



ICT implementation and school leadership

Case studies of ICT integration in teaching and learning

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Abstract *The Hong Kong Special Administrative Region (SAR) government launched a five-year ICT strategy in schools in late 1998. This paper reports the findings of the analysis on models of change in 18 schools striving to integrate the use of ICT in teaching and learning across the school curriculum. The study shows that the strategy adopted by a school in instituting such change and the resulting variation of pedagogical practices using ICT is strongly dependent on the school leaders' vision and understanding of the role and impact of ICT in the curriculum, their goals and objectives for ICT integration, as well as the history, culture and background of the school and its general vision and mission.*

Introduction

During the past decade there has been an exponential growth in the use of information and communication technology (ICT) which has made pervasive impacts both on 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 to employ ICT to improve learning, the emergence of the knowledge economy has also brought about a much greater emphasis on education. A number of masterplans on ICT in education has been produced in many countries (Pelgrum and Anderson, 1999). Such plans reveal that educational innovations in ICT have been increasingly embedded within a broader framework of education reforms that aimed to develop students' capacities for self-learning, problem solving, information seeking and analysis, and critical thinking, as well as the ability to communicate, collaborate and learn, abilities that figured much less importantly in previous school curricula.

The Hong Kong Special Administrative Region (SAR) government's five-year strategic plan on ICT implementation in schools launched in late 1998



shares this broader educational framework mentioned previously (EMB, 1998). With this launch, Hong Kong entered a very exciting period of rapid expansion and development in this area. The challenge involved was not simply a case of technological adoption, but rather a process of innovation, which required both financial and training support for schools, as well as cooperation between teachers and school leadership to ensure success.

The study reported in the present paper is based on findings from the case studies on early adopters of ICT implementation which formed the local extension of the Second International Information Technology in Education Study – Module 1 (SITES-M1) undertaken by the Center for Information Technology in School and Teacher Education (CITE) of the University of Hong Kong (Law *et al.*, 2000). There were two major themes in the study. The first theme was on “ICT usage in the classroom”, which reported on the results of the analysis on data collected on lessons that made use of ICT. The second theme was on “ICT implementation at the school level” reporting on the results of the analysis on models of change implementation at the school level. The study was conducted during the period March 1999 to April 2000, which covers the period up to the first 18 months of the implementation of the Hong Kong government’s five-year strategy on ICT in education (EMB, 1998).

In the case studies, it was found that the schools concerned had actually started planning and exploring ICT implementation before the announcement of the government’s strategy. At this point in time, some achievements like the establishment of an ICT infrastructure were more tangible while the impact of implementing ICT on teaching and learning was more difficult to detect, though arguably the most important. It also was found that institutional innovation or reform experience was a strong contributing factor towards the success of ICT implementation. Strong school-based initiatives were crucial in bringing about success at both the school and classroom levels.

This paper aims to explore the leadership issues in ICT implementation based on the results of the analysis on models of change implemented at the school level in a case study of 18 schools (Law *et al.*, 2000).

ICT implementation and leadership

The study of technology implementation in organizations started around the 1950s. The rapid evolution of technology has necessitated a change of approach to corporate technology management (Applegate *et al.*, 1999). Wiseman (1985) identified three eras in terms of objectives for information system use:

- (1) to improve business efficiency by automating information processing;
- (2) to improve management effectiveness by satisfying information needs;
and
- (3) to improve competitiveness by affecting the business strategy.

Furthermore, Laudon and Laudon (1998) indicated four types of organizational change enabled by ICT, namely, automation, rationalization, reengineering and paradigm shift. Automation refers to the application of ICT to assist employees in performing their jobs more efficiently and to speed up the performance of existing tasks. Rationalization of procedures means “the streamlining of standard operating procedures, eliminating bottlenecks so that automation makes the procedures more efficient” (Laudon and Laudon, 1998, p. 391). These two models of change in general take an engineering approach, emphasizing the processes of designing, planning, constructing and controlling. On the other hand, reengineering refers to the radical redesign of business processes used to produce services or products with the goal of reducing significantly the costs of business; and paradigm shift, a more radical form of reengineering, involves the radical reconceptualization of the nature of the business and the nature of the organization. Obviously, each model of change carries different rewards as well as risks. It is believed that the reengineering approach is a valuable way of rethinking the nature of school leadership and management to meet the challenges of the twenty-first century (Davis, 1996).

