THE ADOPTION, DIFFUSION AND USE OF COMPUTER TECHNOLOGY IN INSTRUCTION IN PILOT SMART SCHOOLS: A CASE STUDY

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A Dissertation Submitted to the Faculty of Education, University of Malaya in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Education

2003
Dedicated to my father, Woo Hom Wee,
and my late mother, Lliau Sau Lan,
who suffered three long years of neglect as I plodded through the study
and then left,
just when I was about to finish.
ACKNOWLEDGEMENT

First and foremost, I would like to thank the Scholarship Division, the Teacher Education Division and the Educational Planning and Research Department of the Ministry of Education, Malaysia, for making this study possible. Without their sponsorship and cooperation, this study would not have materialised in the first place.

My thanks too to the Selangor and Wilayah State Education Departments for granting me permission to carry out the research in schools within their jurisdiction.

My gratitude and heartfelt thanks to my supervising lecturer, Professor Dr Zulkifli Abdul Manaf who provided me with many hours of thought-provoking discussions and patiently guided me in the preparation and writing up of this research study. Your support, advice and encouragement is a source of inspiration to me.

To the principals, senior assistants, teachers and students of the case study schools – Rajawali, Gemilang, Temasik and Sendayan – thank you very much for your assistance and support. You suffered my presence for two long years and welcomed me into your world. This study could not have been completed without your cooperation.

A special note of thanks is also extended to the following:

- The Principal and lecturers of College E.
- The lecturers at University Malaya, in particular Dr Abtar Kaur, Dr Siow Heng Loke and Associate Professor Dr Mogana Dhamotharan for their advice and guidance.
- Dr Gan Siowck Lee for her invaluable constructive feedback to my initial research proposal.
• My dear friend, Ms Tan Gim Ean, who painstakingly read and edited my draft of the thesis.

• Dr Maney Kevin for his friendship, telementoring, suggestions and moral support throughout the entire duration of the study.

And last but not least, I wish to express my deepest appreciation and gratitude to my husband Richard, and three children, Lee Shien, Jian Loong and Jianwei, who made many sacrifices and willingly put up with cold lunches, moody fits and temper tantrums throughout the course of my study but remained understanding and supportive in ways too numerous to mention. I could never have made it without your love.
ABSTRACT

This study focuses on the adoption, diffusion and use of computer technologies in instruction in four pilot smart schools in the Klang Valley. The aim of the study is to see how teachers specially trained in the 14 Weeks In-Service Training Programme For Teachers of Smart Schools coped with the introduction of technology-integrated instruction in the schools.

The study adopted an ethnographic-style, qualitative research paradigm using the critical case approach. A critical case is a close approximation of an ideal case profile typified by the statement “if it won’t work here, it won’t work anywhere” (Patton, 1987). All four selected schools met the criteria for critical cases.

Data collection stretched over 26 months. The teachers were observed in the training milieu from June 1999 and followed back to schools till August 2001. Multiple research techniques such as a review of related literature, observations, interviews and ‘shadowing’ were used to gather data which was triangulated via member checks, peer reviews, verbatim accounts and thick description.

The study used the Stages of Concerns Questionnaire (SoCQ) of the Concerns Based Adoption Model (CBAM) to identify the primary concerns of teachers confronted with the innovation. The number of adopters was found to have doubled over the research time frame. The Levels of Use (LoU) protocol of the CBAM also identified an upwards shift in the teachers’ levels of technology use although many of them encountered difficulty progressing beyond LoU3 to higher levels of use.
The study also identified factors at policy, institutional, teacher and client levels which affected the technology adoption-diffusion process. The voices of teachers, students and principals were tapped to provide ‘bottom-up’ feedback regarding the problems they encountered.

Systemic factors, the teacher factor and mediating influences were found to have affected the teachers’ responses to technology-integrated instruction. Although systemic factors explained differences in the teachers’ responses to technology in different physical and technological settings, the teacher factor was better able to account for variations among teachers within the same setting. The teacher factor comprises mental belief systems, risk tolerance levels, teaching goals and technological quotients. All these factors were put together into a theoretical model referred to as the Systems-Mediators-and-Teacher (SmaT) model to explain teachers’ acceptance and use of technology in schools.

The study also crystallised the notion of optimal uses of technology by identifying four characteristics of such benchmark practices – the technology should encourage borderless learning, nurture creative and higher order thinking skills, enhance collaborative structures and emotionally satisfy and empower technology users.

Finally, the 14 Weeks In-Service Training Programme for Teachers of Smart Schools was evaluated based on Carney’s (1998) staff development model and Russell’s (1995) Stages of Technology Competencies, and found to have met the criteria for effective technology-based training. It is hoped that the study will provide formative feedback regarding the implementation of the smart school initiative as well as guidelines to teachers about to embrace technology-integrated instruction.
ABSTRAK


Kaedah penyelidikan ialah kaedah kualitatif berasaskan etnografi. Sekolah-sekolah untuk kajian dipilih berdasarkan prinsip ‘kes kritikal’ (Patton, 1987) dengan andaian bahawa jika inovasi tidak berjaya di sekolah yang mempunyai suasana yang unggul bagi inovasi itu, maka ia tidak akan berjaya di mana-mana sekolah lain. Oleh itu sekolah-sekolah terpilih mempunyai ciri-ciri yang menggalakkan kejayaan inovasi yang diingini.


Alat penyelidekan Stages of Concern (SoC) dalam model Concerns-Based Adoption Model (CBAM) digunakan untuk meninjau keprihatinan para guru terhadap inovasi ini. Dapatkan kajian ialah bilangan guru yang telah mula mengamalkan pengajaran-pembelajaran berintegrasi teknologi telah meningkat dalam tempoh masa kajian. Tahap penggunaan teknologi di kalangan guru ditinjau melalui alat Levels of Use (LoU). Dapatkan kajian ialah tahap penggunaan teknologi telah meningkat walaupun masih ramai yang menghadapi masalah mecapai tahap yang lebih tinggi daripada LoU3.
Faktor-faktor di peringkat dasar, institusi, guru dan pelajar dikenalpasti sebagai faktor yang mempengaruhi takat sebaran inovasi ini. Masalah-masalah yang dihadapi oleh pengetua sekolah, para guru dan pelajar dihuraikan secara terperinci.

Walaupun faktor persekitaran atau sistem dapat menerangkan perbezaan dalam tindak balas guru terhadap inovasi ini di sekolah-sekolah yang berbeza dari segi kemudahan fisikai dan teknologi, hanya faktor guru dapat menjelaskan perbezaan dalam respon guru di sekolah yang sama. Faktor guru ini terdiri daripada gugusan kepercayaan mental, pengamatan risiko, matlamat mengajar dan wawasan teknologi. Semua faktor ini digabungkan dalam sebuah model baru yang digelari model Systems-Mediators-and-Teacher (SmaT).

Kajian ini cuba menjelaskan apakah yang dimaksudkan dengan istilah ‘amalan pengajaran-pembelajaran berintegrasi komputer yang baik’. Empat syarat dicadangkan sebagai petanda amalan berkenaan, iaitu, ia harus menggalakkan pengajaran-pembelajaran tanpa sempadan, mengasaskan pemikiran kreatif dan kritis, memperatkan hubungan sosial dan kerjasama di bilik darjah, serta menyemai perasaan jaya diri dan puas hati di kalangan pelajar.

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CHAPTER 1

Introduction

As Malaysia prepares to take up the challenges of the new millennium under the visionary leadership of her distinguished premier Dato Seri Dr Mahathir Mohammad, her aspiration to become a developed nation and to transform into an information society looks set to become a reality. In much the same way that mechanical technologies had precipitated the industrial revolution at the turn of the 20th Century, so too are advances in electronic technology spearheading changes in Malaysia and recent technological milestones suggest that she is poised to assume a more dominant role in the ASEAN region in the near future.

Perhaps the greatest testimony to Malaysia’s commitment to technology is the setting up of the Multimedia Super Corridor (MSC). Seven flagship applications, scheduled to attract a critical mass of world-class companies to the region, have already been targeted for rapid development and are hailed as the catalysts to leapfrog the country to developed nation status by the year 2020. However, these projects can only succeed if the nation is backed by a productivity-driven, globally-competitive and technology-literate workforce. Fundamentally, this calls for groundbreaking changes and a transformation in the education system. The vehicle earmarked to bring about this transformation – and the central focus of this research study – is the Smart School Project.
The Malaysian smart school project

The Malaysian smart school project was launched to address the nation’s need for technology literate workers who can effectively participate in the global economy and handle the challenges of the Information Age. There is no denying that the workplace of the future needs technology competent workers. It is to the credit of the Malaysian government that she has been quick to capitalize on the MSC to jumpstart deployment of technology to schools by creating a nucleus group of 90 pilot smart schools in 1999 to spearhead the nationwide roll out of the smart school project, scheduled for 2010 when, according to the Malaysian smart school conceptual blueprint (Smart School Project Team, 1997a), approximately 10,000 schools will become smart schools.

The move to bring the local education system more in line with the demands of an increasingly techno-savvy society can be traced back to 1996 when the Ministry of Education (MOE) found itself involved in intense discussions about smart schools. However, it was only after the project was made a flagship application and formally documented that a project team comprising industry representatives and education officers came up with the Malaysian smart school conceptual blueprint (Smart School Project Team, 1997a) and identified 90 schools – including nine new, high-tech schools – as pilot smart schools.

Implementation of the smart school project was adversely affected by the economic downturn of the late 1990s. However, even at the height of the crisis in mid-1998 when the Malaysian ringgit fell by 34%, share prices by 61% and market capitalization by 64%, the project was not shelved (Call for unlimited cooperation among
Asia Pacific Economies, September 2, 1998). Instead, an interim project was set up and
the Finance Ministry continued to give it top priority, even approving an allocation of
RM17.5 million for computers in schools for the year 1999 (RM17.5 million boost for
computer education, August 28, 1998). Training of teachers, based on the cascade model
in which master trainers trained other teachers and rapidly propagated the knowledge to
others in the ranks, continued.

The focus of this study is to look at the products of the training program –
namely, the teachers – to see if they are able to use their newly-acquired information and
communication technology (ICT) skills in the classrooms. Since the ultimate target of the
technology implementation initiative involves 450,000 teachers and 5.8 million students
(Malaysia, MOE, July 1997), a formative assessment – formative as the project is still
ongoing – of how teachers actually cope with the technology in schools should provide
interesting and illuminative baseline data. Feedback of this nature will cast light on the
effectiveness of training hitherto conducted as well as yield insight into problems
encountered and give hints as to what should come next in the training agenda. As such,
it is felt that this study is both timely and necessary.

In a nutshell, this study aims to look at the adoption, diffusion and use of
computer technology in selected pilot smart schools, using the perceptions and
experiences of teachers who have undergone the 14 Weeks In-Service Training Program
for Teachers of Smart Schools as a platform to provide snapshots of the technology
adoption process, in cognizance of the fact that these teachers are critical change agents
for technology adoption in schools.
Before we proceed to enter the small world of these teachers, however, let us first briefly review the historical perspective of the computer technology scenario in schools prior to the inception of the Malaysian smart school project and then examine the structure and content of the *14 Weeks In-Service Training Program for Teachers of Smart Schools* as both these constitute the backdrop and setting of the study.

The computer technology scenario in Malaysian schools

Computer use in Malaysian schools can be traced back to 1981 with the setting up of the first computer club at La Salle Secondary School in Petaling Jaya (Zuraidah, 1998). Since then, the number of school computer clubs has increased by leaps and bounds. However, computer education in the mainstream curriculum was only introduced in April 1986 with the launching of the Computer Literacy Pilot Project (CLPP). Under the auspices of this project, 20 schools were each presented with five personal computers, application software and a printer as well as given an introductory course to computers (Zuraidah, 1998). Unfortunately, this project was discontinued after a year’s trial due to funding problems.

In December 1986, a joint committee comprising members from MOE and the Malaysian Institute of Microelectronic System (MIMOS) was set up to work out details for a comprehensive information technology (IT) programme in schools. The outcome was the Computers-In-Education (CIE) policy launched in 1989 which advocated computer integration across the curriculum (Gan, 1997). Soon after this, a Computer-Integrated Learning System (CoMIL) incorporating computer-assisted instruction and the automation of administrative work was adopted for the first time by undergraduates of
two faculties at *Universiti Putra Malaysia* (Zoraini, 1991). This has since been developed further.

In 1992, a second CIE project was launched. Sixty secondary schools throughout Malaysia were each given 21 networked computers and provided with training on how to use CoMIL as an authoring tool by the Computer Technology Lab division of the MOE (Zuraidah, 1998). In 1994, a pilot project involving computer-assisted instruction with secondary school students (Forms 1–2) in 15 primary schools in Selangor was launched (Malaysia, MOE, 1997b). Students in technical schools were taught computer programming. At the same time, compulsory computer courses were introduced in teacher training colleges (Zuraidah, 1998). The ‘Education Network’ or *Jaringan Pendidikan* connecting 50 secondary schools to the Internet also made its debut.

The year 1996 also saw the launching of resource centers set up under the *Pusat Sumber Ilmu* (PSI) project, allowing students in selected schools to access information via CD-Rom or the Internet and the *Rangkaian Munsyi* project which facilitated speedy information retrieval and resource sharing via LAN and WAN (Chong, 1999).

The use of IT in Malaysian schools advanced even more rapidly after this. Although the MOE was involved in intense discussions on smart schools as early as 1996, it was only after Smart Schools were instituted as a flagship application and conceptually documented in 1997 that the training of master trainers started in earnest. The Form Six Computer Programme was also started with 12 schools in 1997 (Smart School Project Team, 1997b). The technology implementation initiative was given a further boost when information technology became an examination subject in the open certificate system at *Sijil Pelajaran Malaysia* (SPM) level in the year 2000.
The 14 Weeks In-Service Training Programme for Teachers of Smart Schools

Programme objectives. In 1998, the Teacher Education Division of MOE started training teachers to spearhead the introduction of technology-integrated instruction in the pilot smart schools. The first cohort of 210 teachers were trained in June 1998 in 12 teacher training colleges throughout Malaysia. The specific objectives of the course as spelt out in the curriculum guidelines (Teacher Education Division, 1998a) were four-fold – to produce a learning package based on the smart curriculum, to facilitate and manage child-centered learning through innovative and creative strategies, to apply and integrate the use of technology (multimedia, internet and digital communications) into classroom instruction and finally, to manage multimedia classrooms.

Programme schedule. The 14 Weeks In-Service Training Program for Teachers of Smart Schools is a full-time in-service program comprising 10 weeks’ interaction in the selected teacher’s training college and 4 weeks’ practical teaching in schools. The maiden training programme comprised two intakes in 1998, one for teachers of Bahasa Malaysia and Science (June) and another for teachers of English and Mathematics (September).

Programme structure & content. Training methodologies included lectures, workshops and reflective discussions. The training programme culminated in the preparation of self-developed learning packages integrating the new core skills of thinking, learning, evaluation and technology which were then tested at a simulation session before the teachers started their practical stint in schools. Essentially, course content covered four major areas as represented in Table 1 on the following page.
### Table 1: Structure and content of the training programme (1998)

<table>
<thead>
<tr>
<th>Course Component</th>
<th>Content Component</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASIC 41.6%</td>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>(126 hours)</td>
<td>- Concept of Smart Schools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Management of Change</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>B. Generic Skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Evaluation Skills</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>- Critical and Creative</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>- Thinking Skills (CCTS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Information Technology Skills</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>- Learning Skills</td>
<td>10</td>
</tr>
<tr>
<td>PEDAGOGY 58.6%</td>
<td>C. Organization of Learning</td>
<td></td>
</tr>
<tr>
<td>(178 hours)</td>
<td>- Specifications of Smart School Curriculum</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>- Management of Smart Learning</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>D. Smart Learning Practices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Learning package</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>- Simulation</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>E. Practicum</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>104</td>
</tr>
<tr>
<td></td>
<td></td>
<td>304</td>
</tr>
</tbody>
</table>

* Sub skills / components in the smart school training curriculum

As shown in Table 1, the first content area touched on the conceptual aspects of
the smart school vision and change management. The second content area focused on the
four generic skills of evaluation (20 hours), critical and creative thinking (20 hours),
learning (10 hours) and information technology (60 hours). The third content area
outlined the new curriculum specifics for Science, Bahasa Malaysia, English and
Mathematics as well as imparted strategies for managing smart learning in technology-
based classrooms. And finally, the last content area required teachers to develop an
integrated learning package for their respective subjects.

Assessment of training outcomes was developmental, that is, portfolio-based as
the teacher participants signed learning contracts listing tasks to be completed and
deadlines for submission, and then worked at their own pace. They were allowed to touch
up on assignments in order to improve grades if they wished to do so.

Statement of the problem

Theoretically, the Malaysian Smart School Project is set to usher in radical,
groundbreaking changes in both the curriculum and teaching-learning processes as well
as in the administration and management systems of schools. However, in reality, much
depends on the commitment of those involved in the implementation of the innovation at
group-roots level. Although MOE is the architect and driver of the Smart School Project,
its success in the undertaking is dependent on a whole kaleidoscope of factors. Research
findings suggest that the availability of computers in schools does not always result in
meaningful use of the technology (Means and Olson, 1994; Schwarz 1996; and the US
Congress, 1995). Consequently, the issue of what teachers actually do with technology
in classrooms after being trained to handle the technology is of great interest to all
stakeholders in education, especially teacher trainers.

This research study attempts to shed light on the issue by looking at what happens
in four technologically-enriched, pilot smart schools in the Klang Valley. It uses the
Concerns-Based Adoption Model (CBAM) to provide snapshots of the teachers’ primary
concerns as they wrestled with the innovation in the classroom. By tapping into and
charting the teachers’ shift in concerns and levels of technology use over a longitudinal
time frame, it is hoped that insight will be gleaned regarding the factors which impacted
upon the technology adoption-diffusion process in schools, the problems encountered and
the patterns of technology use practised.

In short, this study investigates the pilot implementation of technology-integrated
instruction in selected schools by tapping into the experiences of teachers directly
involved in the innovation in the hope that they will offer lessons to be learnt by others
waiting in line. This is in keeping with the philosophy that the best way to learn to build
a house is by “…observing the builders, the building processes and also the finished
structure” (Kanter, 1988).

**Rationale for the study**

The rationale for this study is as follows.

Firstly, as computer skills are deemed essential for the work place of the 21st
Century and schools are traditionally expected to prepare students for the work force later
in life, it follows that schools constitute one of the best places to start imparting computer
skills to the younger generation and that teachers should therefore, be able to use the
technology in meaningful ways. Most research studies however, readily acknowledge that availability of technology plays a secondary role to human ware in technology implementation initiatives (Gan, 1996; Stoddart & Neiderhauser, 1993). In fact, Druin & Solomon (1996) advised that any technology program was “...only as good as the teacher facilitating it” while Collis, Knezek, Lai, Miyashita, Pelgrum, Plomp & Sakamoto (1996) described teachers as the gatekeepers to the diffusion of educational innovations. Thus, there seems to be a strong case for research into teachers’ responses to the introduction of technology use in schools so that baseline data is obtained to assist other schools undergoing similar transformation processes.

Secondly, the study aims to give a realistic description of teachers’ experiences with the technology in the pilot smart schools. In doing this, a formative assessment of the technology adoption-diffusion process in the case study schools is actually being conducted and an evaluation of the training programme to prepare teachers to teach with technology implicitly carried out. Given the present trend to urge teachers onto the IT bandwagon, research in this area would certainly not be amiss as research findings would provide stakeholders in education with a pulse on the innovation and yield much-needed feedback on the progress of the technology implementation initiative. The research findings may even help in-service training coordinators identify weaknesses and pinpoint new directions in technology-based training.

Thirdly, as substantial investments have already been pumped into the pilot smart schools, the study can be regarded as an informal watchdog of public funds. To date, RM5 million has been spent on training 1780 master trainers and another RM12 million on equipping teacher training colleges with multimedia computer laboratories (New
Straits Times, February 4, 1997 in Chong, 1999). The Government is also paying
Telekom Smart School Sdn Bhd for its leading-edge expertise in Project Management
and Implementation, Business Process Reengineering, and Change Management. The
cost of the Smart School Project through this cooperation is three hundred million
Ringgit Malaysia (RM300,000,000), with RM183,573,737 for capital expenditure and
RM116,426,263 for operating expenditure (Ong, 2001). With such heavy capital
investment, it is only good economic sense that efforts be made to monitor the progress
of the project so as to provide some sort of accountability to stakeholders in education.

And finally, as the Smart School project is a flagship of the MSC, it is under
intense scrutiny from within and outside the country. It would be a shame if the project
failed due to the lack of monitoring measures and appropriate support systems. Doubts
have been raised as to the practicality of implementing such a massive project in
uncertain economic times. However, pitted against this caution is the feeling that it is
unwise to allow schools to lag too far behind changes in the workplace—"the most
dangerous experiment we can conduct with our children is to keep schooling them the
same at a time when every other aspect of our society is dramatically changing"
(President’s Committee of Science and Technology, 1997). Thus, there are mixed
feelings regarding the project but those in authority are pressing ahead. However, the
implementation of the technology implementation initiative will be staggered to offset
financial constraints. This makes this study even more timely and necessary as it will
provide diagnostic and prescriptive cues to schools at different stages of the technology
implementation initiative. Ultimately, this will ensure that sufficient checks and balances
are put in place to help the project stay on track.
Objectives of the study

Basically, this study aims to look at the adoption and diffusion of technology-integrated instruction in four pilot smart schools. Its objectives are as follows:

1. To examine teachers' concerns regarding the implementation of technology-integrated instruction in the case study schools.

2. To determine the factors that promote or inhibit the adoption of technology in schools and to come up with a model to explain why teachers respond differently to the technology.

