the "Dismissal of the Urban & Regional Councils"; and
3. S4 students can learn how to think critically from S5 students.

S4 students worked in four groups before the lesson to prepare the presentation on the topic of "Dismissal of the Urban & Regional Councils". The structure of the lesson was simple, including mainly students' presentation and discussion. ICT was used in this lesson primarily as a tool for information searching and students' presentation. The structure of the lesson is outlined as follows:

1. Lesson objectives and discussion topic: Teacher states the objectives and discussion topic of the lesson
2. Group presentation: S4 students' presentation
3. Students' discussion: Discussion among S5 and S4 students
4. Teachers' feedback: Teachers provide feedback to the students

In SCA lessons, students can learn, construct new knowledge and relate it to prior knowledge through interacting with others. There were three groups of participants in the knowledge construction process, including S4 students, S5 students and the two teachers. The following episode represents a typical interaction between S4 and S5 students during the co-construction process:

> *Student A (S5): Can the functions of the Urban Council and Regional Council be completely replaced by the Food and Environmental Hygiene Department and the Leisure & Cultural Services Department?*
>
> *Student B (S4): I guess so. As their duties have been assigned to these two departments, they would probably give people a new image. This could be better, but I believe the duties themselves are still the same. Any other question?*
>
> *Student C (S5): Excuse me. Some amendments could be made to the information on your board. After the dismissal of the two Councils by the Legislative Council, their duties are assigned to the two Departments which are under the Environment and Food Bureau. The departments are thus subsidiary under the bureau and not vice versa.*

Student B (S4): I guess they are interchangeable.

Student C (S5): How come?

Student B (S4): I don't know.

Student C (S5): Under the organizational structure of HKSAR, the ranking of bureau should be higher than a department.

In this dialogue, Student B (S4) constructed his own views and acquired knowledge through interaction with the S5 students who were more knowledgeable.

S5 English Language

The second example focuses on the second phase of a project which aimed at training students' reading, writing and speaking skills. The project functioned within the formal S5 English Language curriculum and consisted of three phases:

Phase 1: No ICT was used in this phase. Students were asked to read newspaper articles about Clinton. After discussing the case in groups and going through vocabulary and expressions in the articles, the students were required to write a letter to express their views on the issue.

Phase 2: In this phase, students were asked to search for more information about the issue on the Internet. Then they clipped the information into a word document and shared it with their classmates.

Phase 3: Students made use of the information found in Phase 2 to write imaginative stories or reflective essays, titled 'The Clinton Story'. They were then asked to read aloud their stories. After the reading, the students put the stories together into a book 'The Clinton Story by Form 5A'. Finally, a discussion and reflection section named 'Justice & Truth; Fiction & Reality' was held.

There were three weekly sessions conducted in Phase 2. The third session was observed and reported in this chapter. The teaching objective of the third session was two-folded: (1) to develop students' ability in the access and evaluation of information, and (2) to develop students' skills in reflective and critical thinking through sharing and discussion. The following episode showed the interactions between the teacher and the students in the process of knowledge construction:

T: [...] Can you tell us what was the original target and what is the

present goal?

S: We are searching for how people in America thought of the incident, and now we've decided to further investigate how they've affected by this.

T: Good. So it's actually something more than what you intended to do in the first place. How about the team at the back? ...

S: We've found out that we...in the US... We've decided to... President... Because the whole issue is so complicated, and we want to include the children's point of view.

T: Children's point of view. That's nice. How about this group? Is the target the same or have you got something different? What did you...

S: We've discussed what is our target and we have decided that we want to emphasize Clinton's reaction.

.....

T: What is it?

S: We want to... about how the Americans feel about this issue, and we aim at...

T: Thank you very much. Now... you are still on Word document, is that right? Type an extra sentence for me, [...].

This lesson was conducted by Teacher C (female) who has experience in using ICT for her instruction, e.g. asked students to use ICT in presenting their projects. Teacher C had a clear conception on teaching English writing. She thought writing must be based on certain ideas or views, and thus developing students' ability in accessing, analyzing, reflecting and evaluating information and critical thinking is indispensable in teaching and learning English writing. At the time of the data collection (i.e. spring 1999), the network infrastructure of the school had just been installed. The IT team of the school considered the access and support for both teachers and students to be the key condition for successful ICT implementation in the school. Many non-technically oriented teachers, including Teacher C, were encouraged to use ICT in their instruction. Teacher C was willing to try to use ICT in her teaching as she believed that ICT could help to make learning and teaching more interesting and effective. She used the Internet and word processor in this lesson with the support from the IT team.

Roles of Teachers and Students

Teachers who adopt the social-constructivist Approach like to arrange for their students to learn in a collaborative learning environment (Jaramillo, 1996). Students, on the other hand, play the role of the co-builders of knowledge. They have to respond to challenges, share ideas and critique others' works/ideas actively in the lessons.

It is the opinion of Teacher A and Teacher B that the roles of teachers have changed. In the past the relationship between students and teachers was unilateral. For example, teachers used to bring a lot of books or TV videos to show the class. Now students could share with their teachers the information and knowledge they acquire. As one teacher shared:

> *"We want to train students and let them know they can challenge the validity of the teacheris thinking. For example, they can see mistakes made by the teachers as they follow the news closer ... What is on the Internet can actually be stimulate them to learn better and they can better than their teachers ..."*

Another teacher felt that it was becoming more demanding to work as a teacher. Teachers now needed to guide students to evaluate and select appropriate information.

Regarding teachers' professional development, Teacher A commented that teachers had to be willing to change, otherwise, nothing could be done in implementing the development of using ICT. Teacher B pointed out that although the government had provided hardware for the school, teachers still needed to learn the skills in using them.

Both Teachers A and B encouraged students to search relevant information from the Internet. They believed it was important to train students to think critically and be able to select information. In fact, in the past, students tended to print out a lot of information and did not know how to use it. They thought, however, in certain subjects, such as History, the use of ICT might not be that easy as it was hard to find relevant information.

The students enjoyed the lesson and the discussion, according to the teachers' perception. Teacher A said:

> *" S5 students have adopted the view points of general citizens and students from S4 are more on the government side. Therefore, both sides have different opinions and they can exchange their ideas."*

Students thought that the application of ICT in their learning had shortened the distance between teachers and students in terms of their information access. One student said:

> *"Though teachers like to make use of the Internet to look for updated information about the topic, it sometimes happens that we may have even more updated information. When the information between us is different, we will then share and exchange the new information ...."*

Another student held an interesting view that teachers in general should be teaching students how to live a meaningful life. Most students also realized that the role of teachers has changed:

> *"I think the teachers' role has changed, their role is not to impose information on us. We should learn and search for information by ourselves, the role of a teacher should be teaching us how to live a meaningful life, and help us to improve our moral standards and spirituality."*

> *"If we can explore, learn and think by ourselves, and the teachers' role is to inspire us, then we can understand the world and different issues more."*

Regarding the role of teachers in helping students to select relevant information, one student shared:

> *"Everything has its pros and cons; teachers list out opinions from both sides and allow us to think. If we do not understand, they will offer suggestions and help. After we have decided on our standpoint, we will continue to search and develop further insight."*

Benefits from Using ICT in SCA Lessons

Noss and Hoyles (1996) view the computer as a window for students, teachers and others involved in the meaning-making process. The computer plays a mediating role, providing a medium for linguistic and notational expression. ICT does not only enable the transmission of the teacher's understanding to the students, but it is a medium through which teachers' and students' understanding can be externalized. It provides not only a means to display the teacher's knowledge for the students, but also for the emerging knowledge of everyone involved to be expressed, changed, and explored. Thus, ICT plays a significant role in enhancing social interactivity and presenting information/idea effectively (McMahon, 1997). ICT may be used as an effective and attractive means of presentation, and more importantly, to facilitate synchronous

communication as well as asynchronous interaction, for example, E-mail, Newsgroup, Internet Rely Chat, Online Discussion Forum and MOOs.

The teachers think that ICT can bring a lot of convenience to teachers and students in their search for information. Besides, students can do better presentations with the help of ICT. For example, if two groups of students need to do presentation, then only one group may write down their presentation on the blackboard while the other group has to use the paper board. With the help of PowerPoint, it will be easier to coordinate students' presentation. However, there are teachers who express the hope of better ICT coordination within the school, as they experience difficulties in the set up of computers at the beginning of the class. In their opinion, ICT plays an assisting role in education, the most important thing is how teachers and students use ICT in learning and teaching.

Students also mentioned about some of their reflections during the interview. They reflected on the use of ICT in these particular lessons; and their views were expressed as follows:

> *"These topics have stimulated a lot of discussion and PowerPoint can allow us to have ample space to write on. Also, wall space is limited and it will be very difficult to put up too many sheets of paper on it."*
>
> *"It is also not environmental friendly to use too much paper."*
>
> *"It will be too messy if we write everything on the blackboard."*
>
> *"Also, it enables clarity of presentation. For example, using PowerPoint can produce clear and systematic presentation."*
>
> *"It's the first time we use computers in an English Language lesson. However, we always work in groups to discuss our ideas before we write. We think it's helpful to have such discussion and to use computers."*
>
> *"It will be very convenient to search for information and we do not need to go to the library."*
>
> *"The information on the Internet will be more updated."*

When asked if ICT had facilitated their overall learning, the students' responses were as follows:

> *"Yes, the use of ICT has made easy the search for information. Newspaper contains too many pages and students may not take the trouble to look through all the pages. With the help of ICT, it is easier*

to search for the needed information, and we will also pay more attention in class."

"Only half and half. Because when I do research on certain topics, like today's lesson, I usually find a whole pile of information and there is no way I can finish reading them all. Moreover, we are studying many subjects and we do not have too much time for searching. We may find something interesting on the web sites which may cause distraction to our studies. So I think ICT can be both good and bad to us."

"We have access to a lot of information, the issue is how we identify the more important ones. Some people will look at this and others will look at that, but we do not know how to select what is important and what is not. I think those who use the Internet must know how to use it. Only then can ICT be useful. The information we receive must be digested or else it will be useless."

From what was observed in the GPA class, the students demonstrated great interest in the topic and were actively involved in the discussion. The group that used PowerPoint in the presentation simply used PowerPoint for presentation. Most students were able to explain to the teacher what information they had clipped. In the S5 English Language lesson, the students demonstrated their search skills on the Internet and were learning how to select information relevant for their specific purpose. Some of them could give reasons for their choice of certain information but not everyone was able to do so. Most groups were able to work cooperatively. Students also demonstrated reflective thinking through sharing and discussion.

The Importance of Technical Support

The two examples of SCA describe in this chapter took place in two different schools. In talking to the teachers involved, it was apparent that the availability of ICT infrastructure and technical support was very different in the two schools.

Teacher B shared that she experienced some difficulties at the beginning when using ICT for teaching and she received help from Teacher A as they were working together on this project. As for Teacher A, while he claimed he could handle software operations, he encountered great difficulties in operating the hardware, as the school could not provide enough support in this respect. The teachers had to borrow computers and peripherals from different locations, as there was no complete set up ready in any classroom. As a result, the teachers might waste a lot of time in setting up the equipment.

Also, the small size of the classroom was another issue of concern for Teachers A and B. The existing classrooms were not big enough to accommodate extra ICT equipment for class use. The only computer room that can accommodate a class size of 40 students was always occupied. Sometimes teachers tried to split a class into two groups, but this made it difficult for them to keep the same pace between the two groups in the same class. Moreover, the design of the computer room was for students to work individually with the computer and was not suitable for the purpose of teaching. Teachers had difficulty in knowing whether the students were paying attention to the monitor or doing something else. Students might log on to the web and surf around and the teachers complained about not having master control of the students' computers. There was also a smaller computer room with a capacity of 20 people. It was mainly used for students to work on their own during recess and lunch-time.

Teacher A and B also commented that besides the IT-coordinator, there was no other IT-technician in the school and the only backup support was from students. They thought the government had not provided enough support in this respect, and support from ICT professionals was necessary apart from the provision of computer hardware. On the other hand, Teacher C did not perceive any difficulty concerning technical support in her school.

Regarding the implementation strategy of the school, both Teacher A and B understood the vision of the principal that ICT development in the school should involve all teachers and not just rely on the IT-team. However, they also thought if there was a team, then they could consult other staff on different issues and work together.

Summary

The social constructivist theory proposes that learning occurs through students' sharing, discussing and critically reviewing their own and others' ideas. Interaction, sharing and discussion among students and teachers are all significant components. This approach is often used alongside with task-based approach or problem-based learning approach in classroom practice. Students are the co-builders of knowledge and have to respond to challenges and review their own and others' work/ideas critically. The major role of teachers is to design classroom activities in which students can participate in knowledge co-construction and exploration. The teacher's primary role is no longer that of an expert, but rather someone who poses challenges to students and respond to students' discussion and presentation. ICT played a significant role in helping students to access information and present ideas effectively in the examples cited. However, the use of ICT as a medium to support synchronous and asynchronous sharing of ideas and reflection has not yet been exploited.

In this chapter, we have presented two examples of ICT-supported lessons using SCA in teaching S4/5 GPA and S5 English Language. It is apparent that teachers and students were positive about the uses of student interactions as a key process of learning as well as the uses of ICT in the classes. The results of classroom observations and interviews clearly demonstrate that both students and teachers realize the pedagogical change in relation to the roles of teachers and students in the SCA lessons. It is perhaps not surprising that both Teacher A and B perceive that the technical concerns, such as computer equipment, ICT infrastructure and technical support, is a major challenge in the implementation of ICT-supported pedagogy in schools. Nevertheless, all would agree that a balance must be drawn between teaching and technology.

References

Chen, I. (1997). *An Electronic Textbook for Technology and Teacher Training. http://www.coe.uh.edu/~ichen/ebook/ET-IT/cover1.htm*

Jaramillo, J. A. (1996). Vygotsky's sociocultural theory and contributions to the development of constructivist curricula. *Education*, Vol. 117, pp.113-140.

McMahon, M. (1997). *Social-constructivism and the World Wide Web - A paradigm for learning*. Paper at presented 1997 ASCILITE Conference. *http://www.curtin.edu.au/conference/ASCILITE97/papers/Mcmahon/Mcmahon.html*

Noss, R. & Hoyles, C. (1996). *Window on Mathematical Meanings: Learning Cultures and Computers*. Dordrecht: Kluwer Academic Publishers.

Vygotsky, L.S. (1978). *Mind in Society*. Cambridge: Harvard University Press.

Epilogue

W.W. Ki

In the description of the emerging paradigm by Pelgrum et al. (1997) much emphasis has been put on the differentiation of the emerging paradigm and traditional paradigm in terms of the roles/ relations among the parties involved in the educational process. Namely, in the emerging paradigm, school learning is more closely related to society, and open to new information and inputs as these evolve. There is also less isolation between school and parents, with the parents co-steering the learning of their children and/or learning also with their children. In the emerging paradigm, the relationship between teachers and students also changes: the students become more active in setting their own path of learning. They are also active in getting inputs from diverse sources and to make sense of what they see. The teachers would change to be more like a helper to help the student in the process. The relation among students also changes with more emphasis on communication and collaboration.

It is useful at this point to contrast what is mentioned above with the good practices we see in the study. From the teacher interviews, on the conceptual level, most of the teachers involved in these good practice agree that there is a need to move in the direction of the emerging paradigm. In terms of practice, however, we can see that the good practice we observed only partly concur with the description above. With the use of ICT, there seems to be more opportunity in the classroom for student work or group work besides whole class teaching by the teacher. However in terms of the other aspects, it seems that there are more often change in terms of the content of the information and activities of the lessons than a change in the relation between the student and the teacher and their respective roles.

In some of the lessons described, we can see that ICT is used for the introduction of authentic situation/problems/information from life or society. There are examples like discussions about decisions concerning selection of toys, and debates on the dissolution of the Regional Council. In these examples, Internet websites were often introduced to students so that they can do independent study before or after the class discussion. This indicates a general trend for making school learning more related to society in terms of the content and their respective roles.

In terms of the kinds of activities in the classroom, ICT was also observed to be used to provide new activities that are not easily available with conventional media. There were the usage of spreadsheet for easy trial of different ways of data analysis, dynamic geometric tools for exploring variant and invariant features in geometry through

experimentation. However, if we look carefully at the classroom interaction, for almost all of the lesson types described in the preceding chapters, we can see that the teacher was always playing a very important role in structuring the learning process, setting targets, and guiding interpretations. The teachers were assuming a strong responsibility for their students' learning. They wanted to make sure that the discussion was about key points that they deemed important. This appears to be related to the general oriental culture or educational belief. As for the amount of parent participation, there is little evidence to show any change in this area.

In one of the schools observed, parents were involved in supervising the booking and use of the computer laboratory facilities during lunch and after school. Though this is not involved at the curriculum level, it is still a good beginning that may be further extended.

Having said that there is a dominant culture of teacher directness, we also observed that there seemed to be some change towards providing more room for students to externalize their ideas with the use of ICT. There are more student work and group work in class. Some of the teachers also tried to let students express their views and to evaluate the work of themselves and their peers. This concurs with the general preference for more active learning by the students as reflected from the student interviews.

The technological dimension of ICT use in the classroom sometimes also brought impact on the predominate role of the teacher as an expert, especially at the secondary school level.

Sometimes, we observed the teacher learning from the students in mastering some of the computer software functionalities. In the process, the teacher became a learner together with the students while he/she was also teaching. The teacher and the students became partners in a shared task.

The emerging paradigm does not only anticipate changes in classroom practices, but also changes in the school culture, including sharing among teachers and schools. Furthermore, changes at the classroom level are dependent on policy and strategies at the school and system levels. These issues will be explored in the next section.

Reference

Pelgrum, W.J. & Anderson, R.E. (1999). *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and Practices.* Amsterdam: IEA & Enscheda: University of Twente.

Part three:

ICT Implementation at the School Level

Part three: ICT Implementation at the School Level

Introduction

H K Yuen

Introduction

The aim of this section is to explore the models of change for ICT implementation at the school level. Telem (1996) presents a framework for the implementation of a school management information system, which includes five components, namely, technical, structural, psychological, goals and values, and managerial. The five-component framework clearly indicates that the change brought about by ICT implementation in schools is a complex process. Apparently, the implementation does not merely entail the installation of hardware and software accompanied by some staff training. Rather, it should be considered in a holistic and integrative way. Fullan (1993) provides a detailed discussion on the complexity of the change process in schools. According to Fullan (1982), any change can be examined in terms of the difficulty involved, skills required, the extent of necessary alterations in beliefs, and the use of materials. Later he adds clarity, complexity, quality and practicality as key factors affecting the implementation of innovative measures (Fullan, 1991). These frameworks guided on design of the data collection at the school level. The implementation of change perspective of Fullan (1992, 1993) is also used to analyze the processes of ICT implementation in the 17 school cases studied.

Each school case consists of the following data: (1) school background, history and mission (2) ICT implementation plan and strategies, (3) description of ICT resources and infrastructures, (4) documentation and videos of observations on lessons, and (5) interview data of students, teachers, ICT teams and the principals. There are great variations as well as similarities among the schools. The cases are analyzed using the constant comparative method based on the grounded theory approach. By continually comparing specific incidents in the data set, the research team identifies key properties of the change process and their relationships to one another, and integrated them into coherent models. Three models of change have emerged: the technological adoption model, the catalytic integration model and the cultural integration model. These models relate fundamentally to the understanding of the nature of change involved in ICT implementation, a finding that is consistent with earlier work on school change. House

(1979) presented three perspectives on educational change: the technological, the political and the cultural. The technological perspective assumes a rational view of the world and believes that educational implementation follows the logic: if A happens then B will follow. The political perspective focuses on the idea that educational change inevitably involves conflict. The cultural perspective of educational is concerned with the social setting in which innovation intervenes. Meyerson and Martin (1997) take the position that organizations are cultures, and view organizations as patterns of meaning, values and behavior. They presented three different aspects of organizational change based on three paradigms of culture, namely, integration, differentiation and ambiguity. These perspectives provide us with an initial and valuable conceptions to explore the models of change for ICT implementation at school level.

Three Models of Change

The key characteristics of the three models, Technological Adoption Model, Catalytic Integration Model and Cultural Integration Model are summarized in Table III. We find that the key distinctions among these three models are the established vision and values that the schools hold, the perceived role of ICT and its impact on the school system as well as the established culture and reform history of the school. Given a specific set of contextual characteristics of a school, it seems apparent from the data that the particular model of change adopted is consistent and predictable.

Table III: Key Characteristics of the three models of change identified in the study

Technological Adoption Model	- does not have a strong school tradition or culture in terms of a distinctive school vision and mission - enhancing teaching effectiveness and ICT competence of students are perceived as the main objectives of ICT implementation in the school - the principal is the main change agent - often has clearly defined targets and schedules for achieving specific ICT competency and demonstration of such use in classroom
Catalytic Integration Model	- characterized by a visionary leadership and a school philosophy which engages the school in a continuous reform process, and achieves that through engaging teachers in the process as members of a learning organization - the use of ICT in teaching and learning is deliberate and designed as an integral part of the curriculum consistent with the school ethos - the principal is the key change agent who has a clear vision and implementation strategy, with staff professional development focusing on curriculum tailoring and pedagogical innovation being the most important elements
Cultural Integration Model	- strong cultural and historical foundations that results in a distinctive school vision focusing on student empowerment - well-established student organizations and good multi-age interactions as a "school tradition" - realization of student's individual potentials and development of self-actualization, life-long learning ability is emphasized the most - ICT is mainly seen as an empowering tool both for students and teachers

Chapter Highlights

Chapter 9 discusses the technological adoption model for the implementation of ICT in schools, which conforms to the managerial perspective in technology planning (Kearsley, 1990). This model places emphasis on managing technological infrastructure, organizational structure and teachers' technical skills. Three school cases are presented in this chapter. Schools classified under this model generally do not have an influential school tradition or culture. In schools where the technological adoption model is employed, expository and resource-based inductive approaches are the most commonly found pedagogical practices. The role of the teacher is seen as someone who presents information and evaluates performance, while the functions of ICT are to enhance the effectiveness of information presentation and to stimulate students' learning interest through appropriate multimedia, especially graphics and animation. Thus the nature of change is perceived essentially as one of "technological automation/ improvement" that has the potential to enhance the effectiveness of current educational processes.

Technology can also be used to relieve teachers of the tedious, repetitive work in monitoring and providing feedback to students' assignments and exercises. Within this model, an important function of teachers in the IT age is to produce good ICT-based learning resources. Hence, authoring multimedia courses has become an integral

part of staff development in these schools. The ability to produce "interactive" (meaning able to provide feedback to students' input) multimedia resources becomes a pre-requisite still for the teachers. Moreover, strong leadership is also a common feature found among schools that are successful in employing this model to implement change. The presence of strong leadership ensures that the teachers possess a minimal degree of technical competence. Another important value promoted in these schools is the sharing among teachers of the multimedia of course materials produced among teachers.