Adapting from a framework developed for information system management in organizations, Telem (1996) presented a framework for school management information system implementation, which included five components, namely, technical, structural, psychosocial, goals and values, and managerial. This five-component framework clearly indicates that the change involved in ICT implementation in schools is a complex process and needs special attention even when the change involved is related to management and does not involve teaching and learning in schools. Many studies have been taken up by different scholars in an attempt to study the process of implementing ICT in schools. Regarding the study of change involving curriculum and pedagogy, Fullan (1993) provided a very useful framework that takes into account the complexity of the change process in schools, which argued for the formulation of a common vision as a most critical step in the implementation process. This framework can also serve as a general conceptualization for understanding the nature and challenges of change involved in ICT implementation in schools. Kearsley and Lynch (1992) also noted that the ability to develop and articulate a vision of how ICT could produce changes is a critical element in ICT leadership.

Are there developmental pathways or models that schools would necessarily go through when implementing ICT? Mooij and Smeets (2001) suggested five successive phases of ICT implementation within schools, representing different levels of ICT transformation of the educational and learning processes. These include:

- (1) the incidental and isolated use of ICT by one or more teachers;
- (2) increasing school awareness of ICT relevance for the school at all levels;
- (3) emphasis on ICT co-ordination and hardware within school;

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- (4) emphasis on didactic innovation and ICT support; and
 - (5) use of ICT-integrated teaching and learning that is independent of time and place.

With the exception of the last one, all of the phases were generalized from case studies of the ICT implementation development of ten secondary schools in The Netherlands. The five phases of ICT implementation were assumed to constitute five successively related models in the gradual ICT transformation of schools. The fifth model was a theoretical construct, as this phase had not yet been realized in school practice. Mooij and Smeets (2001) further suggested ways in which schools could learn from each other's ICT implementation experiences and indicated intervention possibilities for national policies, school management and leadership to support desired school development. However, given that the classification of the five phases-cum-models focused on the technical history of ICT use rather than the implementation history and development in the schools, the challenge to schools in learning from "more advanced" counterparts may not be a developmental one. We argue for the importance of examining implementation history and school development in understanding the challenges to ICT implementation.

Implementation necessarily involves stakeholders and issues of leadership. In a case study of the implementation of computers in schools in Ontario, Fullan (1992) identified three dimensions of change for the teacher using computers in the classroom:

- (1) the use of new hardware and software materials;
- (2) the adoption of new activities, behaviors or practices; and
- (3) changes in beliefs and understanding.

He emphasized that we need to think through the change process and address the key factors associated with the implementation of computers in classrooms, such as characteristics of the innovation, commitment and support, professional development, and leadership of the principal. Yee (1998) proposed five information technology leadership types from a study of school principals in New Zealand, namely, technology entrepreneur, technology caretaker, technology trainer, technology modeler, and technology learner. Organizational challenges, opportunities, responsibilities, and leadership strategies must be considered well before ICT implementation in schools, and principals are leaders of change, supporters of teacher development, and modelers of ICT use (Yee, 1998). In a qualitative study of the principals in ten ICT-enriched schools in Canada, New Zealand, and United States of America, Yee (2000) further defined eight types of ICT leadership, namely, equitable providing, learning-focused envisioning, adventurous learning, patient teaching, protective enabling, constant monitoring, entrepreneurial networking, and careful challenging. The principals in the

study demonstrated these eight roles, but in varying degrees. Based on the theory of transformational leadership, this study managed to describe some characteristics of ICT leadership in the sample schools. However, this raises the question about how these roles relate to ICT integration in teaching and learning and the implementation of change since leadership and the management of change are closely interrelated (James and Connolly, 2000).

The important role of school leaders in educational innovations has been well documented. Leithwood *et al.* (1999) summarized the latest leadership theories in education into six different approaches: instructional, transformational, moral, participative, managerial, and contingent. However, it is evident that power and influence are central in leadership (James and Connolly, 2000; Yukl, 2002). Leithwood *et al.* (1999) further identified four dimensions of influence in relation to the six leadership approaches: who exerts influence, sources of influence, purpose of influence, and outcomes of influence, and each of the six approaches has its primary source of leadership influence. Hence, successful implementation of change ICT is not about equipment or software but influencing and empowering teachers; it is not about acquiring computer skills, but supporting teachers in the ongoing engagement with students in their learning.