3. To identify benchmark practices or optimal uses of computer technology-integrated instruction.

4. To propose solutions to the problems encountered and to suggest guidelines for future training initiatives.

Research questions

In order to achieve the objectives listed above, several questions were asked to provide a focus and framework for exploring teachers' perceptions regarding the adoption and diffusion of technology-integrated instruction. These research questions (and sub-questions) are summarized as follows:

1. Have the teachers who underwent the 14 Weeks In-Service Training Program for Teachers of Smart Schools adopted technology-integrated instruction in the school milieu?

2. What were their primary concerns related to the adoption of such instruction?
3. What levels of technology use did they attain?
4. What factors promoted / impeded the use of computer technology for instruction?
5. What were the perceived problems?
6. Given the same technological training and physical infrastructure, what caused
   variations among teachers in their responses towards technology-integrated
   instruction?
7. What were the teachers' patterns of practice with the technology in schools? What
   uses of technology did they find most useful and effective?
8. How did the students perceive the use of computer technology for instruction?
9. What were some of the optimal uses / best practices of technology-integrated
   instruction?
10. How effective was the 14 Weeks In-Service Training Program for Teachers of Smart
    Schools in preparing teachers to implement technology-integrated instruction? What
    are the implications for future training initiatives?

Significance of the study

As the Smart School project ultimately involves all the 10,000 schools in the
country, it is expected to have far-reaching impact. Thus, the publication of what appears
to be working, or not working, in the pilot smart schools provides baseline information
which is significant for several reasons.

Firstly, by outlining the experiences of schools ahead in the IT implementation
initiative, the study provides other schools with a technology road map about potential
pitfalls and potholes to avoid in the long trek towards adopting technology-integrated instruction.

Secondly, the study provides an avenue for teachers to share experiences and pool resources. Teachers on the brink of adopting an innovation need guidance and support and the presence of a researcher linking teachers working towards a common goal will, hopefully, help forge a sense of collegiality and a feeling of *esprit de corps* among those involved in the Smart School project.

Thirdly, this study constitutes both an insider’s account, and a formative assessment, of the technology implementation initiative, right from the first day of implementation. If the technology initiative aspires to create knowledge workers to leapfrog the nation to developed nation status, it is important to learn – early – how things stand in the technology initiative so that appropriate decisions might be quickly made regarding future channelling of financial and human resources.

A further significance of this study is that it generates ‘bottom-up’ rather than ‘top-down’ feedback on the pilot project. There is certainly merit in actually going back to school to touch base and see what goes on there if one wishes to find out how an innovation impacts upon schools. As Eisner (1991) put it:

The qualitative study of *particular* classroom and *particular* teachers in *particular* schools make it possible to provide feedback to teachers that is fundamentally different from the kind of information that they are given in in-service education programmes or through journal publications... (p. 11)
And finally, this study is significant as it allows for a situational analysis of a very current educational phenomena sweeping across schools throughout the world – the integration of technology into classroom instruction. In a way, this study actually documents the ‘birth pangs’ of implementing technology-integrated instruction. In adoption and diffusion research, capturing the birth process is sometimes more rewarding than researching outcomes or products as it is the rich, detailed descriptions of the process which capture the complexity of what happens to teachers and students faced with the innovation. The fact that the innovation is examined through the eyes of the teachers rather than focused on the technology or the learner – as is the trend of most similarly related research (Brovey, 1994; Cuban, 1984) – means that this study is actually documenting another dimension of slices of reality.

Limitations of the study

However, this study has several limitations. Firstly, the study focuses only on what individual teachers do in schools after attending a technology-based training program. As such, it is entirely school-based and deals with teachers’ concerns and uses of technology at school level only. It does not attempt to evaluate the other components of the Smart School Project such as curriculum development, management solutions and changes in evaluation systems. Neither does this study concern itself with education policies at ministerial level.

Secondly, the exploratory phase of this study started with observations of teacher participants in the training milieu as they underwent the 14 Weeks’ In-Service Training Programme for Teachers of Smart Schools. However, due to manpower constraints,
observations during this phase of field work were confined mainly to one teacher training college in the Klang Valley. Data was triangulated with sporadic observations made at another college ranked lower on a specially-devised rating scale (please refer to Chapter 3 for details) but the limited number of training milieu observed means that evaluation of the training programme was holistic and the findings thus not fully generalisable.

Similarly, financial and manpower constraints also restricted the number of schools observed to four in the Klang Valley. However, to minimize the impact of this limitation, a critical case strategy approach (Patton, 1987) was adopted. This is explained in greater detail in the chapter on methodology.

The same constraints also restricted the number of teachers who could be ‘shadowed’. Consequently, the Stages of Concerns Questionnaire (SoCQ) was used to identify the teachers’ composite concerns profiles and to select teachers for ‘shadowing’. It is hoped that the inclusion of those with different composite concerns profiles will capture a wider spectrum of teachers at different stages of adoption in the case study schools and hence, increase the chances of the reader observing recurring features in future.

A fourth limitation of the study was the research time frame. Time constraints made it impossible for the researcher to conduct observations over the preferred longitudinal time frame of at least two to three years that adoption and diffusion studies usually benefit from. However, attempts were made to meet Wolcott’s (1973) recommendation of at least “one full cycle” of observations – translated as one academic year in this study.
Two other limitations need to be mentioned. One concerns the reliability of the study. In qualitative research, the researcher is the main research instrument. As such, the biases and weaknesses of the researcher are sometimes imbedded in the study, especially towards the later stages when researcher fatigue sets in. To minimize this limitation, attempts were made to triangulate all data via “member checks” (Stake, 1975b), thick descriptions and verbatim accounts as much as possible.

The other limitation is the “anthropological strangeness” highlighted by Robinson (1974) – the suggestion that qualitative researchers, especially ethnographers, should research worlds ‘new’ to them so that they are more sensitive to happenings in the field setting. As a teacher trainer, I am hardly new to the setting being researched. However, as I have not taught in schools for the past 15 years – and never in a smart school at that – I believe there is still sufficient strangeness in the setting for me to engage in the study with a certain degree of “official neutrality” (Robinson, 1974). In fact, I take comfort in the fact that being a teacher trainer gives me an advantage in this study as it means I speak the language of the people in the research setting and am thus better able to develop rapport and to exchange meaningful information with them (Wolcott, 1973).

Definition of terms

The following is a list of terms, in alphabetical order, used throughout the study.

Adopters / adopting teachers

Teachers who have adopted technology-integrated instruction as indicated by the presence of peak Stage 3 (or higher) concerns in the SoCQ of the CBAM.
Bestari

A word in Bahasa Malaysia meaning ‘smart’ as in the context of smart schools.

Concerns

Composite representation of the feelings, preoccupations, thoughts and considerations given to a particular task or issue. It is an aroused state of personal feelings and thoughts about a demand (Hall & Hord, 1987).

Concerns-based adoption model CBAM)

A model of change developed by Hall, Wallace & Dossett (1973) which posits that a predictable, measurable statement of concerns will emerge that reflects the extent to which individuals are using or not using an innovation.

Innovation

In this study, the innovation referred to is technology-integrated instruction or the integration of information and communication technologies into the teaching and learning of curricular subjects.

Instruction

Smart schools

The 90 schools in the pioneer phase of the Malaysian Smart School Project launched in 1999. A smart school is a “learning institution that has been systematically reinvented in terms of teaching-learning practices and school management in order to prepare children for the Information Age” (Smart School Project Team, 1997a).

Smart school flagship application

A network of schools and companies using multimedia technology to develop a thoughtful school culture by transforming educational practices and developing worldwide linkages (Smart School Project Team, 1997a).

Smart school teachers

Teachers who have undergone the *14 Weeks In-Service Training Program for Teachers of Smart Schools*.

Stages of concern questionnaire (SoCQ)

A 35-item questionnaire developed by Hall et al. (1973) to measure the concerns of individuals involved in an innovation. Extensively used and validated.

Technology

In this study, ‘technology’, ‘information technology’ (IT), ‘computer technology / technologies in instruction’ and ‘technology-integrated instruction’ are used interchangeably to refer to new information and communication technologies.
<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>TEXT IN FULL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACOT</td>
<td>Apple Classrooms of Tomorrow</td>
</tr>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>CoMIL</td>
<td>Computers Integrated Learning System</td>
</tr>
<tr>
<td>CBAM</td>
<td>Concerns-Based Adoption Model</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disc</td>
</tr>
<tr>
<td>CIE</td>
<td>Computers in Education</td>
</tr>
<tr>
<td>CIPP</td>
<td>Context-Input-Process-Product</td>
</tr>
<tr>
<td>CLPP</td>
<td>Computer Literacy Pilot Project</td>
</tr>
<tr>
<td>COINS</td>
<td>Corporate Information Superhighway</td>
</tr>
<tr>
<td>CRFPs</td>
<td>Concept Requests For Proposals</td>
</tr>
<tr>
<td>DOI</td>
<td>Diffusion of innovation</td>
</tr>
<tr>
<td>G</td>
<td>Gemilang (name of a case study school)</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and communication technology</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>JARING</td>
<td>Joint Advanced Research Integrated Networking</td>
</tr>
<tr>
<td>LoU</td>
<td>Levels of Use</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<td>---------</td>
<td>-------------</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCD</td>
<td>Laser Crystal Display</td>
</tr>
<tr>
<td>LCS</td>
<td>Loosely Coupled System</td>
</tr>
<tr>
<td>MCA</td>
<td>Malaysian Chinese Association</td>
</tr>
<tr>
<td>MIMOS</td>
<td>Malaysian Institute of Microelectronic Systems</td>
</tr>
<tr>
<td>MOE</td>
<td>Ministry of Education</td>
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<tr>
<td>MSC</td>
<td>Multimedia Super Corridor</td>
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<tr>
<td>OD</td>
<td>Organisational development</td>
</tr>
<tr>
<td>OHP</td>
<td>Overhead Projector</td>
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<tr>
<td>PSI</td>
<td><em>Pasat Sumber Ilmu</em> (Knowledge Resource Center)</td>
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<td>Rajawali (name of a case study school)</td>
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<td>R &amp; D</td>
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<td>R, D &amp; D</td>
<td>Research, Development &amp; Diffusion</td>
</tr>
<tr>
<td>SoCQ</td>
<td>Stages of Concern Questionnaire</td>
</tr>
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<td>Sendayan (name of a case study school)</td>
</tr>
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<td>T</td>
<td>Temasik (name of a case study school)</td>
</tr>
<tr>
<td>TED</td>
<td>Teacher Education Division</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web</td>
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### INDICES

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<th>INDICES</th>
<th>EXPLANATION</th>
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<td>&quot;...&quot;</td>
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CHAPTER 2

Review of related literature

A prologue

It is not usual to start the literature review of a dissertation by referring to the opening scenes of a movie. However, I will borrow this analogy from Hueth (1998) as I find it both relevant and compelling, and thus worthy of reflection. Witness the following two scenes from the film *Modern Times*.

Scene 1 showcases the title – ‘*Modern Times*, a story of industry, of individual enterprise, of humanity crusading in the pursuit of happiness’.

The camera pans herds of sheep on a runway before zooming in to focus on a factory with lines of men hurrying towards it. We are quickly whisked into the factory where a vista of glistening turbines, shiny gauges, dials and Jules Verne-like technology greet us. Quite clearly, efficiency and productivity are the gods reverently worshipped here.

Then, the star of the movie – the Tramp – appears.

The Tramp is an unassuming and simple man whose job is to tighten the bolts on a conveyor belt. Although his workplace is the epitome of technological sophistication, it is quite apparent by his demeanour and childlike awe that the Tramp is but a common man who has been propelled into the high-tech world only because he happens to be in a particular place at a particular time. He looks lost. Clearly, he has to pull up his socks if he wishes to survive in a workplace where technology and efficiency rule supreme.
Scene 2 takes us forward in time.

The apoplectic face of the company president flashes across the screen. He appears mad at something or someone. He gestures wildly, signalling for the conveyor belt to be speeded up. The foreman complies — he has no choice really — and turns a dial, and soon, the sound of machines speeding up is heard.

Further down the conveyor line, the Tramp tries frantically to increase his pace of work. He grabs at the bolts as they race past him on the conveyor belt, struggling to tighten them before they move on but often failing to do so. His co-workers urge him to hurry up. As the tempo increases, he misses more and more bolts. Then suddenly, he spots an errant bolt and dives after it. No points for guessing what happens next!

The poor Tramp is caught between the meshes of the machine and disappears down the shoot. His co-workers make a grab for him but miss. Then, we see the Tramp INSIDE the machine, entangled with the gears and sprockets. The poor man has been swallowed by the technology he is supposed to work with!

The scenes from the movie described above are certainly reminiscent of what is happening in many schools today. Teachers would have little problem identifying with the Tramp as they too are experiencing what he was facing — the invasion of technology into the workplace that is gradually transforming education and how its work is accomplished. And like the Tramp, they have to try and survive.

Scene 2 is particularly evocative of the local educational sector. The president makes decisions and the foreman issues directives accordingly. However, it is the Tramp (alias the teacher) who has to actually come to grips with the technology. In the process, interesting questions come to mind. Why does the Tramp try so valiantly to please the
powers that be and work with a technology he is clearly not cut out for? And why should the factory, in the first place, wish to implement a technology that its workers find so difficult to handle? More importantly now, will the technology get adopted and, if so, how and why?

These are the very questions that schools are grappling with today. There have been so many changes on the educational technology front in recent years – with familiar gadgets like film projectors, slides and overheads making way for sophisticated computer-based technologies such as the Internet, CD-ROM, digital video, email and online conferencing – that it is hardly surprising many teachers feel overwhelmed by the changes. This problem is also compounded by the fact that, just like the Tramp’s factory, schools are dynamic systems with structures, processes, controls and cultures which are exceedingly vulnerable to internal and external forces of change. Consequently, they need to respond and to adjust. Herein lies the need for this study.

**Introduction to literature review**

As this study is concerned with the adoption, diffusion and use of computer technology in instruction, the literature review is divided into two sections. The first part looks at the technology adoption-diffusion process by examining the school system which constitutes the template on which the innovation attempts to take hold, reviewing some of the commonly accepted models of organizational change and exploring the kaleidoscope of factors impacting upon the technology adoption-diffusion process. The second part highlights some of the teachers’ patterns of practice with the technology in the school milieu.
The technology adoption-diffusion process

Template for change: The school system

In order to fully understand the intricacies of technology adoption and diffusion, it is necessary to examine the template on which the adoption process is played out, in this case, the school system. Many researchers contend that school systems are best viewed via a systemic perspective as schools essentially comprise interconnected systems and subsystems, with decisions made in one part affecting other parts (Hueth, 1998; Senge, 1990; Washington, 1993). Take the Modern Times scene in the prologue as an example. Although the assembly line workers were far removed from the company president, they were nonetheless affected by decisions from his office. Ultimately, it was the president’s command to speed up the conveyor belt that caused the plant to be shut down.

In a way, systems thinking facilitates deeper understanding of the school system as it enables us to climb to vantage points from which the entire system may be viewed and alternative methods for restructuring elements and relationships towards greater productivity and efficiency may be explored, just like in business systems (Salisbury, 1996). However, there are fundamental differences between school systems and business organization systems.

Weick (1976) described school systems as “loosely-coupled systems” (LCS) because of the tacit but impermanent link connecting the sub-systems which interact and support each other while retaining respective identities, as epitomized by different departments within the school which remain separate and independent despite being connected.
Senge (1990) also highlighted the relevance of systemic thinking in understanding educational change when he pointed out that human endeavour is bound by invisible fabrics of inter-related actions which sometimes take years to play out their effects on each other.

Eisner (1991) further supported the relevance of systemic thinking in understanding educational innovation and change when he said that schools were a “mix of interacting factors (where) what teachers do is influenced by their location within the system…” (p. 2).

There is limited literature on loosely-coupled systems and organizational change with regards to the use of computer technology in schools. Telem’s (1995-96) study looked at management information systems in a high school. Washington (1993) studied the implementation of a technological innovation in an Indiana public school system and discovered that its failure was due to the fact that the original design and intent had been changed by adopters. Hueth’s (1998) study of technology use in a Midwest college emphasized the relevance of LCS theory in understanding technological adoption.

However, despite the limited number of studies using LCS as a theoretical framework to examine computer technological innovations, the systemic perspective is deemed relevant to this particular research study because the schools observed were independent systems nestled within the larger MOE system.

Consequently, all decisions made had to consider the needs of the immediate school system as well as satisfy the requirements of the larger, all-encompassing MOE system. Similarly, measures to promote technology adoption had to bear in mind that schools comprised structures, processes, controls and cultural subsystems which were separate, yet connected in various ways, to varying degrees.
The innovation

Based on Rogers’ (1995) definition of an innovation as “an idea, practice or object that is perceived as new... whether or not (the) idea is objectively new as measured by the lapse of time since its first use or discovery” (p. 11), technology-integrated instruction is definitely an innovation in Malaysia despite its having been adopted for some time in schools in the developed world. In fact, such is the impact of the use of technology in schools that it has been touted as the learning revolution “unparalleled since the invention of the printing press” (Bork, 1980) and “the most important change in learning since the 16th Century” (White, 1987). There is little doubt that this innovation is set to usher in large scale changes and a look at global developments in education will only confirm this.

In the United States, ever since the 1983 publication of *A Nation At Risk* by the National Commission on Excellence in the United States sounded the call for the restructuring of education, there have been efforts to increase computer-based resources in schools. A survey which polled 1000 school teachers and other K-12 educators found that in the 1994-95 academic year alone, at least 85% of educators used computers, laser discs or CD-Rom, 16% used the Internet and 12% used other online computer services (Chiew, 1999). Technology-integrated instruction was given an added boost when in 1996, President Clinton announced four goals for American schools in the 21st Century – to make computers accessible to every student, to get classrooms connected, to provide educational software as an integral part of the curriculum, and to train teachers to teach with technology (Executive Office of the President, 1996).

In Singapore, the ‘Thinking Schools, Learning Nation’ vision and the ‘Master Plan for IT in Education’ launched in April 1997 aim to provide every Singaporean child with access
to an IT-rich school environment. A total of S$2 billion has been committed to this objective and the target is to have all schools fully networked by 2002, with students devoting 30% of their curriculum time accessing electronic resources and computers (Singapore Ministry of Education, 1998).

In Malaysia, the Smart School Project aims to prepare Malaysians for the IT age by teaching them IT skills via the tools of IT (Smart School Project Team, 1997a). While the Seventh Malaysia Plan saw the government allocating RM2.994 billion to primary and secondary education, including the building of nine prototype smart schools, the 1999-2000 period also saw 81 Government-initiated Smart Schools launched, albeit on a smaller scale than originally envisioned due to the economic downturn. This was complemented by the Malaysian Chinese Association’s (MCA) pledge of RM2.28 million to eventually upgrade all Chinese schools in its constituencies to smart schools (Indramalar, 1999).

Thus, it can be said that the call to embrace computer technology in schools is a global response to the need to pick up new skills to meet the challenges of the Information Age. However, this call will only yield results if people are prepared to accept change. For innovation is synonymous with change and the innovation of technology-integrated instruction is an instance of planned, organizational change. Consequently, it is necessary, in this literature review, to look at not only the innovation but also models of planned change in order to better understand the change process.

Models of organizational change

Five models of organizational change are reviewed here – the power-coercive model, the research, development and diffusion (R, D &D) model, Rogers’ diffusion-of-innovation
or social interaction model, the organizational development (OD) model and the concerns-based adoption model (CBAM). All five models have been used to explain the adoption of innovations and the implementation of change strategies in various settings.

The power-coercive model

Traditionally, change in education is regarded as a process of natural diffusion with the innovation spreading slowly but surely, if in an unplanned way, from teacher to teacher, school to school and district to district (Owens, 1992). However, contemporary management approaches prefer systemic models which aggressively plan for change. One such model which still enjoys widespread acceptance is the power-coercive model which advocates change through the direct exercise of power (Owens, 1992).

The best illustration of this model in action is when students are 'persuaded' to master a subject which has been made compulsory to pass in major examinations. Other instances of power-coercive change strategies include the red carrot incentives that school principals sometimes dangle in front of teachers to get them to accept change.

However, although this change strategy model has been found to be effective in business organizations (Kanter, 1988), it is less applicable to schools which are largely peopled by a non-voluntary clientele (Owens, 1992). Fullan, Miles and Taylor (1978) highlighted several attributes of schools which undermine the tenets of the power-coercive model – the diffused goals which make measurement difficult, the loosely-coupled systems which render stringent control impractical, the low technical capabilities and weak scientific base, the generally non-competitive environment and the nominal autonomy bounded by national constraints. These attributes often blur the lines of control and communication
between the change advocates (policy makers) and end-users (teachers) who work in self-contained classrooms with little fear of repercussions even if they reject an innovation.

Consequently, persuasion is probably a more potent factor than coercion for instigating change in schools. For instance, Brunner (1992) found that administrators who encouraged teachers to experiment with technology without fear of reprisals were far more successful in promoting technology adoption than administrators resorting to strong-arm tactics. Similarly, Ely (1990) discovered that teachers included in decision-making processes in schools were also more likely to adopt technology than those who were coerced.

To sum up, the power-coercive model enjoys only limited success in schools – and that only on a superficial ‘quick fix’ basis – because schools are composed of “loosely coupled components through which it is difficult to transmit precise orders and from which it is difficult to extract compliance” (Owens, 1992).

The research, development and diffusion (R, D & D) model

The R, D & D model regards the production of empirically tested and validated knowledge as the key to planned change in education. Emphasis is on research, development and the diffusion of the innovation, that is, making it readily available in attractive, easy-to-use formats. The rationale is that if an innovation is shown to be effective, it will be adopted by rational end-users.

Subsequent experience shows that this model does not always work in schools because teachers do not always respond as expected to the quality of the materials presented and the ideas underlying an innovation (Siti Hawa Ahmad, 1986). The classic illustration of the failure of this model is the rejection of the Biological Sciences curricula designed in the early 1960s and the Rand Study of 1975-78, which showed clearly that the success of an
innovation depended not only on its nature and the funding available but also on the characteristics of the organization and its management system (Horsley, 1990; Owens, 1992).