Chapter 10 endeavors to delineate the catalytic integration model for implementing ICT in schools and to examine the different ways that ICT has contributed to changes in schools. Generally speaking, schools categorized under the catalytic integration model are characterized by having a visionary school leader and there is deliberate integration of ICT in teaching and learning as an integral part of the curriculum tailoring and reform within the school. The pedagogical practices found in these schools have mostly adopted the task-based, problem-based or social-constructivist approaches. Two school cases are discussed in this chapter. In schools where the catalytic integration model is adopted, there is a strong curriculum directive from the principal, including how ICT should be developed and integrated with the entire school curriculum. Teachers are provided with continuous professional development programs organized by the school, and ICT is included as one of its integral components. In these schools, the ICT supported pedagogical practices tended to place emphasis more on student-centred approaches and was frequently accompanied by staff collaborations and curriculum innovations that are part of the bigger reform projects. To take the analogy with change in business corporations, then these schools are in fact engaged in a process of re-engineering to meet the challenges of the changing society. Technology is just one of the many assets that the school make use of in the process of re-engineering.

Within the sample of schools studied, a few of them embarked upon the process of change in relation to ICT implementation in a relatively smooth manner without apparently causing serious conflicts or extra demands on leadership. At the same time, some of the ICT implementation were well integrated into the formal school curriculum to promote the deep seated educational value and vision of the school in profound ways. Upon closer inspection, we find that all these schools share similar characteristics: they all have a strong sense of mission and a clearly identifiable vision of education that permeates practice over a long period of history in the school. Further, these schools are all well-established with a long history and school tradition. We categorized the change process undertaken by these schools as the cultural integration

model. Chapter 11 describes the key characteristics and contexts of two schools that are categorized under this model.

In schools where the cultural integration model are adopted, there is no compulsory staff development program and the teachers are generally respected and trusted by the school leadership. These are generally well-established schools that admit students with higher academic abilities. There is neither coercion nor encouragement of specific choices of pedagogical approaches and the use of ICT in teaching is generally encouraged and supported. The adoption of a particular kind of pedagogical practice in the classroom largely depends on the belief of the teacher involved. Thus, a variety of approaches can be found in these schools. In other words, they have more diverse pedagogical practices than schools adopting the other two change models. In fact, all the five pedagogical approaches identified in this study can be found in this category of schools. Another important feature is that ICT tends to be heavily used by students in these schools in all sorts of extra-curricular activities, and some very innovative projects involving students of different ages can also be found.

Models of Change and Pedagogical Practices

All three models of change described above can be found in the secondary schools studied while only the catalytic integration model and the technological adoption model are identified in the primary school samples. This is possibly because the cultural integration model is only practicable when the school has a well established ethos and a relatively capable cohort of students. Moreover, ICT was only beginning to be available in some primary schools for teaching and learning after the summer of 1998, and only the expository, inductive and task-based approaches, with some elements of social-constructivist orientation are observed in the primary schools that we visited. Admittedly, this narrower range of pedagogical practices observed might have been a result of the limited number of samples we had at the primary school level. However, we are confident that, especially in the case of primary schools, we have included those schools that are publicly recognized as schools with the best experience in using ICT for teaching and learning. Further, as the lessons we observed were all selected or approved by the school principal, they should reflect best practice as perceived by the school leadership.

While the apparent relationship between the change models and pedagogical practices are grounded on a limited number of case studies, and it is imperative that further work on an extended scale be carried out to refine the models and to explore how school contexts relate to the pedagogical practices present in a school, we are pleased with the initial discovery of a systematic and consistent pattern in our study. However,

with the rapid development of ICT in Hong Kong schools, the situation is constantly changing. We look forward to seeing further research in this area in both Hong Kong and beyond.

References

Fullan, M. (1982), *The Meaning of Educational Change*. NY: Teacher College Press, Columbia University.

Fullan, M. (1991), *The New Meaning of Educational Change*. NY: Teacher College Press, Columbia University.

Fullan, M. (1992), *Successful School Improvement: The Implementation Perspective and Beyond*. Buckingham, Philadelphia: Open University Press.

Fullan, M. (1993), *Change Forces: Probing the Depth of Educational Reform*. London: Falmer press.

House, E. (1979), Technology and Craft: A ten year perspective on innovation, *Journal of Curriculum Studies*. 11(1), 1-15.

Kearsley, G. (1990), *Computers for Educational Administration*, NJ: Ablex.

Meyerson, D & Martin, J. (1997), Cultural change: an integration of three different views, in Harris et al (eds), *Organizational Effectiveness and Improvement in Education*. Buckingham: Open University Press.

Telem, M. (1996), MIS implementation in schools: a systems socio-technical framework, *Computers Education*. Vol 27(2), pp.85-93.

Chapter 9 Technological Adoption Model

H K. Yuen & Y Lee

This chapter discusses the technological adoption model (TAM) for the implementation of ICT in schools. The technological adoption model places emphasis on managing technological infrastructure, organizational structure and teachers' technical skills, which conforms to the managerial perspective in technology planning (Kearsley, 1990). Schools categorized under this model generally do not have a strong school tradition and culture in terms of a distinctive school vision and mission. The background and key characteristics of three such schools are described in the following. They serve as the basis for analysis of the processes and factors in relation to the implementation of ICT in the schools. These include the use of ICT in the schools, implementation strategies, teacher development, and understanding of ICT in education.

School Backgrounds

We begin our discussion by offering description of three technological adoption model schools, school A, school B and school C. These sketches attempt to capture the background of the schools in relation to their ICT infrastructure.

School A is a primary school. It is one of the pilot schools under the Hong Kong Government's Information Technology in Education Plan. There are 30 normal classes, 2 remedial classes and 43 teachers in this school. The school has two computer rooms and classes are scheduled to fully utilize the facility. Teachers can sign up to use the computer rooms for their lessons, and students can also use the computers during formal lessons as well as in extracurricular activities. 10 computer stations have been set up in the school hall and corridors to allow students to log on to the Internet during recess and before classes begin. There are 8 portable computers available for teachers to use ICT in classroom teaching.

School B is an aided secondary school, with 29 classes of students. There are two computer rooms with 44 computers installed in it. Besides, there are 11 computers in the music room, all of which are equipped with 17" monitor, speaker, headset, 'Wave Editing' sound card, MD mixer and MIDI keyboard. Students are allowed to use the computers in the music room and computer rooms after school.

School C is a whole day primary school located in a rural area. It is run by a Christian organization and has a total of 12 classes. The school has been established for many years and moved to the existing location three years ago. Most of the students come from the nearby villages. It is also one of the pilot schools in the Information Technology in Education Plan. There are more than 120 computers in the school, all of which can have access to the Internet. The computers are installed in the computer rooms, the library and classrooms. Each teacher is equipped with a notebook computer for teaching. Each classroom has a wall mount screen, projector, a computer system for teacher presentation and five computers. There is also a resource room for teachers to prepare their teaching materials.

History of ICT Implementation

At the beginning (1995-1996), computers in school A were only used for administrative work (SAMS). At that time, all the administrative work was shouldered by teachers who knew how to operate the SAMS; those who knew nothing about the system were not involved in any administrative work. Workload was not evenly distributed and this had greatly hindered the progress of the school administration.

The Computer Awareness Program (CAP) was started in the first semester of 1998. As stated in the school homepage, the learning objectives of this program for Primary 1 to 3 students included learning how to use Paintbrush, word processor, internet browser and input in English. Learning input in Chinese and English, e-mail, Front Page, Excel and PowerPoint were the objectives for Primary 4 to 6 students. In the same year, teachers also started using ICT in their teaching. A computer club was established in 1998. The main goal of which was to organize activities using ICT in daily life. In 1999, students' ID cards were issued by computer technology. Barcodes were put on the ID cards to allow easy identification of the students. This has saved manpower to handle information relating to students' being late, absent, or on leave, borrowing books from the library and the arrangement of school bus routes.

During our visit, the research team also observed that ICT was used in various aspects in school A. The newly established computer club organized activities such as publishing newsletter, webpage design and post card design for the Mother's day. School A joined a "Parents-Children Go Online" project organized by HKIMS and other organizations in December 1999. All the teachers got involved in it. The project consisted of a 2 hour lecture and a 4 hour practical session. The aim of which was to enable the participants to have a general knowledge on the computer, the Internet and sending emails. Parents appreciated this kind of activities as they could learn more about the computer and their communication with their children was also enhanced.

In school B, computers were mainly used for administrative purposes (SAMS) before, and only in the subjects of computer studies and computer literacy. It was not until 1997 that computers were adopted in the entire school curriculum. Since then, teachers teaching music, life education, history, mathematics and physics have used ICT more often in their teaching. From 1998 onwards, F.1 and F.2 students start to learn Music with the use of ICT devices mentioned in the previous section. There are 2 music lessons for each class in every cycle. One is about music theories, singing skills and instrument playing skills while the other is about digital music. Each class is divided into 2 groups taught by two teachers at the same time.

In school C, the use of ICT falls into three stages. In stage one (1993-1995), a computer interest club has been organized since 1993. Those who are teaching this club are hired from the computer company and students need to pay the tutorial fee for the course. In September 1995, a computer course was introduced to the P5 and P6 formal curriculum.

During stage two (1995-1998), an open day on 'computer world' was held in January 1997. The computer course has been extended to P3 in the formal curriculum since September 1997. Since then teachers of this school have started to write their own teaching materials for the course. In the same year, School C joined the CAP project held by the Education department of Hong Kong. In 1998, the computer course was implemented at all levels from primary 1 to 6. Eight computer courses were designed for primary 1 to 6. These courses are conducted weekly, aiming to provide students with basic computer knowledge and skills. The aims of this course are as follows:

1. students can master basic computer skills,
2. students are able to search for information via the use of ICT,
3. teachers can use ICT in their teaching,
4. teachers are able to use information on the Internet that enhances the quality of their teaching,
5. to encourage self-learning via the computer,
6. to develop school based teaching materials,
7. to establish a school home page, and teachers are able to use Internet to share their experience with teachers in other schools.

In stage three (1998-present), the main concern is to produce teaching software. Teachers start to design their own teaching materials by using the computer.

Pedagogical Approaches Observed

In school A, the research team has conducted observation in two lessons, one is an Art lesson and the other is a Music lesson. Both lessons are analyzed and categorized as expository or task-based lessons. In school B, two lessons are observed. They are Music and Chinese History. These lessons are also categorized as expository or task-based lessons. In school C, the research team has observed a total of nine lessons which include Chinese, mathematics, general studies, English and Chinese tutorial lesson at different levels. All these lessons are categorized as expository lessons.

In short, we find that expository or task-based approaches are the most commonly found pedagogical practices in School A, B and C as well as in other TAM schools. The "inductive" approach is also found in a few TAM schools. The role of the teacher is mainly seen as someone who presents information and evaluates students' learning. The main function of ICT is to enhance the effectiveness of information presentation and to stimulate students' interest in using good multimedia, especially graphics and animation. Technology can also be used to relieve teachers of the tedious work in monitoring and providing feedback to student exercises.

Implementation Strategies

Setting Up a Clear Implementation Goal/Plan and Organization Structure

Good implementation requires good planning. During the initial phase, planning should focus on creating an organizational structure and process for the change (Fullan, 1992). We find that the emphasis of implementation in the TAM schools is put on organizational structure as well as having a clear implementation plan.

In school A, there is a clear IT implementation plan for each academic year. For example, after SAMS has been implemented in the school for one year, all the teachers were required to use computers in preparing minutes of meetings, worksheets, test papers and everything that the principal needed to read. A IT team which comprised the principal and 7 teachers was also set up to coordinate the implementation of ICT in the school. Each member in this team looked after a different aspect, such as teacher training, infrastructure and maintenance in the school, IT club, software and academic matters.

Concerning the implementation strategies for the whole school, there is a five-year plan in School B. Two main areas are identified. They are the use of multimedia and

the use of Internet. There are three levels in each area - elementary level, intermediate level and advance level. However, the detail requirements are different for different subjects.

Besides, a IT steering group has been established in 1998. Including the principal, there are five members in this steering group. They are responsible for the different aspects of implementing ICT in the school, including:

1. Hardware
2. Resources (purchasing and distributing resources to teachers)
3. Curriculum support for teachers
4. Training courses for teachers

During the interview, the principal mentioned that there was also a IT coordinator allocated by the government. The school thus could employ a full time staff to help the IT development in school.

Similar to school B, school C included the ICT plan in their five-year school development plan before the school moved to the present location. In order to manage and develop ICT in the whole school, an IT coordinator was appointed. The IT coordinator only had to teach 8 computer lessons and the rest of the time he took up the responsibility of helping teachers to solve ICT-related problems. Apart from this, an IT team was set up to coordinate the work. The IT team comprised of three teachers and all of them were teaching computer subjects.

Setting Up Computer Awareness Lessons and Determining Implementation Timelines

The documentary data and the interviews revealed that the Principal and teachers in school A and C conceived that it was important for the students to manage basic computer skills before ICT could be used in classroom teaching and learning practices. They believed that basic computer skills should be taught separately. Therefore, both schools A and C included a computer lesson at each class level for the students to acquire some basic computer knowledge. During the interviews, the IT team members, the teachers and principals expressed deep concern about integrating ICT into the formal curriculum.

In school A, the principal pointed out that they had set a lower requirement of using ICT in each subject for the present academic year:

I hope teachers can be better equipped and be able to produce suitable teaching materials for use in the curriculum and do not just use what is available on the market.

The main issue is what kind of teaching materials one can make. The teaching materials that one uses this year may not be suitable for next year. So we need to re-edit again to match the needs of the students.

In school C, teachers told us that they were required to conduct at least two lessons using PowerPoint presentation. There was no policy regarding the using of ICT in teaching and learning in school B. Teachers were encouraged to share their teaching experiences in using ICT in the existing curriculum.

Relying on Existing Manpower vs. Getting External Help

In School A, it is the principal's opinion that manpower is very costly and the way to improve efficiency is not by increasing the number of staff. As he shared his opinion,

We have more than 40 teachers in this school and adding one more teacher is not sufficient to enable other teachers to have one more free lesson, as one teacher cannot teach for more than 30 lessons!

The principal believes that the correct way is all teachers can apply ICT in both their teaching and administrative work.

Nevertheless, there are also variations in the implementation among the schools. As aforementioned, boths school B and C have employed an IT coordinator to take care of ICT implementation in the school. Furthermore, school C planned to employ some student teachers from the HKIED to help teachers who did not have the technical competence in producing ICT-based teaching materials. The teachers would design the teaching materials while the student teachers would carry out the technical implementation. This strategy, to a certain extent, reduced the teachers' workload. However, there were still other problems faced by the teachers. As one of them mentioned:

Sometimes the materials made by the student teachers are not suitable as they do not have real teaching experience.

Another teacher also shared that,

"It is not easy to find a student teacher that can do what you want exactly. Even though we have presented our ideas to them, the product turns out to be something else."

Staff Development Policies and Implementation

As mentioned in the previous section, implementation in TAM schools often has clearly defined targets and timetables for achieving specific ICT competency and for the demonstration of such use in classrooms. Good planning at the initial stage is dependent on the active input and participation of students and front-line teachers, "since they are in the best position to identify the nature and location of problems, and may contribute effective solutions from the field". (Fullan, 1992, p.41). Thus, teacher's professional development during the implementation process should be stressed.

In school A, there was a set of goals for teachers in relation to the use of ICT in teaching:

1. To promote teachers' ICT skills to intermediate level as a response to the government's IT in Education policy.
2. In order to increase the effectiveness of teaching and learning, teachers should know how to use the ICT devices in the school.
3. To discuss among themselves the use of software and the skills needed in teaching and learning.

Teachers were also assigned to take courses offered by the Education Department. The principal would invite personnel from commercial companies to introduce and demonstrate the use of software, such as the use of mathematics database. However, as the IT coordinator of School A pointed out, there are possible drawbacks in this form of staff development:

> *"Staff have different opinions on using ICT, while some of them are very willing to work hard, others have reservation in using ICT in education and they show resistance. Their attitude will influence the progress of the implementation."*

To solve the problem and to facilitate the process of implementation, panels in each department of School A have introduced guidelines titled ICT resources, direction and development for their fellow teachers.

Concerning staff development, the teacher also suggest that a technical expert should be employed:

> *"Besides educational resources, we may need technical personnel to help us. For example, there were problems with the hardware during the*

lesson, I could not fix it after spending a lot of time on it. So I had to ask students to use other computers. If we have technical personnel stationed in the school, then we can go to them when having problems."

The principal of School A acknowledges that the workload in the development of ICT is heavy and it involves a lot of work and time. There is no specific assistance in lessening the teaching duties of teachers who are involved in the ICT development. However, to allow time for staff development and individual planning is a valuable form of assistance, particularly during the early stages of implementation when teachers are still struggling with the mechanics of organizing and learning how to carry out new practices (Fullan, 1992).

Instead of forcing teachers to use ICT in their teaching, the principal in school B encourages rather than stipulates the teachers to attempt using it. Besides organizing sharing sessions, ICT training courses (either school based or those offered by the Education Department) for teachers are offered.

The principal of School C pointed out that the most important thing was to improve teachers' receptiveness to the new technology. In order to achieve this goal, the principal states that three different strategies are employed. First, to visit other institutions and invite guests to give talks to the teachers. Second, to give training to the teachers. According to the principal, every Friday afternoon was scheduled to be a teachers' development day. Students will have half-day off on that day, while the school will offer some computer courses for the teachers at that time. Third, the principal will organize meetings and observations in lessons for the teachers to share their experiences with colleagues and teachers from other schools.

In schools adopting the technological adoption change, an important role of teachers in the ICT age is seen as the producer of good ICT-based learning resources and thus an important part of staff development in these schools is focused on technical and skill based training, such as authoring multimedia course. The ability to produce "interactive" multimedia is a kind of necessary pinnacle for teachers to reach.

Understanding the Role of ICT in Education

The understanding of the nature of the change and the implementation process is interwoven. In order for implementation to succeed, a clear understanding of what to do and what to change in order to put ICT into practice is crucial (Fullan, 1992). Policies or written documents can help clarify the meanings of change. This can be reflected in the mission statements or school plans. The principals' leadership and

teachers' perspective on change are also important factors that affect the change. In this section three perspectives are discussed.

Mission and Vision for ICT Implementation

The TAM schools generally have clear documentation of their vision or mission in ICT implementation.

In school A, the principal pointed out that the mission of ICT implementation is twofold:

1. To arouse the interest of students in learning.
2. To promote students' ability in self-learning.

According to the principal, at the present stage the focus is put on arousing the students' learning interest. Therefore, a lot of activities are organized in the school and the use of ICT in teaching and learning is carried out from an appreciation perspective.

In School C, their five year school development plan specified that the use of ICT was one of their main development foci. For instance, at the school level, they aim at establishing an information technology system, computerization for the administrative work and using ICT to assist teaching. At the teaching and learning level, they aim at promoting active learning by using ICT. Besides, as stated in their ICT plan, the mission of the school-based computer lesson is:

1. To enable students to master basic computer skills
2. To use different kinds of software
3. To promote self-learning via learning with computers.

It was hoped that the effort can establish and motivate students' interests and confidence in learning with ICT and develop a positive attitude among them. As a result, school C has a detail syllabus on the learning of basic computer skills at each level and a clear schedule for staff development.

The mission of School B for implementing ICT in education is threefold: (1) to promote active learning among students, (2) to encourage two way communication between teachers and students, and (3) to encourage creativity and critical thinking. As the principal pointed out, the school was still in its infant stage with regard to the implementation of ICT in teaching and learning, they were still searching for the right way at that stage. The present focus for them was to get the ideas written down and to encourage more teachers to take part in this work.

Principals' Perspectives and the Implementation

Regarding the initial implementation of ICT in School A, the principal believed that everyone has his/her own inertia, and not everyone would take the time to learn and use ICT. As mentioned in the previous section, the principal therefore took a stern stance, enforced the use of ICT in the school and set a schedule for teacher development. He believed that technical difficulties could be solved through practice. As he recalled:

> *"The teachers used a month to learn and a month to practice, after 2 months, more than 90% of them could use computers to set test papers and do word processing. They must be working very hard, but what I wanted was to get the result as soon as possible. [...] My intention was to let fellow workers to share the fruit of success as soon as they can, just like what the students have done."*

The principal of School A considered his role in the school's ICT development as one of establishing a favorable environment and conditions for the future development of the teachers. He shared:

> *"I encouraged my teachers to think about the future. But as they are so busy with their present work, I think the principal can be more forward looking and prepare for future developments. I think IT should not only be used for demonstrations, students should have their self-learning CD too. Ultimately, IT is for self-learning and it will be the best if students can go to the school web site if they find difficulty in what they have learnt at school."*

The principal of School C believed that students must learn the technical skills first. As he said,

> *"Now we cannot integrate IT skills in teaching other subjects. As you know we need to teach the students some basic skills before they use it. For example, how to use a mouse. We need to teach the student what is 'double click' and 'click'. Another example is how to key in the URL on the web. We cannot teach this in the general studies or Chinese lesson, because it will waste lots of class time. Therefore I believe these skills should be taught in an individual lesson."*

As a result, computer lessons for students to learn the basic computer skills were introduced.

Effective implementation is dependent on the principal taking an active role in initiating and responding to change efforts within the school. In the technological adoption model schools, the principal is the main change agent, and teachers led, by the top-down expectation of the school management, are also involved in the ICT implementation. The success of the implementation is dependent on the strong leadership role of the principal.

Teachers' Perspectives and the Implementation

Teachers' acceptance and their commitment to the use of ICT are important during implementation. Such consensus and consistency are emphasized in the technological adoption model schools. All teachers are required to participate actively in the ICT implementation. Such "all" culture, excluding ambiguity, is common in this type of schools.

Teachers in school A and C are at similar levels of computer skills. Teachers are assigned with different duties, such as training, hardware management, student computer club, etc. As the IT coordinator in school A shared,

> *"We are in fact working together, just that each of us is responsible for a different part. For example, a teacher who takes charge of the cyber campus network will be responsible for meetings and providing information. Teachers are divided into 2 groups: one is responsible for equipment and the other is responsible for the application of IT."*

Besides, teachers in school C also mentioned that the sharing of teaching materials and experiences did help them in the use of ICT in their daily teaching practices.