The case studies

The sample

Case studies have been widely used in studies of educational change at institutional levels (Fullan, 1991, 1993, 1999) as well as pedagogical practices in classrooms (Stigler and Stevenson, 1992; Stigler and Hiebert, 1999). Case study reports are also powerful means for the dissemination of information (Merriam, 1998). Multiple case studies were adopted in the present research with the focus on identifying models of good practices and the pathways to change in the use of ICT in Hong Kong schools.

Effort was devoted to the selection of cases that would provide a range of examples reflecting the widest range of teaching approaches present in Hong Kong schools. In order to arrive at a list of potential schools for the study, the research team consulted members of the Steering Committee of the SITES-M1 and Education Department officials of the government who had good contacts with schools, as well as used publicly available information and events like newspaper features and education, and 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 schools. The key criterion for selection was that the team should be allowed to observe some classrooms where ICT was used and that the team could videotape the lesson when it was being conducted (Law *et al.*, 2000). The researchers finally selected seven primary and 11 secondary schools from a

diverse range of backgrounds and differing forms of ICT use in classrooms. In each case, the following data were collected: documents containing information about the school background and history; documents about school ICT implementation strategies, resources and infrastructure; lesson observations; and interviews of students, teachers, ICT team members and the principal. The data were analyzed according to the comparative method of the grounded theory approach (Strauss, 1987). The research team identified various key properties that could be integrated into some coherent models. Attempts were made to understand the influence of the leaders in the process.

Lesson observations

In lesson observations, the following data were collected:

- Field notes – one researcher stayed at the back of the classroom throughout the lesson and took notes to describe the setting, the transactions that took place as well as comments on the observations made.
- Video recording – another researcher independently took a video recording of the lesson.

The video recording and the field notes were complementary to each other. In addition, the researchers also collected curriculum materials related to the lessons observed, including lesson plans, worksheets, handouts and other printed curriculum materials used as well as some basic information about the technology (hardware and software) used.

Interviews with teachers and students

Brief interviews were conducted with teachers before the lesson took place to find out about the lesson objectives. After the lesson, the teachers were also asked to comment on how far they felt the targeted learning objectives were achieved. The research team sought permission and help from the teachers to invite a group of four-six students to stay behind after the lesson for a focus-group interview. This was to seek students' views on the attractiveness and effectiveness of the lesson activities and the particular uses of technology during the lesson.

Documentary data

The research team also requested the following documents/information from the school:

- goals and missions;
- development plan and/or year plan;
- annual report;
- vision and policy relating to ICT in the school and the ICT implementation plan;

- ICT infrastructure, including the number and kinds of computers and peripherals, network, configurations etc; and
- staff development plan in support of ICT implementation in the school.

Interview with the school principal, ICT team and other students

In each case, interviews with the principal and a focus-group discussion with the ICT co-ordination team were arranged. When the research team found significant use of ICT by the student body in informal, often student-led extra-curricular activities, interviews with students were also conducted.

The analysis

Portraits of change

Among the 18 schools, three clusters of characteristics related to the implementation of ICT were identified (Table I), pertaining to three different models of change management. We found that the key distinctions between these three models are the established vision and values of the school, the perceived role and impact of ICT in education and the established culture and reform history of the school. Given a specific set of contextual characteristics of a school, it seems apparent from the result of the data analysis that the particular model of change adoption is consistent and predictable.

Model A: the technological adoption model. The most prevalent model of ICT implementation in schools (Model A) conformed to the managerial perspective in technology planning (Kearsley, 1990), and emphasized on managing the adoption of technological infrastructure, organizational structure and teachers' technical skills. Thus, we named model A as the technological adoption model. This model is likely to be found in the initial stage of innovation where the immediate concern of the school leaders was whether the teachers were able to master the necessary skills or technologies. What the principal of school A said explained it well. This principal expressed his immediate concern:

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.

There are 11 schools classified under this model, five primary and six secondary, comprising the majority of the cases in this study. The tradition or culture for this group of schools generally does not have a strong educational philosophy. This does not mean that the history of these schools is necessarily a short one. In fact, a few schools in this category were established in the early 1950s. Despite such a long history, these schools have failed to build up a tradition or culture favorable for adopting changes or empowering students.