Another weakness of this model is its assumption that potential adopters are passive players in the adoption process. Hativa, Shapira and Navon (1990) found that far from being passive, teachers were extremely critical and evaluative when it came to adopting computer-assisted instructional material. Research also suggests that teachers' perceptions and mental beliefs in the efficacy of an innovation impacted upon adoption (Bear, Richards & Lancaster, 1987; Christensen, 1998; Dupagne & Krendl, 1992; Lawton & Gerschner, 1982; Sheingold and Hadley, 1990; Washington, 1990; Woodrow, 1992).

To sum up, the R, D & D model advocates that empirical verification of an innovation's effectiveness will guarantee its adoption by passive but rational end-users in the school setting. However, the historical inability of this model to produce lasting change coupled with research findings highlighting the importance of factors besides the nature of the innovation suggest that the major tenets of this model are not always valid.

The social interaction model

The third model of change is Rogers' (1995) social interaction model, also known as diffusion-of-innovation (DOI) model, which maintains that the crucial key in the diffusion process is interpersonal networks and social modeling. Rogers categorized potential adopters as either innovators who introduced ideas; early adopters or opinion leaders who disseminated information; the early majority who adopted before the innovation spread to other members; the late majority who adopted after the innovation has been declared safe, and laggards who only adopted after the adoption process had slowed to a crawl.
The strength of this model is that it not only looks at adopters' characteristics and the
decision-making process but also examines the pre-innovation stage by evaluating the
relative advantage, complexity and compatibility of the innovation. The assumption is that
adoption is more likely to take place when an innovation is perceived to be better than – and
easy to adapt to – current practices, when it can be easily tried out (trialability) and when the
results yielded are easily visible (observability). Research suggests empirical support for this
model. The study by Hativa, Shapira and Navon (1990) for instance, supported the relevance
of notions like trialability, compatibility and relative advantage. Ely (1990) also found that
teachers who were allowed to try out an innovation were also more likely to adopt it.

To sum up, Rogers’ model not only explains how and why individuals adopt
innovations but also addresses the issue of what happens to an innovation before and after it
has been adopted. However, the weakness of this model as it applies to schools is its heavy
reliance on interpersonal communication networks. As schools are loosely-coupled systems
where teachers often work in isolation in their “egg-crate” classrooms (Lortie, 1975), the
opportunities for developing interpersonal networks are sadly limited in schools.

The organizational development (OD) model

This model, which had its beginnings in business settings and was adapted for use in
schools only in the 1960s, relies heavily on the principle of organizational self-renewal as the
primary vehicle for change (Owens, 1992). It is based on the assumption that change is a
complex process involving various subsystems identified as task, structure, people and
technology systems in schools (Owens, 1992). In essence, this model sees schools as
comprising systems of people moving from task to task, collaborating with other sets of
individuals. The ultimate objective is to enhance effective functioning of all the subsystems so as to develop organizational adaptability.

Research suggests empirical support for this model. Ely's (1990) study, for instance, identified four subsystems as crucial to technology adoption – the *people* component, the *technology* component, the *structure* component (including time and opportunity to master software and hardware), and *task* considerations (visible leadership, school climate, etc).

Carstens (1995) injected elements of OD theory into his study of microcomputer implementation in a secondary school and discovered that teachers were primarily involved with primitive “first order” use of technology, advancing to sophisticated “second order” uses only when the organisation has developed appropriate systems to support such uses.

The advantage of the OD model is that it recognizes the extensive interaction of the four subsystems of tasks, technology, people and structure, and views schools as dynamic and holistic institutions. However, its weakness lies in the difficulty of finding empirical validation due to the innate complexity of the model (Maney, 1994).

**The concerns-based adoption model (CBAM)**

And finally, the last model of change to be discussed in this literature review is the Concerns-Based Adoption Model (CBAM) developed by Hall, Wallace & Dossett (1973) after more than 10 years of research. This model was developed at the Center for Research And Development in Teaching in the University of Texas at Austin to allow researchers to monitor the implementation of educational innovations. Several assumptions underscore the application of the CBAM to the technology initiative in schools.
Firstly, the CBAM emphasizes that change is a highly personal experience of which chances of success are affected by the teachers’ personal perceptions of the innovation, in this instance, technology-integrated instruction. Secondly, the CBAM posits that as change is not an event but a process which requires time to institute, teachers have to be prepared for the long-term nature of the change effort. Thirdly, the CBAM suggests that change is developmental, with identifiable stages through which individuals progress at different paces. Thus, the adoption process can be enhanced by providing appropriate assistance at each stage. Fourthly, the CBAM stipulates that as the focus of change is the individual, the impetus for change is greater if it comes from students and teachers rather than administrative mandates. And finally, the model recognizes that anyone can be a change facilitator.

The thrust of the CBAM is that teachers involved in the change process will experience related characteristic concerns, defined as “the composite representation of the feelings, preoccupations, thoughts and consideration given to a particular issue or task” (Hall & Hord, 1987, p. 58), as they are brought face-to-face with an innovation. These concerns are organised in clusters or stages as depicted in Figure 1 on the following page.

The presence of these stages of concerns means that composite profiles of teachers can be drawn to yield information about where they stand in relation to the innovation. For instance, teachers with peak Stage 0–2 scores are preoccupied with ‘self’ concerns and are primarily concerned about either finding out more about an innovation (peak Stage 1 or ‘information’ concerns) or about their ability to cope (peak Stage 2 or ‘personal’ concerns) with the demands of the innovation. This profile is typical of teachers on the verge of adoption.
<table>
<thead>
<tr>
<th>Cluster</th>
<th>Stage</th>
<th>Concern</th>
<th>Concern defined in behavioural form</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>Refocusing</td>
<td>Questions existing computer use and evaluates and modifies the innovation to make it more effective or consider alternative innovations.</td>
</tr>
<tr>
<td>Impact</td>
<td>5</td>
<td>Collaboration</td>
<td>The focus is on collaboration and cooperation with others regarding use of the innovation—computer user groups, support group meetings, team teaching, etc., are frequent.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Consequences</td>
<td>Attention focuses on the impact of computers in the classroom. The teacher is concerned if there will be positive outcomes if he adopts the innovation and notes successful practices.</td>
</tr>
<tr>
<td>Task</td>
<td>3</td>
<td>Management</td>
<td>Attention is focused on the processes and tasks of using the computer. The teacher is concerned with the nitty-gritty of how, when and where the innovation is to be implemented.</td>
</tr>
<tr>
<td>concerns</td>
<td></td>
<td>Personal</td>
<td>The teacher is uncertain about the demands of the computer and her ability to meet those demands—begins to question how the innovation will affect her personally.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Informational</td>
<td>A general awareness of computer integrated instruction. The teacher’s primary concern is learning more about the innovation, including what it is and what it can do.</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Awareness</td>
<td>The teacher has little awareness of the innovation and is not concerned about it. The person may express anti-computer feelings such as “I hope I retire before they make me use one”.</td>
</tr>
</tbody>
</table>

Figure 1: Stages of concerns in the concerns-based adoption model (CBAM)

(Hall, G. & Hord, S., 1987:60)
However, teachers with peak Stage 3 or ‘management’ concerns are considered adopters of the innovation as they are preoccupied with the nitty-gritty of actually managing it in the classroom. As the teachers become more experienced at the innovation, their peak concerns move to the higher stages or impact concerns (Hall & Hord, 1987).

Since a combination of concerns may be manifested at any one time (Hall, George & Rutherford, 1979; Hall & Griffin 1982), an analysis of the two highest stages of concerns provides illuminative data about the teachers’ feelings in respect of an innovation. It is generally accepted that developing the conditions that stimulate arousal of impact concerns takes a fairly long time – “…for most innovations and innovation bundles, it takes three to five years” (Hall & Hord, 1987).

The CBAM is adopted as the main theoretical framework for this study as it is deemed best able to capture the role of individuals in the adoption process. Furthermore, its tenet that management concerns are most intense during the first use of an innovation (Hall & Hord, 1987) enables adopters to be identified via peak Stage 3 concerns. Maney (1994) based his doctoral dissertation on this tenet, citing that “arousal of Stage 3 Management concerns indicates that an innovation has been adopted”. This criteria is also used in this research study to determine the extent of technology adoption in the four case study schools.

Besides the Stages of Concerns Questionnaire (SoCQ), the CBAM also contains the Levels of Use (LoU) protocol and the Innovations Configuration (IC). There are three levels of non-use (non-use, orientation, preparation) and five levels of use (mechanical, routine, refinement, collaboration and renewal) in the LoU protocol, as shown in Figure 2 on the following page. The IC focuses on the operational forms of the innovation as teachers tend to make adaptations to an innovation as they use it (Redman, 1989).
<table>
<thead>
<tr>
<th>Level</th>
<th>Level of use</th>
<th>Behavioural indices of level of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>Renewal</td>
<td>User reevaluates the quality of use, seeks modifications or alternatives, examines new developments in the field and explores new goals for self and the system</td>
</tr>
<tr>
<td>V</td>
<td>Integration</td>
<td>User combines own efforts with colleagues' efforts to improve impact on students</td>
</tr>
<tr>
<td>IVB</td>
<td>Refinement</td>
<td>User varies use to increase the impact on clients (experiments with software and lesson designs, develops materials with authoring systems and assists students in developing own material with the computer)</td>
</tr>
<tr>
<td>IVA</td>
<td>Routine</td>
<td>Use is stabilized; little thought to improving current uses</td>
</tr>
<tr>
<td>III</td>
<td>Mechanical</td>
<td>The user focuses most effort on the day-to-day use of computers with little time for reflection. Changes are made more to meet user needs than client needs. Disjointed and superficial use (with little modification to software packages)</td>
</tr>
<tr>
<td>II</td>
<td>Preparation</td>
<td>The user is preparing for the first use of computers. She has participated in preliminary instruction in its use and is planning to use it</td>
</tr>
<tr>
<td>I</td>
<td>Orientation</td>
<td>The user has recently acquired or is acquiring information about computers and exploring how other teachers are using it</td>
</tr>
<tr>
<td>0</td>
<td>Non use</td>
<td>The user has little or no knowledge of the innovation, is not involved and is doing nothing towards becoming involved</td>
</tr>
</tbody>
</table>

Figure 2: Levels of use in the concerns-based adoption model (CBAM)  
(Hall, G. & Hord, S., 1987: 84)
All three diagnostic tools of the CBAM may be used independently or in combinations as an adopter may be at any particular SoC or LoU with any particular IC at any time. Together, they provide a diagnostic and prescriptive framework (as shown in Figure 3 below) to help change facilitators decide on what change strategies to implement and which resources to provide to whom. However, in this particular research study, only the SoC and the LoU were adopted.

Figure 3: A diagnostic-prescriptive framework for CBAM

(Hall, G. & Hord, S., 1987: 340)
The literature review suggests widespread support for the CBAM. Initially, Fuller's (1969) pioneer studies with teachers' concerns provided empirical support for the theory but later work (Adams & Martray, 1981; Demarte & Mahood, 1981; Hall & Loucks, 1978) also confirmed and refined Fuller's work. Harvey, Kell, & Drexler (1990) verified the usefulness of the CBAM in their research study on the Apple Language Series-Early Learning (ALS-EL) project when they compared two samples of the SoCQ taken at different times of the year and found a steady progression of teachers' concerns consistent with the Stages of Concern scale.

Dwyer, Ringstaff & Sandholtz (1990) compacted teachers' concerns into three stages (adoption, adaptation and appropriation) and developed a model which later found verification in the Apple Classrooms of Tomorrow (ACOT) study. ACOT's first year teachers struggled with survival concerns (similar to CBAM's Stages 1-3) such as coping with technical glitches, chalk dust in computers, monitor glare, technical breakdown, student misbehaviour, excessively high noise levels in the classroom, disks being erased, etc. Mastery concerns (reflective of the CBAM's Stages 4-5) clouded ACOT's second year whilst impact concerns emerged during ACOT's second and third years as teachers began to focus on instructional impact.

The CBAM is a relevant model to study the adoption-diffusion process. Many studies have been conducted using the instruments in the CBAM both singly (Maney, 1994; Redman, 1989) and in combinations (Hope, 1995). Quantitative studies include Martin's (1989) examination of how a software change impacted a faculty's concerns profile and Maney's (1994) survey of the adoption of multimedia technology in selected K9-12 public high schools in Northwest Ohio. Qualitative CBAM studies include Wesley's (1996) study
on the role of voluntary K-12 faculty adoption activities in promoting innovation and Frame’s (1991) and Sarmiento’s (1991) studies which explored the effects of computer training on K-12 faculty concerns and faculty post-training computer usage, respectively. Most of these studies confirmed the importance of adopting a holistic, systemic perspective in looking at the adoption and diffusion process.

To conclude, it is clear that all five models of organizational change highlighted in this literature review have different strengths and weaknesses. However, this particular research study draws strongly upon the constructs of the CBAM as it is firmly believes that teachers are important considerations in the change effort and that cataloguing their concerns paves the way for setting up appropriate intervention measures which resonate to the actual needs of teachers in the frontline of the innovation.

**Factors impacting upon the technology adoption-diffusion process**

A review of literature on the factors impacting upon the technology adoption-diffusion process in schools suggests a kaleidoscope of factors at work. Many researchers have examined these factors (Holden, 1989; McCormick, 1992), either from an administrator-versus-teacher perspective (Maney, 1994), or via a three-dimensional typology that views resistance to change as people-determined, technology-determined and environment-determined (Bishop-Clark & Grant, 1991), or eclectically (Hueth, 1998). Let us now briefly examine some of these factors.
Availability and access to technology

The availability of, and accessibility to, technology has often been cited as a critical factor affecting technology adoption (Becker, 1994; Hueth, 1998). In a study on Malaysian schools, Zuraidah (1998) found that lack of computers, as measured by a large pupil-to-computer ratio, was the main factor impeding technology adoption. At the Model Technology Schools (MTS) project in Cupertino-Fremont in California, Stearns (1991) reported the same factor as a major obstacle.

Likewise, access issues were listed among the top seven barriers to technology adoption in Sheingold and Hadley’s (1990) survey of technology-using teachers. Ely’s (1990) exhaustive review of literature also highlighted availability and access to technology as an essential prerequisite for adoption. When access to technology was limited and unreliable, teachers were reluctant to devote time and energy to planning technology-integrated lessons as they feared being unable to implement such lessons when the time came (Denk, Martin & Sarangarm, 1993). As Gay (1997) so aptly put it: “Teachers will rarely spend the additional time to plan a technology lesson if they are not assured that they will have access to a machine or machines on that day and time when they need them.”

Time constraints

Time constraints is another recurring theme in literature on technology adoption (Becker, 1991; Cuban, 1993; Marcinkiewicz, 1995). Gallo and Horton (1994) emphasised the need for teachers to have uninterrupted time with computers so that they may become comfortable enough with the technology to want to integrate it into
instruction. Other researchers have backed the call for more release time to explore technology, pointing out that teachers needed time to acquire multiple skills ranging from understanding the operating system to running the host of applications and managing peripheral devices and networking (Croft, 1994; Ely, 1990; Schofield, 1995).

Beasely & Sutton (1993) recommended at least 30 hours of computer instruction to reduce computer anxiety and another practice period of 3 to 6 years for teachers to familiarise themselves with computer use. Unfortunately, most schools are unable to provide teachers with this amount of release time. The time constraints problem is compounded by the fact that the learning curve for technology is steep and never levels off completely, meaning that teachers constantly need to upgrade skills acquired earlier. Besides acquiring and upgrading technological skills, time to trouble-shoot and resolve technical glitches constitute another facet of the time constraints problem.

Technical glitches are part and parcel of technology use – “You decide to use technology; well you also decide to deal with the problems at the same time” (Gay, 1997). Unfortunately, the time needed to resolve such glitches can take anything from a few minutes to a few months and this drains teachers who work with tight datelines in tightly-scheduled environments (Gay, 1997).

Previous experience with computers

Sheingold and Hadley (1990) cited teachers’ prior experience with computers as another important factor impacting upon technology adoption. Their study found that teachers with five to nine years of previous computer experience were most likely to adopt the technology whilst teachers with no previous computer experience were the least
likely to be interested in hardware and software paraphernalia and to want to integrate them into instruction. Washington (1990) also reported a positive correlation between teachers who used computers at work and the success of computer programmes in schools. Similarly, research by Harvey et al. (1990) in the Apple Language Series-Early Learning (ALS-EL) project also found a positive correlation between teachers’ self perceptions of computer expertise and the implementation quality of computer programmes. Scott, Cole & Engel (1992) found that teachers with computer experience were usually more confident about using the technology effectively in the classroom.

Training

Although research studies have often highlighted the need for more training initiatives to promote technology adoption (Hannafin & Savenye, 1993; Siti Suria Salim, 2000), this factor is often overshadowed by the rush to install hardware and software. The school district technology budget allocations by the United States Congress in 1995 for instance, allocated 55% of the total budget for hardware and 30% for software but only 15% for staff development activities (Conte, 1997).

The call to give more emphasis to technology-based training has already been made (Burkholder, 1995; Christensen, 1998; Kearsley & Lynch, 1994; Shermis, 1990; Stoddart and Neiderhauser, 1993). Marcinkiewicz (1994) for instance, reiterated time and again that the key to promoting technology adoption lay in helping teachers understand effective ways of utilizing computers in instruction. Hueth (1998) pointed out the plight of low-technology using teachers who found themselves in a Catch 22-dilemma when they were denied technology-related staff development opportunities simply because they were perceived as low-technology users. Joyce and Showers (1983)
suggested that teachers be allowed to practise new skills in controlled environments until they acquired a minimum degree of executive control over the technology. Evans-Andris (1996) advocated more directed learning in technology training initiatives.

Unfortunately, the training of teachers to prepare them to implement technology-integrated instruction is centrally organized in Malaysia. Due to limitations in finance and manpower, not all teachers desirous of being trained are given the chance to attend the training programme and those not selected are offered few incentives to seek training on their own. Consequently, the lack of adequate technology-based staff development opportunities constitute a huge bottleneck in efforts to promote technology adoption in schools.

Support

The setting up of an adequate backup support system is essential for technology adoption although this invariably adds to the cost of the technology implementation initiative (Becker, 1994; Evans-Andris, 1996). The need for backup support is especially important for networked schools which require trained professionals to cope with technical problems. In order to reduce the negative impact of cost constraints, clusters of coordinators may service an entire district as in the Jefferson County in Kentucky which has 153 schools serviced by a Computer Education Support Unit comprising 22 professionals who assist teachers in their use of technology in the classrooms (President’s Committee of Advisors on Science and Technology, 1997).

Besides technical backup support, a strong moral support network among and between colleagues and the school leadership is also important (Nik Zaharah, 2000). Research findings show clearly that support from the school leadership unites teachers,
making it easier for them to break from traditional modes of teaching (Boutwell, 1995; Kearsley & Lynch, 1994; Maney, 1994). Unfortunately, this support is sometimes lacking, especially in cases where school heads do not stay abreast of technological developments:

Many principals and superintendents openly acknowledge how little they know about integrating technologies...(how they) feel threatened and try to hide their discomfort and lack of knowledge (with) indifference or bureaucratic roadblocks...

(Foa, Schwab & Johnson, 1996:53)

In 1990, a survey of school superintendents in New York and Rhode Island showed that “85% knew nothing about computers, had never used a computer, and did not intend to use one... (but) made decisions about student and teacher uses of computers in schools” (Morton, 1996, p. 418). Naturally, this impedes technology adoption by teachers.

Collegial support is also important to novice technology users as these teachers are usually apprehensive about their abilities to cope and thus derive strength from peers grappling with similar problems (Armstrong, Davis & Young, 1996). The importance of collegial support and sharing in promoting technology adoption is also highlighted in the ACOT programme (Sandholtz, Ringstaff & Dwyer, 1997).

Attitudes

Another factor which impacts upon technology adoption is teacher attitudes. Researchers have often pointed to the link between the teachers’ attitudes to technology and eventual technology adoption in the classroom, citing that teachers with positive attitudes towards technology were more likely to adopt it (Ely, 1990; Maney, 1994;
Sheingold & Hadley, 1990; Washington, 1990). To a certain extent, teachers’ attitudes to technology are affected by their perceptions of its efficacy in instruction.

Among the many research studies which have examined the efficacy of computers in instruction is a meta analysis of related research (Kulik, 1983; Kulik, Bangert & Williams, 1983; Kulik & Kulik, 1986; 1987) which found that the use of computers in instruction had improved student achievement at all levels of schooling, had positive effects on student attitudes and yielded substantial savings in instructional time.

In 1990, Bialo and Sivin’s analysis of 61 studies discovered that most students found technology-integrated instruction motivating, enjoyable, empowering, easy-to-stick-with and less anxiety-provoking than traditional methods of learning. Collins (1991) reported that technology-integrated instruction had resulted in more cooperative social structures in the classroom. A later analysis of 86 studies by Sivin-Kachala and Bialo (1993) confirmed these findings and helped boost teachers’ attitudes to technology, thereby promoting adoption in the schools.

Summary

To sum up, the literature review recommends viewing technology adoption in schools via a systemic perspective because schools are loosely coupled systems with intricate, closely inter-linked systems and subsystems. Five models of change were examined to facilitate understanding of the change process.

The power coercive model which prescribed the direct exercise of power as the best way to effect change was found to produce only superficial changes and was thus less suitable to be adopted as a theoretical framework for this study.
The classic R, D & D model which emphasized empirically-tested and effective innovations was found to be rather difficult to adapt to current situations. Its assumption that teachers played passive roles in the adoption process was also debatable. Consequently, this model was also not adopted as the framework for this study.

Parts of Rogers’ DOI model was found to have relevance to this research study but its heavy reliance on interpersonal communication networks makes it fall short of being the ideal choice for studying change in the loosely-coupled structures of schools.