True understanding, however, comes only when teachers are given opportunities and time to work with ICT in the classroom and to talk about what they are doing with others (Fullan, 1992). Some teachers may have different views, as a teacher of School A said,

> *"My concern is how to coordinate IT to fit into the curriculum. It should not be just finding some information to put into the computer for students. However, it is also beyond my capacity to use IT to enhance their learning efficacy and interest. Even if I find relevant information that matches the use of IT, it is questionable that I would have the skills to produce teaching materials. Besides, what are the sources for looking up relevant materials? I think it is hard for me."*

The quality of implementation also depends on how "practical" the use of ICT in the school (Fullan, 1992) is. Some impractical examples were found in the technological adoption model schools, such as requesting teachers to construct databases during the implementation. The teachers, however, thought that it was not practical:

> *"I think it is impractical for individual school to construct a data base. The education department should take the lead; other schools in Hong Kong can be involved through the network."*

Another example is about the computer awareness program designed by School A. Teachers in School A shared that sometimes the execution of the program might not work according to the original plan:

> *"The content of this program for P1 classes was mainly focused on playing games, using the mouse and no typing was required. The main software used was paint-brush and the aim was to train students to use the mouse. One difficulty was that even though the projector was used to provide instructions, the teacher still needed to tutor students one by one. We did not expect that 6 lessons had to be spent on teaching them how to turn on the computers. Also, the information on the screen was mostly English and students could not understand. They needed to practice many times in using the control-alternate-delete keys with their small fingers. P2 classes always wanted to type Chinese even though they were supposed to type English only. The reason was they wanted to learn typing Chinese for a card design competition. After teaching students in senior grades the Chinese inputting method for 4 lessons, they still preferred to use the more convenient method - the writing pad. So the teacher gave them worksheets to work on. Some of the students took computer classes after school and they had better computer skills than the teachers, but others lagged behind, so the teacher tried to ask them to help one another."*

Changes in the Classroom as a Consequence of ICT

What kind of things would have changed in the classroom if ICT is to be implemented? Fullan (1992) suggested three dimensions of change for the teachers in the school: (1) the use of new hardware and software materials, (2) the adoption of new activities (including group work), behaviors or practices, and (3) changes in beliefs and understanding.

For the first dimension, the use of new materials (hardware and software) is most obvious because it is concrete and tangible. One can observe the use and production of materials, and can readily answer the question of whether computers are actually being used in the classroom. Enhancing teaching effectiveness and ICT competence of students were perceived as the main objectives of ICT implementation in School A, B and C. In School A, some teaching software applications were shared among teachers. For example, there were 4-5 teachers teaching P5 Chinese who decided to each make teaching software for one or two lessons and to share the use among themselves. Teachers can thus share the fruit of success together and lessen their workload.

Activities using ICT including instances of teachers teaching with technology, the introduction of formal computer courses for students, the organization of extra-curricular activities on ICT and the use of ICT to improve school administration were found in School A and Schools C.

The third dimension, changes in beliefs and understandings, is much more fundamental and difficult to be observed because it involves what teachers think and perceive. It is apparent that the changes in the first two dimensions were found in all three Schools A, B and C. However, we cannot identify any notable changes in the third dimension among these schools, such as understanding and beliefs regarding curriculum reforms.

Conclusion

The technological adoption model was the most common form of change model adopted among the schools in the present study. In schools where the technological adoption model was adopted, expository ,task-based and inductive approaches were the most commonly found pedagogical practices. The role of teachers is mainly seen as someone who presents information and evaluates students' learning. In these schools, the main function of ICT is to enhance the effectiveness of information presentation and to stimulate student interest by using good multimedia. Technology can also be used to relieve teachers of the tedious repetitive work in monitoring and providing feedback to students' exercises. An important role of teachers is seen as the producer of good ICT-based learning resources and thus most teachers are trained to be technically competent to produce "interactive" teaching materials. Another important achievement in these schools is the setting up of a good technological infrastructure for teaching. Often schools that are successful in implementing changes through the technological adoption model have strong leadership that can ensure the successful achievement of teachers' ICT competence as well as technical infrastructure in the school. The implementation of ICT in schools arguably does not merely entail staff

training and the installation of hardware and software but should be considered in a broader framework of educational change. The challenge to the technological adoption model schools is how to move from a managerial perspective to a re-conceptualization and rethinking of curriculum and learning which requires a new vision of how the school processes are to be organized.

References

Fullan, M. (1992) *Successful School Improvement: The Implementation Perspective and Beyond*. Buckingham, Philadelphia: Open University Press.

Kearsley, G. (1990) *Computers for Educational Administration*. N.J.: Ablex.

Chapter 10 Catalytic Integration Model

S C Li & Y. Chow

This chapter endeavors to delineate the catalytic integration model for implementing ICT in schools and examine the different ways that ICT relates to school change. Generally speaking, schools categorized under the catalytic integration model are characterized by having a visionary school leader and deliberate integration of ICT in teaching and learning as an integral part of the curriculum consistent with their school ethos. The pedagogical practices found in these schools were mostly task-based, problem-based and social-constructivist approaches. There was strong curriculum leadership regarding how ICT implementation should be developed and integrated with the entire school curriculum. Teachers had always been provided with continuous professional development programs organized by the school leadership, which broadened the scope to include ICT as an integral component. The ICT supported pedagogical practices tended to put more emphasis on student-centred approaches and frequently involved staff collaboration and curriculum innovation that were part of the bigger reform projects.

Among the schools identified with the catalytic integration model in relation to the strategies and processes of ICT implementation, School D, School E and School F are chosen as typical examples to depict the salient features of the model.

Though all 3 schools have visionary principals who perceived ICT as a catalyst to promote curriculum innovation, there were variations in the role played by ICT in the development. For example, School E has a detailed explicit framework of curriculum plan and ICT is perceived as one among other ways to achieve these curriculum goals, whereas School D and School F perceive ICT as the main change agent in curriculum reform. Besides, among the 3 schools, only School D has explicit ICT skill expectation of their teachers.

School Backgrounds

School D is a primary school located in the New Territories with most of their students coming from neighboring public housing estates. The school aims at providing students with a supportive learning environment that foster pupils to become active, explorative, creative learners who will become lifelong learners and be able to undertake self-directed learning. As stated in the school plan, enabling students to benefit from task-based and project-based learning is one of the major objectives of ICT in education. The ICT supported teaching and learning activities started in 1997, together with the

establishment of an IT team comprising of 7 teachers and the introduction of the Computer Awareness Programme (CAP) to teach basic computer skills in the formal curriculum.

School E, a government aided school, located in a newly developed residential district in the New Territories, was founded in the mid-90s'. As the principal maintains, in order that the school can be a progressive learning environment for students, it must be a nurturing environment for teachers' professional development. The school aims at fostering a positive and caring environment in which students can develop their intellectual and academic potentials, react positively towards the changing society, develop social responsibility, critically inherit the Chinese culture, embrace cultural diversity, and play an active role in the family, the society, the whole nation and the world. Regarding teacher development, the school is expected to provide an encouraging and reflective environment in which teachers can put their professional knowledge into practice, keep abreast of the trends in educational reform, conduct educational research and experiment with innovative practices.

School F, also a government aided school, has been moved to the present campus since 1993. The school principal joined the school in the late 80s' with a vision to promote the use of IT in reforming the school curriculum. School F has a religious background with the mission to cultivate a sense of righteousness, benevolence and love in students. The school comprises 55 teachers and about 1100 students in thirty classes. In order to implement curriculum innovation and evaluate ICT integration in teaching and learning, the curriculum development team and the educational research team were set up recently.

History of ICT Implementation

In School D, there were about 140 computers installed in the classrooms, the library, the two computer rooms and the multimedia language laboratory. Each classroom was equipped with a teacher workstation, a data projector and a wall-mounted screen. The school does not treat ICT as a separate subject. Instead, the use of ICT is integrated into all subjects and students learn ICT skills through the use of ICT in various learning activities. Among the various school subjects, Mathematics, Chinese and General Science were selected as the 3 pilot subjects to incorporate the use of ICT in their teaching and learning.

As aforementioned, project-based learning is emphasized in School D. In 1998, the IT group members acted as pioneers to facilitate pupils, ranging from P.4 to P.6, to complete a project in groups with a self-selected topic for their extra-curricular activities. Apart from selecting topics, these primary pupils had to decide on ways of

collecting and analyzing information, and presenting findings. With the support of their teachers, the students made use of the Internet and some ICT Tools, such as spreadsheet, word processing software and PowerPoint to complete their projects. These students presented their completed projects an school Open Day.

In School E, at the time of data collection, there were 160 computers and 6 servers installed. There was a computer with Internet access in every classroom. Besides, there were 4 computer rooms in the school with a multi-media learning centre still under construction. In terms of ICT supported pedagogical practices, project-based and task-based approaches were often employed in the school. Students use ICT as tool for searching information, communicating and exchanging ideas, as well as presenting and externalizing their thoughts. ICT was generally perceived as providing tool for empowering students to learn.

In School F, both the IT club and the omputer club have been playing an active role in fostering the school's 'IT culture'. According to the school IT coordinator, the 'IT culture' becomes real when staff and students use ICT as a natural part of their day-to-day activities, such as e-mailing, downloading songs and engaging in discussion groups etc. In light of this, various activities have been organized by the two clubs to enhance students' interest and skills in using ICT in their own learning. The school homepage was created to allow students to access school information at any time or any place. Further, the school provided students with e-mail accounts and personal homepage hosting services. In terms of ICT access in school, students were allowed to use computers after school, during recess and lunch time, and the IT club was entrusted with the responsibility to manage the usage of the various ICT facilities.

To encourage students to engage in self-accessed learning, School F, in collaboration with a tertiary institute, attempts to construct a database with built-in artificial intelligence to compile a question bank for students. The questions were classified according to the concepts elicited, skills and level of difficulty. Students could perform self-accessed evaluation anytime during their learning process. The program can interact with the students if they need extra tutorials. It is expected that by using the data bank in conjunction with a virtual course delivery platform, individual needs of students can be dealt with. For instance, if a student has problems in doing mathematics, the program could take care of it by generating particular types of questions according to the mistakes he/she has made, and teachers can subsequently provide specific guidance to the student.

Implementation Strategies

In School D, there is an IT team with 7 teachers to coordinate the IT implementation in the school. Led by the principal, the major duties of the team was to develop an IT policy, the school-based curriculum as well as to organize staff development programs. An ICT Club was established which aimed at training students to acquire ICT skills, so that they can help teachers in carrying out some technical duties in return.

Unlike school D, in School E, one IT coordinator (titled as IT director) has taken up the leading role in implementing ICT in the school since 1997. To perform this role, the IT director has been released of all teaching duties. His major duty was to plan ICT implementation for the school and to provide technical support to teachers who used computers in their teaching. As the position of technical support was found to be a time-consuming task, this role was further supported by two non-teaching staff who were former graduates of the school since 1998.

Table 10.1 Stages of ICT Implementation in School E.

Stages of ICT Implementation	
Stage 1 (1996-1999)	Infrastructure and Resources Preparation
Stage 2 (1996)	Started offering Computer Studies at Secondary 4 & 5 levels
Stage 3 (1997 to present)	Integrating ICT into the teaching and learning of various school subjects

Supporting the work of the IT director was an IT team comprising 7 teachers from various subject areas who were competent in using computers. From 1996 onwards, the school has undergone three stages of implementation as shown in Table 10.1. To effectively implement ICT, the school has adopted the strategy of 'student empowerment'. Essentially, this involves enabling students to use ICT and to learn with it, teachers can then be motivated to use ICT in their teaching. As the IT coordinator said,

> *"There are many strategies to implement IT in education. One of the strategies is to involve students first. The other is to implement it by teachers. IT can also be implemented through school policy. I believe that implementing IT by involving students first has a greater chance of success. The chance of getting students to accept using IT is greater too. Therefore I have taught students knowledge and skills beyond the formal curriculum. For example, I have taught students how to make web pages, although the content of the web pages created by students*

are not good enough. The students would then ask teachers to comment on their web pages. This interactive relationship can motivate teachers to accept IT and develop an IT culture in the school."

The kinds of learning outcomes and learning experiences of the students therefore served as a change agent in the process of ICT implementation.

Similar to the implementation strategy used by School E, School F stressed very much on the cultivation of an 'IT culture' among students. The principal expounded that if students enjoyed using ICT to enhance their learning, teachers would follow subsequently. As he further elucidated, the change process might be delayed if the implementation relied solely on teachers' efforts, as some of them might have difficulty in acquiring ICT skills. In this school, students are therefore the major thrust in the implementation of ICT. For instance, the two student clubs, namely the computer club and the IT club, have been playing a pivotal role in supporting and promoting the use of ICT in school. The computer club, having a longer history, is more technical orientated and caters for hardware installation and computer networking. In fact, the computer networking in school is designed, built and maintained by graduated students who are former club members. The IT club was formed shortly after a computer-related competition held last year. The IT club focuses more on the applications of ICT in education and provides technical support to teachers with respect to acquiring ICT skills.

Against the odds, there was no IT committee in School F. Instead, the principal has been playing a proactive role in the promotion and planning of ICT use in teaching and learning. It is the principal's belief that if only a group of teachers were assigned to be responsible for ICT development, the rest may react passively in using ICT and may rely heavily on the support from the committee. In this way, every teacher can get involved and contribute to promoting and exploring the use of ICT in all subject areas.

It was the school's belief that the use of ICT has to be kept in pace with the school curriculum development. To cope with this, an educational research team was established by the principal, consisting of teachers from different subjects. One of the team's functions was to design or identify meaningful research topics for students to conduct their own projects. Besides, the team also worked on evaluating the use of ICT in teaching and learning, and looked for innovative practices and effective uses of ICT within the school. These successful stories and experiences provide momentum to bring about a change in the conception of teaching and learning with ICT among the teachers. In addition to the educational research team, there is also a curriculum department composed of panel members from different subjects as assigned by the

principal. Its duty is to support the school-based curriculum development and innovation.

Staff Development Policies and Implementation

All 3 schools provided teachers with continuous professional development programs organized by the school leadership. In School E, the principal and the IT team organize seminars for teachers, in which the teachers can share their experience in using ICT in teaching. Teachers obeserving each other teaching was encouraged by the principal. Among the 3 schools, only School D has explicitly stated the expected ICT competence of their teachers:

1. *Teachers should be able to use ICT in teaching, design curriculum material and use ICT as a tool for evaluation.*
2. *Teachers should be able to master some general application software; for example, Word, Excel, e-mail, PowerPoint and other teaching software to assist teaching and learning activities.*
3. *Teachers should be able to use some general administration software; for example, SAM in managing students' records.*
4. *In order to help students to solve problem in learning activities, teachers should know some basic computer skills such as saving and retrieving a file.*
5. *Teachers should know how to guide the student to use ICT as a tool for their learning; such as handling data, analyzing data and nourishing a life long learning habit.*
6. *Teachers should have awareness of the new ICT products so as to match curriculum development.*
7. *Teachers should be aware of development in the rules and regulations for the safety use of ICT in conjunction with curriculum development.*
8. *Teachers should be able to use ICT to enhance self and professional - development. For example, using ICT in teaching and learning.*

(quoted from IT Policy Document of School D)

In School F, the propelling force for staff development derives from both internal and external sources. The activities of the educational research team and the curriculum development team, as well as growing demands and expectations from the students, provide great driving force and motivation for teachers to involve in continuing professional development. The principal also plays an active role in staff development.

He conducts training sessions for teachers on the five subject groups (Mathematics, Science, English, Chinese and others) every Monday. During this weekly meeting, the principal disseminates new information, new ideas and innovative practices pertaining to using ICT in education. Hands-on workshops on ICT skills will be organized if necessary. Teachers also receive in-house training from the universities on PowerPoint, e-mailing, use of the World Wide Web etc. The school has been maintaining a good collaboration with local universities. This kind of partnership provides an external driving force for staff development. School F has joined the Unified Professional Development Project (UPDP) run by The University of Hong Kong since 1998. This project operated a teacher fellowships scheme. The school took advantage of this scheme and sent two teacher fellows for the university. During the period of the fellowship, these teachers were released from teaching duties for three months to collaborate with academics on various research projects. The principal expected that the partnership scheme can help the school to develop a strong mentoring force, and to expose teachers to a wider community of educational practitioners and researchers. The principal also hoped that, through such partnership, findings from research work on teaching and learning can benefit the teachers to better carry out school improvement and pedagogical innovation.

Leadership Roles of the Principals

All three principals perceived their own schools to be undergoing school reform and that the leadership of the principal was necessary to motivate change. Also, as the financial cost of implementing ICT in school was very high, they believed that the principal should play a supportive role in ensuring that the expenditure is worth spending. The development of ICT infrastructure is therefore moving in a coordinated and cohesive manner. The principals possessed clear visions and provided strong leadership in terms of curriculum reforms and integration of ICT into teaching and learning.

In School D, the principal perceived the establishment of an ICT culture and shared vision among teachers to be the key factors for successful ICT implementation. As aforementioned, sharing experiences of using ICT in teaching and learning and peer observation in lessons were encouraged.

In School E, strong curriculum leadership was evident. The school defined the entire curriculum to comprise four components, namely, (1) the formal curriculum - learning of subject content knowledge within classrooms; (2) extension activities - activities and projects conducted beyond the formal curriculum; (3) pastoral care - focussing on students' attitude and (4) student affairs - focussing on students' personal

development. Deriving from the four components, the school has ten curriculum goals. They are:

1. *Students can develop creative and logical thinking through acquiring communication, language, information and mathematical skills.*
2. *Students can acquire the knowledge and learning skills in various domains of knowledge; and be able to apply the skills across the disciplines.*
3. *Students can understand, comprehend and appreciate achievements in the fields of arts, culture and science.*
4. *Students can acquire and apply their knowledge about political, economical and social structures of Hong Kong, China and other countries.*
5. *Students can respect and uphold the basic civic rights in Hong Kong Special Administrative Region.*
6. *Students can understand and appreciate the perspectives, beliefs and attitudes of people with different ability, gender, race, country, religion, culture, economic and social background; and are able to cooperate with other people.*
7. *Students can understand the ecological effects of consuming natural resources.*
8. *Students are able to learn independently and collaboratively.*
9. *Students can develop knowledge, skills and attitude to manage their own life; and develop positive and active parental skills.*
10. *Students can prepare themselves for life-long learning, be ready to accept new ideas, and apply technological devices with positive ethical values.*

(quoted from the homepage of School E)

ICT was perceived as a means to achieve the above curriculum goals.

In School F, strategic initiatives have been organized to facilitate the process of implementation. In this respect, the principal has adopted both the bottom-up approach by motivating and mobilizing students in the change process, and the top-down approach by encouraging every teacher to participate in curriculum development and pedagogical innovation. Under the principal's proactive leadership, new roles and new units, namely the educational research team and the curriculum development team, were established for the purpose of developing ICT in teaching and learning.

The principal also demonstrated his commitment to staff professional development. Under his leadership, a weekly training and experience sharing session about pedagogical issues in using ICT was maintained. In addition, he has made initiatives to maintain close partnership and collaboration between the school and various tertiary institutes.

Perceived Role and Impact of ICT on the School Curriculum

All 3 schools perceived ICT to be a catalyst for promoting curriculum changes. However, in School E, with a pre-constructed framework which explicitly states detailed curriculum goals and strategies of achieving these goals, ICT implementation was only viewed as one of the elements which contribute to the accomplishments of the curriculum goals. In the other two schools, ICT implementation was perceived as the main change agent to promote curriculum changes.

In School E, ICT is seen as a vehicle to achieve the curriculum goals aforementioned. It is believed that ICT should be integrated into the teaching and learning of subject-oriented and cross-disciplinary knowledge. The school emphasized the use of Internet in teaching and learning. "Extend students' learning beyond the boundary of the school" is what teachers believe that Internet can help students achieve. Their notions about ICT in education, to a certain extent, can be reflected from the school homepages:

> *There is unlimited information on the Internet, including technological, medical, social, geographical and environmental information. Internet is the most informative electronic library in the world and students can search information in it conveniently and quickly ... The multi-media elements of the information like music, pictures and animations help to higher students' interest. Students can find pictures of real objects, video clips of chemical reaction or biological transformation on the Internet. These resources help students to understand abstract objects or theories ... Through interacting with other in the newsgroup on the Internet, students can have a more comprehensive perspective and understanding of the world. Their interest in learning foreign language and their language proficiency can be higher by making pen pal with foreign students ...*

As some English teachers commented, their role became more challenging after integrating ICT into their lessons. In the past, the relationship between students and teachers were unilateral. Teachers were the authority and the sole source of knowledge.

Now students could have more sources of information and more autonomy to learn. As one teacher shared:

> *"We want to train students and let them know they can challenge the validity of the teacher's thinking. For example, they can see mistakes made by the teacher as they follow the news closer ... What is on the Internet can stimulate them to learn better and they can actually be better than their teachers ...*
>
> *Students need to know about ICT. Asking them to draw (by hands) is already outdated as computer can do that already, so I see ICT in education is a must and the whole process has positive meaning. But background support is also very important. If ICT is to be integrated into the curriculum, it will take a long time to prepare. We have to have a clear planning and coordination of relevant resources within the school."*

Another teacher felt that the expectation towards teachers has been increasing. Instead of being a knowledge transmitter, teachers are now required to give more guidance to students about searching for relevant information and how to think through the information in a critical manner.

From the students' perspective, they thought that the distance between teachers and students was shortened as a result of using ICT in their learning.

> *Though teachers like to go to the Internet to look for updated information about the topic, it sometimes happens that we may have even more updated information. When the information between us is different, we will share and exchange new information ..."*

Another student expressed an interesting viewpoint on the role of the teacher:

> *"I think the teachers' role has changed, their role is not to impose information on us. We should learn and search for information by ourselves, the role of teacher should be teaching us how to live a meaningful life and help us to improve our morale and spirituality ... If we can explore, learn and think by ourselves and the teachers' role is to inspire, then we can understand the world and different issues better."*

In general, students reacted positively towards the use of ICT in teaching and learning, and they expected that ICT can make their learning more interesting and meaningful.

Teachers' Reactions to the Change Process

In all 3 schools, there were clear directions and good communication among all staff and students regarding how ICT can be used to enhance teaching and learning. In School E, the notion of ICT in education was stated explicitly as the school ethos. Teachers generally shared the notion that empowering students to learn should be the ultimate concern of implementing ICT in school, though there is still a few of them who are skeptical of ICT and hesitated to use it.