In these schools, expository and inductive approaches (Law *et al.*, 2000) were the most commonly found pedagogical practices in the classes observed. In both the eyes of the principals and the teachers, the main role of teachers was seen to be a good presenter and evaluator of learning. ICT was used to enhance

Models	Key characteristics	Leadership strategy
<i>Model A</i> (5 primary and 6 secondary schools)	Schools did not have strong traditions or cultures Enhanced teaching effectiveness and ICT competence of students were the main objective for implementing ICT Emphasis on sharing of teacher-produced course materials as one key implementation strategy	Top-down management to ensure all teachers reach minimum level of ICT competence Set clear targets and timetable for achieving specific ICT competencies Set timeline for all teachers to demonstrate actual use of ICT in teaching and learning
<i>Model B</i> (2 primary and 3 secondary schools)	Schools have successfully engaged in a continuous process of reform through engaging teachers in the process of change ICT in teaching and learning – interest was focused on ICT which supports/ enhances the curriculum reform Have more interesting uses of ICT than those found in model A schools	Visionary leadership and principal is the key change agent Top-down arrangement with teacher involvement actively cultivated Staff development is stressed
<i>Model C</i> (2 secondary schools)	Strong cultural and historical foundation ICT is used as an empowering tool for both students and teachers Students are given opportunities to initiate new ideas with ICT themselves Realization of students' individual potential – and development of self-actualization	Multiple leadership and the principal was not necessarily the leader in initiatives related to ICT Teachers have free hand to implement new ideas in a supportive and enhancing culture

Table I.
Summary of key characteristics and leadership strategy

the effectiveness of information presentation and to stimulate student interest using good multimedia, especially graphics and animation. In these schools, technology was used to relieve teachers of the tedious repetitive work in monitoring and providing feedback about student exercises. In a few cases that were considered to be more “advanced” the teachers played the role of producers of ICT-based learning resources with multimedia and animation. Hence an important part of staff development in these schools was that of authoring multimedia. The ability to produce “interactive” multimedia that can provide feedback on the correctness of students’ input becomes the pinnacle of teacher development. The principal of school A described the change process he instituted:

The teachers used a month to learn and a month to practice. After two months, more than 90 percent 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 share the fruit of success as soon as they can, just like what the students have done.

A criterion for success in these schools, according to the principals, is to ensure some minimal technical competence of all teachers in the school. Further, as ICT in education is more or less equated with using multimedia curriculum resource materials, another important value promoted in these schools was the sharing of teacher-produced course materials.

Model B: the catalytic integration model

There were five schools in this category, all sharing rather similar characteristics. ICT use in this second cluster of schools was characterized by the deliberate integration of ICT into the teaching and learning process as an integral part of the curriculum. The pedagogical practices in these schools were mostly task-based, problem-based and social-constructivist approaches (Law *et al.*, 2000). Further exploration of the data shows that the pedagogical approaches and values embodied in the classroom practices using ICT observed in this study are consistent with the educational ideal and orientation of these schools. A common feature found in these five schools was that they were all consciously engaged in the process of curriculum innovation and reform. When ICT was introduced, attempts were made to integrate it in different curricula so as to further the school's curriculum innovation goals. We thus labeled this second change model (model B) as the catalytic integration model to indicate that the ICT integration here plays a vital catalytic role in curriculum innovation and reform involving changed roles for the teachers and learners. The school principal played the critical role of the curriculum leader, engaging staff in the process. The difference between this model and the technological adoption model is that the leaders in these schools did not stay at the surface level of simply adopting the technology innovation but went one step further to achieve some genuine integration. In developmental terms, this could be seen as a more advanced stage of development in the ICT innovation.

Another noticeable difference is that in these schools, the ICT-supported pedagogical practices tended to focus more on student-centred approaches and frequently to involve staff collaborations and curriculum innovations that were part of bigger reform projects. A student of school B made the following observation:

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, help us 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.

Model C: cultural innovation model. Within the sample of schools studied, there were two that embarked on 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 was arguably among the most profound. On closer inspection, we found that these two schools shared 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 a deeply ingrained school tradition. We labeled the change process undertaken by these schools as the cultural innovation model, in which “cultural” indicates a well-established school tradition and culture.