The OD model approached change from a holistic point of view and also offered many aspects which had pertinent bearing on this study but since the innovation was still in its infancy stage, there was extreme fluidity in structures which resulted in difficulties in verification.

The CBAM approach which emphasized the importance of teachers in the change process and offered valid and reliable instruments for tracking the adoption process from non-use to initial, novice use and refocusing attempts was found to be most appropriate to investigate the scope of this study and consequently adopted as the main theoretical framework for this study.

The literature review also examined some of the factors which impacted upon the technology adoption-diffusion process in schools. The next section will look into some of the more common technological practices adopted by the teachers in the classrooms.
Patterns of practice with technology

Many researchers have called for more research into optimal uses or benchmark practices of technology-integrated instruction which teachers may adapt to individual classroom settings (Becker, 1994; Marcinkiewicz, 1994). Unfortunately, there are still limited studies in this area, especially in the local context. Consequently, what is set out in this section of the literature review is an overview of teachers’ patterns of practice with technology rather than optimal practices. Nevertheless, note is taken of the call for more research into optimal uses of technology which can contribute to the knowledge base of teachers (Bozeman & House, 1988; Gilbert, 1996; Krendl & Lieberman, 1988; Marcinkiewicz, 1994).

Word processing

Word processing is a computer application that enables the user to write, edit, format, print, store and retrieve text easily (Mandell & Mandell, 1989). It is currently the most popular, most rapidly growing and perhaps most commonly used computer application in education (Maddux, Johnson & Willis, 1997). More than 60% of personal computer use revolves around word processing (Collis, 1988), so much so that it is now widely regarded as an invaluable tool at home, in schools and in the business world (Lewis, 1993). However, while many teachers sense the potential of this application in education, research on it is still limited (Geisert & Futrell, 2000; Maddux et al., 1997) although the few studies thus far completed suggest significant gains in writing ability as a result of its use (U.S. Congress, Office of Technology Assessment, 1988).
Another reason for the popularity of word processing lies in its ease of production and revision (Madduz et al., 1997; Vockell & Schwartz, 1992). Bangert-Drowns (1993) found that this application helps children concentrate on complex writing tasks by relieving them of the drudgery of mechanical revisions. Montague (1990) believes it promotes cognitive development during the composing process. Collis (1988) says that students collaborate more when working with word processors. Reidesel and Clements (1983) opine that word processing inculcates positive attitudes towards writing whilst Cannings and Brown (1986) point to the creation of positive learning environments via this use of technology:

…it (the microcomputer) does present a medium that makes a new social organization for reading and writing possible. (p. 149)

A variation of word processing especially helpful in developing writing skills among students is desktop publishing, a tool which allows writers to publish their own stories, books, reports, newsletters and newspapers. Research suggests students are more motivated to pick up writing skills when they have a “sense of audience” (Lewis, 1993).

On the negative side, Mitton (1987) researched spelling errors made by 15-year-olds and found that 40% of the errors could only be traced via human proof-reading rather than the use of the word processor. Similarly, Dalton (1991) compared use of a spelling checker with peer editing among fourth grade students and found that there were adverse effects from over-dependence on the spelling checker.

To sum up, research suggests that although word processing appears to improve the “quality of writing, length of compositions, number and kind of revisions and students’ attitudes toward writing” (Roblyer, Castine & King, 1988), teachers have to
clearly define their purpose and objectives (Montague & Fonseca, 1994), encourage peer
collaborating and collaboration (Roberts & Mutter, 1991) and incorporate a process approach to
writing (MacArthur, Graham & Schwartz, 1993) if they wish to maximize the potential of
using this application.

Computer mediated communication (CMC)

Computer mediated communication or CMC involves students communicating
with the teacher and/or each other through list serves, computer conferences, news
groups, email or other technologies (Iseke-Barnes, 1996). There are two types of CMC –
synchronous communication where individuals send and receive messages at the same
time and asynchronous communication in which there is a time lapse between the
messages.

While much of literature pertaining to the use of CMC relates to adult education,
in particular, distance learning (Waugh, 1996), there is increasingly more research on the
use of CMC in schools. Ghaleb's (1993) study on the impact of synchronous instructor-
student CMC use in a college writing class found that CMC provided a positive writing
environment for English-as-a-Second-Language (ESL) students. Harris (1994) described
how American literature classes at two schools read The Glass Menagerie together and
discussed the play via email. Similarly, Hoogstrate-Cooney (1995) examined the
synchronous communication patterns, discourse and attitude of 10th-grade English
students who used CMC to discuss the American play The Crucible and discovered that
although the students' experience was positive, it did not really help to create a more
egalitarian environment in the classroom.
Projects on asynchronous communication have also been carried out in schools. In 1994, the Camelot project linked Bayside Middle School in British Columbia with the Faculty of Education at the University of Victoria to deepen students' understanding of the Middle Ages through the use of email. Although research findings showed only limited increase in student understanding, there were signs of an emergence of student voices, especially those of shy students, and an increase in technical expertise (Berge & Collins, Vol. 2, 1998).

The main obstacle to the use of CMC in instruction is the high cost of getting students connected and the difficulty in getting enough computers, modems and telephones (Berge & Collins, 1998, Vol. 3). However, this computer application offers tremendous possibilities for developing thinking skills as students are encouraged to construct their own problem-solving solution path and to manipulate the problem environment for alternate solutions (Berge & Collins, 1998, Vol. 3).

**Internet-based research**

The Internet has been defined as a “network of networks, connecting over six million host computers in 100 countries... growing at the rate of 10-15 per cent per month” (Hueth, 1998). The thousands of networks that comprise the Internet enable data and information to be shared easily and make it an extremely powerful tool for information gathering.

The World Wide Web (WWW) is especially potent. Korolenko (1997) described the WWW as a “body of homepages that currently run on the Internet” and homepages as “...linked documents that contain text, graphics, sound and animation as well as
hypertext-written words presented so that the user can jump form topic to topic" (p. 88).
The WWW is a global storehouse of knowledge which has faciliated students’ research
in various fields including Social Studies (Dale, 1997), Science (Nelson, 1997) and
English (Davis, 1995).

To date, there is still limited research on the effects of the Internet on students and
instructors although much has been written about its mind-broadening allure (Maddux et
al., 1997) and its ability to capture the interest of students (Zainal Abidin Hassan, 1999).
Maddux et al. (1997) for instance, talked about the thrill of the search and described how
the Internet broke down the walls of the classroom – “expand the horizons of students
everywhere…” – but warned that students may “…get lost in the electronic forest and
never find (their) way to the highway” (p. 168). Teachers who frequently use the
Internet for instructional purposes usually advocate imposing some form of structure and
control on the students as opposed to simple free browsing (Maddux, et al. 1997). While
some researchers echo fears concerning the ready availability of adult material on the
Internet, many feel that this characteristic of the Internet offers students an opportunity to
learn responsibility (Maddux, et al., 1997).

Simulations

Curry and Moutinho (1992) describe a computer simulation as a software package
which assumes the characteristics of reality. Maddux et al. (1997) highlights simulations
as a fun and inexpensive way of providing students with experiences in areas where it is
dangerous to allow them to experiment freely. Simulations encourage better transfer of
knowledge by allowing students to experiment with alternatives in an atmosphere of
socialization and collaboration. Perhaps their greatest strength is that they are realism-adjusted, that is, they represent aspects of the real world in the classroom.

The use of computer simulations in instruction can be traced to the game ‘Monopologs’ which required participants to perform as inventory managers in the Air Force supply system (Faria, 1987). Early research focused on the mechanics of integrating simulations into instruction. Horn and Cleaves (1980) for instance, identified three phases when integrating simulations into classroom instruction – preparation, supervision and debriefing – whilst Willis, Hovey and Hovey (1987) added the phases of selection, adaptation and evaluation. Maddux et al., (1997) emphasized the need for supervision to capitalize on teachable moments. Recent research however has focused on comparing the effectiveness of computer simulation games to other educational mechanisms (Thompson & Thompson, 1995; Worrell, 1995).

Constructivist uses of this computer application require considerable planning, flexibility, on-the-spot analysis and decision making (Maddux et al., 1997). Perhaps its edge over other modes of computer use is that students are more actively involved in the learning process, something long championed by renowned educationists such as Vygotsky (1978).

Conclusion

To conclude, this literature review advocated a systemic perspective in looking at the adoption-diffusion process in schools, examined several models of change, highlighted factors impacting upon the technology adoption-diffusion process and
described common practices with technology in schools. However, it must be reiterated that as is often the case with qualitative studies, the literature review is by no means exhaustive but ongoing and symbiotic with data collection. Hence, as fieldwork progresses, related literature will continue to be reviewed, with relevant research findings subsequently highlighted and incorporated into the succeeding chapters.
CHAPTER 3

Methodology

In this chapter, the research design of the study is discussed. Details pertaining to the research design paradigm, the selection of sample schools and subjects for the case studies, the instruments employed and methods of data collection are outlined.

Design of the study

The selection of a research design depends on the purpose of the study and the research questions it aims to answer. LeCompte & Preissle (1993) illustrated this clearly when they said that a research design involves “deciding what the research purpose and questions will be, what information most appropriately will answer specific research questions, and which strategies are most effective for obtaining it”. Thus, theory and methods in research are “inextricably linked” because theoretical assumptions influence the formulation of questions as well as determine data collection methods (LeCompte & Preissle, 1993).

This is a longitudinal study on the technology adoption process in four public, pilot smart schools in the Klang valley. It looks at adoption-diffusion issues from the perspectives of teachers specially trained to implement technology-integrated instruction. More specifically, it seeks answers to the questions listed in Table 2 on page 59. Since the premise of this study is that change is brought about by individuals within a system, it
follows that both individual and systemic factors need to be examined and the most
appropriate research design is a holistic and dynamic, investigative approach (Borg &
Gall, 1989). A review of related literature shows that many researchers have, in the past,
rejected the variance research methodology of quantitative studies for a less structured
qualitative approach to studying the innovation decision process (Eisner, 1991; Bogdan &
Biklen, 1992; Rogers, 1995).

My selection of a qualitative research design is based on the nature of the research
questions asked in the research study, the answers sought, my theoretical platform as a
researcher and my self-perceived research skills and strengths. Translated into
operational terms, my choice was shaped by the answers to four simple questions: “What
am I looking at?”, “What am I looking for?”, “What platform am I operating from?” and
“What special skills do I bring into the study?”

Reflection on these four questions supported the adoption of a qualitative research
paradigm. Firstly, my research questions dealt with the technology adoption process and
as ‘process’ connotes dynamism and evolution not easily quantified or captured in a one-
off survey, the best methodology was a hands-on approach where I could be on site to
observe events as they unfolded.

Secondly, the answers sought were not close-ended “yes-no” answers as I wanted
to tap into the thoughts of those involved in the technology adoption process. In all
probability, the answers would run along lines of “Yes when...” or “No when...., or “It was
yes but became no because...” or “It was no but became yes due to...” Again, the case
begged for a qualitative research design.
Thirdly, although my study revolved round the use of technology in schools, my interest was not so much in the technicalities of the technology as in the people involved in the change process. My training in sociology also means that I am more comfortable with the anthropological-based, ethnographic approach than with any other approach.

And finally, I find that I enjoy acting like a sleuth, investigating and triangulating suppositions. It is my habit to hold running conversations in my head – “why did she say this?” – long after an event and to dwell on conversations past. I think of repartees when the time for making such responses is over, observe details which replay themselves in my mind and remember snatches of conversations vividly. However, although I make connections slowly, I am also patient and do not mind waiting for things to fall into place. These are my observations of my research strengths and I believe these skills particularly suited to qualitative research. Consequently, I selected the qualitative paradigm – it was a matter of ‘best fit’ based on my answers to the four questions posed.

As is often the case with qualitative studies, I embarked upon the study with very general research questions. As a teacher trainer, I had been involved with the smart school programme to train teachers to teach with technology but was uncertain what teachers did with their skills upon completion of the training. I wanted very much to find out what went on in the school milieu – did the teachers accept technology and if so, how were they using it in the classroom? Thus, I started field observations with that most basic of ethnographers’ questions: “What is going on here?” (Wolcott, 1977).

However, after a preliminary exploratory study, clearer questions emerged which I listed down, together with plausible sources of information and possible methods of data collection, as show in Table 2 on the following page.
<table>
<thead>
<tr>
<th>General Research Questions</th>
<th>Data to be collected</th>
<th>Sources and methods of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have the teachers who underwent the 14 Weeks in-service Training Programme for Teachers of Smart Schools adopted technology in the case study schools?</td>
<td>Determine the number of teachers who have adopted technology-integrated instruction</td>
<td>SoCQ (Appendix 2)</td>
</tr>
<tr>
<td>2. What were their primary concerns?</td>
<td>Draw up individual composite concerns profiles of teachers</td>
<td>SoCQ Workbook</td>
</tr>
<tr>
<td>3. What levels of technology use did they attain?</td>
<td>Determine type, extent and pattern of technology use</td>
<td>SoCQ Profile Charts</td>
</tr>
<tr>
<td>4. What factors promoted / inhibited the use of computer technology for technology-integrated instruction?</td>
<td>Identify factors impacting upon technology adoption in the case study schools</td>
<td>Observations</td>
</tr>
<tr>
<td>5. Given the same basic technology training, what caused variations in the teachers' responses to technology?</td>
<td>Pinpoint factors for causing variations in the teachers' patterns of practice with technology</td>
<td>Observations (Appendix 3 &amp; 4)</td>
</tr>
<tr>
<td>6. What uses of technology did the teachers find most useful? What were the perceived problems and benefits?</td>
<td>Investigate teachers' perceptions of the role of technology in instruction</td>
<td>Classroom observations</td>
</tr>
<tr>
<td>7. What were some of the optimal uses?</td>
<td>Develop a profile of technology use by teachers</td>
<td>Interviews</td>
</tr>
<tr>
<td>8. How did students perceive the use of computer technology for instruction and how do these perceptions differ from those of the teachers?</td>
<td>Determine students' response to technology use</td>
<td>Classroom observations</td>
</tr>
</tbody>
</table>

- Interviews with teachers and principals
- (Appendix 2bii & 5)
- Classroom observations and interviews
- Classroom observations
- Interviews with teachers, principals and students
- Classroom observations
- Interviews with students
- Appendix 6
However, it must be emphasised that while these research questions guided the
direction of the study, they only emerged and crystallised over time and needed to be
rephrased and redefined as the study evolved. There was little attempt to hold variables
constant to test theories. Instead, fieldwork was aimed at watching events unfold based
on a generative model encouraging variation and change. No attempts were made either
to influence pedagogical changes as my role was strictly that of a non-participant
observer.

**Subject selection**

**Phase 1a (exploratory): Selection of training milieu**

Although this study focused on the use of computer technologies in instruction in
the pilot smart schools, fieldwork actually commenced outside the school setting, in the
training milieu where the teachers underwent a special training programme to prepare
them to implement technology-integrated instruction. Starting fieldwork from the training
milieu meant an extra 14 weeks of field observations but I believed this starting point was
necessary because teachers' responses to technology in the school are often affected by
their experiences during training.

As things later turned out, this exploratory phase did yield benefits as it bought
me time to interact with the teachers on neutral ground before I ventured onto their turf.
The increased interaction provided me with insight into their backgrounds, strengths,
preferences and idiosyncrasies. It also allowed the teachers to get used to my presence
and to develop rapport with me so that by the time I finally joined them in the school
milieu, they were at ease in my presence.
Consequently, my first task was to select a college to observe the teachers during their training. I decided to refer to the outcomes of a nation-wide monitoring exercise conducted by the Teacher Education Division (TED) between August 7 and September 2, 1998. Three factors constituted my selection criteria – the context factor (the IT facilities and infrastructure in the training milieu), the input factor (the course facilitators' expertise) and the process factor (the quality of training as evaluated by officers from TED).

Scores were allocated to each of the three criteria based on the report by the TED (please refer to Tables I, II and IIIa-c in Appendix I for details). Every ( ) awarded to the college by TED was given one mark and the summation of scores from Tables I, II, IIIa-c provided a tentative ranking of the colleges as represented in Table 3 on the following page. Please note that this rank carries no significance other than providing a measure to select the most suitable college for field observations.

As Table 3 on the following page shows, the highest ranked teacher training college within comfortable travelling distance (a prerequisite to reduce researcher fatigue) was college E which ranked third on the list. Consequently, throughout the 14 weeks of the training from June 1999, I was based in the college three days a week to observe the implementation of training. The teachers' portfolios, grades, attitudes and interaction patterns were scrutinized to identify suitable candidates for phase 2 of the research study. The teachers were also interviewed about the technological infrastructure in their schools and questioned about their willingness to be involved in the research study in line with the notion of informed consent.
Table 3: Ranked score of the training colleges/ training milieu

<table>
<thead>
<tr>
<th>Criteria for Selection</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological infrastructure</td>
<td>13</td>
<td>11</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>10</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Quality of facilitators</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Management of smart strategies</td>
<td>26</td>
<td>16</td>
<td>28</td>
<td>19</td>
<td>24</td>
<td>23</td>
<td>23</td>
<td>21</td>
<td>26</td>
<td>6</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>Portfolio Evaluation</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>15</td>
<td>4</td>
<td>7</td>
<td>16</td>
<td>18</td>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Learning Package</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>4</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total scores</td>
<td>71</td>
<td>59</td>
<td>74</td>
<td>61</td>
<td>73</td>
<td>60</td>
<td>63</td>
<td>70</td>
<td>77</td>
<td>28</td>
<td>63</td>
<td>59</td>
</tr>
<tr>
<td>Crude Rank</td>
<td>4</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>12</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

Phase 1b: Selection of schools and teachers

In September 1999, the selection of schools for phase 2 of the research study was carried out in earnest. Teachers identified as potential case study material - articulate, reflective and empowered teachers with an interest in information and communication technologies - were sounded on their receptiveness to being involved in a long-term study. Those who were amenable were visited in their schools so that the IT infrastructure in the schools could be ascertained. An important factor influencing my choice of schools was their geographical locations. After all, as the key research
instrument (Bogdan & Biklen, 1992), I had to travel between schools while juggling multiple tasks—classroom observations, interviews, transcribing of field notes, literature review to design succeeding phases, and reflection on emergent data to triangulate and check for bias (Goetz & LeCompte, 1984).

Finally, four pilot smart schools in the Klang Valley—two level ‘A’ and two level ‘B’—were selected. These levels refer to the levels of sophistication of the IT infrastructure provided by the MOE. Level ‘A’ schools are newly-built, custom-made smart schools, each with wired classrooms and more than 400 computers whilst level ‘B’ schools are ordinary lay schools with upgraded IT facilities (for details, please refer to Chapter 4).

The rationale for adopting multiple sites for observation—four in this study—was to capture as wide a range of teacher concerns in different levels of technological settings as possible in order to “maximize variation” (Merriam, 2001). No level ‘B+’ school was included as such schools were fully residential, boarding institutions and thus unrepresentative of typical lay schools. The four schools selected—Rajawali, Gemilang, Temasik and Sendayan—also had a ‘kick start’ IT component in their curriculum (Crawford, 1997) as computer literacy classes honed the students’ computer skills prior to the introduction of technology-integrated instruction.

A critical case strategy was adopted to select the 4 schools. A critical case is a close approximation of an ideal case profile of a given condition and is typified by the statement “If it won’t work here, it won’t work anywhere” (Goetz & LeCompte, 1984; Patton, 1987). This strategy is helpful when resources limit the number of study sites which can be chosen as it allows ‘best’ sites to be selected. The strength of this approach
is that a good and persuasive critical case often lends more weight to generalisations and extrapolations.

All 4 schools selected were critical cases for technology adoption as they were officially-designated pilot smart schools provided with special technological infrastructure and smart teaching-learning materials. These schools were also backed by technical support services and staffed by a core group of teachers trained to implement technology-integrated instruction. In short, the case study schools were all poised to spearhead the implementation of technology-integrated instruction despite the fact that they had different levels of technological infrastructure and differing numbers of technology-trained teachers (as shown in Table 4 below).

Table 4: The technological levels of the case study schools

<table>
<thead>
<tr>
<th>School</th>
<th>IT Model</th>
<th>IT level</th>
<th>N (technology-trained teachers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajawali</td>
<td>Lab &amp; classroom model</td>
<td>A</td>
<td>12</td>
</tr>
<tr>
<td>Gemilang</td>
<td>Lab model</td>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td>Temasik</td>
<td>Lab &amp; simulation room model</td>
<td>B</td>
<td>8</td>
</tr>
<tr>
<td>Sendayan</td>
<td>Lab &amp; simulation room model</td>
<td>B → A</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>47</td>
</tr>
</tbody>
</table>
The data collection process

Getting started

The entire data collection process for this study – from phase 1 (exploratory study) to phase 2d – stretched over 26 months, from June 1999 to August 2001. Phase 1a, which comprised observations of teachers at College E, started in June 1999 and lasted for 14 weeks. This was followed by a hunt for schools in September 1999 when, based on a list of potential candidates from field work in phase 1, several principals were contacted about the possibility of conducting a longitudinal qualitative study in their schools. Interestingly, some principals voiced reservations about the benefits of being involved in research studies, citing that past involvement had inconvenienced rather than benefited teachers and students. Eventually, the choice was narrowed down to four schools and the principals agreed, on condition that permission was obtained via proper bureaucratic channels and research findings shared with the school.