> *I'm a bit uncertain that ICT can really help students learn better. Most of the learning experience and learning outcomes being quoted as exemplars can also be achieved without using ICT.*

Rationalization does not necessarily imply psychological readiness. Although some teachers accept that integrating ICT into the curriculum is an irresistible trend in education, they are still reluctant to change. As a teacher expressed her concern:

> *"I think psychological readiness is the most important. Teachers must be willing to change, otherwise nothing can be done in the development of ICT in education. As I comes from an arts background, I know little about computer. Therefore I have to equip myself with computer skills first ... then I have to find ways, on my own, to integrate ICT into my teaching ..."*

Regarding implementation strategy, teachers in School F shared the vision of the principal that ICT development in the school should involve all teachers and not relying on a single IT team. However, they also believe that if there is a team, then they can consult team members without wasting their efforts in struggling through all the technical obstacles. This would probably accelerate the whole change process.

Summary

Schools categorized under the catalytic integration model are characterized by having someone with clear vision and courage in the leadership position. In the change process, teachers are required to learn new technological skills and applications, to explore new pedagogical approaches to the planning and delivery of content knowledge within a new context. This challenges teachers to reconsider personal attitudes and beliefs held about their roles as educators and re-examine their conception of technology's role in the school, in society and in their lives. In order to enhance teachers' susceptibility to change, it demands the principal to have strong awareness and strategic commitment to foster a culture that values student empowerment as the crux of ICT implementation, encourages professional development, appreciates and embraces innovation and quality in education.

Chapter 11 Cultural Integration Model

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Within the sample of schools studied, there were a few that embarked upon the process of change in relation to ICT implementation in a relatively smooth manner without apparently causing serious conflicts or extra demands on teachers or the school leadership. At the same time, ICT was well integrated into at least some aspects of the total school curriculum in these schools such that the impact of ICT on the learning outcome of the students is arguably amongst the most profound. Upon closer inspection, we found that these schools share similar characteristics: there was a strong sense of mission and a clearly identifiable vision of education that permeates practice in each of the schools. Further, these schools were all well-established schools with a long history and an established school tradition. We label the change process undertaken by these schools as the Cultural Integration Model. This chapter describes the key characteristics and contexts of two schools that can be categorized into this model as an elaboration.

School Backgrounds

School G is a government aided secondary school. It moved to the present campus in 1948. The student association in this school has a long established tradition of being very active in organizing all sort of student activities. In recent years the student association took up a large responsibility in promoting the use of IT in the school and initiated a variety of IT related projects like setting up a large Intranet for students. There are about 300 computers located in different locations in the school, including the computer rooms, library studentsí association, and along the corridor. It is the school principalís belief that good education should encourage and support students to realize their dreams. The students are academically able. Students coming from a variety of social economic backgrounds from working class to upper middle class.

School H is also a government aided school and was founded in 1927. There are over 60 teachers and 1000 students in this school. There are about 200 computers located in the two computer rooms, library, art room, geography room and the staff rooms. This school has a strongly collaborative culture established amongst the teachers to conduct various focus of school-based curriculum development. The students are high achievers coming mainly from middle class families.

These two schools were also known for their relatively liberal school atmosphere and the wide variety of extra-curricular activities on offer to students. Both schools have

strong studentsí associations, which play a major part in the planning and organization of extra-curricular activities. One of these two schools has recently abolished its prefect system, which was considered to be a kind of student policing system incompatible with the school philosophy.

The strong spirit of trust that is strongly inculcated into the school culture is well elaborated in the 'Philosophy of Education' expressed in the homepage of one of these schools:

> *In the spirit of close cooperation, built on mutual trust, respect and appreciation of the distinct roles of one another, the Supervisor, Principal and Staff work together for the common goal of providing quality education to the students. Likewise, the relationship between the teachers and students is governed by the same spirit of understanding and trust.*

Curriculum Examples of ICT Implementation

Using ICT in the Non-Formal School Curriculum

A very special feature of these two schools is the rich and diverse range of student-directed extra-curricular activities which attracts and involves a significant proportion of the student population. We found that to understand the impact and role of ICT on the learning experience of the students in these schools, an understanding of the use of ICT in such non-formal, extra-curricular activities is crucial and at least as important as understanding its use in the formal school curriculum. In one of these two schools, we found it necessary to interview some members of the student population to gain a better understanding of the wider school context beyond the classroom.

Many of the non-formal, extra-curricular activities were not ICT focused per se but may make heavy usage of ICT to accomplish its goals. Another special feature of these activities was the complex organization and extended time frame that such projects involve. Such activities may take place under the umbrella of a student society or club and a project may be planned to have an extended life span of several years involving cross-age collaboration and literally passed on from one ìgenerationî of students to the next. In addition, many of the student activities involvd not only collaboration of students within the school but are conducted in the context of inter-school or even international projects or activities. In these activities, the teachers only play a supportive role and the key decision-making were made by the student body responsible. Some specific examples of such activities are described below.

At the time when we were conducting the study in one of the schools (School G) in early 1999, there were two large student-led projects in full swing: a large-scale systematic study and documentation of the botanical species within the school grounds (Nature Trail) and the IT-Week. These projects are described at some length here to illustrate the nature and impact of this kind of activities.

A Campus Nature Trail: from a Bare Rock to a Forest and to the Internet

As a school with such a long history of establishment, this school boasts a beautifully wooded and relatively spacious campus compared to most other schools in Hong Kong. This Study first started in 1996 as a one year joint project of the Biology and the Horticulture Clubs when the students decided to take up the suggestion of one of the teachers to establish a nature trail that guides students and visitors to examine and appreciate the large variety of plant species on the school grounds. The main goal was that of promoting interest and appreciation of the environment. This was accomplished with very little funding support. The completed trail was about 1 km along which plastic name plates were erected at 70 check points for the 58 species of plants identified. Each check point was then coded and marked on the school map.

Encouraged by the achievement and the positive reactions from the school community, the two clubs decided to extend the project for another year so that they could conduct a systematic study and documentation of the physical characteristics and annual changes including flowers and fruits of the plants along the trail and to compile the results into a book for students, friends and alumni of the school. The publication work was made financially feasible when they secured sponsorship and support from a past graduate and a printing firm. The work at this stage has become much more complex and the team membership has grown from 24 in the first year to 65 in the second year. Further, we note that none of the initial team members carried on to the second year so that all the 65 members in the second phase of the projects were new recruits. Also, while the first group of team members were mainly senior form members (secondary 5 and 7), the second team were predominantly secondary 4 students with only 3 members from the 6th form. Noteworthy though is that the two teachers who acted as supervisors in the first phase continued to be on the advising team, mainly looking after the photographic and editorial aspects of the project. By now, the project has also grown way beyond a botanical study of species and requires a wide range of expertise to accomplish: photography, digitization of images, desktop publishing, language and writing skills, information search and retrieval, etc. and thus the project has become a much more multi-disciplinary one involving clubs other than botany and horticulture.

To take charge of such a complex set of activities, half of the members were organized into 9 special purpose teams: desktop publishing, art & design, information research, computer system, data entry, photography, patrol, proofreading and general affairs. The final product was a professionally edited and produced book of 150 pages. For each of the 60 plants documented, the publication provides information on the location, the scientific name, common name and family name of the plant as well as four photographs providing a view of the plant in the school setting as well as close-up details of its bark, leaves, flowers and fruits. ICT has been used heavily in all aspects of this publication project. The following excerpt from the foreword written by the two student project team chairmen provides a vivid picture of their experience through this period:

> *"In this project, the work was massive and endless. The task was difficult and challenging but the participation was unbelievable. More than fifty student members were needed to run here and there, enter the data page by page, take photos roll by roll, and participate actively day and night. However, we have learnt a lot in this year and felt the importance of the sense of commitment. In addition to the great exposure to macro-photography, data processing and desktop publishing, we also knew how to organize various information and identify an unknown species ..."*

As expected, to embark on a project of such magnitude, the school has to be extremely supportive. The students were given the use of a cleaned-out storeroom to house the computers, photographic and editing equipment some of which belonged to the school, some bought with donation money and others were borrowed from various sources, including teachers. A number of teachers other than the two advisers also offered help to the students on art and design, looking up information resources, photography, proofreading, publication and map production technique and computing support. The students also reached out for more specialist advice and support from the wider community: the Hong Kong Herbarium of the Agriculture and Fisheries Department for help with the identification of some plant specimens and botanical references, and the Survey and Mapping Office of the Lands Department for granting permission to reproduce the aerial photo of the school campus.

Before the second phase of the project was completed in 1998, the students already had plans to go a step further to make the information contained in the publication more widely accessible through their school webpage and to build up an image bank of more than 500 photos. The project successfully received funding from the Hong Kong Quality Education Fund for this third phase of the project, thus allowing the project to acquire more sophisticated equipment such as computers, a scanner, a printer

and a digital microscope. This phase was scheduled for completion in 2000.

The Students' Learning Gains

An interview was conducted with 9 of the students participating in phase 3 of the project. They were responsible for different aspects of the work and apparently they joined because they were interested in the kind of work they were responsible for in the project, be it web design, photography, biology or generally working with computers. The students came from all academic streams cutting across a wide age range and during the interview they talked rather spontaneously about what they gained through participation:

> *"Initially, I did care about what trees are there on our campus, but after joining the project I discovered that there is a variety of trees on our campus. I think this is important." (Chairman of the project)*

> *"I did not know how to use the computer and in doing this project I of course need to learn, for example desktop publishing, etc."*

> *"Before this, I wrote webpages according to my own wishes and now I need to follow the views of the entire team ... We need to discuss before we do anything. When we need some graphics that I donit know how to do, I can ask other team members to help."*

The Teachers' Role

When we first interviewed the students, it was not obvious how large a role was played by the teachers. To the students, the idea about the project was initiated by the students and the teachers together. The teacher helped them to raise funds, secure resources and to help recruit members from a wider range of classes. The students felt rather strongly that it was their own project. However, when we reviewed the membership for the project over the years and the interview we had with Mr. S, one of the two advisers of the project, we came to the realization that the teachers played a crucial role in making this student-led project successful.

Securing the necessary resources and funding for the team was but one aspect of the supportive and facilitative role of the teachers. Helping the project to recruit students with a wide range of interest and expertise to work on the various aspects and to help the project to set up the different task teams was another major role played by the teachers, as exemplified by the interview excerpt:

> *"I think the most important is to coordinate the students and put them together ... I work together with Mr. W very well. His main responsibility*

is the network system and hardware. I am responsible for multimedia as I am more familiar with these: video, photography and image processing ... We need to coordinate them [the students]. For example, those who compose the webpages need to get the images from those who write the script, and the script writers in turn need to get those from the photographers who themselves need help from the graphics team to scan their photos. I need to coordinate them, this is very important. For example, those who work at the computer system level can generate a whole lot of things easily, but the content could be wrong or useless ..."

"To get students to work together is very difficult. Say, [pointing at one of the students working in the room] he is very capable, but rather undisciplined. He has good intentions and does whatever comes into his mind. Heís like a wild horse, if guided appropriately, his potentials can be developed very well. Some Arts students, they can write but are rather quiet, unlike these noisy ones and found it difficult to work with the others ... I need to teach them that when you go out into the world and do something , we need to learn to compromise. Our own ideas or work are not perfect, we may not like criticisms. Different people have different likes and dislikes, some people like multicolors and others like single colours. We need to put them to work together, convince them to put aside their own designs and integrate their ideas with others' work. This is very difficult as nobody wants to give up their own designs...

I need to look after policy matters: I give freedom to students and have to be accountable to the funders and the public, and I do not reprimand students."

The teacher advisers were in fact also playing the role of the human resource manager while the whole school seem to be involved in the building up of different expertise teams:

"[I don't need to worry about webpage and network expertise. They (referring to the students working on the computers) were all making webpages already. I just got them off a list. He (pointing to the graphics student) was introduced to me by the Art teacher. I donít teach them the skills, I just coordinate ... I provide them with image processing skills ... many of them are good at the computer but lack imaging skills ... We trained a photographer, a very professional photographer. "

The advisers were also helping students to build up their own organization and leadership capabilities:

> *"The students' organization abilities are pretty good. The webpage and the school computer team were all organized by themselves, but they still need to learn how to get different people to work together."*

IT Week

This was the other major student activity in the school during the time when the study was conducted. It was jointly held by the different student bodies, including Students' Association, Students' Computer Team, Computer Club and the Electronics Club.

According to the student-in-charge of the IT Week, the aim was to introduce to fellow schoolmates better ways to making use of IT. The motivation for the activity came from their observations of misuses of IT, for example, spending too much time on ICQ was commonly observed among Wah Yan students. The objectives of the exhibition were:

1. To encourage students to use computers for a boarder range of tasks,
2. To promote the use of Information Technology in everyday activities,
3. To arouse students' interests in Information Technology through on-campus and web-based activities,
4. To present the development of Information Technology in the school,
5. To demonstrate the various uses of Information Technology on the school campus.

All information on the IT Week were posted on the school website. The Organizing Committee Chairman explained that putting the message on the web can let more people know about what they were doing. Besides, students could also participate in these activities from home through the Internet. IT Week was not to be confined to the school grounds only. Besides, there were a variety of activities to cater for different studentsí interests.

The Students' Learning Gains

It is understandable and unexpected that students involved both as organizers and participants would gain in computing skills as well as the organizational and collaborative skills that are required for the organization of such a large project. What the organizing committee members were most excited about was the experience of

using email as an important channel of communication in the process of organizing the exhibition:

> *"We experienced a new way of communicating. After the first meeting held at the school campus, all other communications were done through e-mail. For example, if the president wants to post some information on the webpage, he sends an e-mail to the web designer for the IT week about this, copying the e-mail to other committee members."*

The Student Association President found the use of e-mail to be a very convenient way to communicate, making the committee work more efficiently:

> *"If I send an e-mail to a committee member, the job is done in the evening ... Besides, all committee members know what happens."*

Participation in Institutionalized Inter-School and International Activities

While students in School G were also involved in some inter-school/international activities, they generally did not find to be as engrossing as the school-based projects described above. The second school (School H) categorized under this Cultural Integration Model did not report on such large-scale school-based extra-curricular activities. Instead, their students had been actively involved in many extra-curricular activities involving other local schools or schools outside of Hong Kong. These include Hong Kong Joint School Computer Olympics, various competitions involving use of ICT, such as homepage design competitions, organized by both public and private sectors, and on-line exchange programs with schools in other countries. As such, the frameworks, targets and time schedule for these activities were all determined by an external agent and generally well supported, reducing greatly the risk involved in organizing new modes of activities in out-of class activities.

Uses of ICT in the Formal Curriculum

In School G, the research team observed two lessons, one being an Art lesson at the lower secondary level and the other a Chemistry lesson in the senior secondary level. The teachers were generally rather casual and welcoming in terms of allowing the research team to observe their lessons. However, the teachers were keen to point out that they don't see think their attempts there would be particularly impressive. Both lessons were later analyzed and categorized as expository lessons. There was not much coordination amongst teachers in terms of using ICT in the formal curriculum. The intended learning goals were also essentially focused on the subject matter content.

In School H, the use of ICT in the formal curriculum was much more actively pursued by teachers and given more attention. The variety of approaches exhibited in the lessons observed were also more diverse. We observed seven lessons in different subject disciplines, Art, Chinese language, English language, English literature and Chemistry, at different grade levels. These lessons were subsequently categorized as exemplifying three approaches: inductive, task-based and social constructivist. There was also a range of learning outcomes targeted in the lessons observed, often incorporating the development of higher order thinking skills and capabilities rather than simply content knowledge.

History of ICT Implementation

Both schools G and H were pilot schools, indicating that both were considered to be amongst the more "ready" schools for trialling ICT implementation across the school curriculum on a larger scale. In fact, both schools have a long history of computer use, which dated back to the earlier '80s. However, their development history and emphasis were different.

Building a Supportive and Enabling Infrastructure for Authentic, Autonomous Activities

The history of implementation of ICT in School G reflects remarkable efforts in the building up of a supportive infrastructure that can be used by students and teachers alike for realizing their visions of desirable activities. According to the IT coordinating team in School G, the school went through three stages of development in ICT implementation in the school.

The first stage was from 1980 to 1990. This school was one of the earliest in Hong Kong to have introduced the Computer Studies subject into the school curriculum in the early '80s. Since 1987, the school has made various efforts to extend the access of computers to both teachers and students beyond the teaching of computer-related subjects.

The period 1990-1995 marked the second stage of implementation for the school when more systematic efforts were made to make use of computers in various aspects of school life. Since 1990, a computerized school report system and a computerized barcode system for the school library were in place. The school also joined the government initiated School Administration and Management System (SAMS) to make use of ICT for a wide range of administrative functions. In this same year, the

typesetting and pagemaking of the Annual School Magazine and School Newspaper were done in-house using the school computers. Starting 1990, students were taught computer graphics design in their Art lessons and Chanjei Input Method (倉頡輸入法) in their Library Lessons. Students were given free access to CD-ROMs in the school library since 1992.

ICT developments in the school entered a new stage from 1996 when the school started building up a network to provide ubiquitous internet access on the school campus. Since that time, there has been a significant expansion in the school ICT infrastructure, the most significant of which came with the success in the schoolís application to join the IT pilot school scheme of the HKSAR government in 1998. It was observed that the new capacity provided by the expanded and upgraded infrastructure was quickly taken up various activities in the formal and non-formal curriculum in the school, especially the latter.

Since 1995, computers were used widely by the various student societies as an integrated productivity tool for their various activities. It began with the use of computers in supporting the Studentsí Association General Election. The Student Computer Operation Service Team (SCOST), which was formed by a team of students to offer technical support to all teachers and students, was established in 1996 to promote wider use of technology in the school. In 1998, upon initiation of the Chairman, the team was renamed the Student Computer Team (SCT). Compared with SCOST, SCT was a more student-oriented and students-directed team. In 1997, a LAN system was established which also provided a whole-school email service for all teachers and students was developed. Since then, each teacher and student was given an e-mail account. In addition, many school publications and information such as the School Annual Magazine, School Newspaper, photographs and personal information (including interests, participation in Club activities, etc.) of individual staff and students were also posted on the school webpage.

At the time of data collection (mid-1999), School G had over 300 computers, 70 of which were workstations with access to the internet, located in the Library, Careers Room, Guidance Room, History Room, Art Room, Geography Room, Students' Association Headquarters, Students' Common Room and all the staff rooms. Each teacher was provided with a notebook. While it was not compulsory for teachers to use computers in teaching, 12 teachers already started to use computers in their teaching of non-computing subjects.

Building an Enabling Infrastructure to Support Curriculum Innovation

School H also started the introduction of computing subjects into the school curriculum in the early '80s and continued to be amongst the most enthusiastic schools in promoting the use of ICT in teaching and learning. However, the development focus differs from that of School G where the important function of technology was to support the rich and diverse range of activities on campus, much of which was in fact not part of the formal school curriculum. In School H, much of the development centered round supporting innovations of the formal school curriculum.

Again, the IT coordinating team reported three stages of ICT development in the school. The period 1984-1990 was considered to constitute stage 1 of the development, which started with the introduction of the Computer Studies subject at Secondary 4 and 5. During this period, there was not much use of computers beyond the teaching of informatics with the exception of the use of computer in the subject *Art and Design* where the teacher taught students how to use electronic images to complete projects in the subject.

Starting from 1990, there began within the school explorations of integrating the use of general office applications into the wider school curriculum to support teaching and learning across the curriculum. This reflects a vision of the impact of IT as a productivity tool for learning as well as in the wider society. *Computer Literacy* was introduced in 1990 at the junior secondary level and *Computer Applications* at the Advanced Supplementary Level for Secondary 6 and 7 in 1992. Since 1993, the school made school-based modifications to the *Computer Literacy* curriculum so as to broaden it beyond programming and database concepts to include systematically computer application skills, including English and Chinese word processing skills, skills of using Excel and PowerPoint, and later Internet search skills and web publishing. This subject thus provided the baseline competency that teachers in other subjects can assume when planning their curriculum activities requiring students to make use of such skills and abilities.

The school considered itself to have entered into a third stage of development since 1998 when it was able to set up a much bigger network of computers with broadband internet connections in the school. This made it possible for teachers to consider ways of using computers more widely in the curriculum and as more of an established practice rather than ad-hoc events. The focus of development was on use of ICT as an enabling technology in the formal school curriculum and in particular to realize the continuing curriculum innovations in progress in the school. As stated in the school's IT plan:

> *[The school] already has a long history of using project works in our curricular teaching. Hence, many subjects are committed to including IT to improve their existing project work.*

The IT coordinating team of the school considered access and support for both teachers and students to be the key conditions for successful ICT implementation in the school. The school conducted a survey on ICT access from home and found that 95% of teachers and 80% of F.1 students have access to a PC at home which was considered to be a very positive factor in implementation considerations. The school also made the computing resources in the school open to students from 7:30 a.m. to 5:00 p.m. so that students could access the resources beyond formal class contact hours. The other major consideration was the ICT competence of both students and teachers. Computer Literacy was a core subject which has been used as a pivotal channel to ensure that students have the necessary ICT skills to make use of ICT in their learning. This echoes the serious efforts the IT team put in to continuously review and tailor the curriculum for the Computer Literacy subject for the needs of the broader school curriculum. The IT team considered both the competence as well as the confidence of teachers in using ICT to be of paramount importance in ensuring successful implementation. The team organized training sessions to teachers for voluntary participation on basic ICT skills, including office applications, Internet applications like email and web access as well as some basic network operations. In addition, the team strongly believed that the lack of confidence in handling unforeseen technical problems to be a serious hurdle that needed to be overcome if ICT were to be used more widely in the school curriculum. To this end, the team offered on a voluntary basis to be ìbookedî to provide on-site emergency support to colleagues wishing to conduct classes that require the use of ICT by both teachers and students. This has been much appreciated by teachers in the school and this seemed to have encouraged many non-technically oriented teachers to take the ìriskî of the first step and became more confident of their own ability to handle the challenge as well as the advantage of using ICT in organizing teaching and learning. In fact, the supportive and collegial approach this encouragement created has resulted in a growing team of ìbookableî support teachers beyond the initial IT team members to include at least one or more teachers in each subject panel, comprising mainly those teachers who have benefited from such voluntary service by their willing colleagues.

At the time of the data collection (spring 1999), there were 3 well-equipped special rooms in School H, including the Computer Room and the Geography Room, each of which had 40 computers and the Art Room which had 20 computers. In addition, there were about 20 computers in the well resourced library. All these computers had Internet access.

Staff Development Policies and Implementation

While staff development needs are widely recognized as essential considerations in ICT implementation, the specific requirements and perceived needs may differ according to the vision and plans of the school. However, in the case of schools G and H, we found very similar beliefs for both the principals and the teachers in these two schools about factors that are crucial to successful implementation of ICT across the curriculum. Both schools also established a small IT team comprising computer studies teachers as well as teachers from other subject areas.