Interestingly, in these two schools, there was no compulsory staff development program on ICT, yet many staff acquired the necessary skills, often through informal channels. In one school, a self-learning package on Chinese character input was developed by a teacher in promoting the use of Chinese for teaching and learning with ICT. When we visited the school, we saw the package was widely used in the school and in classrooms. The teachers in these schools were generally respected and trusted by the school leadership. As an ICT team member of school C said:

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 ideas would be generated.

Since these two schools were well established, both attracted a student intake at the upper ability level. This is an important component in supporting the more liberal atmosphere of the schools. The school principals did not seem to exercise coercion for specific choices of pedagogical approaches. The use of ICT in teaching was generally encouraged and supported. There was no control when using ICT in terms of regulations. The kind of pedagogical practice occurring in a particular classroom in the schools largely depends on the belief of the teacher involved. Thus, in these schools, a greater variety of approaches of methods could be found (Law *et al.*, 2000).

Another interesting but important feature in these schools is that ICT was heavily used by students in all sorts of extra-curricular activities and some very innovative projects involving multi-age groupings of students could be found here.

Limitations of the technological adoption model

Among the three models of change mentioned, the technological adoption model is the most common form of change model adapted among the schools in the present study. This perhaps is typical in the first generation of ICT innovation. Obviously, the role of teachers was quite narrow in this model

where teachers were seen as good presenters and evaluators of learning. The role of ICT was only to enhance the effectiveness of information presentation and to stimulate student interest using attractive multimedia.

Important achievements in the schools under the technological adoption model were the readiness of the technical infrastructure and also the fact that most of the teachers were trained to be technically competent. Nevertheless, the challenge to the technological adoption model schools is how to move from an engineering approach, using ICT to automate or rationalize the tasks and processes in the school, to a reengineering approach which involves the fundamental rethinking of the nature of education using ICT and possible redesign of school processes. Such change requires shifting transactional management to more transformational practices and leadership (Cooley, 1997).

Keeping the momentum of change

Schools under the catalytic integration model were engaging a reengineering approach in adopting ICT in their schools. In the change process, teachers learned new technological skills and applications, and explored new pedagogical approaches to the planning and delivery of content knowledge within a new context. This challenged teachers to rethink their personal attitudes, beliefs and values about their roles as educators. For a few teachers, this may have led them even to reconceptualize their understanding of schooling and society. This development also required the principal to have a clear direction. When the school culture favored student empowerment, as shown in the example of the schools under the cultural innovation model, the impact and magnitude of change was profound.

The present study shows that ICT innovation adopted by the schools has been affected by schools' objectives, their perception of ICT's role in education as well as their understanding of teaching and learning and the part played by teachers and students. The different models of change reflect the different educational values and emphasis that are deeply rooted in the history and culture of the schools presented. The leadership role of individual schools plays an important part in shaping the responses to ICT innovation. This should emphasize developing other leaders and acknowledging the changing relationships among principal, teachers, staff, parents and members of the community (Begley, 1994). Together with the variation of school level factors, such as the intake ability of students, and the teachers' value system, subsequent models of change were adopted.

In a way, the change force of individual schools is internal and contextual. Schools are different in their responses to the ICT innovations. The challenge for the schools studied is how to maintain the momentum of change and innovation and to extend their achievement beyond established strengths.

Concluding remarks

Heifetz and Laurie (1998) believed that changes in societies, markets, and technology around the globe had forced many organizations today to clarify their values, develop new strategies, and learn new ways of operating. The most important task for leaders in facing these changes was to mobilize people in the organizations to become adaptive.

ICT is an innovation which can promote and foster various degrees of organizational change. This is happening in Hong Kong where the government has clearly pointed out the direction. The change models of ICT identified in the schools in the present study could be matched with the models in business organizations (Laudon and Laudon, 1998). The technological adoption model is similar to the engineering approach and the catalytic integration model is similar to reengineering, whereas the two secondary schools in the cultural innovation model have experienced a “paradigm shift” in the process owing to an internal “cultural” drive.

These 18 schools are publicly recognized as schools with the most experience in using ICT in teaching and learning in Hong Kong. The 40 lessons we visited were recommended by the school principals as the ones that would reflect the best practices in the schools. Hence, they represent the latest practices in ICT in Hong Kong schools. This is not to deny the necessity of further research work, particularly in view of the fast development in ICT use in Hong Kong schools where the situation is changing every day. The next study could examine the role of the leaders, including both the principals and middle managers.

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