Feedback from the exploratory phase also helped to sharpen the focus for subsequent phases of the study. Interactions with teachers in the training milieu indicated that teachers had mixed feelings about the innovation – some were skeptical, some curious and excited while others were simply uncertain. However, all were concerned about their new roles with the technology. Consequently, a literature review on the concerns of teachers confronted with change and innovation was conducted and the Concerns-Based Adoption Model (CBAM) was selected as the most viable framework to tap into and give voice to the teacher.
The Stages of Concerns Questionnaire or SoCQ (Appendix 2) was adopted as a tool to chart the teachers' responses to technology. It was translated into Bahasa Malaysia and back-translated by a lecturer at the university. Both versions were then piloted in a school in October 1999 with a sample group of teachers who had attended the 14 Weeks In-Service Training Programme for Teachers of Smart Schools. Surprisingly, more than half the teachers opted to fill in the English version, citing greater comfort with the language as the reason. Consequently, it was decided that both versions should be made simultaneously available to teachers to accommodate different language preferences and competencies.

Phase 2a: Walking the field

The research study entered its second phase in January 2000. As field observations stretched over 20 months, this phase was figuratively divided into several sub-phases to facilitate analysis of data. Phase 2a saw the administration of the SoCQ to teachers in the four case study schools who had attended the 14 Weeks In-Service Training Programme for Teachers of Smart Schools. These teachers (totaling 47 in all) were considered change agents in the schools as they had been trained to lead the technology initiative. Their SoCQ scores were tabulated via an Excel Workbook to yield composite profiles and these provided the first snapshot of the teachers' concerns in the technology adoption process.

An addendum attached to the SoCQ compiled background data about the teachers and asked for permission to involve them in the study, in line with the notion of informed consent. An oral briefing advised them about the long-term nature of the study but
emphasized that participation would be at different levels and that only those who did not mind being observed in the classrooms and shadowed in schools would be so involved.

The teachers were informed that identities of the case study schools and respondents would be kept confidential and that they would be given pseudonyms in the write-up – they also reserved the right to edit parts of the study related to them.

In March 2000, all the teachers were interviewed, using an interview schedule based loosely on the LoU protocol of the CBAM (Appendix 3 & 4) to determine their levels of technology use. Attempts to videotape the interviews were abandoned when the teachers expressed reluctance to be caught on film. Thus, the interviews, conducted mainly in the school resource rooms during the teachers’ free periods, were merely audiotaped on a mini recorder when the teachers permitted it. In instances when they were unwilling to be even audio recorded, only notes were jotted down.

Observations of the teachers in the classrooms started in April 2000. Given the time constraints, it was not possible to observe all the 47 teachers without incurring extreme physical and mental fatigue. Consequently, the SoCQ was used to identify adopters via their peak Stage 3 concerns (Maney, 1994). As the objective of the study was to look at how teachers used technology in the classroom, only those identified as adopters – 18 in all – were selected for classroom observations.

I visited every school at least once a week, usually for three to five hours per visit, except during examination seasons. The visits continued right through April, May, June and July 2000. On days when I was unable to visit the school for observations (there was a week when my car broke down and had to be sent to the workshop for repairs), telephone conversations and email kept me in constant communication with the teachers.
On occasions when I felt there was something worth seeing, two schools were slotted for observations in a day.

Interspersed with observations of the teachers were “one-legged conferences” (Hall & Hord, 1987). These referred to casual, informal interviews lasting only minutes, conducted as and when the opportunity arose. Usually, these interviews or encounters took place in corridors, in the car park, staff room, canteen, etc. My normal greeting of “Hi, how’s the technology going?” often triggered an avalanche of information and invariably ended with a short trip to the school canteen ‘for a drink’, which did wonders for strengthening rapport.

However, although classroom observations were focused on the 18 teachers, the other 29 teachers were constantly talked to in order to perform “member checks” to triangulate what was said (Stake, 1975a) and to confirm emergent patterns and highlight discrepant cases which offered alternative or rival explanations (Lincoln & Guba, 1985; Silverman, 1993). Discrepant or negative cases function like null hypotheses as they enable the researcher to qualify, refine or elaborate on emergent constructs and thus challenge the fit and relevance of the patterns to the social reality of the experience under study (Goetz & LeCompte, 1984; Patton, 1987). Furthermore, there was the likelihood that non-adopting teachers might, over the duration of the field study, move on to become adopters and I wanted to be on hand to tap into their shift in orientations.

Phase 2b: Widening the radius of the walk

In August 2000, after the school break, phase 2b of the study was set into motion. I arranged for interviews with the heads of schools (Appendix 5). Other
administrative staff – the senior assistants, IT coordinators and technical support people – were interviewed via casual, one-legged conferences. A questionnaire was also administered to 233 Form Two students (Appendix 6). These students were selected because they did not have to sit for major public examinations at the end of the year. Furthermore, they had attended IT literacy classes in Form One and had been exposed to teachers’ experimental forays into technology-integrated instruction in 1999 and 2000.

Consequently, two classes of Form 2 students from each school were asked to fill in the questionnaire. A relatively ‘good’ and ‘weak’ class were selected from each school in order to ‘maximise commonalities and contrasts’ among the respondents (Saye, 1994). Three students from each class were randomly selected and interviewed to get in-depth feedback as regards their perceptions of technology-integrated instruction. The interviews with students were carried out both singly and in groups as some students were observed to be reticent when interviewed alone but willing to share their views in groups. Most of the interviews were not taped due to the incessant background noise. However, lengthy field notes were taken.

Phase 2c: Zooming in

Phase 2c involved ‘shadowing’ of the teachers. Due to time and manpower constraints, only five teachers were selected to be shadowed. Although the initial plan was to ‘shadow’ at least one teacher in each of the four subjects – Bahasa Malaysia, English, Mathematics and Science – this criteria was later rejected in favour of teachers who were articulate, empowered, technologically competent and pedagogically innovative. As the focus of the study was technology adoption, it was felt that the
content or subjects taught were not of significant importance. Other factors considered in
the selection of teachers were their composite concerns profiles, recommendations from
school principals and the teachers' willingness to be 'shadowed'. A teacher from the
pool of non-technology using teachers was also included for 'shadowing' to provide a
discrepant case.

'Shadowing' of the five teachers began in September 2000. This phase
overlapped slightly with interviews of two school principals who had earlier postponed
their interviews due to tight schedules. In a way, this turned out to be a blessing as
classroom observations interspersed with interviews provided welcome respite and
reduced researcher fatigue.

I tried to glean information about my five teachers in order to understand their
general psyche and perceptions of life as well as their attitudes towards technology-
integrated instruction. I kept an open email dialogue with them and made telephone calls
to follow up on email that weren't answered. These five teachers were observed in action
in the classroom at least five times each over the period of 'shadowing' but they were
constantly interviewed and their lesson plans, projects and participation in technology-
related activities were regularly reviewed to gain insight into their pedagogical practices.

Phase 2d: Closure

The last phase of the fieldwork - the administration of the second SoCQ - was
conducted in July and August 2001 to get a second snapshot of teachers' concerns
regarding the adoption and use of technology in schools. All the teachers who had
responded to the first SoCQ were invited to answer the second SoCQ to enable the
changes in concerns profiles to be charted. Thanks to the cooperation of the school principals, all did. Follow-up interviews were conducted where deemed necessary and the data reviewed for emergent patterns. Fieldwork officially ended in August 2000 but phone calls were still made to teachers to clarify doubts right till the end of the writing process.

I find the setting up of a timeline to guide data collection extremely helpful. This timeline provided a list of milestones to achieve, moving me from one target to the next. I stayed longer than the “one full cycle” on the field advocated by Wolcott because I felt there were still things to see. In retrospection, I think data collection is like taking a train journey – one has to be firm about getting off the train, however hard that may be. My timeline for data collection process is represented as in Figure 4 below.

Figure 4: Timeline for data collection
The instruments

The Stages of Concern Questionnaire (SoCQ)

In this study, the CBAM's Stages of Concern Questionnaire (SoCQ) served two purposes. Firstly, it provided a snapshot of the primary concerns of teachers confronted with technology use in the case study schools at two different points in time – the beginning and end of the research time frame – and in doing so, shed light on how teachers had progressed in the technology implementation initiative. Secondly, it was used to differentiate between adopters and non-adopters of technology (Maney, 1994) so that by interviewing teachers from both groups or populations, the factors impacting upon the technology adoption-diffusion process were identified.

As shown by Appendix 2, the SoCQ comprises 35 questions covering seven stages of concern (Hall et al., 1979) ranging from awareness to informational, personal, management, consequence, collaboration and refocusing concerns. As it has been validated and confirmed to have high internal reliability and validity (Hall et al., 1979), no attempt was made to revalidate the instrument in this study, especially since the original English version of the SoCQ was administered together with the translated version.

The Levels of Use (LoU) Protocol

The LoU describes what innovation users actually do with an innovation. It is a developmental growth continuum with eight levels that an individual moves through, starting with 'lack of knowledge' to a more sophisticated and highly effective use level.
Initial use of the innovation is typically disjointed and characterized by many problems but these usually diminish with continued use. To gauge the teachers’ levels of use of the technology, a branching format of the focused interview technique was adopted (Appendix 4). The focused interview starts in an open-ended fashion and proceeds through a sequence of questions in a branching fashion that closes in on a particular subject. Each of the basic branching questions is followed by a series of levels and specific probes which helps the interviewer determine the level of use the interviewee is at. The CBAM’s LoU has also been validated many times (Loucks, Newlove, & Hall, 1975). For more information about the LoU, please refer to the literature review.

**Data collection methods**

All four methods of data collection often employed in ethnographic studies were used in this research study (Glaser and Strauss, 1975; Miles and Huberman, 1984).

**Review of related material**

An extensive review of related reading material was carried out. Case studies on the adoption of technology-integrated instruction in developed countries such as the United States and Singapore, and in the developing world, were examined. Formative evaluation reports, concept papers, theoretical blueprints and documents pertaining to the smart school pilot project were reviewed. These included the CRFPs (Concept Requests for Proposals), the Conceptual Blueprint and the technology master plan which outlined government initiatives as regards technology-integrated instruction in schools. In the
exploratory phase of the study, the teachers' lesson plans, learning packages, reflective journals, log books, attendance sheets, worksheets, portfolios, etc, were reviewed regularly to cull information on what actually happened during training. In the subsequent phases, the teachers' lesson plans, memos, teaching records and students' portfolios, exercise books and task sheets were systematically reviewed.

Observations

This was the primary tool for data gathering. Direct observation of school and classroom life is the richest vein of information, so I 'hung out' in the schools as often as possible, adopting the non-participant observational mode for several reasons.

Firstly, I believed participant observation would have exacted demands on my time and energy that I might not have been able to cope with. Secondly, I wanted to avoid the likelihood of role conflict as the teachers were aware of my involvement in teacher training prior to undertaking the research study and I did not want them to think that I was in the school in any supervisory capacity as research has shown that teachers were sensitive to differences between themselves and administrators (Wolcott, 1977). A more active role on my part might also have contaminated the 'reality' that I wanted to observe. Furthermore, there was the possibility that had I engaged in active participation, I might have found myself subjected to projective distortion and ended up over sympathetic with the teachers and less impartial to the natural course of events (Woods, 1986). Consequently, the mode of non-participant observation was preferred so that I might "lurk and watch" (Delamont, 1976).
Interviews

Eisner (1991) described educational connoisseurs as watching and listening to what is said in order to arrive at an understanding of what is happening. Consequently, in addition to observations, the interview method was also adopted to get information about people as well as from them. Interviews were conducted with school principals, teachers, students and Ministry officials to get as many different viewpoints as possible. These interviews were held both individually and in groups, via structured formats or casual, informal conversations. Efforts were made to encourage participants to speak their minds in an uninhibited way to allow for grounded theory to emerge. And as field notes were transcribed and analysed, new questions which cropped up were asked during subsequent interviews to gain deeper insight and to clarify ambiguities.

During interviews, the possession of a “third eye” (Woo & Zulkifli, 2001) which can tap into both the overt and subtle qualities of interviewees is a definite advantage. The “third eye” is the ability to instinctively zoom in on subtle cues and innuendos in speech or behaviour in the natural setting. It is this quality which enables the qualitative researcher to sense when something is “not quite right”, when a pause might be too pregnant, a reply too glib. In other words, the “third eye” is the springboard which launches hunches and insight that, once triangulated, give qualitative studies that edge over quantitative ones.

‘Shadowing’

Attempts were also made to ‘shadow’ five teachers as they participated in all type of school activities including staff development meetings, project briefings, etc. The aim
was to build up a composite picture of how these teachers actually used the technology in schools. This ‘shadowing’ took place randomly but was restricted to the school boundaries and within the teachers’ schedules to minimise disruptions to their teaching duties and personal life. Nevertheless, I did manage to slip in a few home visits on a social level.

Data triangulation methods

Validity and reliability are issues of central concern in qualitative research because conclusions are drawn based on the analysis of cases instead of on a large sample or population. As such, qualitative studies do not enjoy the advantages of control and standardization offered by statistical tests and different techniques need to be employed to ensure that the data collected is valid and reliable.

Internal validity is the accuracy or congruence of one’s findings with reality (Merriam, 2001). In qualitative research, reality actually hinges upon the researcher’s interpretation of participants’ understanding of a phenomenon. As these interpretations are accessed directly through observations and interviews, internal validity is not a huge problem in qualitative research (Merriam, 2001). Nonetheless, to shore up the validity of findings in this research study, various triangulation strategies such as interviewing multiple participants, observing multiple situations and cross-checking via multiple data collection methods were adopted (Borg & Gall, 1989).

I interviewed multiple participants for both verbal and non-verbal communication cues. These were then cross-checked with independent corroborations from other
respondents to verify the accuracy of information transcribed and interpreted as well as to
minimise researcher bias. Multiple situations meant the teachers were observed in
diverse situations at different times on different days. Multiple collection methods were
also adopted to ensure that data obtained was not biased but representative. Artifacts,
technology reports, hardware and software statistics, historical materials, record books,
lesson plans, etc., were subjected to verification checks. Even drafts of this research study
were not exempt but distributed to selected participants to be reviewed and edited for
accuracy whilst posited relationships were checked against discrepant cases. A peer
review (Merriam, 2001) was conducted by asking a teacher trainer to scan some of the
raw data and assess the plausibility of the findings based on the data.

To a certain extent, the longitudinal time frame of the study also enhanced its
validity as it increased the chances for rival explanations to emerge and be adequately
investigated (Goetz & LeCompte, 1984; Patton, 1987). This reduced the risk of any
‘Hawthorne effect’ arising from reactivity to my presence in the school milieu. I knew
that I was no longer ‘reactive’ when the students started greeting me by name in the
corridors and teachers continued with their conversations without skipping a beat when I
walked into the teachers’ room; on one occasion, a senior assistant even asked if he could
give me some relief classes.

External validity deals with the generalisability of the research findings, or the
extent to which the findings can be applied to other situations. Two measures were
adopted to enhance generalisability and encourage “context-bound extrapolations”
(Patton, 1987).
Firstly, the technique of rich, thick description was adopted to enable readers to determine the applicability of findings to their particular situations. Secondly, the observations of multiple study sites – four in this case – meant that research findings could, hopefully, be applied to a greater range of situations.

Reliability refers to the extent the study and its research findings can be replicated. To enhance reliability, I again resorted to ‘thick description’ to clarify my role as researcher, my criteria for selection of teacher respondents, my description of settings and outlining of data collection methods and analysis (Goetz & LeCompte, 1984).

The use of verbatim accounts was also adopted wherever possible (Goetz & LeCompte, 1984). The use of the SoCQ and LoU protocols gave some elements of consistency to the study as it enabled the same procedures to be adopted to interview and observe respondents (Yin, 1993).

An external audit on the use of the SoCQ and LoU was conducted via periodical tele-mentoring by a researcher well-versed in the use of these instruments. Comparisons of research findings with current literature on technology adoption also provided further checks for consistency and replication of findings.

And finally, a clear audit trail was laid out, with regular monthly meetings with my supervising lecturer for discussions on the research process, especially with regards to observation techniques, subject selection, coding issues and interpretations arising out of the observations, interviews and the setting. Field notes were kept of all the meetings, documenting the subjects discussed along with suggestions and new leads for continuing investigation.
Data analysis was ongoing and concurrent with the data gathering process in keeping with the ‘constant comparative’ method (Glaser and Straus, 1975). Data collection, analysis and literature review were symbiotic and inform or drive each other. After each visit, field notes were reviewed and recorded within 24 hours. These notes were kept in duplicate, with the first copy retained in its original form so as to constitute a set of undisturbed running raw material of observation. This was to ensure that events could be easily reconstructed should there be inquiries at a later date.

The duplicate copy was then analysed by coding incidents into tentative conceptual categories which formed the basis for formulating other questions to guide further investigations on the field. The duplicate copy was initially cut up and filed in various shoe boxes based on emergent categories so that findings could be easily compared with initial categories. Through this constant comparison of data, analytical categories crystallized. Eventually, however, the data was keyed into the computer, making it easier to toggle data, create new categories and collapse them when necessary. The data was constantly checked for fit and to identify themes or patterns, with the original transcriptions read and re-read to get a sense of the whole and to provide a governing structure for analysis (Miles & Huberman, 1994). The special attention given to data that challenged original conceptualizations meant a return to data source which took place constantly right till the end of the study. In essence, this process of data analysis resembled taking data apart and then reconstructing it to identify the patterns that might reside within the data.
Summary

This chapter summarises the methodology adopted in conducting the research study. The research design is a qualitative framework using methodological pluralism and organisational holism as its conceptual pillars. The main research instrument was myself as the researcher and the vehicle for analysis was ‘thick description’ to penetrate manifest behaviour so as to arrive at the meanings events had for those who experienced them.

In order to increase ontological and procedural objectivity (Newell, 1976), multiple methods of data collection including extensive review of literature, perusal of documents and artifacts, interviews, observations and ethnographic-style ‘shadowing’ were employed. All data was checked, triangulated and structurally corroborated to seek a confluence of evidence. Special efforts were made to look for recurrent behaviour or patterns to ensure that events interpreted and appraised were not aberrant or exceptional but were characteristic of the situation. The CBAM model was adopted to increase procedural objectivity and decrease the scope for biased, personal interpretations. Member checks verified the accuracy of information transcribed and interpreted to minimise researcher bias. Informants were also invited to review and edit the information representing their perspectives to verify accuracy.

However, to a certain extent, the lines for research remained deliberately fluid to allow for the emergence of grounded theory. There were no fixed rules to direct my steps, no tests of significance to calculate, no variables to control in a lab-like setting. Instead, the cornerstones of the research were flexibility and adjustment underpinned by a
strong sense of faith that I had enough of the “enlightened eye” (Eisner, 1991) and the “third eye” (Woo & Zulkifli, 2001) to be able to recognize the significant when it came and would make the right moves.

This methodology was characterised by the constant need to change gears and was fuelled by my desire to interpret the educational world and say what could not be effectively said through numbers. In fact, it can even be said that this case study was not designed to test theory but to construct theory based on the practical experiences of the respondents involved. It is entirely up to the reader to determine whether it is appropriate to extrapolate and transfer the findings of this research to similar situations and settings.

As this research study is presented as a realist’s tale chronicling the perceptions and experiences of teachers going through the technology adoption process, the chapters are arranged somewhat differently from that of quantitative dissertations in order to give voice to the participants as the need arises. The next chapter starts by providing a description of the schools and the teachers.
CHAPTER 4

A description of the setting

This study is concerned with the technology adoption process in four pilot smart schools in the Klang Valley. As it is not possible to understand the change process without knowing something of the setting in which the change is occurring, this chapter paints for the reader a visual picture of the case study schools so that he/she may visualize the setting which constitutes the backdrop to the study. In the later part of this chapter, an attempt is also made to come up with a profile of the technology-using teachers based on their responses to technology use.

A point to note is that the names of all case study schools in this study have been changed to protect the identities of the real participants. As such, Rajawali refers to a secondary school named Sekolah Menengah Rajawali, Gemilang to Sekolah Menengah Gemilang, Sendayan to Sekolah Menengah Sendayan and Temasik to Sekolah Menengah Temasik. The names of the case study teachers are also pseudonyms and any perceived semblance to teachers in real schools is purely coincidental and conjectural.

The schools

Rajawali

The first sight of Rajawali usually takes one’s breath away. After the smog-filled city, the fresh beauty of the suburban countryside in which the school is nestled acts like balm to the soul. The school itself is attractively designed. Sprawled in a north-south
orientation, the ultra-modern buildings in shades of beige and orange overlook a large lake. Its red roofs sparkle in the sun. Beautiful landscaping and flowers lend a somewhat surreal touch to the surroundings. The facilities are excellent – an open-air amphitheatre, a hall which seats 13,000, six large badminton courts and a stadium of international stature. Rajawali is indeed a showcase school. The school is designed with functionality as well as aesthetics in mind; there is even anti-static vinyl flooring in the computer labs to absorb noise and dust so that students can study in maximum comfort.

As a level ‘A’ public smart school, Rajawali boasts of excellent IT facilities. However, at the time that field work commenced in 2000, the IT infrastructure was not yet fully laid out. Nevertheless, the school had 86 stand-alone computers, two scanners and four printers. This infrastructure was upgraded towards the end of 2000 when fibre optic trunking was laid out and more hardware brought in. Two ISDN lines, for video conferencing and as back-up for the lease line, were installed.

The beginning of the academic year 2001 saw the school equipped with 535 computers, all networked with an integrated assessment and school management system. The school was linked in a wide area network (WAN) via Telekoms Malaysia’s Corporate Information Superhighway (COINS) network. Internet access was through a data center set up at the Ministry’s Education Technology Division which monitored and restricted access via a firewall. All 40 classrooms were each equipped with seven computers and a 29-inch mounted television set connected to the teacher’s computer. In addition, seven science labs and two computer labs were fitted with seven and 35 computers respectively. The number of computers in the teachers’ room totaled 24. Other high-tech features included a multimedia studio with 15 computers, a resource room with 6 computers, 8
self-access centers with 2 computers, respectively, and a computer in the counsellor’s room. The school’s IT network was supported by 6 servers.

Population-wise, the student enrolment was low as the school was new. In January 2000, there were only 300 students and 40 teachers but by the end of field work in mid 2001, the number of students had doubled and teaching staff had increased to 60. The advantage of the low student enrolment meant a comfortable student-to-computer ratio of less than 8:1. Although the students had no Internet access in the school for much of the year 2000, an IT-savvy teacher donated a modem which provided teachers with dial-up Internet access.