The principal of School G believed that IT is a means to achieve good teaching and learning rather than an end in itself: *'I believe that the use of computer is to assist teaching. It should not be an important part in teaching. Like chalk and board, it is a tool only.' He believed that the key to successful implementation was access and training: 'If you donit really have a chance to get in touch with the machine, you will be scared. Therefore, getting to know the machine is the first thing. For this reason, I allow the students to use computers to play games in school.'* At the teacher level, each teacher was provided with a notebook computer to be used in whatever ways the teacher sees fit. It was entirely up to the individual teacher to choose whether or not to integrate the use of IT in their teaching. He believed peer influence among teachers to be more effective in bringing about change than a top-down approach. As one of the IT team member says,

> *"In my experience, we are free to try out everything. The school does not give us any pressure or time limit. This is the school culture. We believe that even though sometimes we fail, we have learned a lesson and we have put lots of effort in it. The product is not important."*
>
> *"If our boss uses a top down approach and asks us to ensure that there will be a product after a certain time, I think no one would like to try and no new idea would be generated."*

In addition to access, teachers in School G could also get technological support from the IT team as well as take part on a voluntary basis in the frequent courses on basic ICT skills organized by the IT team.

At the student level, the principal also believed that learning from peers to be an important mode of learning. One major focus of the school was to ensure access to computers for students. Therefore, there were many computers located around public places in the school such as along the corridor, the library, student association and Nature Trail project room.

Given the wide range of activities involving use of ICT in various teaching and learning activities, it was almost surprising to note that the school IT policy did not have specific goals and targets listed in terms of activities or achievements, only infrastructure development and training plans. There was a strongly held belief that given the appropriate support structure, both students and staff would thrive and good projects would be cultivated and developed.

School Vision

Vision about the Role of ICT in Education

Self-learning was strongly emphasized in School G and IT was perceived to play a crucial role in this, as expressed clearly its IT Plan:

> *It is seen that teachers can obtain information on the computer to augment their teaching; and students can do a lot of reading and searching outside the classroom via the same channel, which will certainly arouse their interest in self learning and open up new fields of interest. It has always been the wish of the school to expose students to as many fields as possible.*
>
> *There is a whole universe of information and human wisdom stored in CD-ROMs and available on the internet. It is hoped that through the teaching techniques of information technology, students can access the cultural legacy handed to this generation by our forerunners in every discipline. It is also hoped that teachers and administrators can learn form the experience and research findings in other parts of the world so that they can do their job more efficiently. It is hoped that if financial resources are available more activities can be planned.*

In the case of School H, the vision for IT include rather more specific expectations on the achieved learning outcomes, as expressed in its IT Plan:

> *With the implementation of IT, the school aims at create an IT environment and culture which fosters creativity, analytical inquiry, constructive and collaborative learning, brings about effective teaching and learning ... Students could learn to be an independent learner and to have the skills to pursue studies creatively, analytically, and constructively.*

Overall Vision and Mission of the School

It was observed that in both schools G and H, the visions about the role of IT in the school were consistent with their overall school vision and mission.

School G aimed to create an environment that encourages independent learning and co-operation for everyone and to encourage students to take an initiative role in learning. The following as some relevant excerpts from the school mission statement:

> *To build a school community in which teachers, students and non-teaching staff would have a spirit of mutual respect and co-operation.*
>
> *To develop in our students a desire to work for a just society, and to teach them to be generous in placing their knowledge and competence at the service of others, particularly the disadvantaged.*
>
> *To encourage our students to be independent-minded in their search for knowledge, while being open to learn from the opinions of others.*
>
> *To foster the emotional development of our students, thereby helping them to appreciate their abilities as well as their limitations, and to get on well with others.*
>
> *To encourage a knowledge and appreciation of the students' own culture, as well as the ability to express themselves both in Chinese and English with correctness, clarity and even elegance.*

As revealed by our interviews with both teachers and students, discussions between teachers and students were common in the school. Students often learned beyond the boundaries of the public examination syllabus set by the Hong Kong Authority, when either the teachers or the students felt so inclined.

There were 32 clubs in the school. Students were encouraged to participate in extracurricular activities and to plan and make decisions for themselves. The school gave rights to students to form any studentsí clubs and to do any project within getting prior permission from the school authority. Students were even permitted not to attend lessons, provided that they were spending their time on doing 'meaningful things'.

School H, on the other hand, had different emphasis and approaches. The school believed in the provision of a well developed curriculum to bring about the learning that the school stated in its vision:

Through varied programmes, the school seeks to provide the setting and opportunities for the formation of values and attitudes, the acquisition of knowledge and the development of skills and potentialities.

The aim is to create in the school an atmosphere which facilitates the total development of the student - spiritual, moral, intellectual, physical, social and aesthetic.

Achievements and Challenges

From a study of the developments in the introduction and integration of ICT in the school curriculum in these two schools, it is obvious that ICT has contributed much to the promotion of the school vision and mission of the individual schools, though in somewhat different ways. The differences in fact lie in the different educational values and emphasis that are deeply rooted in the rich tradition and history of the two schools. Schools without such established traditions and culture would find it extremely difficult to implement ICT in the curriculum in the same way that these two schools have. The process of implementation itself as reviewed above is possibly characteristics of how these schools would go about implementing other new technologies, processes or innovations into the school. As schools with established traditions and records of achievement, the challenge is how to maintain the momentum of change and innovation and to extend their achievement beyond established strengths.

Epilogue

H.K Yuen

ICT can promote and foster various degrees of organizational change. In studies on ICT enabled business process reengineering, four models of change were found: automation, rationalization and reengineering and paradigm shifts (Laudon & Laudon, 1998). Automation refers to using ICT to substitute human and to speed up the performance of existing tasks. Rationalization means the streamlining of standard operating procedures, eliminating bottlenecks so that automation makes the procedures more efficient. These two models take an engineering approach which emphasizes the processes of designing, planning, constructing and controlling. Reengineering refers to the radical redesign of business processes used to produce products and services with a view to reduce business costs. Furthermore, paradigm shift, a more radical form of reengineering, involves the radical re-conceptualization of the nature of the business and the nature of the organization. Obviously, each model of change carries different rewards and risks. Here, we endeavor to draw comparison between business organizational change models and the three school educational change models revealed in this study.

Similar to the business sector, the technological adoption model is also the most common model of change among the schools in the present study. In schools where the technological adoption model is observed, the role of teachers is mainly seen as someone who presents information and evaluate performance, while the functions of ICT are to enhance the effectiveness of information presentation and to stimulate students' learning interest through attractive multimedia. An important achievement in these schools is the establishment of a reasonable technological infrastructure and that most teachers are trained to be technically competent. Nevertheless, the challenge to the technological adoption model schools is how to move from an "engineering" approach, i.e. using ICT to automate and rationalize the tasks and processes within the school, to "re-engineering" which involves the fundamental rethinking of the nature of education and the radical redesign of school processes.

Schools categorized under the catalytic integration model are characterized by a visionary leadership and a school philosophy of continuous reform through engaging teachers in the process as members of a learning organization. Such a "re-engineering" approach is potentially of high reward but also involves high risks. In the process of change, teachers are required to learn new technological skills and applications, as well as to explore new pedagogical approaches for the planning and delivery of teaching and learning activities within a new context. This challenges teachers to

rethink their personal attitudes, beliefs and values they held about their role as educators and to re-conceptualize their understanding of schooling and society. Thus, to foster and support teachers through this change process, it demands that the school principal has a clear vision, strong awareness and strategic commitment to foster a culture that values student empowerment as the crux of ICT implementation, encourages professional development, appreciates and embraces innovation and quality in education.

It is obvious that ICT has contributed much to the schools that adopted the cultural integration model. It helps promote the established school vision and mission, which may differ from school to school but in line with current reform direction. The differences lie in the different educational values and emphasis that are deeply rooted in the rich tradition and history of the two schools in our study. Schools without such established traditions and culture would find it extremely difficult to integrate ICT into the curriculum in the same way that these cultural integration schools do. Nevertheless, the cultural integration model is unique in comparison to the business process models and can not be clearly characterized under the engineering nor reengineering models. It may be appropriate to use the label "non-engineering" to describe the cultural integration model. The change force of such "non-engineering" schools is internal and natural. The process of ICT implementation itself is possibly characteristic of how these schools would go about implementing other new technologies, processes or innovations in the school. For schools with established traditions and records of achievement, the challenge is how to maintain the momentum of change and innovation and to extend their achievement beyond established strengths.

Reference

Laudon, K. & Laudon, J. (1998), *Management Information Systems: New Approaches to Organization and Technology*. (5 ed.). N. J.: Prentice Hall.

Chapter 12 Conclusions and Recommendations

N Law

The set of case studies reported in the earlier chapters on good practices using ICT in teaching and learning in Hong Kong classrooms have furnished us with a very rich data source both on the status of implementation as well as the dynamic aspects of change and change management observed in schools that have made significant efforts towards the integration of ICT in classroom teaching and learning, as recorded at the beginning of the HKSAR government's 5-year IT in Education Strategy (ITEd Strategy). Many of these efforts were stimulated and supported by the government's IT in Education initiatives. The case studies thus reflect not only the achievements of the schools and teachers involved, but also reflect the impact of the policy initiatives of the HKSAR government. This chapter summarizes the achievement as observed in the case study schools and on that basis reviews the success or otherwise of the government's IT in Education initiatives and the school implementation factors involved. Finally, this chapter will finish with a set of guidelines and recommendations for both policy makers and practitioners alike.

Reviewing Achievements

The case studies reported here were conducted during the period March 1999 to April 2000, which covers the period up to the first 18 months of the implementation of the government 5-year IT in Education (ITEd) Strategy. To have achieved visible results within such a short period of time is remarkable and it is not surprising to find that in all the cases reported, the schools concerned had actually started planning and exploring ICT implementation before the announcement of the Government's ITEd Strategy. Strong school-based initiatives are crucial in bringing about success at both the school and classroom levels. At this point in time, some achievements like the establishment of an ICT infrastructure are more tangible while the impact of implementing ICT on teaching and learning are more difficult to detect, though arguably the most important. Based on the results from this Study, we find that institutional innovation/reform experience is a strong contributing factor towards success of ICT implementation. Readers may be surprised to see school-based curriculum development and innovation experiences, presumably a description of the processes that the schools went through, to be reported in this section as part of the achievement. It is important for those

involved in promoting and implementing ICT in education to recognize that school-based innovation and reform experience gained through the process of ICT implementation is no less important an achievement than the impact made by the use of ICT on teaching and learning. In fact this achievement will feedback into the cycle of development to bring about further success.

Impact on classroom interactions and learning experiences

Student learning outcomes

As pointed out in the first section of this report, the focus of the present research is on the impact made by the introduction of ICT on the roles and interactions among the teacher, the students and the technology in the classroom. Obviously, classroom interactions and learning experiences are interesting in so far as these contribute to possible differences in learning outcomes. However, it is a limitation of the present research that it was not possible to conduct a systematic study of the impact of ICT on learning outcomes. The limitation was not purely circumstantial but methodological as well. This theme will be the focus for Module 3 of the SITES study. In this section, we will summarize the perceived learning outcomes observed during the classroom observations and in some instances as reflection in the samples of the students' work collected. Also, there is no claim made here on the extent of the contribution made by the use of ICT, if any, to bring about the observed learning outcomes

The learning outcomes that were perceivable during the lesson observations vary greatly according to the pedagogical approach adopted by the teacher. In cases where the expository approach was adopted, the focus was on effective teaching through presentations and the lessons were teacher-centered. It was thus not possible, just through observation, to discern the level of understanding or mastery that the students had, nor what have been achieved by the students during these lessons unless the teacher made a lot of efforts to obtain feedback from students. It was also observed that even when the teachers were doing a lot of questioning during the lessons, the questions were generally focused closely around the specific content taught and thus only achievements at lower levels of understanding of the content could be found out through such interactions. Also, the number of students that can be involved in answering questions in such settings was necessarily limited.

In the case of inductive lessons, as students had opportunities to experiment and test their ideas using the specially designed software, it is often not difficult to find out whether they were able to master the concepts involved through observing students progress with the computer-based tasks, if the targeted learning were relatively focused and simple. Again, where more interactions were designed for students to answer

questions and give explanations, then it became easier for the observer to know the general progress of the students. Where the learning goals involve complex concepts and reasoning, we found that the inductive approach had to be coupled with other approaches like the social constructivist approach before students' progress can be observed more clearly.

In both task-based learning and problem-based learning, students were involved in productive learning tasks where they had to deliver a product at the end. Often, such tasks or projects were organized as tasks or projects involving students working together in groups over extended periods of time. Therefore these approaches were often found operating in conjunction with the social constructivist approach. In such circumstances, as the students' performance become the focus of attention in these lessons, and every student was involved, it was very easy to discern the level of understanding and mastery achieved by the students. In fact, as the knowledge and skills involved in the accomplishment of tasks or the solution of problems often involve the application of concepts and skills taught in specific lessons in conjunction with a broad repertoire of prior knowledge and skills, the ability and inadequacies of students' learning can often be reflected much more deeply through observing students' behaviour during their task performance as well as through inspections of their products. A much richer complex of learning outcomes can also be targeted through such approaches.

While both task-based and problem-based approaches allowed students to exhibit their levels of competence while engaging in tasks or projects, the difference in task nature for these two approaches also lead to different competency requirements. Tasks are generally well specified and need not relate to realistic situations or contexts and thus are like open-ended learning exercises. Problem-based learning, on the other hand, is generally concerned with authentic problems that are ill-structured and open to interpretation, requiring the learner to define the problem further before attempting to solve it. There are generally also different sets of criteria for evaluating solutions to a problem and compromises are often necessarily so that different solutions may be maximizing different criteria. Problem-based learning thus often made more complex demands on the learners and the learning outcome (or incompetencies) that can be exhibited are broader and closer to those demanded of life-long learners.

Roles of teachers and learners

It was observed that in parallel with the introduction of ICT into the classroom, some teachers were ~~also~~ taking the opportunity to implement teaching approaches that were changing the roles of teachers and students in fundamental ways. Traditionally, the teacher plays the role of the knowledge expert and the pedagogical expert, presenting

content, assigning learning tasks and evaluating learning outcome for students. In expository lessons, this relationship between the teacher and the learners have not changed. However, this relationship is changed to different extents in the other approaches.

It was found that the teachers we met in the various case studies were excited about the use of ICT for very different reasons and such differences contribute largely to the observed differences in their classroom practices. Some teachers believed that ICT has great potentials in providing much more interactive and interesting teaching aids that make lessons more engaging and more easily understandable. These teachers generally spent a lot of efforts in developing multimedia teaching aids and sourcing good demonstration software and CAL materials. A change in the teacher-learner relationship was not prominent on the agenda and the expository approach was the obvious choice. On the other hand, some teachers saw in the introduction of ICT a different future for education. First of all, information becomes much more accessible and volatile such that the key problem for education becomes one of knowing how to access, evaluate and make use of information effectively rather than mastery of particular content. Secondly, the rapid advances in knowledge force everyone to become lifelong learners in order to keep abreast with developments. Thus we need to provide opportunities for students to become effective autonomous learners: to be able to define their own learning problems, learning needs and to devise a learning plan to achieve the goal. To achieve this requires a change in the roles played by the teacher and the students. Thirdly, a major impact of ICT is derived from the multiple channels of communication for all kinds of media available for concerning to different parts of the world. Individuals and businesses alike would not be able to survive if they cannot communicate with different people using a variety of communication media and technology effectively for different contexts and purposes. For this latter group of teachers, the design and implementation of productive learning activities that required students to make use of information and communication technology in the completion of learning tasks became their priority. Their role as a teacher was also changed in this process.

ICT competency

In the case study schools, it was observed that both teachers and students have variously also gained in their mastery of ICT skills. However, there were also large differences across schools in this respect. Where the focus was on technology supported teaching, the teachers were all generally more competent, with many having mastered skills of multimedia production and programming. Other schools with a pedagogical focus on ICT integration, in particular those schools implementing a Catalytic Integration or Cultural Integration model of change, the general ICT competency of the teachers

were lower and they tended to develop student learning activities that made use of commonly available general application software. In fact, the task-based, problem-based and social-constructivist case studies reported here all made exclusive use of general application software and the teachers concerned did not have to master specialized ICT skills at all.

The present study cannot provide any evidence that the ICT competency of teachers in a school is related to the ICT competency of students. In classrooms adopting expository and inductive approaches, the teachers generally exhibited high levels of ICT competence but no evidence on students' ICT abilities were available just from the classroom observations. In the more student-centered approaches like task-based and problem-based learning, the students were generally developing their ICT skills in the context of the tasks or problems they were working on. There were ample opportunities in these circumstances that we found students' ICT competency to be higher than their teachers', an observation that was generally well accepted by the teachers concerned as well.

ICT Infrastructure

In order to implement ICT in the teaching and learning process, the availability of suitable ICT infrastructure is essential. The schools reported in this study have all made remarkable efforts to establish a reasonably good technological infrastructure to allow teaching and learning with information technology to take place. The level of resourcing available in these schools differ widely, some of the schools studied were not pilot schools and had to develop their own infrastructure within very limited means while some pilot schools were further endowed with extra funds from the Quality Education Fund and other sources to set up very impressive infrastructures. However, it was observed that even at the same level of resourcing, schools differ in their development priorities and some schools invested heavily in providing a good infrastructure for supporting teachers teaching with multimedia display capabilities while others focused on ensuring student access and improving the student: computer ratio. Some of schools with the latter type of development focus made innovative use of community support like parents and former graduates to donate used machines and labour for setting up the network connections within the school. It is thought provoking to note that within the sample of schools studied, there was no obvious relationship between the level of resourcing in infrastructure available in the school and the range of ICT supported pedagogical practices present. In fact, the more student-centered pedagogical practices tended to be found in schools that have put emphasis on student access. It is not surprising to observe that schools adopting the Technological Adoption Model of change focused much more on setting up a good infrastructure for teaching.

Curriculum change and Innovation - school-based experiences

The introduction of ICT into classrooms involves a complexity of changes at the school level, which would include at the minimum organizational and infrastructural changes. The nature and extent of the change depends largely on the vision for change and the innovation and reform experience of the school. In section 3 of this report, we described the three models of change observed: Technological Adoption, Catalytic Integration and Cultural Integration, which paralleled closely "engineering" "re-engineering" and "non-engineering" approaches respectively to change in business process reengineering. The "engineering" approach focuses on automation and rationalization of processes, while "re-engineering" focuses on reconceptualization of the processes as well as paradigm shift. "Non-engineering " refers to situation where the institution has already established a reform tradition of continuos renewal and ICT is just seen as an integral component of the repertoire of resources available. Obviously, the nature of change and the extent of change achieved differed across the different models of change and from school to school.

For schools adopting the "Technological Adoption Model", the main agenda was seem to be setting up the ICT infrastructure, getting teachers trained in ICT skills and accumulating good ICT-based curriculum resource materials for teaching. Most of the schools in this category have made significant achievements in these respects, often through strong directives from the leadership. The achievements made thus indicate that these schools have the vitality, determination and ability to make changes and progress. The challenge for these schools is whether they can move onto a "Catalytic Integration" model of change to institute curriculum changes that targets new learning goals and learning relationships and impinging on the roles of the teacher and the learner. Without developing new visions, it is very easy for the school to feel "mission accomplished" and become complacent, without actually achieving significant gains in students' learning.

For schools adopting the "Catalytic Integration Model", the agenda that was taken up went far beyond technological adoption. It was a fundamental reform that aimed to establish new curriculum goals and learning relationships, which impinges on the whole culture and organizational relationships within the school. Refreshing and stimulating lessons have been observed in these schools that demonstrated various levels of success in bringing about changes in the roles of the teacher and the learner as well as new learning gains. It was also encouraging to see that such success were well appreciated by teachers and students alike, hopefully reinforcing their desire to develop further in such a direction. The success and experience gained by these schools in the change process have helped to build up a momentum and culture for innovation and reform, which are extremely valuable assets. However, the extent of such

achievements is still small in the context of the entire school curriculum, and schools are still operating within a curriculum and assessment framework that is largely content driven. The challenge is in making the changes sustainable and in maintaining the momentum of innovation.

Schools that were able to adopt a "Cultural Integration Model" to the implementation of ICT were indeed fortunate schools in that these schools had a long established tradition of supporting student-centered initiatives and a history of teacher-initiated innovations. These schools have a relatively able student population and a long history of establishment. Strong leadership from the principal is exhibited through promoting and supporting initiatives in line with the established school values and visions. Both schools in this category had started integrating ICT in the teaching and learning of various school subjects and students' extracurricular activities several years before the government announced its ITEd Strategy. These initiatives were largely initiated by the teachers and students in these schools as they envisaged that the use of ICT would enhance the curriculum innovations and activities they were engaged in. The school leadership supported and promoted such initiatives and worked hard to provide the resources and support needed. Thus the announcement of the ITEd initiative was welcomed by the schools and both took advantage of the opportunity to advance the changes that were already underway. While recognizing the enviable culture of change and innovation to further the institutional vision that have been established in these two schools, it does not mean that developments in the school has been thoroughly and uniformly established. In fact, it is the nature of "Cultural Integration" institutions that there probably exists a wider range of disparities than that found in the "Technological Adoption" or "Catalytic Integration" institutions as coercion is alien to the established nurturing and supportive culture. A broader range of ICT-supported pedagogical approaches has indeed been observed in these schools as compared to the other two school categories. The challenge to these schools is to widen the scope and impact of change while strengthening the existing school culture and to review the school vision in the face of changes and developments.

Reviewing the Impact of the HKSAR ITEd Initiatives

Vision and key strategies

In the HKSAR 5-year strategy document *Information Technology for Learning in a New Era* announced in November 1998, the vision for promoting IT in education included four elements:

- To turn schools into dynamic and innovative learning institutions where students can become more motivated, inquisitive and creative learners
- To link up students with the vast network world of knowledge and information to enable them to acquire a broad knowledge base and a global outlook
- To develop students' capabilities to process information effectively and efficiently
- To develop in students the attitude and capability for independent life-long learning

The document recognizes that to achieve such vision, *"school education needs to see a paradigm shift"*. It then detailed a four-pronged strategy for the realization of the vision: providing *access and connectivity* to students, training opportunities for *teacher enablement, curriculum and resource support* and to encourage a *community-wide culture* to support the IT in Education initiatives.

Fostering IT readiness

Consistent with the 5-year strategy, the government selected 10 primary and 10 secondary schools as pilots to implement ICT across the curriculum. It also embarked on an ambitious timetable to set up a basic ICT infrastructure and internet access for all schools in Hong Kong as well as organized various IT-related training opportunities for teachers.