The students, predominantly of Malay ethnic origin, ranged from 13 to 18 years. An examination of the school register showed that 25% of the students were from middle income homes while the rest came from families of drivers, clerks or security guards. The low socio-economic status of the majority of the students suggested low home computer ownership. This was later verified by a random survey on two classes of students which confirmed that only 33% had home computer access and 19% had Internet access. However, the large pool of technology-trained teachers in the school (12 in all) meant that Rajawali had a definite lead in the technology initiative, at least during the research time frame.

Gemilang

Gemilang is a co-educational, public secondary school located in a prime residential housing scheme. Set up in the 1980s on nine acres of gently undulating land to
cater to the needs of about 90 children, the school rapidly expanded until, in January 2000, it boasted a student population of 1,400 and a teaching staff of 77.

The school itself comprises five main blocks tucked snugly out of sight from the main road by lush greenery. With 22 classrooms, seven science labs, a school hall, four workshops, two prayer rooms, a library with more than 5,000 books, a large school field, badminton court, cricket pitch, tennis court, gymnasium and volleyball court, the school is well-equipped to handle the needs of its students.

In the 1990s, the school principal, a dynamic lady with a technology vision and mission, worked hard to upgrade the IT facilities in the school. She enlisted the help of the local community and managed to set up a computer lab with the aid of a private sponsor. In recognition of her efforts and the commitment shown by the teachers, the school was declared a Research & Development school and in 1998, selected as one of the 78 pioneer level ‘B’ smart schools in the country.

The official designation of the school as a pilot smart school gave its IT programme a boost. By the year 2000, the number of computers in the school had increased to 68 including 21 in a computer lab, 24 in a multimedia lab and 12 in a hypermedia lab open to student use after school hours. Another three computers were placed in the science lab, five in the administrative block and three in the teachers’ room. The servers were housed in a separate room with a hub and a web ramp. The school was also given an LCD panel, CD writer and a digital video with motion video capture and broadcast system.

The students hailed from diverse backgrounds. Although the majority came from middle and high income families, about one-third were the children of immigrants from a
nearby squatter area. A questionnaire distributed by the school administration to 305 Form 1 students in January 2000 revealed that about 67% of them had computers at home or were at least exposed to computer literacy programmes (G:2.7.00.2).

From amongst the teaching staff of 77, only 5 had been trained in the Smart School programme. Nevertheless, the school was fortunate as its IT coordinator – a young man who, in the early days of the IT initiative, worked long hours and even slept in the school while setting up the IT infrastructure – was passionately dedicated to promoting IT use in school. In the opinion of the teachers interviewed, much of the credit for the success of the IT initiative in the school went to the principal and this dedicated IT coordinator.

Temasik

Temasik is an all-boys, public secondary school located right in the heart of the city. A former mission school with vast grounds and majestic buildings reflecting the colonial-style architecture of a hundred years ago, the school is both splendid and regal. This is definitely a school with tradition – the students walk around, addressing their seniors as ‘sirs’ while the discipline master makes stentorian rounds with a cane in hand. The physical amenities are commendable. There is a lecture hall, a swimming pool, a museum which houses relics from pre-war days and even a Robinson Crusoe-style scouts’ den. The clock tower is affectionately billed ‘Big Ben’ and an open courtyard – ‘the quadrangle’ to the boys – houses meetings and assemblies, held in the manner of the British public schools of colonial yesteryears.
In January 2000, the school had about 1,300 students and 85 teachers. Students were admitted on merit and boarding facilities were available for those from rural homes. The majority of the students were from affluent backgrounds; many were the children of successful entrepreneur families who regarded Temasik as their alma mater and THE school for their children. Students’ home access to computers was thus not a problem.

The move towards aggressively integrating technology into instruction started in 1997 when a private sponsor presented the school with 41 computers and a server as well as training packages for the teachers. By early 1999, another 2 computer labs with 25 and 16 computers, respectively, had been set up.

The IT initiative was given a further boost when the school was designated a pilot smart school in 1998. Upgrading of the technology infrastructure started the following year with the addition of another 37 computers, 2 notebooks, 4 laser printers, a colour printer, CD writer, scanner, digital camera and 2 LCDs. A classroom on the ground floor was converted into a multimedia room and equipped with 11 computers, two printers and a scanner. Even the science lab was provided with a computer.

Fund-raising efforts by the school principal and teachers resulted in the setting up of two fully air-conditioned simulation rooms, each equipped with four stand-alone computers respectively. Another reason for the pervasive IT culture in the school was the Cyber Brigade, a computer club totally managed by the students. That, plus the fact that the school had eight smart school-trained teachers, a competent IT coordinator and an IT specialist who taught IT as an examination subject at upper secondary level, meant that the school was more than ready for the full roll out of technology-integrated instruction when its upgrading exercise was completed by May 2000.
Sendayan High

Just like Temasik, Sendayan High is a former mission school established in the late 19th century on 7.9 hectares of prime land in the heart of the city. Unlike Temasik however, Sendayan High is an all girls' public secondary school and its location in the commercial hub of the city means that there was little room to physically expand. Consequently, plans were made to relocate the school premises to a new high-tech building outside the city. However, during the first half of field observations, the school was still housed on the old premises where the skyline, dotted with modern skyscrapers and run-down pre-war buildings, bore testimony to the unique juxtaposition of old and new in that particular enclave.

In January 2000, the school's student population was 1,400 while teaching staff numbered 86. The school was highly regarded in the local community as it had a track record of excellence in public examinations. However, the lack of physical space for development meant limited space for setting up new IT infrastructure, and there were only 2 simulation rooms with 24 computers supported by a dial-up line and two hubs. Nonetheless, computer literacy classes run by a private company honed students' IT skills for a nominal RM10 per month.

In January 2001, the school shifted to its new premises with 535 computers, fully-wired classrooms and high-tech facilities similar to those at Rajawali. The school principal, a dynamic woman who had been pushing for the IT initiative even when the school was at its old premises, was ecstatic. She had lots of technology plans she wanted to implement. The pro-technology leadership coupled with the large number of IT-
trained teachers (22 in the year 2000) in the school gave it a definite advantage in the technology implementation initiative.

Summary

To sum up, the four case study schools were public, technologically-enriched secondary schools staffed by a core group of teachers who had undergone special training to implement technology-integrated instruction. However, the levels of IT infrastructure varied and the schools had different cultural and physical settings. The main characteristics of the schools are summarized as in Table 5 below.

Table 5: The case study schools

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>IT level</th>
<th>Number of students*</th>
<th>Number of teachers*</th>
<th>Number of computers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajawali</td>
<td>Public secondary, co-educational</td>
<td>A</td>
<td>600</td>
<td>60</td>
<td>535</td>
</tr>
<tr>
<td>Gemilang</td>
<td>Public secondary, co-educational</td>
<td>B</td>
<td>1400</td>
<td>77</td>
<td>68</td>
</tr>
<tr>
<td>Temasik</td>
<td>Public secondary, all-boys</td>
<td>B</td>
<td>1307</td>
<td>85</td>
<td>98</td>
</tr>
<tr>
<td>Sendayan High</td>
<td>Public secondary, all-girls</td>
<td>B → A**</td>
<td>1375</td>
<td>86</td>
<td>535</td>
</tr>
</tbody>
</table>

* Figures taken in February 2001
** This school was upgraded to Level A after shifting to its new premises in 2001
The teachers

Based on observations of the 47 teachers in the school setting, the following profile of technology using teachers was drawn.

Shah: The trailblazer

An earnest man in his mid-forties, Shah had tried his hand at banking and insurance before venturing into teaching. He was passionately interested in technology and spent much of his free time tinkering with computers, sometimes till the wee hours of the morning, and attending technology-related workshops on weekends: “I like IT... I’m self trained...” he explained as he gestured proudly to the plethora of computer-related books scattered on his work table in school (R:12.6.00.2).

He was thrilled when he first learnt about the smart school project as he perceived it as a golden opportunity to specialize in a field he liked. He applied to participate in the training programme and was delighted when posted to serve in a pilot smart school upon completion of training.

At Rajawali, Shah blazed the trail as a technology man. Asked to teach Bahasa Malaysia, he ended up integrating technology into his teaching whenever possible: “…(I) used technology for almost all lessons” (R:12.6.00.2). He was in his element, often staying back to help other teachers troubleshoot and sort out technical glitches. His talent did not go unnoticed and he soon found himself singled out to prepare school brochures and slide presentations for the constant stream of visitors. As he himself put it: “Anything to do with design (computers), HM (the headmaster or principal) comes to me...” (R:12.6.00.2).
Shah revelled in his role as a pioneer of IT use in the school. He created templates for his colleagues and helped conduct technology-related staff development courses. When the school was invited to participate in a national-level video conferencing project, Shah readily contributed time and expertise, driving the students around the wetlands to snap pictures to be uploaded onto computers. He was also the prime mover behind the development of the school’s homepage.

When Rajawali found herself short of an Accounts teacher and Shah’s background in Economics made him the most suitable candidate to take over, he agreed to switch subjects. Accounts was not one of the four subjects included in the pioneer phase of the technology implementation initiative but that did not deter Shah from integrating technology into instruction. In just a matter of weeks, Shah again blazed the trail, creating templates of ledgers, journals and cash books which he readily shared with other teachers. His enthusiasm for technology use was infectious and he was soon perceived as THE technology resource person in the school. A colleague described him thus:

When I find something new, I share with (Shah) and he gets interested in what I find. He gets very interested. Like the other time, I saw this smart classroom management (system) in the Internet. I told him the next day. And he actually went to the site and he actually bought the thing. He bought it, he paid with his own money because he felt it was good. You see, we have people like this, eh... it becomes very, very motivating for you, you know. I get excited...

(R:21.8.00:7)

Coffee breaks with Shah usually meant a discussion on computers and teachers actively sought him for advice. A colleague commented:
(Shah is one of) a few people I enjoy talking to here, about technology. We try to look at things from a different perspective, from a new angle and we try to do something on our own. He's very good, he loves technology.

A check of the entries in the logbook which recorded teachers' use of the Internet line in school showed that Shah surfed the Net at least two to three times a week. He readily shared his knowledge with his peers. Once, after meeting teachers from the United Kingdom, he sourced for online information on e-learning and printed a load of material which he distributed to his colleagues.

However, Shah was also a discerning user of technology and constantly worried about the impact of technology use on the students. He readily admitted that integrating IT into instruction posed an extra burden to students as it required them to acquire an extra skill:

(If) no technology, they do better because teaching and learning (is) simpler...

He perceived implementation problems as the main obstacle to technology integration and cited the dichotomy between the idealism of the smart school vision and the harsh realities in school as the primary source of disenchantment among teachers involved in the pilot smart school pilot project:

*Kita ini dwi alam... fantasi dan realiti* (we are living in two worlds – fantasy and reality.)
He acknowledged his helplessness to move the technology initiative forward on a national basis,

I’m a small man, MOE has to do it (implementation), I can’t start bestari (smart school)... the man who pulled the trigger has to continue... (R:12.6.00.1)

but remained convinced that technology was the way forward and consequently strove to do whatever he could to accelerate its adoption in the school: “the world is moving towards IT, if don’t use, students rugi (lose out)...” (R:12.6.00.3). Thus, true to the spirit of a pioneering leader, he blazed on, lighting the way for others to follow in his wake.

[Note: Shah is a trailblazer because he leads others in the technology initiative. He is passionate about IT. Before an innovation can take root, people like Shah are essential as they play a fire-lighting role, igniting sparks which get the fire going and fanning the flames for diffusion. However, this does not mean that trailblazers blaze all the time as field notes show instances when even Shah encountered problems and faltered! But the strength and beauty of trailblazers is that they move under their own steam and are sustained by their faith and belief. And so it is with Shah – his enthusiasm nosedives at times, but, as is typical with trailblazers, he soon picks himself up and resumes his fire-lighting role in the technology-adoption process.]
Ling: The beacon

Ling celebrated her 45th birthday recently. An experienced teacher with more than 20 years’ experience, she holds a diploma in English and a Master’s degree in Media Technology from the United Kingdom. The eldest in a conservative family, she had quit school early to help ease the financial burden at home:

I am the eldest and the only girl, and my father felt that sons should be given priority in education

(R:18.6.00.4)

Consequently, she “wandered into teaching” when, at the age of 21, she applied to a local teacher training college and subsequently entered the teaching profession (R:18.6.00.4).

Ling liked being a teacher. Her interest in teaching took a new turn when she started working with computers in the university and she discovered her aptitude for them — “I enjoy doing computer and... I zoomed into computers...” (R:18.6.00.4). Her initial forays into computer-aided instruction sparked off a long-term love affair:

It’s my pet thing now... I really enjoy computers, authoring, and I find that using computers motivate the children a lot and that motivates me...

(R:18.6.00.4)

When the smart school project was initiated, Ling applied to participate in the training programme: “(It)... is the kind of thing I like, right up my doorstep” (R:18.6.00.5). Upon being posted to Rajawali, Ling was delighted because she felt that it offered more opportunities for her to explore and experiment with technology-integrated instruction:
... the smart school syllabus allow a lot of freedom (to explore technology) as we are not tied so much to specifications... given a big topic and could move round it... English teachers have a lot of (technology) resources if we are creative and resourceful...

(R:18.6.00.5)

Ling soon started using the authoring tools and templates she had brought back from the United Kingdom. The lack of readily available software did not deter her:

There's a global pool of expertise online. I surf... at least, I know what people are doing around the world... there's a teacher from Finland who's in schools. She's good. I also get ideas which I can use from the Listserv. I got Hot Potatoes from there...

(R:4.7.00.1)

But she admitted to encountering problems in her efforts to integrate technology into her lessons:

(l)... seemed to be going off tangent, seemed to be struggling... I was struggling between KBSM and Bestari. I find that Bestari is very student-centered, self paced. I find that I'm not able to do that just yet. I'm still chalk and talk. I'm still struggling towards independent learning

(R:18.6.00.6)

Top on her list of problems was time constraints. As she put it:

(Computer-integrated instruction) need a large backing of resources. We have a wee bit. I use some, but a teacher, I like to come up with my own resources. And that take time, time I don't have... Also, we are pretty exam-oriented, have to produce good results, familiarise students with exam format, drills. Computer time eats into my time for drills and practice

(R:18.6.00.6)
Ling also felt that teachers were over burdened with non-teaching duties:

...non-teaching expectations eats up a lot of time – administration, visitors, co-curriculum, see which glass is broken, have to see defects in the building... yes, a few of us have to do this. No maintenance personnel to look at school building maintenance...

(R:18.6.00.7-8)

She realized that there was a novelty element attached to technology-integrated instruction which teachers needed to beware of:

Once the novelty of IT is gone, then we have to be more serious, more content based. Once the bells and whistles are gone, have to go down to the core business, the content, the language...

(R:18.6.00.7)

Perhaps the one characteristic which set Ling apart from the other teachers was her independence – she had clear ideas of what she wanted to do and how to go about it, and unlike the other teachers, was not waiting for learning packages from MOE:

I’ll accept the package when it comes. The CDs (are) just one teeny drop in the ocean... (I) don’t even use the textbook all the time. I look at the scheme of work, topic, skill, see which ILO (intended learning outcome) fits it, then I’ll think what I can do. I’m an on-the-spot sort of person, see something with potential, how can make it into a nice exercise, teach from it and make some computer-based lesson. Takes time but I enjoy it... To get ideas, I look at the package but I like to do my own; don’t have to see into other people’s minds. I’m a bit wary of the package, I think even when it comes, I’ll still be doing my own thing. We are teachers, build our own materials but that’s the joy of teaching, to be creative...

(R:18.6.00.8)
To Ling, the best reason for integrating technology into lessons was the response it elicited from students: “[They get] so excited and motivated…” (R:4.7.00.1). She felt the technology provided her with a bridge to her students:

Even if they don’t learn much English, I know they’re with the lesson and with me, they’re getting closer to the language and to me, and they are at least learning technology…

(R:4.7.00.3)

[Note: Just like Shah, Ling is an innovator and a technology champion. Her belief in the merit of technology empowers her and gives her a strong sense of self and possibility. In that sense, both Shah and Ling are imbued with the personal mastery described by Senge (1990) as vital to the change process. This sense of personal mastery nurtures creative tension within Ling and inspires her to persist with pedagogical explorations, even when others around her falter. An introvert, Ling does not exhibit fire-lighting tendencies or try to ‘sell’ technology and win teachers over. However, through her unwavering personal commitment to technology use, she becomes a role model to peers who try to emulate her. For that reason, Ling is described as a beacon, shining brightly at sea and guiding others.]

Chin: The survivor / strategist adopter

Forty year-old Chin is a veteran teacher with 15 years of experience behind her. She entered the teaching profession at the encouragement of her husband, a conservative man who perceived the teaching profession as ideal for women juggling career with
family life. Chin had readily agreed. The result is a family unit comfortably ensconced in a lovely home just behind the school where she teaches Science and Mathematics.

Chin enjoys her work and is a devoted wife and mother. It is hardly surprising that she hopes to teach in her present school till she retires: "My house is just behind the school... I don’t see myself asking to be transferred out" (G:12.6.00.3).

Her initiation into the world of computers started when she was selected by the principal to attend the 14 weeks’ smart school training programme. Upon completion of training, she bought a personal computer – which she regarded as a “sophisticated typewriter” (G:12.6.00.3) – but was reluctant to integrate technology into her lessons due to various reasons. Her first excuse was that her class was too large and the abilities of the students too diverse to allow technology to be used in the classroom smoothly. Then, she cited the problem of student discipline:

Using IT is not easy because the students don’t behave well... cannot take no for an answer... (G:12.6.00.3)

She explained:

The minute (students) go into any lab, they’ll do what they want, totally disobedient... They’ll give you heart attack... (G:21.4.00.1~2)

Field notes showed that she struggled with the ‘maintaining discipline versus introducing technology’ dilemma throughout the entire duration of the study. She said:
Ideally, the smart school concept is, every child can learn and should be given a chance to learn. I want to do that but these children aren’t ready to learn... they don’t treat education as something serious... (some) treat school as a playground, very noisy with technology... (some) use instruments menacingly... (I) have to make sure they don’t have knives, have to watch them carefully...

(G:21.4.00.3)

Punishing students for misbehaviour was not a viable solution to her problems because:

I live near the school. Students pass by every day... don’t want to do lot of scolding in school... don’t want them to throw stone at my house...

(G:21.4.00.2)

Another reason for her reluctance to adopt technology was her lack of confidence in her technology skills:

I’m not a hardware person, so if problems, (I) don’t know what to do...

(G:21.4.00.1)

Despite all these reservations, her attitude towards technology underwent a dramatic change in early 2001 when the school principal exerted pressure on the staff to adopt technology:

She’s coming down hard on the teachers who don’t want to enter the bestari lab, says we have to give show cause letters. So all the teachers are scared, so they go in, at least surf the Internet...

(G:20.3.01.1)
Her response?

I'll toe the line. What if they transfer me out? My house is just behind the school...

(G:20.3.01.1)

Thus, Chin’s decision to adopt technology was due not so much to her belief in its merit as to her desire to remain in the good books of the school administration. She was happy in the school and feared incurring the displeasure of the principal and getting transferred out. Consequently, when there was top-down pressure to adopt technology, she embraced it in order to please the principal. In a way, her adoption of technology can be perceived as a strategy to win approval. She was astute enough to realize that to survive comfortably at Gemilang, she had to devise ways to please the people in charge. For this reason, she is actually a strategist adopter as she adopted the technology as a way to work the system to her benefit. As subsequent field work showed, Chin’s strategy paid off when her enthusiasm and efforts were noticed by the principal who rewarded her with an excellent appraisal report culminating in a double pay increment.

Chin’s strategic adoption also invoked an unexpected bonus when she found herself enjoying new warmth and collegiality with her peers as a result of her involvement in technology-related staff development programmes:

The science teachers all very keen when I share with them the IT part of it. We explore together, scold the computer together...

(G:21.4.00.2)
Unfortunately, Chin's misgivings about technology use were never totally dispelled and this affected her instructional strategies which remained essentially teacher-centered despite being infused with technological elements.

[Note: Chin's profile is typical of many teachers who are not fervent technologists but wish to appear so. Although she has little passion for technology, she adopts it in order to strengthen her position at her workplace. In essence, her adoption of technology is little more than an attempt at self preservation and survival. For this reason, she is referred to, in this study, as a survivor or strategist adopter.

Chin's profile also illustrates clearly the impact that a teacher's belief systems has on subsequent patterns of practice with computers. Senge (1990) referred to these beliefs as mental models; Diamond (1993) described them as personal constructs from which teachers structured their thinking to choose between alternative roles. Chin's mental model of a good teacher is one who holds the locus of control firmly in her hand. Consequently, she persisted in structured, whole-class instruction and refused to relinquish control over the direction and pace of learning even after she integrated technology into her lessons. The technology became just an add-on, issued in lockstep fashion. The fact that Chin maintained this typology of technology use for one and a half years suggests the tremendous impact of mental models on teachers' responses to technology.

Perhaps Chin's reluctance to relinquish classroom control can be better understood given the context of the state of discipline in schools during the research time frame. At that particular point in time, student indiscipline was at an all-time low, with
serious cases of indiscipline reported almost every other day in the daily tabloids. Given that kind of scenario, it is perhaps hardly surprising that Chin was reluctant to embrace an innovation which required transferring the locus of power to students.

Anna: The fence-sitter / ambivalent adopter

After graduating with a degree in English, Anna entered the teaching profession because she wanted to work with young people. This decision seemed to have been the right move for her as, eight years down the road, Anna still enjoyed her work. Blessed with a cheerful disposition, Anna treated her students as friends and they seemed to reciprocate her feelings.

When asked by the school principal to attend the 14 weeks’ smart school programme, Anna was initially hesitant as she perceived herself as not technically-inclined: “I personally am not so computer savvy... wiring, plugging, I don’t dare touch that” (T:14.9.00.7). However, she eventually agreed and was pleasantly surprised by the alternatives made possible by the technology. Upon returning to Temasik after the training programme, she was unable to immediately put her newly-acquired technology skills into practice because of major upgrading to the school’s IT infrastructure. By the time the infrastructure was ready, she found that her IT skills had also plummeted: “I’ve forgotten how to do Web page, etc. I tell you, if we don’t practice our skills after the training, we’ll forget” (T:15.8.00.1). Consequently, she shelved the technology aside and resolved to let things be.

However, she was not allowed to be impartial to the technology wave for long. She was pushed to adopt technology and the push came from an unexpected source – her
students! They were bright boys and full of enthusiasm for the technology. To them, technology was “cool”. Some came from well-to-do homes and were very IT-savvy. When Anna explained that she lacked sophisticated IT skills, they offered to help her. Soon, she was actively implementing technology-integrated instruction in the classroom, with the students as her assistants:

I do depend on the students to help me out... I have very good students who are very sure of what they are doing...like my superior had mentioned that it would be better to have all the students’ presentation in one or two diskettes, something about zip or unzip or whatever. I’m not so clear about that. I sort of talked with the students about that and asked them, some of them say ‘There are certain things that you need’, some diskettes or something, these things I’m not so clear but they are very clear about it and they do tell me. I do depend on them because they are so familiar with it...

(T:14.9.00.7)

Anna readily admitted that without the assistance of her students, she would probably not have bothered to use any technology as she would be “… caught with pants down”

(T:26.7.00.2).

Anna’s adoption of the technology was thus due to external stimuli. Initially a fence-sitter ambivalent about technology use, she was coerced into adopting technology by IT-savvy students who promised to handle technical glitches. She complied with their wishes because by doing so, she received the psychic rewards (Lortie, 1975) that she so clearly valued.

However, it is precisely because students were her main motivating force that her pattern of use was also affected by them, with peaks and dips in usage generated by their
responses to her efforts. For instance, in the academic year 2001, Anna’s use of technology dropped drastically because of the students’ negative responses:

I don’t know what’s wrong with the students this year. I asked them to download something from the Internet, only one out of 36 handed in their work. It’s not the language problem, they’re real chatter boxes. It’s not access, we have the computers. I don’t know why, but they’re so different from the students last year. I don’t really see (myself) using it (the technology) this year…

(T:18.3.01.1)

Her efforts dipped again when problems with class control cropped up – “(This batch of) boys are so boisterous (when using technology)…” (T:15.8.00.1) – and when she noted the “tendency for those who are familiar with computers to dominate” (T:14.9.00.7–8). Variation in student abilities and problems with language also gave her reason to pause:

The good are excellent but not everyone is good… in a class, some are so weak, especially the students from the FELDA schemes, cannot understand instructions even…

(T:15.8.00.1)

Once, an unpleasant experience with students put her off technology use for more than a month:

They messed up the screen… I trusted them wholeheartedly and I believed that they would be sincere but they changed the screen or configuration. The IT teacher had to redo it…

(T:14.9.00.8)

However, there were also spells of intensive technology use. A review of her teaching record book showed a peak in usage in the second week of September 2000 when she used the technology every day for two weeks.
Her reason? Because the students loved the technology and had fun with it in the classroom: “IT does add a lot of colour to the class activity” (T:14.9.00.8). Perhaps Anna herself best summed things up when she said:

Starting using IT is difficult. (Teachers) need motivation — internal and external. Teachers need to be motivated, self motivated. Students’ response (is so) important...

(T:19.3.01.3)

[Note: Anna is essentially a fence-sitter in the technology game. She is neither pro nor against technology use. However, she values rapport with her students and is prepared to adopt technology in order to please them. But when faced with students who are less keen on technology, she readily switches to more passive pedagogy which demands less energy. Perhaps Anna’s actions stem from her inner conviction that as a teacher, she needs the students’ cooperation to ensure that her instruction is successful. Consequently, she adopts and rejects technology based on the students’ preferences and not because she believes in technology or possesses personal mastery over it. In other words, she is neutral about technology use and is thus described as an ambivalent adopter. Anna’s profile is the most commonly observed profile among the teachers in the case study schools — most of the teachers appeared to be sitting on the fence and ready to either adopt or reject the innovation depending on external push factors].

Mei: The resistor

Mei is a petite 38-year-old teacher who had been teaching Mathematics for 12 years at Sendayan High before she was asked to attend the 14 weeks’ smart school training programme. She enjoyed the course, welcoming it as a diversion from the usual
routine but brushed off suggestions that she seriously integrate technology into her lessons. Initially, her reasons for not adopting technology was because of the lack of availability of technology and difficulty in access:

Right now, we can only enter (the simulation room) once a week. And that is only on the first and third week. The second and the fourth (week) are for English and Malay

(S:18.2.00.2)

But later, when the principal worked out a schedule which allowed every teacher access to the simulation room on a regular basis, Mei still refrained from adopting the technology wholeheartedly – "...a little bit, a little bit, that's all" (S:4.3.00.1). Her complaint was insufficient space: "...the room is too crowded-lah. Not enough empty space to move" (S:16.3.00.1).

Throughout the duration of the study, Mei voiced multiple reasons for rejecting the technology. At one point, she cited the lack of software on Mathematics. When referred to the large amount of material on the Web, she lamented the students' difficulty in translating Mathematical terms from Bahasa Malaysia into English as another reason for non-adoption. Later, she talked about the inherent difficulty of integrating technology into Mathematics: "I see ah, very difficult to implement for Maths..." (S:14.2.00.1).

Time constraints was another reason for her procrastination:

I'm teaching Form 4 and 5, exam classes. Maths and Add Maths (Additional Mathematics)... you know Add Maths-lah, especially Add Maths, the syllabus is a lot. I don’t think using the bestari way would work...

(S:4.3.00.1)

She elaborated on her problem with time:
Time. Rushing to complete the syllabus. Here, ah, if don’t finish the syllabus, parents will complain... Where got time? ... so much non-academic stuff too. This is the second month, already more than 10 meetings, stay back every afternoon...where got time for technology? (We) can’t go away from chalk and talk... impossible to change things overnight...

(S:27.2.00.2)

The old system of evaluation which emphasized good grades was also cited as a reason for her reluctance to embrace technology:

We have to stop using it because the students are taking PMR and SPM – if anything happens, they (parents) will blame us... we feel that it was not really working in terms of outcomes

(S:4.3.00.3)

Interestingly, Mei was not only unenthusiastic about using the technology but also reluctant to commit herself to technology use in the near future: “Really cannot say if I’m going to use it (in future). I don’t know” (S:20.2.00.1).

[Note: Mei’s profile is typical of a resistor to the innovation. Resistor profiles were found in all the case study schools although the number of teachers with this profile varied. Teachers with these profiles had closed minds towards the innovation and gave all types of reasons and excuses for not adopting the innovation irrespective of whether the reasons / excuses were founded or otherwise.]

Summary

To summarise, field observations of the teachers revealed that they fell into five distinct types – trailblazers, beacons, strategists, ambivalent users and resistors.
Trail-blazing teachers were usually high profile innovators keen to experiment with technology in the classroom; their computer competencies were good and they exerted a great deal of influence over their peers. Teachers who were beacons were also in the technology frontline. They usually trailed after the trailblazers but were equally competent at computer and integration skills. However, strategic and ambivalent adopters of technology were usually less techno savvy and more preoccupied with efforts to handle the technology in the classroom. Consequently, they were less dynamic as opinion leaders and tended to fall in with decisions made by the majority in the group. The last profile that emerged from field observations was the resistor. Resistors were generally less receptive to changes, technologically less competent and tended to lag behind others in the technology adoption-diffusion process.

Table 6 below summarises the five profiles observed, as epitomized by teachers Shah, Ling, Chin, Anna and Mei.

<table>
<thead>
<tr>
<th>Name</th>
<th>Profile</th>
<th>Sex</th>
<th>Age</th>
<th>Subject taught</th>
<th>Forms taught</th>
<th>Academic qualifications</th>
<th>Teaching experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shah</td>
<td>Trailblazer</td>
<td>Male</td>
<td>45</td>
<td>B. Malaysia</td>
<td>2, 4, 5</td>
<td>Master degree</td>
<td>13 years</td>
</tr>
<tr>
<td>Ling</td>
<td>Beacon</td>
<td>Female</td>
<td>45</td>
<td>English</td>
<td>2, 3, 5</td>
<td>Master degree</td>
<td>24 years</td>
</tr>
<tr>
<td>Chin</td>
<td>Strategist</td>
<td>Female</td>
<td>40</td>
<td>Science</td>
<td>1, 2</td>
<td>Master degree</td>
<td>15 years</td>
</tr>
<tr>
<td>Anna</td>
<td>Ambivalent</td>
<td>Female</td>
<td>33</td>
<td>English</td>
<td>1, 2, 6</td>
<td>Master degree</td>
<td>8 years</td>
</tr>
<tr>
<td>Mei</td>
<td>Resistor</td>
<td>Female</td>
<td>38</td>
<td>Mathematics</td>
<td>2, 4, 5</td>
<td>Master degree</td>
<td>12 years</td>
</tr>
</tbody>
</table>
Towards developing a profile of the technology-using teachers

Different researchers have different ways of profiling technology-using teachers. Bliss, Chandra and Cox (1986) adopted a seven-point scale – favourable, critical, worried, unfavourable, antagonistic, indifferent and uninitiated – to categorize teachers based on their attitudes to technology.

Honey and Moeller (1990) grouped technology-using teachers according to their pedagogical beliefs and practices – those with progressive pedagogical practices and high technology integration, those with progressive practices but technology ambivalence, those with progressive practices but lack opportunity to integrate technology and finally, those with traditional practices and technological refusal.

Wolcott (1977) profiled teachers based on their stances towards change and technology use in schools. He used the term 'educator moieties' and identified two distinct moieties – the technocrats and the craft teachers. The technocrats, usually comprising administrators and academicians, have progressive attitudes and future-oriented perspectives, valued efficiency, rational decision-making, have clearly-stated goals and measurable outcomes, and differed greatly in world views from the teacher moiety who were more classroom-based and concerned with the practicalities of teaching.

Aquila and Parish (1989) also categorized teachers into technical or craft types. The former embraced change, new technologies and improvement whilst the latter resisted change, focused on the individual and placed more premium on utilitarian knowledge.
Saye (1994) used the terms ‘accidental tourists’ and ‘voyageurs’ to describe technology-using teachers. He likened technology-using teachers who detested disruptions to routines and used technology to reinforce old ways to ‘accidental tourists’ unwilling to surrender the pleasures of home life on trips. These ‘accidental tourists’ were in direct contrast to ‘voyageurs’. The ‘voyageurs’ referred to the French adventurers of 18th Century Canada employed by fur companies to transport goods to and from remote regions and were likened to adventure-seeking teachers excited by new technologies and determined to stretch themselves to new limits.

If the five categories of technology-using teachers described earlier are superimposed on a continuum of pedagogical practices based on Wolcott’s moieties, Saye’s voyageurs and accidental tourists, and Aquila and Parish’s cultural types, the resultant profile which emerges will be as represented in Figure 5 below.

![Figure 5: A continuum of technology-using teachers](image-url)
As Figure 5 shows, the profile of technology-using teachers drawn from field observations can be perceived as a continuum of pedagogical practices with two totally divergent worldviews at both ends. At the technocrat end of the continuum are teachers like trailblazer Shah and beacon Ling who are future-oriented and progressive and see technology as the way forward. These teachers are the voyageurs keen to explore technology in the classroom.

At the other end of the continuum are the craft teachers who remain deeply devoted to the traditional paradigm, sometimes at the expense of innovative technologies. Resistor Mei typified this extreme.

In between these two extremes are teachers like Anna and Chin who exhibited worldviews with varying mixes of traditionalist and constructivist mindsets. A point to note is that fieldwork suggests the teachers’ worldviews seemed to evolve and to change over time, as they experienced shifts in beliefs and mindsets.

This profile of technology-using teachers will be developed further in chapter 6. The next chapter examines the concerns of teachers directly confronted with the innovation in the school milieu.
CHAPTER 5

Report of findings: Technology adoption

This chapter adopts a three-pronged approach to examining the technology adoption process. Firstly, it tries to answer the research question ‘Have the teachers who attended the 14 Weeks’ In-Service Training Programme for Teachers of Smart Schools adopted technology-integrated instruction in the four case study schools?’ In attempting to answer this question, this chapter inevitably charts the progress of the technology implementation initiative as it taps into the teachers’ primary concerns regarding technology use within the research time frame. Secondly, this chapter also explores teachers’ levels of technology use via the CBAM’s LoU protocol. And finally, the chapter investigates the factors which impacted upon the technology adoption process in the school milieu.

Examining teachers’ concerns

Identifying technology adopters

In order to determine whether the teachers trained in the 14 Weeks’ In-Service Training Programme for Teachers of Smart Schools have integrated technology in their classroom instruction, their composite SoC profiles were examined to determine the two highest stage scores. If the teacher’s peak or second highest stage concern was Stage 3 or higher, then he or she was, as explained in Chapter 3, wrestling with management concerns and therefore, an adopter of technology (Maney, 1994).
Based on this line of reasoning, out of the 47 teachers whose concerns profiles were drawn in February 2000, the number found to have the concerns profiles of adopters was 18 (38.3%) as indicated in Table 7 below.

Table 7: Number of teachers with adopter profiles (February 2000)

<table>
<thead>
<tr>
<th>School</th>
<th>Number of teachers trained to teach with technology</th>
<th>Number of adopters (N)</th>
<th>(%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temasik</td>
<td>8</td>
<td>5</td>
<td>62.5</td>
</tr>
<tr>
<td>Rajawali</td>
<td>12</td>
<td>5</td>
<td>41.7</td>
</tr>
<tr>
<td>Gemilang</td>
<td>5</td>
<td>2</td>
<td>40.0</td>
</tr>
<tr>
<td>Sendayan</td>
<td>22</td>
<td>6</td>
<td>22.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>18</strong></td>
<td><strong>38.3</strong></td>
</tr>
</tbody>
</table>

*Arranged in descending order

As Table 7 above shows, Temasik had the most number of adopters (62.5%) in the year 2000 followed by Rajawali (41.7%) and Gemilang (40.0%). The school with the least number of adopters was Sendayan which had less than a quarter of its technology-trained teachers (22.7%) categorized as adopters.

In August 2001, a second snapshot of the teachers’ concerns profiles was taken to determine if the wave of technology adoption was cresting or ebbing. The number of adopters was found to have increased to 28 (77.5%) as indicated in Table 8 on the next page.
Table 8: Number of teachers with adopter profiles (August 2001)

<table>
<thead>
<tr>
<th>School</th>
<th>Number of teachers trained to teach with technology</th>
<th>Number of adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(N)</td>
</tr>
<tr>
<td>Gemilang</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Temasik</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Rajawali</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Sendayan</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>

*Arranged in descending order

Comparison of the concerns profiles suggests that the technology implementation initiative was on an upswing. Although the total number of teachers in the sample had dropped from 47 to 40 due to movement accruing from transfers, resignations and death, the number of adopters more than doubled from 38.3% to 77.5% within the research time frame. Thus, in answer to the first research question ‘Have teachers who were trained in the 14 Weeks In-Service Training Programme for Teachers of Smart Schools adopted technology-integrated instruction in the pilot smart schools?’, the answer appears to be a resounding ‘Yes!’.

Drawing composite concerns profiles

The SoCQ also allowed individual and group composite concerns profiles to be drawn so that more in-depth information could be gleaned via analyses of peak and mean stage scores.
Peak stage scores. Table 9 below shows clearly that the peak concerns of teachers in February 2000 were information concerns but that these had shifted to management concerns by August 2001.

Table 9: Teachers’ peak concerns in February 2000 and August 2001

<table>
<thead>
<tr>
<th>Number of teachers</th>
<th>Peak Stage Concerns of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 2000 N = 47</td>
<td>S0</td>
</tr>
<tr>
<td>(%)</td>
<td>10</td>
</tr>
<tr>
<td>(21.3%)</td>
<td>(25.5%)</td>
</tr>
<tr>
<td>Aug 2001 N = 40*</td>
<td>5*</td>
</tr>
<tr>
<td>(%)</td>
<td>(12.5%)</td>
</tr>
</tbody>
</table>

* Total citation of peak stage concerns exceed total number of teachers because some teachers had several stages with the same peaks, in which case, all peak stage scores were included as peak stage concerns.

This shift in concerns, captured via the two SoC snapshots, became even more pronounced when the concerns were arranged in descending order of importance as shown in Table 10 on the following page.
Table 10: Comparison of teachers’ peak stage concerns

<table>
<thead>
<tr>
<th>Teachers’ peak concerns in Feb 2000</th>
<th>Teachers’ peak concerns in Aug 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information (25.5%)</td>
<td>Management (42.4%)</td>
</tr>
<tr>
<td>Awareness (21.3%)</td>
<td>Refocusing (22.5%)</td>
</tr>
<tr>
<td>Management (14.9%)</td>
<td>Collaboration (20%)</td>
</tr>
<tr>
<td>Collaboration (14.9%)</td>
<td>Awareness (12.5%)</td>
</tr>
<tr>
<td>Personal (10.6%)</td>
<td>Information (12.5%)</td>
</tr>
<tr>
<td>Refocusing (10.6%)</td>
<td>Personal (12.5%)</td>
</tr>
<tr>
<td>Consequence (2.1%)</td>
<td>Consequence (0%)</td>
</tr>
</tbody>
</table>

As Table 10 above shows, the list of concerns in February 2000 was information concerns (25.5%) followed by awareness (21.3%), management and collaboration concerns (14.9% respectively), personal and refocusing concerns (10.6% respectively) and finally, consequence / impact concerns (2.1% respectively). However, by August 2001, management concerns topped the list at 42.4%, followed by refocusing concerns (22.5%), collaboration concerns (20%) and finally, awareness, information and personal concerns (12.5% respectively.) The picture which emerges is one of increased adoption. However, enhanced refocusing concerns suggests that teachers were looking at alternatives, a hint that not all was well and that intervention measures might be required. The impact concerns were low, probably because the teachers were novice users of technology who needed guidance and support from others (also suggested by the increase in collaborative concerns from 14.9% to 20%).
This finding is consistent with literature on technology adoption which states that new adopters often look to others for help (Nik Zaharah, 2000). The pattern of peak stage concerns which emerged is also consistent with the profile of concerns drawn from a separate and independent study of 74 smart school teachers in 12 pilot smart schools throughout Malaysia carried out at about the same time (Sathiamoorthy Kannan, 2001).

**Mean stage scores / profile analysis.** The teachers’ composite concerns profiles also allowed school composite concerns profiles to be drawn. To do this, individual stage scores were aggregated to obtain mean stage scores for the school as shown in Table 11 (for February 2000) and Table 12 (for August 2001). The peak and second highest stage scores are in italics. For actual stage scores, please refer to Appendices 7.1a–d (for February 2000) and Appendices 7.2a–d (for August 2001).

<table>
<thead>
<tr>
<th>Schools</th>
<th>S0</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajawali</td>
<td>70</td>
<td>86</td>
<td>85</td>
<td>87</td>
<td>76</td>
<td>88</td>
<td>84</td>
</tr>
<tr>
<td>Gernang</td>
<td>88</td>
<td>90</td>
<td>78</td>
<td>85</td>
<td>41</td>
<td>63</td>
<td>51</td>
</tr>
<tr>
<td>Temasik</td>
<td>77</td>
<td>81</td>
<td>85</td>
<td>88</td>
<td>43</td>
<td>74</td>
<td>81</td>
</tr>
<tr>
<td>Sendayan</td>
<td>78</td>
<td>86</td>
<td>86</td>
<td>73</td>
<td>44</td>
<td>76</td>
<td>78</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>78</td>
<td>86</td>
<td>84</td>
<td>83</td>
<td>51</td>
<td>75</td>
<td>74</td>
</tr>
</tbody>
</table>
Table 11 shows clearly that in February 2000, Rajawali and Temasik had composite adopter profiles (peak Stage 3 concerns), Gemilang was seeking information about the innovation and on the verge of adoption whilst Sendayan had strong personal concerns and was clearly a non-adopter. However, as indicated by the peak Stage 3 concerns in Table 12 below, all four pilot smart schools had become adopters by August 2001.

Table 12: Percentile mean scores of teachers’ SoC (August 2001)

<table>
<thead>
<tr>
<th>Schools</th>
<th>S0</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajawali</td>
<td>68</td>
<td>82</td>
<td>84</td>
<td>87</td>
<td>84</td>
<td>89</td>
<td>85</td>
</tr>
<tr>
<td>Gemilang</td>
<td>90</td>
<td>86</td>
<td>85</td>
<td>93</td>
<td>60</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>Temasik</td>
<td>92</td>
<td>91</td>
<td>89</td>
<td>94</td>
<td>66</td>
<td>80</td>
<td>91</td>
</tr>
<tr>
<td>Sendayan</td>
<td>73</td>
<td>88</td>
<td>89</td>
<td>90</td>
<td>80</td>
<td>86</td>
<td>91</td>
</tr>
<tr>
<td>Mean</td>
<td>81</td>
<td>87</td>
<td>87</td>
<td>91</td>
<td>72</td>
<td>84</td>
<td>87</td>
</tr>
</tbody>
</table>

To take the analysis one step further, when the mean stage scores from the first and second snapshots of the SoC are plotted on a SoC profile chart, the ‘growth’ of the innovation is charted. This is represented as in Figure 6 on the following page.
Figure 6: Comparison of aggregated mean SoC scores for the case study schools (2000 and 2001)

Figure 6 above reveals that the technology adoption process has undergone several interesting changes within the research time frame. Firstly, teachers’ concerns about the innovation have generally increased in intensity by the year 2001. Secondly, the overall concerns profile which emerges is one of increased adoption of technology use as indicated by the emergence of new peak Stage 3 concerns. And finally, the ‘tail-up’ in the concerns profile for the year 2001 sends a clear message that not all is well with the innovation and that appropriate intervention measures are called for.
In addition to the mean SoC profile for schools, individual growth profiles for the respective schools for 2000 and 2001 were also drawn to zoom in and to compare how individual schools fared in the technology adoption process within the research time frame. These individual school profiles are represented as in Figure 7 for Rajawali, Figure 8 for Gemilang, Figure 9 for Temasik and Figure 10 for Sendayan.