In reviewing the progress made by the schools in this Study, it is evident that these ITEd initiatives have made crucial contribution to the developments in most of these schools, especially in primary schools, as most of these never had computers for student access until the implementation of the Strategy. The training opportunities for teacher enablement were particularly instrumental to promoting changes in schools adopting a Technological Adoption Model of change. For these schools, the lack of ICT-based curriculum resource materials closely supporting the existing school curriculum has been an especially acute problem even though efforts have been made

by the government to build up a bank of ICT-supported curriculum resources. On the other hand, schools adopting the other two change models perceived rather different obstacles: difficulties in changing the learning culture, constraints of the existing assessment framework and inadequate access for students. Such differences originate from the different visions and development priorities of the schools involved.

Paradigm shift - a jargon embraced by everyone

While the Strategy document highlighted the need for schools to undergo paradigm shift in the implementation of ICT, the meaning of paradigm shift was merely described as changing *"from a largely textbook-based teacher-centred approach to a more interactive and learner-centred approach"*. The advantage of such lack of specificity was that no one challenged this claim, as everyone can easily interpret its essence as consistent with his/her own understanding. Many of the teachers and principals in the study actually interpreted the key components of the shift as to reduce the reliance on textbook-based teaching to teaching with interactive multimedia enriched classroom presentations. Within such a definition of paradigm shift, schools taking a technological adoption approach to change are also making paradigm shifts even though the goals of education and the roles of the teachers and learners remain unchanged.

The meaning of paradigm shift was not only inadequately described in the Strategy document. The document was in fact not consistent in terms of the key demand on teachers that would be fundamental to their ability to undergo paradigm shift. While the examples of paradigm shift involving use of ICT included in the document were describing pedagogical and curriculum changes as the key characteristics for these cases, the levels of competence described in the chapter on Teacher Enablement was predominantly concerned with the teachers' technological competence. The "competent" teachers were characterized as having the capability to *"make more advanced use of authorware for lesson preparation, etc."* and the "creative" teachers as those who can *"design instructional materials with use of IT and choose appropriate IT equipment to meet a school's needs"*. Such characterizations led to the provision of rather technologically focused training courses to teachers and a reinforcement of the understanding that the essence of ICT in education is in fact an "automation" of traditional modes of teaching and learning with technology and media. It is thus not an accident that while schools in the current Study were all supportive of and committed to the implementation of ICT in the school curriculum, most of the lessons observed were expository and most of the schools perceived the nature of the change as one of technological adoption.

School-based change management strategies - the missing link

Irrespective of the vision for ICT in education and the model of change adopted, it was evident from the results of this Study that in order to achieve the changes documented, the school leadership had to be very committed to the change and had to institute changes in the school at the organizational and infra-structural levels and beyond. In short, the school leadership had to make plans for and to implement school-based changes for ICT integration. Section III of this report and the earlier discussions in this chapter have all pointed to the importance of the model of change adopted by the school in determining the nature of change experienced by the students. However, the Strategy document only focused on providing territory-wide system level support to help schools attain "IT readiness" in terms of access, connectivity, teacher enablement and curriculum resource support so that ICT implementation in teaching and learning can be started. Schools are provided with "flexibility" in implementation without guidelines or suggestions for how to approach or manage change. Further, the document highlighted the importance of Teacher Enablement but did not recognize the need to provide professional development and support to school principals to help them to understand the nature of the challenge they face, key elements of change management they need to work on and some possible courses of action to take. There were a limited number of staff development opportunities organized for principals but these were essentially focused on developing the technical skills of principals and not focused on helping them to face the challenge of leading their school to use *Information Technology for Learning in a New Era*. In this context, the principals in the case study schools reported here were all admirable life-long learners who took up the challenge of developing an understanding of the problems involved and working with the teachers in their schools to plan for and implement their solutions. It is important that the government recognizes the missing link in the policy strategies in order to provide effective leadership to schools.

One of the Strategy components was on developing a community wide culture to support ICT developments in education. It was observed that only a very limited number of schools had pro-actively made use of community resources as an integral part of the school development strategy. This reflects a lack of understanding at the school leadership level of the scope and nature of paradigm shift possible dimensions of an effective school ICT implementation strategy.

Recommendations

Summarizing the findings from this Study, we wish to make the following recommendations for everyone involved or interested in promoting ICT use in education in Hong Kong.

- Establish a personal/institutional understanding of *Paradigm Shift* that should encompass, at its core, visions and goals of learning that are consistent with the demands on life-long learners of the 21st century. Such an understanding of paradigm shift will include not only changes in instructional technology, but also more importantly changes in the roles played by teachers and learners as well as changes in teaching practices. The specific understanding of paradigm shift may differ from institution to institution and from individual to individual, and should be evolving as progress is made. A commitment to a clearly established understanding of paradigm shift is crucial for establishing a direction for change and a yardstick for measuring outcome.

- The visions and goals for ICT implementation should guide policy decisions at both the system and the institutional levels. This includes decisions on the ICT infrastructure provisions to schools, whether the priority is on presentation facilities and teacher control or student access and support for students' independent use. It also affects the priorities in the provision and development of curriculum resources, whether the focus is on demonstration/exposition of existing curriculum or on software that empowers learners to be more autonomous and creative.

- Sharing of experience across schools at an institutional level is important. The focus should be on ICT integration as a holistic endeavour, in the context of making institutional changes to bring about curriculum change and innovation, and not just on specific dimensions such as hardware and network infrastructure configurations devoid of contextual considerations and goals.

- The sharing across IT teams should encompass the sharing of change strategies and goals, organization and management as well as ways to assess the impact of various strategies. It is also important to share experience on how to motivate, involve and support teachers of different subject discipline backgrounds and differing levels of IT competency to integrate the use of technology in their subject teaching. Sharing of ICT implementation experiences that incorporates broader curriculum change such as curriculum integration in especially beneficial.

- If the aim of implementing ICT in education is mainly to bring about a paradigm shift in education, then teacher training should not just focus on technological skills, but more importantly, to focus on developing an understanding of paradigm shift, as well as pedagogical and curriculum development skills.

- Sharing among teachers is an important means to enhance and promote developments across the territory, but this sharing should not be primarily focused on or limited to curriculum resources. An over-emphasis on curriculum resources is generally related to an over-reliance on expository teaching and a reluctance to venture beyond the established curriculum. Such approaches to teaching would not be conducive to developing life-long learning abilities in students. What is more important is the sharing of curriculum planning and development experiences and the experience of bringing about curriculum innovation, new learning goals, objectives and activities through this process.

In addition to the above general recommendations, we have the following recommendations for specific stakeholders: policy makers, principals, IT coordinating team members and schoolteachers:

At the system level, we recommend policy makers to

- Develop and promote a better understanding of paradigm shift and to evaluate existing strategies and initiatives in the context of achieving such shifts;

- Recognize that within the existing initiatives, the lack of guidance and support to school principals and school organizations in terms of promoting change at the school level is a serious missing link in the strategic plan;

- Remedy the missing policy link by providing professional development support to school leadership teams including principals and IT coordinators on strategic planning for promoting and managing change.

At the school level, we recommend principals to

- Review progress and achievement of the schools' various initiatives in the implementation of ICT, preferably involving IT team members and teachers in the school. An important component of the review would be to assess changes in curriculum and teaching practice and whether there has been changes in kinds of learning outcomes in students due to changes that include the implementation of ICT.

- Review the school's ICT implementation strategy, reviewing and strengthening the school's visions and goals in relation to the school's understanding of the paradigm shift associated with ICT implementation, and to re-formulate existing plans if necessary.
- Organize the key implementation strategies, for example staff development, school-based curriculum innovation and development, and infrastructural additions that are necessary to implement the re-formulated plans and to seek resource support if necessary.
- Consider ways to make use of community resources, e.g. PTAs, community centers, past graduate associations and other non-government organization to support the development plans of the school.

At the school level, we recommend IT team leaders and members to

- Review the rationale, impact and cost-effectiveness of the school's IT development plan, including ICT infrastructure development and staff development, in conjunction with the school level implementation strategy review mentioned above;
- Make adjustments to the various aspects of the school implementation plan based on the results of the review, in conjunction with changes in school strategy and plans identified at the school level;

At the individual level, we recommend school teachers to

- Review personal efforts in implementing ICT in organizing teaching and learning and the achievements made, especially in terms of personal learning gains and learning gains by students;
- Review and establish personal goals and targets for curriculum and pedagogical explorations and implementation that could profitably make use of ICT;
- Identify personal professional development needs and school level support that are required to achieve the identified targets and to seek ways of receiving such support, from within the school as well as the wider community.

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研究報告簡介及撮要

目錄

研究背景及目的

研究背景

資訊通訊科技在過去數年急劇發展，它對我們的社會、生活都有著巨大的影響。世界各國對資訊通訊科技在教育上的應用都表示關注。很多國家也因此釐訂了一些針對資訊通訊科技教育的整體規劃。 這些規劃不單詳列推行資訊通訊科技教育的策略，更重要的是它們是整體教育改革規劃中的一環。 這些教育改革的目的是拓展學生在資訊年代公民所須具備的能力，包括: 自我學習、解決問題、尋索以及分析資訊、思想批判、溝通力、協作力及從互聯網學習等等的能力。

香港初期的資訊通訊科技教育只是局限於少數與電腦有關的中學科目，直至一九九七年，特區行政長官在他第一份施政報告中表達他對教育上應用資訊通訊科技闊大的眼光和強烈關注這情況才得到改變。 接著，政府在中小學實施了一連串措施，藉以鼓勵和支持將資訊通訊科技融入學校課程。 一年之後，香港政府擬定了一份將資訊科技納入學校課程的五年策略，希望從而提高教育質素。 這五年策略標誌著本港在教育上應用資訊通訊科技的明確目標和發展方向。

自一九九八年政府推出有關資訊科技在學校推行的五年策略，香港已經進入了一個迅速擴展資訊通訊科技的活躍時期。當中的挑戰並不只是科技的採納，亦同時是一個教育創新的過程。 這個過程是需要政府在財政上和師資培訓方面對學校作出支援，以及老師和學校領導階層的通力合作才能成功。雖然，香港可以向很多西方國家學習它們在過去十多年來在資訊通訊科技和學校課程結合方面的寶貴經驗，但是有一些背景因素和規限是香港獨有的。 所以，香港的學校必須運用它們的資源以及創造力，去開展它們在教學上應用資訊科技的新嘗試。

在推行資訊通訊科技教育的進程中，政策製訂者、校長、老師、師資培訓人員、與教育有關的專業人士，以及家長現在面臨的主要問題是:這些改革現時取得了什麼成果? 改革的目標和教育的現況有否差距? 出現了些什麼教育創新? 有什麼證據證明這些創新的成效? 與其他國家相比，香港教育改革的潛力有什麼不同? 我們希望透過第二屆國際資訊科技教育應用研究第一階段的國際部份去尋找關於以上種種問題的答案(Anderson et al.,1997)。 此研究的第一階段是對中小學校長和資訊統籌人員進行問卷調查。 它的目標是提供一些最初步的指標及資料，以了解各參與國家內學校的資訊通訊科技設備和使用情況，藉此衡量及闡明不同國家或不同地區在教學上使用資訊通訊科技的差異。

第一階段的研究報告(Law et al., 1999)指出「...在資訊通訊科技政策的製訂和推行上，香港是屬於較遲的起步者...」，研究結果更顯示「...學校之間對於應用資訊通訊科技來實踐的教學模式差異極大...」。有關更詳盡的結果可參考《第二屆國際資訊科技教育應用研究香港特別行政區研究報告》(Law et al., 1999)。鑑於香港學校在教學應用資訊通訊科技的歷史很短，這些調查結果其實並不出乎意料，而本研究的其中一個主要目標是怎樣才能將研究結果最有效地促進學校在資訊通訊科技融入教與學中的推行及實踐(Law et al, 2000)。

雖然大型的調查研究可以提供有關現時狀況和趨勢的寶貴資料，但那些資料卻未能深入地向學校和政策製訂者剖析有關計劃持續發展的可能性和背後考慮的因素。因此研究小組決定在階段一的本地延伸部份作深入的個案研究。研究的焦點是找出一些在教學上應用資訊通訊科技的優秀案例，其目標是建立一個包含本地成功課堂個案的豐富研究資料庫，及進行探討和系統分析，以便更有效地推廣優秀教學模式的經驗。研究的部份研究結果已於《教學上應用資訊科技優秀案例剖析》(Law et al, 2000) 教師專業培訓資源教材套內刊載。

利用資訊通訊科技實踐嶄新教學

迅速的科技發展將我們帶進一個「資訊時代」，並為現代生活帶來種種重要的影響。這個時代的學生需要的能力不只是擁有一大堆資料或一些特別技能，他們更需要的是隨時學習新知識的能力、以及運用創造力和批判性思考去解決現有的或可預見的問題的能力。因此，學校必須擔負幫助學生發展終生學習的能力，以及裝備他們去應付二十一世紀的挑戰。縱觀現今的教育，資訊通訊科技在課堂教學的應用教育已是不可或缺的部份。本研究採用了「嶄新教學法」一詞去描述因應用了資訊通訊科技而產生的教學過程和目標的創新和改變。這與利用資訊通訊科技單單旨在提高「傳統教學法」的效率有所不同。學者(Pelgrum,1997)介紹了「嶄新教學範式」對不同學校、老師、學生和家長角色引發的「嶄新」特徵。學校透過資訊通訊科技把學校的消息和資訊對公眾開放;教師把工作重點放在培養學生的表達技巧、自學能力並幫助學生尋找合適的學習渠道和方法，以及評估自我的進度，學生則無論在校園內、外，都進行主動自學、提問、尋找答案和參與集體協作學習;而家長則主動與學校合作參與和制訂推動孩子的學習進程。

研究目的

當一九九八年香港特區政府宣佈資訊科技教育的五年策略時，雖然學校和老師的反應都不盡相同，但階段一的調查報告(Law et al., 1999)發現他們在整體上皆抱支持的態度。另外，各的學校帶著不同程度的熱誠和毅力開始將資訊通訊科技融入日常的學校運作中，而各學校對資訊通訊科技教育都有著不同的願景及推行的策略和計劃。在推行資訊科技教育五年策略的同一時期，教育統籌委員

會(E.M.B.1998)亦在主要課程和制度上作出全面的教育改革的咨詢。究竟學校會視資訊通訊科技的推行為只是科技應用，抑或是整體教育改革中的不可或缺部份? 資訊通訊科技進入校園為學校教育帶來了甚麼衝擊？對師生的角色及他們的互動關係上，又引起甚麼轉變？資訊通訊科技對學習帶來什麼潛在的影響? 課堂層面的資訊通訊科技應用模式與學校的背景因素有什麼關係?有什麼學校層面的因素和推行策略會課堂教學應用資訊科技的模式起著關鍵性的影響? 在一個經濟發達，中國人主導的社會中怎樣才可以成功地推行資訊通訊科技教育? 研究小組希望通過對積極把資訊通訊科技引入課堂教學而又取得較佳成果的學校進行深入的個案研究，為以上種種問題尋找答案。我們希望這些研究結果會對教師、學校，以及政策製訂者在推行資訊通訊科技發展方面有所幫助。

值得指出的是本研究的焦點不是探索嶄新教學法，而只是集中了解一些積極推行課堂教學上應用資訊通訊科技於的課堂和學校。由於資訊通訊科技在香港學校教育的教學應用只是剛剛開始，因此，不宜對個案作嚴格的篩選，而應是採用一種較為自然主義的方法去研究個案中充滿熱忱的參與者(如教師、校長和學生等等)，並觀察和分析他們在課堂教學中的「生態」表現和關係。這將會為決策者及教育界人士在推行資訊通訊科技教學應用時提供寶貴的資料。

本研究有四個主要目標: (1) 為教師和其他教育工作者提供有關利用資訊通訊科技去改善課堂教學的新意念; (2) 加深我們對資訊通訊科技對課堂教學影響的認識; (3)描述和檢視導致課堂成功的因素；以及 (4) 探究這些香港的「教育應用資訊優秀案例」與其他國家認為的「嶄新教學案例」的異同。

研究報告簡介

本報告共有三部份。第一部份名為「探討學校在教學上應用資訊通訊科技的情況」共三章。內容介紹本研究的國際背景、研究理念架構及方法。第二章報告及分析了第一階段國際問卷調查部份的一條開放式問題所搜集到的資料和研究結果，旨在了解各中、小學校長認為最滿意的資訊通訊科技課堂教學應用嘗試的特徵。此章節亦詳細介紹「嶄新教學法」，這重要概念。第三章則介紹本研究的研究理念架構及方法。

本報告第二部份名為「課堂上應用資訊通訊科技的情況」，內容介紹了有關課堂層面的研究結果。這些結果是根據研究小組觀察了四十多個運用了資訊通訊科技的課堂而取得的資料分析而來，這些課堂的錄像更是重要的研究資料。這部份的分析著眼於描述在應用資訊通訊科技進行教學的課堂內，教師、學生及資訊通訊科技的角色特點及此三者之間的互動。分析顯示不同課堂的特徵主要取決於教師在該課堂所採納的教學法。此研究以所觀察到的課堂中得出五類課堂教學法，包括講述教學法、歸納教學法、課業為本教學法、難題為本學習教學法及社群建構教學法。第四至第八章分別報告了這五類教學法的特點。

第三部份「資訊通訊科技教育的學校推行策略及模式」分析了參予是次研究的十八間學校的教育應用資訊科技推行策略(本研究共訪問了十九間學校，其中一間為特殊學校，並沒有包括在分析中)。研究發現，資訊通訊科技教育推行策略及學校課堂層面的教學法主要受以下因素影響，包括學校的願景及理念、領導層認為運用資訊通訊科技教學應達到的特定目的及目標、學校歷史，文化及背景等。第九至第十一章分別報告這三類學校的改變推行模式。

最後，報告總結本研究的主要結果，並向政策制定者、學校領導階層、教師及公眾人士作出建議。

參考書目

Anderson, R.E. Haider, G., Pelgrum, W.J., & Watanabe, R. (1997). *Second Information Technology in Education Study: Revised Proposal to the IEA General Assembly 1997.* Amsterdam: IEA.

Education and Manpower Bureau, Hong Kong Government (1998). *Information Technology for Quality Education: Five-Year Strategy 1998/99 to 2002/03.*

Law, N., Yuen, H.K., Ki, W.W., Li, S.C., & Lee, Y. (1999). *Second International Information Technology in Education Study: Hong Kong SAR Report.* Hong Kong: CITE, HKU.

Law, N., Yuen, H.K., Ki, W.W., Li, S.C., Lee, Y., Chow, Y. (2000) *Case Studies on Good Practices in the Use of ICT for Teaching and Learning. (教學上應用資訊科技優秀案例剖析)* CITE, Faculty of Education, The University of Hong Kong.

Pelgrum, W. J., Ten Brummelhuis, A. C. A., Collis, B.A., Plomp, Tj., Janssen Reinen, I.A.M.(1997). *The Application of Multimedia Technologies in Schools: Technology Assessment of Multimedia Systems for Pre-Primary and Primary Schools.* Luxembourg, European Parliament, Directorate General for Research.

資訊通訊科技在課堂上的應用

是次研究的目的在探討資訊通訊科技在課堂應用的實況，總結當中成功的經驗，並提出如何利用資訊通訊科技來提高教學的建議。研究小組決定採用一種「自然主義」(naturalistic)的研究方法，以了解教師如何在課堂教學上運用資訊通訊科技。我們四出拜訪學校，向前線老師了解他們在這方面所作出的嘗試及經驗，最後，研究小組在樣本學校中挑選了四十六節課堂進行觀察。

這些課堂在教學過程中如何運用資訊科技以至老師、學生所扮演的角色，均有很大的差異。我們運用「紮根理論」(grounded theory)的分析方法，發現這些差異多與教師在該課堂所採用的教學法有關，於是便根據這些課堂的主要教學模式，把它們歸納為五大類:

一、**講述教學法課堂** - 教師在這類課堂中扮演學科專家的角色，主要負責傳遞資料及對學生的學習進行評估。教師透過展示清楚準確和有系統的資料予學生，讓他們可以有效吸收學科的知識。教師同時要求學生能運用學科知識去處理與學科相關的問題。

二、**歸納教學法課堂** - 這類課堂要求學生根據教師所提供的資料，從中探究與學習內容有關概念的特性和相互關係。教師利用不同的教學資源，讓學生從許多個別例子中歸納出某種原理或定律。然後再根據他們已有的知識來設計學習活動，並透過提問引導學生了解學習重點及達至適當的理解。學生方面則需要在學習過程中，整合及探索自己的見解。

三、**課業為本教學法課堂** - 學生透過參與創作性的課業活動進行學習。由教師設計一系列讓學生自由發揮的課業活動，再要求學生把學到的理念融匯貫通，加上已有的知識和技能創造性地將課業完成。這種教學法相信通過學生積極參與建構性活動、反思個人的經驗及運用已有知識，便可以達到深層學習的目標。

四、**難題為本教學法課堂** - 學生以小組形式嘗試探索一個根據真實情境虛擬的課題，他們需要運用不同範疇的知識去解決它，並不時監察著自己的學習情況。在此過程中，學生需要先了解問題，然後決定研究方法、再進行資料搜集、分析及作出結論。教師則透過與學生進行討論，幫助學生學習及給予回饋，以肯定學生的學習進度。

五、**社群建構教學法課堂** - 學生須整理及表達他們對某個問題的見解，然後互相給予意見。學生透過積極地與同學討論、表達自己見解及對別人的意見作出回饋來學習。而教師方面，他們需要設計課堂的內容，讓學生參與共同建構及探索知識的活動。教師視他們的主要工作為向學生提出具挑戰性的問題及參與學生的討論，而不是傳授知識的學科專家。

第四至第八章詳細討論是次個案研究的結果，每章介紹其中一種教學模式的課堂，首先是該個教學法的特點，然後描述資訊通訊科技的功能及教師和學生所扮演的角色，並從不同類型的課堂中，選出具代表性的例子作參考。最後討論在該教學法使用資訊通訊科技時要注意的事項及為教師帶來的挑戰。

不同類型課堂的分佈情況

本研究著重分析課堂內教師、學生及資訊通訊科技的角色，及他們之間的互動情況，然後從中歸納類同的課堂模式。研究發現，教師採用的教學法是影響課堂目標及互動的最主要的因素，而資訊通訊科技的使用模式是配合、促進該教學法。在深入討論資訊通訊科技在不同類型課堂中的功用之前，必須指出在是次研究的四十多個課堂案例中，這五類教學法的應用比例差異很大。下表列出各個課堂類型所佔的數目:

講述教學法課堂	歸納教學法課堂	課業為本教學法課堂	難題為本教學法課堂	社群建構教學法課堂
小學課堂 16 節 中學課堂 7 節	小學課堂 2 節 中學課堂 5 節	小學課堂 2 節 中學課堂 10 節	中學課堂 2 節	中學課堂 2 節

從上表所見，在那些被教師視為應用資訊通訊科技的優秀課堂中，講述教學法課堂的比例最多，此類教學法亦是本港最常見的教學法。歸納教學法課堂及課業為本教學法課堂的數目，亦明顯較難題為本教學法及社群建構教學法為多。難題為本教學法及社群建構教學法，不但切合本港教育改革所提倡的教學模式，同時亦與「嶄新教學範式」的特徵類同。這個結果反映本港資訊通訊科技教育的發展，是一個持續演變的過程。因此，我們在理解這過程時，也應同時考慮本港教育文化的因素。

章節重點

第四章討論有關講述教學法。我們選了兩個課堂的片段，用以顯示資訊通訊科技在這類課堂中起著正反兩方面的作用。資訊通訊科技一方面可讓教師在課堂教學時，利用多媒體以不同的表達形式，包括文字、圖片、圖表、聲音、動畫和用來展示抽象概念的視象軟件，向學生講解。如加以善用，這些資料可增強師生間的互動。另一方面，如不加留意，教師便有可能把過量的資料給予學生，以致減少他們思考的空間及吸收資料的時間。在優秀的講述教學法課堂內，教師會很有系統地安排課堂活動及資料，務求在每個教學步驟上，都給予學生充足的空間提出他們的意見。這章亦就視象軟件的使用作出討論。

第五章討論歸納教學法課堂。主要針對學生如何在課堂使用特定的軟件進行學習。其中一類軟件(Dynamic geometry program)提供一個虛擬實驗室，讓學生創作不同類型的物件和探索它們之間的幾何關係，從而建構正式的數學理論。另

一類軟件(geographic information system GIS)不僅讓學生從簡化的數據和描述性資料中學習，他們更可在教師的指引下，探索現實(虛擬)中包羅萬象的數據及引證他們的假設。在這些課堂內，教師會安排學生共同進行探索活動，而教師會扮演領導者的角色以控制討論的質素。教師須決定何時為討論引入一些分歧的見解，及何時帶領學生集中注意力到最適切的範圍，這可說是對教師一項重大的挑戰。

第六章討論資訊通訊科技在課業為本教學法課堂的作用。在大部份課業為本教學法課堂，資訊通訊科技是學生做作業的工具。學生一般以小組形式完成有關學習課題的課業。資訊通訊科技可增加課業的趣味性及為學習過程注入新的元素及新的可能性。然而，除了專注課程內容外，師生還要花額外時間和精神掌握相關的資訊通訊科技。在這類課堂的優秀案例中，教師往往有技巧地應用簡單的直接與課業有關的資訊通訊科技於課堂，只把與課業相關的資訊通訊科技帶進課堂，令師生不會分散注意力到不必要的技術問題上。在使用資訊通訊科技進行課業時，教師必須提醒學生課堂學習的內容才是他們的重點，而非課業的外觀。此外，教師亦要在課業進行前後及期間與學生討論及檢討他們的作品，使學生能夠「邊做邊學」。在討論的過程中，學生亦可透過資訊通訊科技即時觀看其他同學的作品。

第七章討論資訊通訊科技在難題為本教學法課堂的使用。這一章記述一個包括三節課的學習單元，教師要求學生解決一個擬真難題 - 比較兩所快餐店的效率。由於是一個複雜的問題，學生小組須先理解問題，研究用什麼標準來釐訂效率，以及決定搜集及分析數據的方法和計劃。資訊通訊科技在這個學習單元成為了數據處理及分析的工具，而教師則從中幫助學生學習試算表及有關的數學概念。在解決問題的過程中，學生有機會在不同的階段發現他們的理解及知識的不足，而他們亦需翻閱有關的資料，加深認識，以繼續解決這個問題。是次學習活動讓學生認識到做研究的性質和種種限制，同時亦享受到由自己決定學習方向的樂趣。

第八章討論資訊通訊科技在社群建構教學法課堂的使用。在這章所描寫的課堂例子中，教師首先讓中四學生分組搜集有關政府「殺局」的資料，包括在互聯網瀏覽，最後於課堂內向本班及中五的同學表達小組的意見。在中四各小組表達意見後，中四及中五同學就不同的觀點進行討論。負責的教師表示，這類活動有助訓練學生的思考及篩選、分析資料的能力。而學生則認為在這類課堂中，教師的角色從資料提供者，轉為引發他們認識到社會上存在著對事物的不同觀點和不同的價值取向。

推行資訊通訊科技的挑戰

從第四至第八章所引述的課堂例子，可以總結到資訊通訊科技對提高各類課堂的教學質素的寶貴經驗。從教師的訪問中，亦了解到他們對資訊通訊科技在課堂的作用有不同的理解。有部份教師認為應用資訊通訊科技是社會的大趨勢，在課堂教學中亦然。個案中的老師均可以按照自己的教育理念解釋他們在課堂上的安排。他們亦認為資訊通訊科技可以幫助他們或學生實踐一些過去難以實行的想法，以及突破傳統教學的框框。

我們從教師的訪問中得知要成功實踐資訊通訊科技教學，他們須面對及克服不同的挑戰。首先，無論教師實踐何種教學法，他們必須具備信心，自信能掌握資訊通訊科技，並運用自如。一般教師可先嘗試使用較簡單、容易掌握的資訊通訊科技。然而，教師仍然有機會在課堂內遇上技術問題，因此同事之間的相互協作及幫助非常重要。

提高自己的教學能力是另一項教師需要面對的挑戰。首三個教學法的課堂是現時香港最常見的課堂模式，這些課堂能成功，教師的教學能力是一個很重要的因素，如教師經驗不足，應用資訊通訊科技反而可能會減低課堂的質素。而後兩個課堂教學法對教師的教學能力要求更高，這是因為教師需要將控制學習的主動權交予學生，讓學生獲得更多學習的自由和機會，而教師亦須隨時回應學生提出的問題。

此外，在搜集及發展教材方面，教師亦要付出不少的時間和努力。他們要就各方面進行反思，如課堂安排、課堂流程、學生活動及課堂管理等。如果要進行嶄新範式的教學活動，教師更要探索課程及教學目標發展的方向。

結語

學者(Pelgrum et al., 1997)描寫嶄新範式的重點，在於區別在教育過程中所涉及各個單位的角色及他們之間的關係，以分辨傳統範式及嶄新範式。在嶄新範式中，學校教學與社會的關係更為密切，學校對新資訊的態度亦較為開放。學校與家長的關係亦較為密切，家長會幫助指導學生學習，或與學生一同學習。而師生關係也有所轉變，學生在安排、處理自己的學習方面，會擔當一個較主動的角色。他們亦會主動地從不同來源搜集資料及理解這些資料。教師則在學生的學習過程中，扮演輔助者的角色。同學之間的關係亦變得較為著重溝通及協作。

以下我們會就前文提及嶄新範式的特點與是次研究的優秀案例作出比較。從教師訪問得知，大部份涉及這些優秀案例的教師都認為在理念上，教育應朝著嶄新範式的方向發展。但從實際的情況，只有一部份優秀案例帶有某些嶄新範式的特點。在運用資訊通訊科技後，學生有較多在課室內進行個人或小組活動的

機會。但在其他方面來看，課堂的改變還是圍繞資料內容及個別課堂活動的轉變，而不是在於教師及學生的角色或他們兩者之間的互動之轉變。

一些優秀課堂利用，資訊通訊科技引入生活或社會上的擬真情況 / 問題 / 資料，例如學生選擇玩具的原則及學生討論政府「殺局」的原因。在這些課堂，教師皆在討論前要求學生在萬維網搜集資料，讓他們先進行自學及為討論作出準備，這些例子皆顯示教師有意把學校教學的內容設計得與社會有更密切關係的大趨勢。

有些課堂活動利用，資訊通訊科技被用作實踐那些一般教學工具不能進行的新活動，例如利用試算表去嘗試以不同的方法分析數據，利用生動的幾何學工具讓學生通過實驗理一些幾何特性的關係以及其中的解變量及不變量。然而，在分析課堂的互動關係後，我們發現其實在大部份優秀課堂裏，教師在組織課堂學習過程、設計目標及指引學生的理解方面，仍然扮演一個很重要的主導角色。教師仍假設自己要主導學生的學習，他們要肯定課堂討論涵蓋了他們認為的重點，這現象可能是由於東方文化或教育信念所致。

至於家長方面，是次研究並沒有發現有什麼資料可顯示在此方面有所有轉變。值得提起的是其中一間受訪學校的家長參予了該校在午膳及放學後學生借用電腦室的有關管理工作。雖然他們不是參加課程層面的工作，但這標誌著家長參與幫助學生學習的一個好開端。

除了教師主導的文化外，我們發現課堂活動的轉變傾向於讓學生享有較多的空間使他們的意念更為具體化。這些課堂活動包括讓他們在課堂進行更多個人或小組活動。有些教師更讓學生表達自己的意見及評估同學的作品。從學生訪問得知，學生也較喜歡參與自主空間較多的學習。

資訊通訊科技的引入可能會為教師扮演的角色帶來衝擊，他們可能不會再扮演學科專家的角色，這個轉變在中學方面尤其明顯。研究小組觀察到有些教師會從學生那裡學習到一些軟件的操作方法。在這過程中，教師在教學的同時，也扮演了學習者的角色。而教師與學生亦成為了大家學習上的好伙伴。

總結而言，要實踐嶄新教學模式，我們不但要在課堂教學上作出改變，學校文化也要作出改變，包括學校之間與教師之間的經驗分享。同時，課堂層面的改變很大程度上受政府及學校層面的政策和推行策略影響，這些我們會在下一部份探討。

參考書目

Pelgrum, W.J. & Anderson, R.E. (1999). *ICT and the Emerging Paradigm for Life Long Learning: A Worldwide Educational Assessment of Infrastructure, Goals and Practices*. Amsterdam: IEA & Enschede: University of Twente.

資訊通訊科技教學的學校推行策略及模式

這個部份的內容主要論述學校推行教學上應用資訊通訊科技方面所採用的轉變模式。學者(Telem 1996) 提出了一個分析理念架構，包括技術、架構、目的與價值、心理和管理五個方面的元素。這個理念架構顯示學校引進及應用資訊通訊科技教育是一個複雜及充滿困難的轉變過程。誠然，教學上應用資訊通訊科技不只涉及軟件和硬件裝置及教師技術培訓的問題，我們應以一個較全面的角度去綜合理解這個過程。學者(Fullan 1993) 詳細討論了學校改變過程的複雜性，他指出任何改變都要了解當中所涉及的困難、需要的技術、信念的改變及資源運用(1982)。他後來補充，改革的明確程度、複雜性、質素和可行性亦是影響推行創新的主要因素(1991)。研究小組參考這些理念架構來設計及收集學校層面的資料。同時，我們亦引用了學者傅蘭(Fullan 1992,1993)研究學校實施改革的概念來分析受訪的十八間學校推行資訊通訊科技教學的轉變過程。

研究小組向受訪學校收集了五類資料: (一)學校背景及歷史、(二)推行資訊通訊科技教育的計劃及策略、(三)學校資訊通訊科技設備及有關資源、(四)課堂錄像和觀課記錄及(五)與學生、教師和校長的訪問記錄。我們採用紮根理論(grounded theory)提出的「不斷比較分析法」(constant comparative method)，通過不繼比較資料中不同的具體情況，分辨轉變過程的主要特徵及這些特徵之間的關係，最後歸納出不同的學校轉變模式，包括：科技採納模式、催化融合模式及文化融合模式。這些模式之間的分別主要建基於每所學校如何理解教學上推行資訊科技此一變化的性質，而這研究結果跟其他有關學校改革的研究結果是吻合的。

學者(House 1979) 提出三個理解教育轉變的角度: 技術角度、政治角度及文化角度。技術角度假設世界是理性的及相信教育推行會依從以下的邏輯: 如果事件甲發生了，後果乙便會隨之出現。政治角度著的一個重點是，教育改變必定牽涉矛盾和衝突。文化角度主要著眼了解那些受「創新」影響的社會背境。而另一些學者(Meyerson 及 Martin 1997) 則認為組織就是文化，而視組織為理解事物的意義組合、價值觀及行為模式。他們提出團體的轉變其實是該團體文化範式的轉變，而文化範式的轉變有三種，分別是融入模式、區分模式及模糊模式。以上各研究理論為我們在學校層面探究推行資訊通訊科技教學的轉變模式提供了一些初步及寶貴的理念。

三種學校轉變模式

表一列出三種學校轉變模式的主要特點，這三個模式分別是科技採納模式、催化融合模式及文化融合模式，它們最大的分別在於學校的願景、價值觀、對資訊通訊科技教育的角色及功能的理解，以及學校文化和改革的歷史幾方面。是

次研究結果顯示，根據一所學校的背景特點，我們便可預測該校所採用的轉變模式。

表三： 三個學校轉變模式的主要特點

科技採納模式	- 這類學校一般沒有根基深厚的學校傳統或文化 - 在學校推行資訊通訊科技的目標在於提高教學效率及學生應用資訊通訊科技的能力 - 校長為主要改革推動者 - 學校對應用資訊通訊科技的推行均有清晰的目標及實行時間表
催化融合模式	- 學校由一名高瞻遠矚、強調學校須進行持續改革的領導者帶，改革的理念獲得教師的支持，並以「學習組織」成員的角色參與而達成 - 著意應用資訊通訊科技於教學上，並設計成課程的一部份，實踐學校理念 - 通常由一個擁有清晰願景及推行策略的校長領導該校資訊通訊科技的發展，而教師培訓則被視為其中一個主要範疇
文化融合模式	- 學校具備悠久文化及歷史基礎 - 學校具備自律性甚高的學生團體，而跨年級的學生活動非常普遍，並被視為學校傳統的一部分 - 學校重視發展學生才能及其終生學習的能力 - 資訊科技作為教師及學生的工具

章節重點

第九章討論以科技採納模式在學校推行資訊通訊科技教育的情況。這個模式和由管理角度來推行技術計劃(managerial perspective in technology planning) (Kearsley, 1990)的主張相約，兩者都強調技術設施、管理結構和教師技術水平。此章討論在三所這類型學校推行資訊通訊科技教育的策略和發展情況。這類學校一般沒有很強的學校傳統或文化背景，教師在課堂最常採用的是講述教學法及歸納教學法。他們的主要角色是出色的資料演示者和學習評估者。資訊通訊科技的主要功用在於提高教師演示資料的效率和發揮多媒體，如圖畫、動畫等的功能，以提高學生的學習興趣。因此，對這些學校而言，改變的性質是利用科技把教育自動化或改善，使現是教學過程可能得以進行得更為有效率。

此外，資訊通訊科技亦可減輕教師日常管理及批閱學生作業的工作。這些學校中，由於教師擔當製作優質學習資源的角色， 因此學習製作多媒體教學軟件便成為教師培訓的重點，他們需須掌握製作「互動」教材 (即根據學生輸入的

資料給予回饋) 的技術標準。成功採用科技採納模式的學校，領導者一般作風硬朗，並要求所有教師都達到一定的技術水平。除此之外，校方也著力推動教師間共同分享製作教材的經驗和心得。

第十章討論以催化融合模式在學校推行資訊通訊科技教育的情況。這些學校一般由一個高瞻遠矚的校長領導，而課堂層面資訊通訊科技教學的實踐，更經過悉心安排，以配合該校課程改革的目標和內容。其中最常見的課堂教學法包括課業為本教學法、難題為本教學法及社群建構教學法三類。這章引用了兩所此類學校的例子來進行討論。在催化融合模式的學校，校長通常以一個強者的姿態，著力領導該校資訊通訊科技的發展，尤其關注資訊通訊科技如何應用及融入課程發展之中。此外，校方也經常舉辦持續性的教師培訓課程，而如何利用資訊通訊科技來實踐嶄新的教學法更是其中一項培訓重點。由於這些學校在推行資訊通訊科技教學時，多強調以學生為中心，所以經常會出現多名教師共同協作的情況，這些嘗試均是學校課程改革的一個重要的組成部份。

在受訪的學校中，我們發現其中有部分在推行資訊通訊科技教育應用時，校內並沒有因此而產生一個急劇或與一貫運作有矛盾的變化，同時亦不會對學校管理層造成額外的負擔。反之，資訊通訊科技的運用可以融入該校整體的文化和課程之中，來推動及實踐學校的教育理念及願景，這樣整個推行過程可更順暢，所發揮的影響亦更深遠。研究發現，屬於文化融合模式的學校，它們的特點是：學校擁有一個清晰的辦學宗旨及教育願景，而這些宗旨和願景均滲透在學校的日常運作當中。此外，學校創辦多年、歷史悠久，已有其一套運作的傳統。第十一章討論以文化融合模式在學校推行資訊通訊科技教育的情況，以及這些學校的特點和背景條件等。

在文化融合模式的學校，基於校長對教師的尊重和信任，校方並沒有舉辦強制性的教師專業培訓課程。這些都是一些頗有名氣的學校，入讀的學生均是比較資優的。學校亦不會提倡教師採用某一種教學法，卻支持教師教學上應用資訊通訊科技。此外，由於教師所使用的教學法是建基於個人教學理念，因此相對其餘兩個模式，此類學校的教師運用的教學法較為多元化。事實上，研究小組發現前述的五類課堂皆有在這些學校出現。此類學校的另一特點，是學生會經常在課外活動中運用資訊通訊科技，其中更包括一些跨年級的創新研習計劃。

學校轉變模式與課堂教學法

在是次研究中，這三個轉變模式在中學的樣本中均可找到例子。然而在小學的樣本中，就只有科技採納模式及催化融合模式兩類的學校，課堂類型方面亦只觀察到講述教學法課堂、歸納教學法課堂及課業為本教學法課堂，而社群建構教學法則偶爾會在最優秀的例子中看到。這可能是由於文化融合模式只適用於歷史悠久及學生水平較高的學校。第二個原因可能是因為本港於1998年夏季才開始在小學層面推行資訊通訊科技教育，起步較中學為遲。此外，受訪小學的

樣本數量可能亦是造成以上結果的另一個原因。然而，是次研究小組已盡量在有限的資源下收集學校及課堂案例: 第一，我們已將所有在本港推行資訊通訊科技教育方面頗有名氣的學校列入是次研究的受訪名單中，特別是小學。第二，受訪學校亦已安排他們認為是其校的優秀課堂予研究小組觀察。

是次研究總結的三個學校層面的轉變模式、五個在課堂層面的教學法以及這兩者之間的關係，均是基於是次受訪的十八所學校及四十六節課堂所得出。研究小組對是次結果出現的系統及一致性均表滿意，但由於香港資訊通訊科技教育發展瞬息萬變，加上是次受訪學校數量有限，要進一步了解當中的細節，便必須進行較大規模的研究。如此類研究能與海外其他國家相關研究進行，則對我們在這方面持續發展有更大的幫助，研究亦更有意義。

結語

資訊通訊科技可促進團體作出不同程度的轉變。針對資訊通訊科技在商業機構「重整工程」中所扮演的角色，有學說提出三個轉變模式的類型: 自動模式(automation)、合理化模式(rationalization)、重整工程化模式(re-engineering) (Laudon & Laudon, 1998)。在自動模式，資訊通訊科技被用作代替人力資源，以加快現有工作的進行效率。在合理化模式，現時的運作步驟會被重整，樽頸的步驟將會被剔除，使整個工作程序更為有效。此兩個模式採取以工程手法來進行轉變，則強調設計、計劃、建構及控制的過程。在重整工程化模式，公司生產及提供服務過程皆被重新設計，減少公司營運成本。另外更徹底的重整工程化模式甚至包括了公司業務性質及團體性質方面的轉變。明顯地，不同的轉變模式都會帶來不同的效果及危機。在此，我們會就以上各種轉變模式及是次研究所得的三個學校轉變模式作出比較。

與商業機構的情況相近，科技採納模式是這次受訪學校中最常見的學校轉變模式。教師的主要角色是出色的資料演示者和學習評估者。資訊通訊科技的主要作用是提高教師演示資料的效率和利用多媒體效果以提高學生的學習興趣。在這些學校，提高科技設備及教師技術水評被視為學校發展重要的目標。科技採納模式的學校所面對的挑戰是如何利用以「工程化」(engineering) 模式建立得來的優勢去進行「重整工程」，即是以資訊通訊科技把學校的工作及運作自動化及合理化，重新思考教育的基礎性質及重整學校的運作過程。

催化融合模式學校的特徵是由一名高瞻遠矚、強調學校須進行持續改革的領導者帶領，這些改革的理念須由教師以學習團體成員的參與而達成。此種「重整工程化」的手法效果奇佳，但風險亦最高。在轉變的過程中，教師需學習新技術及在一個新環境進行教學的新方法。面對新的挑戰，教師需反思作為教育工作者的個人態度、信念及價值觀，及重整他們對學校及社會的理解。校長方面，他們要有清晰的發展方向、敏銳的洞察力和精細的技巧，以及承擔在學校

推行一個以資訊通訊科技作為學生工具、重視教師專業發展、強調接受改革及鼓吹提高教育質素的文化，才可保持教師和學校對改變的敏感度。

資訊通訊科技可從不同角度實現文化融合模式學校的願景，此類學校之間的差異取決於它們經傳統及歷史建立的教學宗旨和理念。其他沒有悠久傳統及文化的學校，如要以這類轉變模式把資訊通訊科技融入課程之中，相信會面對很多困難。與前文提過的商業機構轉變模式對照，文化融合模式學校很明顯不屬於工程或重整工程模式，以「非工程化」(non-engineering)轉變來標籤文化融合模式學校進行的轉變，應該是較為適合。它轉變的推動力是來自內在，而過程亦自然順暢。這些學校推行資訊通訊科技的特徵，很可能與學校推行其他新技術、經驗新歷程或改革的特徵類同。這些擁有深厚傳統及成就的學校所面對的挑戰是如何維持轉變的動力、創新精神及在現有的優勢再求突破。

參考書目

Fullan, M. (1982). *The meaning of educational change*. NY: Teacher College Press, Columbia University.

Fullan, M. (1991). *The new meaning of educational change*. NY: Teacher College Press, Columbia University.

Fullan, M. (1992). *Successful school improvement: the implementation perspective and beyond*. Open University Press.

Fullan, M. (1993). *Change Forces: Probing the depth of educational reform*. London: Falmer press.

House, E. (1979). *Technology and Craft: A Ten Year Perspective on Innovation*. Journal of Curriculum Studies, 11(1), 1-15.

Kearsley, G. (1990). *Computers for educational administration*. NJ: Ablex.

Laudon, K. & Laudon, J. (1998). *Management information systems: New approaches to organization and technology*. Prentice Hall.

Meyerson, D & Martin, J. (1997). Cultural Change: An Integration of Three Different Views, in Harris et al (eds), *Organizational Effectiveness and Improvement in Education*. Buckingham: Open University Press.

Telem, M. (1996). "MIS implementation in schools: a systems socio-technical framework". *Computers Education*, Vol.27(2), pp.85-93.

總結及建議

前文介紹了個案研究中資訊通訊科技為課堂教學帶來的好處，這些資料可讓我們了解本港推行資訊通訊科技教育的情況、為學校帶來的改變及學校管理層所作的努力，並作為香港特別行政區政府五年資訊科技教育策略推行初期的記錄。這些個案研究不但反映學校及教師在一個短時間內就課程內容努力推行資訊通訊科技的成績，亦同時反映了政府政策的影響。本章總結了參與個案研究學校的成果，並藉此檢討政府的資訊通訊科技教育政策和學校的推行策略。最後，本章會以一系列的指引及建議作總結，讓政策制定及有關人士參考。

目前推行資訊通訊科技教育的成果

本個案研究於一九九九年三月至二零零零年四月間進行，正好是政府推行五年資訊科技教育策略的首十八個月。在這麼短的時間內所得的成果，實在令人感到欣喜，而且，不少學校在五年資訊科技教育策略公佈前，已開始策劃和探究推行方法。因此，學校採納的政策是學校及課堂層面成功推行資訊通訊科技的關鍵。有某些成果比較實在，如資訊通訊科技的基本建設。反之，雖然很多人認為大家應著眼於資訊通訊科技對教學的影響，但這點卻較難評定。讀者可能認為學校的課程發展和創新經驗，在本報告應將之當作學校發展的描述來處理，但在本章卻視之為成果的一部份。研究發現，學校創新及改革是成功推行資訊科技教育的關鍵。*所有參與推行資訊通訊科技的教育界人士都應明白，學校的課程發展和創新經驗與資訊通訊科技對教學帶來的影響同樣重要*。事實上，這些成果會提供回饋的資料，為將來帶來更大的成功。

對課室互動及學習帶來的影響

學生學習

本報告的第一部份指出，是次研究的焦點是資訊通訊科技怎樣影響教師、學生及科技的角色和三者之間互動關係。明顯地，教室互動及學習經驗很重要，因它們會影響學習成果。不過，由於研究環境及研究方法的局限，是次研究並不能為資訊通訊科技對學習成果的影響作出有系統的探討。然而，這將是第二屆國際資訊科技教育應用研究第三階段的焦點。在本章，我們會總結觀察所得或從學生作業所反映出的學習成果。不過，這些總結並沒有涉及資訊通訊科技對學生學習成績構成的影響及程度。

從觀察課室所得，學習成果會因教師的教學法而產生很大的差異。當他們採用講述教學法時，課堂的主要教學活動是教師講解有關知識，課堂會以教師為中心。 因此，研究小組很難只憑觀察來評估學生對教學內容的理解及掌握程度，除非教師在教學時很刻意地要求學生回答問題。另外，即使教師在課堂上作大

量提問，問題一般也只是環繞某些特定的範圍。在這種學習模式下，研究小組不能肯定學生能否對課題有較高程度的理解。再者，在課堂有機會回答問題的學生人數也十分有限。

在歸納教學法的課堂，學生有機會運用一些經特別設計的軟件來引證他們的假設。在這些課堂，尤其是學習目標較集中和簡單時，研究小組比較容易從觀察學生的進度，而得知學生是否能透過這些以電腦為本的活動，掌握當中的概念。而且，這些課堂一般有更多師生互動學習活動，為學生提供回答問題和解釋的機會，所以有更多機會理解學生的學習成果。另外，研究發現，當學習目標涉及複雜的概念和推論時，歸納教學法需要與其他教學法如社會建構教學法互相配合，學生的學習成果方會較明顯。

在課業為本及難題為本學習教學法中，學生都需要參與學習活動，並要交出完成品。此類活動往往需要學生分組合作，作業時間也比較長。因此，這些教學法一般會與社會建構教學法配合運用。在這些課堂，由於課堂重點放於學生的表現上，而且每個學生也參與其中，所以比較容易識別他們掌握知識的程度。事實上，因為學生需要運用課題知識、特定技術及已有知識來完成習作及解決問題，所以透過觀察學生的學習表現及評審他們的製成品，便能更深入了解學生的能力。這些教學法可達成更複雜及較多的學習目標及成果。

課業為本學習及難題為本學習，都能讓學生透過參與課業活動或專題研習，展示他們的能力。由於課業活動或專題研習性質的不同，學生需以不同的能力及技術來完成。一般來說，課業活動的問題是清晰的，亦不會與眞實情況或環境有聯繫，就像沒有特定的答案的練習般。而難題為本學習的研習問題則一般與現實環境有關，並且比較概括，學生需在擬定解決方法前，首先探索問題的重點。每個問題通常都可用不同的標準去評估答案，因此學生需要就著不同的解決方法作出討論及達成協議，以求在不同標準下也做到最好。因此，難題為本學習通常對學生有更複雜及高層次的要求，這與終生學習對學生所作的要求相似。

教師及學生的角色

在課堂運用資訊通訊科技時，有些教師會藉此機會推行一些會大大改變教師及學生角色的教學法。傳統上，教師都擔當一個知識和教學專家的角色。他們講解課程內容、 安排學習作業和檢討學生的學習成績。 在講述教學法課堂上，教師與學生之間的關係並沒有改變。

個案研究發現，教師基於不同的原因而對實施資訊通訊科技抱正面態度，這些差異會在他們的課堂表現出來。有些教師相信，資訊通訊科技可提供更多互動及作為提高課堂趣味性的教學輔助工具，讓學生更投入地參與課堂活動，從而明白課程內容。這些教師會很努力發展多媒體教學工具及尋找優質的演示軟件

和電腦輔助學習教材(CAL)。如果教師並不致力改變師生的角色，他們會採納講述教學法。 另一方面，有些教師則認為資訊通訊科技的推行會為教育帶來一個截然不同的未來。首先，科技發展日新月異，要獲取資訊亦非常容易，因此教育的關鍵問題是在於如何培養學生有效地獲取、分析及運用資訊的能力，而不是掌握某方面的知識。其次，由於知識發展迅速，人們須成為終生學習者，方可以跟上發展的步伐。 因此，我們需要培養學生成為有效率及獨立學習者，使他們具備認定學習問題、學習需要及訂定學習計劃的能力，教師及學生的角色將會因此而改變。 再者，有些人認為資訊通訊科技使現時所有媒介有多種渠道發放，使資訊瞬間流通全世界，所以，如果不能透過通訊媒介及科技有效地在不同環境與其他人溝通來達成不同目的，無論是個人或商業都不能生存。抱著這想法的教師都著重設計及推行學習活動，讓學生積極地運用資訊通訊科技完成他們的課業。在過程中教師的角色也會改變。

資訊通訊科技的功能

參與個案研究的學校，教師和學生都因掌握資訊通訊科技技術而獲益。不過在此方面，學校之間也存在很大的差異。當重點放在資訊通訊科技輔助教學時，教師一般較能幹。他們很多已掌握多媒體製作和程式方面的技術。另一方面，一些學校則著重資訊通訊科技於課堂的融合，尤其是推行催化融合模式或文化融合模式的學校，這些學校教師的資訊通訊科技的能力一般也較低。他們都傾向運用普通的應用軟件來發展學生的學習活動。實際上，這裡報告的課業為本教學法、難題為本學習教學法及社會建構教學法的個案研究，全部皆只使用一般應用軟件， 教師並不需要掌握專門的資訊通訊科技技術。

是次研究並未能提供任何證據証明學校教師的資訊通訊科技能力與學生的資訊通訊科技能力有關。運用講述和歸納教學方法的教師一般具備較高程度的資訊通訊科技技術，而學生的資訊通訊科技能力卻不能只靠課堂觀察來証明。在大多數以學生為中心的教學方法，如課業為本教學法及難題為本學習教學法，學生會透過完成課業及解決問題來發展他們的資訊通訊科技技術。在這些情況下，我們發現學生的資訊通訊科技技術一般比教師的為高，而教師亦樂於接受學生此方面的能力較自己強。

資訊通訊科技的基礎建設

為了把資訊通訊科技引入教學過程中，完善的資訊通訊科技基礎建設是不可或缺的。報告中的學校大多都花了很多功夫，為資訊科技教學建立了頗為完善的基建設施。不同學校擁有的設施差別很大。非先導學校需要用極有限的資源去發展自己的基建。反之有些先導學校更獲得一些額外的資助如優質教育基金和其他途徑的資助，可以建立一套非常完善的基建。不過，就算大家資源一樣，每所學校發展的優先次序都有所不同。有些學校的重點會著於為教師提供多媒

體教學的資源，有些則專注為學生提供電腦，改善學生與電腦的比例。有些學校則有創意地借助家長和畢業生的協助，提供技術和舊電腦的支援，以建立一個校內的網絡。研究中並無發現校內的基建資源和資訊通訊科技支援教學方式任何關連。事實上，讓學生有較多使用電腦機會的學校之教學方式都是較以學生為本。另外，運用「科技採納」模式的學校則較為注重建立良好的教學基建。

學校的課程改革及創新經驗

為了要把資訊通訊科技融入課堂教學，學校需要進行一連串的改變，其中最低限度會包括組織架構上改動和設施的改裝。改變的性質和程度是根據學校願景、創意和改革經驗而有所不同。本報告的第三部分描述了三種不同的改變模式：「科技採納」、「催化融合」和「文化融合」。它們分別和商業機構上重整工程中的「工程化」、「重整工程化」和「非工程化」有密切關係。當然，改變的性質和程度會根據不同改變模式和學校而有所不同。

採用「科技採納模式」來改變的學校遇到最大的困難是安排和建立資訊通訊科技基建、為教師提供培訓和集結一些好的課程教材。這個類別的學校大都因有較強的領導階層，所以在以上各方面提及的困難都有顯著的成果。這些成果可作為學校推行改革中有活力、決心和能力的指標。這些學校所面對的挑戰是怎樣發展至「催化融合」的階段、為課程訂立新的學習目標和學習關係，並且為教師和學生的角色帶來新的變革。學校若不發展新願景，就很容易會以為已經完成任務而感到自滿，而忽略了要為學生提供達至有效學習成果之途徑。

採用「催化融合模式」來作出改變的學校所遇的困難已遠遠超過「科技採納模式」的學校。這類學校是要作出根本的改革，建立新的學習目標和學習關係，這會為整個學校的文化和結構帶來沖擊。我們可以看見這些學校提供較有創新和引發思考的課堂，並為教師和學生的角色帶來新氣象，也帶來新的學習成果。最令人鼓舞的是這些改變都得到教師和學生的認同，並期望能在這方面有持續發展。學校在過程中得到的成就和經驗成為他們未來繼續進行創作的重要資源，這就是改革和創新的動力和文化。但是，若從整體的課程考慮，這類學校現在的成就仍然很微小，因為學校的課程和評核機制仍然在某一程度上受著課程內容的規限。因此，這類學校所面對的挑戰是要維持創新的動力和持續發展的機會。

採用「文化融合模式」來實施資訊通訊科技的學校最為幸運，因為它們一向都支持以學生為本的措施，亦慣於由教師提議創新改革的意念。這些學校有較多能力較佳的學生，亦有長遠的歷史。校長的對新措施的支持和推廣與學校本身的價值觀和願景並行。這類學校遠在政府推行資訊科技教學前，已經在不同學科的教學和課外活動上應用了資訊通訊科技。這些學校的教師和學生都會共同

推行這些新措施，因為他們看到資訊通訊科技對課程創意和他們日常參予的活動都有正面幫助。學校方面，亦儘量提供物資和支援。因此這類學校都很歡迎政府提倡的新措施，這樣亦為他們提供加快改革進度的機會。雖然這兩所學校改變和創新文化的成就令人欣喜，它們的發展仍可更為完整和更有系統。基本上，「文化融合」模式的學校會比「科技採納」和「催化融合」模式的學校在課堂教學模式中會有更多不同。因為後者的培育及支援文化，大多建基於強制性的情況中。「文化融合」模式的學校要面對的挑戰主要有兩方面：強化現有學校文化並同時擴闊變革的範圍和效用，與及檢視學校有關的改變和發展的願景。

回顧香港特區政府提出有關資訊科技教育新措施所帶來的影響

願景與主要策略

香港特區政府於一九九八年十一月發表的一份五年策略文件《與時並進善用資訊科技學習》中指出，推行資訊科技教育的理想包括四大重點：

- 把學校變為充滿活力和創意的學習場所；而學生則成為主動性強、具探究精神和創意的學習者
- 讓學生有機會探索網上的知識和資訊世界，使他們獲得廣闊的知識基礎，並培養廣闊的世界觀
- 培養學生有效並迅速地處理資訊的能力
- 培養學生終生自學的態度和能力

文件指出，為達致這些理想，「學校教育有需要來一次範式轉向」。文件詳列可達致理想的四大策略：讓學生「接觸資訊科技及連接網絡」，提供「教師培訓及支援」，「課程及資源支援」及鼓勵「整體社會文化」支持資訊科技教育的新措施。

為應用資訊科技提供條件

就這份五年策略，政府分別挑選十所小學和十所中學參加先導計劃，把資訊通訊科技推行至整個課程中。策略提出著手建立基本的資訊通訊科技基建和把所有學校接上互聯網，同時亦為教師提供資訊科技培訓課程。

在檢討過參予計劃學校的表現後，可以肯定新措施對大多數學校的發展有一定成效。而由於在策略實行前大多數小學生都沒有機會在學校使用電腦，所以計劃於小學推行的成效尤為突出。教師培訓及支援對「科技採納模式」的學校非常實用。雖然政府已經致力建立一個資訊通訊科技支援中心，但對這些學校來說，缺乏一些緊貼課程的資訊通訊科技教學資源是一個嚴重的問題。另一方面，採納其餘兩種改變模式的學校遇到的難題是：學習文化難以改變，現存評

核準則的規限和學生接觸並使用電腦的時間不足。這些差異是因每所學校的願景和發展項目的優先次序有所不同而出現的。

範式轉向：一個含糊的概念

五年策略文件重點指出學校需要就推行資訊通訊科技而引發範式轉向，但在解釋何謂範式轉向時卻只描述為：「由一個主要以課本為根據、以教師為中心的教學模式，轉向較為互動和以學生為中心的模式」。對於範式轉向沒有一個清晰的界定的好處，就是沒有人會批評這點，因為大多數人都會認為這個要點和他們的實踐要求的相去不遠。很多參予計劃的教師和校長甚至以為轉向的目的是要利用互動的多媒體教學方法去取代傳統以課本教授的方法。當學校這樣理解範式轉向的時候，那麼運用科技採納模式的學校就是在教學目標和教師學生的角色都沒有改變的情況下，但仍可視為有範式轉向。

五年策略文件中不單未能清楚解釋範式轉向，它對教師如何才能達到範式轉向的要求亦不一致。文件一方面舉出運用了資訊通訊科技的範式轉向的例子，描述教學和課程的改變為範式轉向的一大特點。另一方面，有關教師培訓及支援那部份所談到的能力，卻只關注教師的技術應用能力。「中上程度」的教師被分類為「可靈活地運用編寫軟件來備課等」。而「高級程度」的就是那些懂得「利用資訊科技設計教材，以及選擇適當的資訊科技設備，以配合學校的需要」的教師。這種分類方法令大多數的教師培訓課程都只專注於科技知識，亦進一步令人以為資訊通訊科技教育實為傳統教學和科技媒體的結合。所以當學校大力支持把資訊通訊科技融入課程的同時，我們不難發現：大多數課堂仍然是以講解為主，大多數學校都會認為改變的性質就是採用較多的科技。

校本管理改革的策略：被忽視的一環

我們即使不談資訊通訊科技在教育上的願景，不談其採納的改變模式，這次的研究結果已經明確顯示了，學校為了達到五年策略文件中提及的改變，校方領導層必需致力實行這些變更，同時亦要於校內制定改變的政策，以改變校內的統籌組織、基本設施，以及其他各有關方面的相應改變。簡單而言，校內領導階層務必要制定計劃，把資訊通訊科技融入學校課程。本報告的第二部份，以及本章早前的討論都指出了這些模式改變的重要性，而學校採用的那一種改變模式，將會影響學生所面對的改變。可是，策略文件只著眼於為學校提供系統層面的支援，以「好好準備資訊科技的使用」，作為在教與學層面中推行資訊通訊科技的開始。文件為學校提供了推行政策的「彈性」，卻沒有於管理改變方面，提供指引或建議。而且，文件集中討論「教師能力」的重要性，卻沒有察覺到為校長提供專業培訓和支援的需要性，這些培訓和支援可以協助他們理解面對挑戰的性質、推行管理改變中涉及的重要元素，以及其他可以採用的途徑。同時為校長提供的專業培訓機會實在有限，而大部份都只在於培訓他們的技術能力，而未有協助他們應付在帶領學校走進「資訊科技新紀元」時，所面

對的挑戰，在這個範疇，我們看到研究對象中的學校校長，全都是值得敬佩的終身學習者，他們勇於背負起不同的挑戰，例如理解政策所涉及的問題，或者與校內的教師共同研究計劃和推行的辦法等。所以，政府應該正視這個政策中被忽視的一環，為學校領導階層提供有效的領導方法和管理策略。

另外，其中一個推行的策略，是培養出一種廣泛的社會文化，以支持教育上應用資訊通訊科技的發展。據觀察所得，只有少部份的學校會主動地使用社會中的資源，作為學校發展策略中的重要一環。這反映出學校領導層對於如何能在學校成功推行資訊通訊科技的策略，可能採用之範式轉向的範圍和性質的認識是非常不足。

建議

綜合本研究的資料，我們希望為有志於在香港教育中推行資訊通訊科技的各界人仕，提供下列的建議：

- 要對範式轉向有個人或學術機構層面的認識，當中包括了最重要的一部份:學習的目標和願景，這與滿足二十一世紀終身學習者的需求是相符的。範式轉向的認識，不單在於認識教學技術上的改變，同時也在於理解教師與學習者角色上的改變，以及教學方法的改變。不同的人和不同的學術機構會對範式轉向有不一樣的定義，所以應該逐步發展時它的具體理解。事實上，對範式轉向有一個清晰的認識是非常重要的，這不但可以指引改變的方向，也可以作為量度成果的一套準則。

- 在系統以及學術機構的層面上，政策的決定都應該以推行資訊通訊科技的願景和目標作為指引。這些決策，包括對學校提供資訊通訊科技基本設施的決定：應該先行改善講學器材和教師的操控，還是要先改善學生使用資訊科技的設施和支援？同時，這亦會影響提供和發展課程資源的先後次序：應該先做好現有的課程，還是先發展軟件，令學生變得更自主、更具創意？

- 學校與學校間的互相交流是十分重要的。這個重點在於作為資訊通訊科技的整體融入，而彼此的交流應包括制定學校改變的政策，課程內容上的改變和革新，不能只著重於某一些特定的方面，如硬件、網絡的基本設施等，而忽略了前文提及的各方面考慮和目標。

- 至於資訊科技工作小組間的交流，應該包含各方面，如策略的改變和目標、組織與管理、以及不同策略影響的衡量。另外，不同經驗的交流也同樣重要：譬如對於不同的科目、背景和資訊科技技術水平的教師，怎樣去鼓勵他們、讓他們共同參與、以至在技術上支援他們，使他們能夠在自己的學科教學中，揉合資訊科技的使用，這也是不可忽視的。

- 若果在教育上推行資訊通訊科技的目的，是為了於教學上推行範式轉向的話，教師的培訓便不應只限於技術能力的訓練。更重要的，是要注意增進對範式轉向的理解，以及教學和課程發展的技巧。

- 在本地增強及鼓勵發展資訊通訊科技，也有賴於教師間相互的交流，可是這些交流不應只限於課程資源的交流。過份著重課程資源的重要性，普遍是對講述教學法過份依賴，以及不願在現行的課程以外作新的嘗試。這些教學的態度，是不利於發展學生的終生學習能力。在推行資訊科技的教學中，其實更重要的是教師在課程計劃與發展的經驗交流，以及其他經驗交流，譬如如何透過這些方法去做到課程的革新、達到新的學習目標和加入有意義的活動等。

除了上述的一般建議外，我們對特定的重要人仕，包括：政策決策者、校長、資訊科技統籌小組組員及教師，作出以下的建議：

系統層面上，政策決策者應該

- 推廣對範式轉向更佳的認識，以及檢討現行的策略和新措施，以實現範式轉向。

- 要明白到現有的措施之中，對學校校長、學校團體在學校層面上改變的指引和支持，是十分不足。在策略計劃之中，出現了被嚴重忽視的一環。

- 對這個政策中被忽視的一部份作出補救措施，為學校領導層，包括校長和資訊科技統籌人員提供專業發展的支援，為促進校本改革策略管理的發展提供支援。

學校層面上，校長應該

- 檢討校內各種推行資訊通訊科技措施的進度和成績，若校內的資訊科技小組成員和教師能共同參與討論，效果更佳。評估課程和教學方法的改變是檢討中重要的一環，我們必須探討學生的學習成果會否因為資訊通訊科技的推行而有所改變。

- 檢討校內推行資訊通訊科技的策略，對於學校的目標與願景以及對推行資訊通訊科技有關範式轉向的認識，加以檢討與改善。若有需要時，應該重新制定或改動現有的計劃。

- 組織重點推行的策略，譬如培訓職員、校本課程的發展和革新、加建基本的設施，以助推行重整的計劃，如有需要，亦可尋求額外資源的補助等。

- 盡量善用各界已有的資源，例如家長教師會、社區中心、畢業生組織等去支持學校的發展計劃。

學校層面上，資訊科技小組領導人與其組員應該

- 檢討校內資訊科技發展計劃的細節，包括資訊通訊科技基本的建設、員工的培訓等，以配合上述在學校層面推行的策略和策略檢討。
- 因應學校層面上的策略與計劃之改動，相應地改變推行計劃的細節。

個人層面上，教師應該

- 檢討個人在教學上對推行資訊通訊科技付出的努力，以及所得到的成果；尤其是個人和學生從中的得著。
- 對於課程和教學法的探索，檢討個人的目標和方向，並竭力達到這些目標。此外，亦要檢討應用的方法和模式，是否能有效地使用資訊通訊科技。
- 認清個人的專業發展的需要，明確找出需從學校層面得到的支持，以達到釐定的目標。另外，教師亦可從校內、以至校外的社會中，尋求各方面的支持。