![Figure 7: Comparison of mean SoC scores at Rajawali (2000 and 2001)](image)
Figure 8: Comparison of mean SoC scores at Gemilang (2000 and 2001)

Figure 9: Comparison of mean SoC scores at Temasik (2000 and 2001)
The profile analysis provided by Figures 7, 8, 9 and 10 reveals that two schools -- Temasik and Sendayan -- had acquired a distinct ‘tail-up’ while Gemilang seemed on the brink of developing one too. The ‘tail-up’ sends a clear warning signal that teachers in these schools were seriously looking at alternatives and modifications to the innovation.

Follow-up interviews with randomly selected teachers at Temasik, Sendayan and Gemilang suggested that the cause of the ‘tail-up’ was due to dissatisfaction arising from problems with access to technology and disappointment over the first two releases of the software. All this will be dealt with in greater detail in the chapter on perceived problems.
Summary

To sum up, it is clear that the SoC was a viable means to tap into teachers' concerns to show where they stood in relation to an innovation. The stage score (SoC) interpretations provided a gestalt of teachers faced with the daunting task of pioneering technology-integrated instruction and reminded policy-makers that not all teachers were keen to acquire new skills and to teach in new modalities. For that is what technology-integrated instruction demanded of teachers – that they embrace a kinesthetic modality some may have little affinity for and little desire to acquire (Durost, 1994; Geisert & Futrell, 2000). By pinpointing teacher concerns, the SoC profiles actually paved the way for appropriate interventions to be put in place.

The strong interest in collaboration as highlighted by the concerns profiles was also an important point to note. It was almost as if teachers were saying: “I’d like to use the technology but I want someone to be near when I do it in case things go wrong.” Research suggests this to be a common sentiment among novice users of technology (Ray, 1991; Nik Zaharah, 2000). After all, research studies have often pointed to the fact that inter-psychological connections enhance intra-psychological learning (Vygotsky, 1978). Thus, creating new opportunities for collaboration among teachers may prove a commendable measure for policy-makers to consider in order to promote technology adoption. Such measures would provide teachers with avenues of support as well as forums for discussion and the sharing of ideas (Martin, 1993; Nias, 1991; Sandholtz, Dwyer & Ringstaff, 1993).
Exaining teachers' levels of technology use

To answer the research question ‘What level of technology use did the teachers attain?’, the teachers were interviewed based on a schedule adapted from the CBAM's LoU protocol (Appendix 3). These interviews, conducted via the branching format (Appendix 4) and focused interview technique (Hope, 1995), were held twice within the research time frame – in February 2000 and again in August 2001 – and triangulated with classroom observations. The results are tabulated as in Table 13 below:

Table 13: Teacher's levels of technology use

<table>
<thead>
<tr>
<th>Levels of Use (LoU)</th>
<th>February 2000</th>
<th>August 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>0 (Non use)</td>
<td>2</td>
<td>4.3</td>
</tr>
<tr>
<td>1 (Orientation)</td>
<td>27</td>
<td>57.4</td>
</tr>
<tr>
<td>2 (Preparation)</td>
<td>18</td>
<td>38.3</td>
</tr>
<tr>
<td>3 (Mechanical)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4a (Routine)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4b (Refinement)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5 (Integration)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6 (Renewal)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total N</strong></td>
<td>47</td>
<td>100</td>
</tr>
</tbody>
</table>

As can be seen from Table 13 above, none of the case study teachers were at LoU0 in February 2000. This was not surprising as all 47 teachers had attended the 14 Weeks' In-Service Training Programme for Teachers of Smart Schools and had, at the very least, minimal knowledge and involvement in the innovation.
Two teachers (4.3%) were determined to be at LoU1 (orientation) which meant that they were actively acquiring information about implementing technology-integrated instruction although they were still unsure when they would actually do so. When questioned, one of them said simply: “I don’t know” (S:20.2.00.1).

The majority of the teachers (57.4%) were determined to be at LoU 2, that is, they were preparing to use the technology. Some had even targeted specific dates for adoption. One said that she would start using the technology “…as soon as the smart school project (was) launched” (S:29.2.00:1). Another replied that she was waiting for more hardware and software to be put in place but “…the intention to use technology is always there…” (S:29.2.00:1). Yet others linked the date for adoption with the date for moving to their new, high-tech premises:

> when we shift to the new place, the (science) equipment can be attached to measure things and sent direct to computers… teachers can do programming… then, science and computer can merge… (S:19.2.00:1)

Focused interviews with the teachers suggested that about 18 teachers (38.3%) were already at LoU3 or ‘mechanical use’. Field observations supported this, showing teachers using the technology in superficial ways as they tried to cope with technical glitches. Most of the time, the teachers just integrated CDs into lessons, making few modifications or alterations. The general pattern of use among these teachers was disjointed, with occasional lapses into non-use. In a way, this was not surprising as the innovation was still in its first cycle and “individuals do not use an innovation for the first or even the second time as effectively and efficiently as they do after four or five cycles of use” (Hall et al., 1979).
By February 2001, the teachers’ general levels of use had shifted slightly upwards. No teacher was observed to be at LoU1. The number of teachers at LoU2 had also dropped from 27 to 11 (that is, from 57.4% to 27.5%). However, the number of teachers determined to be at LoU3 seemed to have increased substantially from 18 to 27 (from 38.3% to 67.5%).

Two teachers from LoU3 – Ling and Shah – also moved to LoU4a or ‘routine’ use. Ling found herself settled into comfortable routines with the technology quite early in the research time frame. Field observations showed her hovering towards LoU4b or the ‘refinement’ level of use but she was prevented from moving into these higher levels of use by her students’ low English proficiency and inability to engage in independent learning:

I tried a web-based project, a very nice project but they (students) found it difficult, so frustrating... difficult for them to put together. Also the pupils themselves lack of independence and motivation, I had to push and push...

(R:9.2.01.2)

Consequently, Ling stabilized her routine with the technology and remained at LoU4a till the end of the research time frame.

Similarly, Shah, too, was unable to progress to higher levels of technology use but for a different reason – he was asked to switch curricular subjects so often that he did not have time to familiarise himself with a subject long enough to move to higher levels of technology use. Thus, like Ling, he too ended up establishing a routine with self-created templates and subsequently made few changes in his pedagogy once this routine was established with his students.
To sum up, research findings showed a slight upwards shift in the teachers’ levels of use within the research time frame but this movement was limited. Once the teachers reached LoU3, they seemed overwhelmed by user-oriented problems and remained at that LoU till the end of the research time frame. This difficulty in moving teachers to higher and more sophisticated levels of technology use has also been noted by other researchers (Carstens, 1995; Hope, 1995; Sharifah, 2000). Conclusions drawn from analyses of both the SoC and the LoU further confirmed that the technology adoption process was on an upwards trend although the pace of adoption differed. Clearly, there were forces at work that impacted upon the technology adoption process in the four case study schools.

The discussion so far has described and charted the progress of the technology adoption process in the four case study schools. However, it is not enough for qualitative studies to just describe something – there must also be an effort to “account for what we have given an account of” (Eisner, 1991) so that we may appraise the innovation and decide on future courses of action. Thus, the next section will highlight the factors that seemed to have impacted upon the technology adoption process. Field observations revealed that four levels of factors – policy, school, teacher and student level – seemed to have been especially potent in this respect.

Factors impacting upon the technology adoption process

Policy level factors

Shared vision. At policy or bureaucratic level, a key factor to promoting technology adoption is the formulation of a well-articulated, shared vision backed by the
setting up of appropriate measures to manage and nurture the innovation until it becomes part of the established culture (Finkel, 1990; Rowntree, 1974; Wiske & Zodhiates, 1988). Unfortunately, interviews with the teachers in the case study schools revealed that, for much of the academic year 2000 at least, the smart school vision was not that effectively shared with others further down the bureaucratic line.

Feedback from the grassroots implementers of the smart school vision revealed that many of the teachers were hazy about the finer details of the vision: “...the whole concept is too vague, too remote...” (G:12.6.00.2). Almost all the teachers expressed uncertainty about what they were supposed to achieve with the technology, given the lack of changes to the exam-oriented evaluation system in schools:

We need to acknowledge that we have the syllabus and we have the exam. How do we use it (technology) in order to achieve that (good exam results)?

(S:4.3.00.4)

A school principal observed that many of her teachers were confused about what they had to do:

“Sometimes I feel they themselves don’t understand the concept...”

(S:14.2.00.3)

When interviewed, several teachers readily admitted that they did not know how to translate the smart school vision into classroom reality. Many berated the MOE for the lack of clear-cut instructions and directives:
Show us how to use (the technology). Don’t tell us only. You (MOE) know your A-B-C-D... but we (teachers) need to be taught how to read; you know (how to form) the word but we need to be taught how to form sentences...

(S:4.3.00.6)

Some of the teachers felt as lost and swallowed up by the technology as the Tramp in Chaplin’s Modern Times. One lamented:

Presentation, presentation, what’s the point? To me, it’s a waste of time. Not one hour or two hours but HOURS... sometimes the whole day, girls also complain ‘What do we learn?’...

(S:14.2.00.3)

In fact, there was so little information about the smart school project that at one time, teachers were even uncertain whether it was on or off:

Sekarang, smart school dah lancar atau belum? Projek negara dah lancar atau belum? Komputer dah ada... Rugilah kalau tak guna. Apakah kita tunggu?
(Now, is the smart school launched or not, the nationwide project, is it launched or not? Computers are here... A waste if don’t use. What are we waiting for?)

(T:8.8.00.6)

Some wondered about the delay in the official launching of the project when all the hardware was already in place in the schools:

I don’t know what they want to ‘lancar’ (launch), smart school or ‘boleh guna lab’ (use of computer labs)... supposed to be (launched) last September, last April, then last August...

(T:8.8.00.6)
It is true that a great deal of the teachers’ confusion and ambiguity could be attributed to the delay in implementation caused by the economic crisis of the late 1990s. However, it is also true that the perceived lack of top-down transparency in the implementation of the technology initiative did not help. Some teachers complained about being kept in the dark about what was, after all, a national-scale project:

Don’t know what’s happening. MOE never tell us anything... I do not know what to say...

(G:5.6.00.1,3,7)

Throughout the research time frame, interviews with the teachers suggested that although many were aware of the implementation of the pilot smart school project, details about new software, curricular amendments and changes to the examination system were not shared and the exclusion of the teacher corps from these important decisions seriously impeded their commitment to technology adoption.

This finding that many smart school teachers actually lacked a clear understanding of the smart school vision is backed by the research findings of an earlier study which indicated that only 53.3% of 120 teachers surveyed understood the smart school concept (Siti Junaidah, 1999 in Mohammed Sani Ibrahim, Jamalul Lail Abdul Wahab, Mohd Izham Mohd Hamzah and Wannoh Katiman, 1999).

Perhaps a teacher best summed up the feelings of her peers when she said:

We are all fed up. Maybe they meant well but the vision has not been passed on. Somewhere along the line, the fire of the torch has been put out, so we're just passing on the torch without the fire, just the holder...

(G:12.6.00.4)
Appropriate support system. Another factor which adversely impacted upon the technology adoption process in the four case study schools was the lack of an appropriate support system for teachers involved in early adoption. Research on systemic change in education readily attests to the importance of this factor (Dwyer et al., 1991). Sadly, many teachers felt that they were not provided with adequate support, especially in the academic year 2000. A teacher commented:

We plan a vision and it's all worked out, but from point A to point B, nobody is helping us... we need to have the network up and running, we need more training, we have no courseware, we are running on pirated courseware, courtesy of (a teacher's name)... that kind of support which we don't have.

(R:10.7.00.3)

Another complained that "a lot of us on our own do things on our own (sic) the school should be doing..." (R:10.7.00.2). One expressed disappointment over the lack of top-down support: "We thought the smart school project will go on smoothly, (that) we only have to wait for software but..." (R:12.6.00.1). Even a school principal shook his head sadly over the lack of an appropriate support system for teachers to fall back on:

Readiness is the most important factor to push technology. Actually, teachers are always ready, you know. Historically, teachers are up to managing and on record, they're excellent in carrying on projects. I don't see great problems in the teacher community but it's readiness from the bigger picture. Are the systems ready? When we talk about the smart learning using computer as teaching facilities, as an enabler, are we ready with that, you know? Are the computers ready with the software? Are we ready with the backup? Breakdowns? The technical problems — are we ready? I mean, we don't have anybody in school... major problem... major breakdown, we rely on people outside and because we rely on people outside, we have to tolerate their timetables. They have other priorities...

(T:15.8.00.2)
After months of waiting for the MOE to take the lead, the teachers were horrified when they realized that the very people to whom they had looked to for support was instead turning to them for help:

We are waiting for them to give us the software and now the Consortium is hunting us down to produce the software. It’s a joke...

(R:1.10.00.1)

The attitude of certain ministry-level education officers added to the teachers’ perception that top-down support was lacking. A teacher described how her colleagues were called back by MOE to produce technology-based teaching and learning materials again and again but never saw the materials filtered back to the teachers who needed to use them:

We saved it on diskette... we gave her (officer from MOE) diskette so that she’ll copy for other teachers to use as examples but there’s nothing... and she didn’t even return (the diskette), not till now...

(T:10.8.00.1)

This perceived lack of bureaucratic support was an inhibiting factor to technology adoption and discouraged some teachers from even wanting to try out the technology.

When asked if she intended to adopt technology use in the near future, Mei replied: “See how lah. See how the top people, see how they organise it and all” (S:4.3.00.17).

The situation improved slightly in the academic year 2001 when more technical support was provided after Release One and Release Two of the smart school software were installed on the school servers in January and July, and a Help Desk was set up at the Educational Technology Division. However, teachers still expressed frustration over
the delay in technical assistance when glitches occurred. As a teacher so aptly put it:
"Repair must be immediate otherwise teachers (will be) demotivated" (R.21.8.00.6).

To sum up, the perceived lack of an adequate support system, especially in the early part of the academic year 2000, worked against the technology adoption process and resulted in many teachers turning their backs on technology.

**Funding.** Funding also impacted upon the technology adoption process in the schools. The problem of funding is a major one as technology requires a long-term commitment of funds (Brady & Barth, 1992; Finkel, 1990; Siti Suria Salim, 2000). Field observations revealed that all four case study schools grappled with this problem:

( Teachers want to download stuff, (want to) surf for information. Fine but we must have photostating facilities, printing paper, cartridges and ink... 

(G:12.6.00.2)

The principal at Rajawali explained how her hands were tied in this matter:

The per capita grant they give us is still the same, same like the non-smart schools. No changes, no difference, the launching fund they give us, same as the other secondary schools...we have...heads (students), funding is according to heads, the more we have, the more we get, so we're getting very minimum. And this fund covers all the teaching and learning materials for the students. A serious constraint for us. At one point, we had no paper, we borrowed from the primary school. We can do fund raising but it takes time to organise and to get the work force together. So many things to be done... 

(R.20.9.00.3)
In cases where external sources of funds were sourced, the technology adoption process proceeded more smoothly. Gemilang for instance enlisted the help of the local community to provide hardware for the school.

We had help from the community, parents’ support, a IT carnival to collect money to buy PCs, accessories, scanners, printers... The PIBG is very supportive, whatever we needed, they gave it...

(G:5.6.00.3)

At Temasik, the path to technology adoption was smoother partly because the principal was an energetic fund-raiser:

I’m used to this. I’m not new in the field of raising funds... (it’s) what I call ‘internal strength’...

(T:15.8.00.4)

In other words, the ability of schools to source for external funding affected the technology adoption-diffusion process.

School level factors

School leadership. At organizational level, school leadership impacted greatly upon the technology adoption process. The important role played by school principals in deciding the fate of innovations has often been highlighted in research studies. Weick for instance, talked about how heads of schools “stimulate initiatives to move in a common direction” (Weick, 1982). Other studies noted that technology was quickly adopted when school heads actively promoted it and involved teachers in the decision-making process (Brady & Barth, 1992; Hall et al., 1987; Khazimah Mustaffa, 2000; Maney, 1994; McCormick, 1992; Strudler & Gall, 1988). Field observations showed this to be true.
At Gemilang for instance, the technology initiative benefited from a principal who was driven by a technology vision and prepared to bend rules:

I am answerable to the parents, I’m going to force the issue, otherwise it’s (the technology project) going to be a white elephant, I won’t let the (computer) room be locked and turned into a white elephant...

(G:17.2.00.1)

The principal realised very early in the technology implementation initiative that she needed teacher support to ensure the success of technology projects (Willis, 1993) and thus actively sought out “technology champions” (Carstens, 1995) to help her realise her vision. She assigned one such person as the school’s IT coordinator and this person soon became a pivotal force in the school’s technology initiative. The extent of the principal’s influence is best summed up by a teacher who said: “What the Principal wants, we have to follow” (R:12.6.00.1). Under her leadership, the teachers of Gemilang were literally coerced into adopting technology. She herself was a good role model who constantly reminded the teachers to be ready for change:

We better be prepared – although we don’t know how far the exam system will change, if at all, (but we) still have to be prepared and start early...

(G:2.3.00.1)

Similarly, at Sendayan High, the principal realized that while a solid base of support might keep an innovation on an even keel, growth was unlikely to occur unless pressure in various forms and degrees of subtlety was applied. Consequently, she too ‘persuaded’ her teachers to adopt the technology. Her strategy was, however, more
subtle. Convinced of the value of praise in motivating teachers (Brady & Barth, 1992; Finkel, 1990; Wiske & Zodhiates, 1988), she took pains to single out techno-savvy teachers for recognition. A teacher described the positive impact of this:

She’s very, very good. She’ll come and see you personally and give you support, makes your day. I’ve never had that kind of thing with other HM. Once, I was teaching, she knocked, came in and said some nice things. She made it like I did something so good. I just thought I was doing my job. She could come down from the office, say something nice to me. I was in a daze the whole day...

(S:13.4.00.5)

Quite clearly, the principal’s public recognition of teachers’ fledgling efforts with technology increased their commitment levels.

To sum up, school leadership was an important factor in shaping teachers’ responses to technology. The principals’ attitudes and responses to the technology initiative sent out messages which influenced teachers’ inclinations to accept change. Generally, schools with pro-technology heads had more technology adopters among the staff.

**Availability and accessibility to technology.** Many researchers have cited this as a major impediment to teachers’ acceptance and integration of technology into their lessons (Becker, 1991; Brady & Barth, 1992; Wiske & Zodhiates, 1988). As the principal of Rajawali explained:
Of course, the physical environment is important, the infrastructure. As it is now, we’ve been open for nine months, not even LAN. The school (is) not wired up yet. The teachers come and talk to me but I tell them this is a policy matter. The teachers have been trained as early as 1998 and they know they are coming here. They had high hopes. Then they come here and see the facilities not available, they feel, well, they cannot make use of what they have learnt, let’s put it that way.

(R:20.9.00.5)

Lack of hardware seriously inhibited the technology adoption process in all four schools as teachers struggled to manage classrooms where students had to share computers:

There is only one of me. The students have different levels of skills and there is (sic) limited computers. One group can do work on the computer but there are other students and they all need monitoring and instruction. It is better that I give my students 100% of me than split my attention and time between one group at the computer and the remaining students at their desk... the facilities are so limited and our hands are tied... I asked how to overcome lack of networking... (they said to) copy diskettes... I suppose if you’ve nothing better to do...

(R:10.7.00.5)

Besides availability, the issue of accessibility to hardware was equally important. Research suggests that technology has a better chance of being integrated into the curriculum if it is located in the classroom (Watson, 1990). Field observations seemed to support this when technology use at Rajawali dropped drastically after the opening of extra classrooms led to several classes being without computers. A teacher explained:

(I) used to have PCs in my classroom but now, more classes are open and we have to book, so I cut down. Leceh! (Troublesome)...
Her colleague agreed:

I used to use computers every day when the classes sat in the classroom with computers. Now (I) have to book so (I) slow down.

(R:10.7.00.1)

Software was equally important. For much of the academic year 2000, the smart school software was not readily available and teachers depended on the limited CDs prepared by the Educational Technology Division. The software problem was somewhat alleviated with the first and second release of the smart school software but technical glitches still disrupted smooth use, especially for English and Mathematics. As the teachers were contract bound to use only the software developed by the Consortium for the first three years of the pilot project, the lack of availability and accessibility to software became major inhibiting factors to the technology adoption process.

School climate and collegiality. Research studies suggest that school culture affected the technology adoption process (Becker, 1994). Unfortunately, the traditional school climate – conservative (Chiew, 1999), with limited avenues for teacher collaboration (Lieberman, 1995) and generally more tolerant of the status quo than of change and innovation (Payzant, 1989) – is not conducive to technology adoption in schools.

Field observations revealed that school culture and ethos also affected the technology adoption process. Ling, for instance, attributed her enthusiasm for technology use at Rajawali to the pro-change and pro-technology culture prevalent there:
We have people who are quite high tech around here, we discuss, like, web pages, problems, that's why I enjoy here. Makes me go on... I have people who are of like mind with me...

(R:21.8.00.7)

It is the presence of such “like-minded” colleagues that encouraged Ling to explore and to experiment with new software:

(Shah) asked me to try a shareware (called) ‘Mark in’... students emails a composition and you can mark it, marking without a red pen. I’m going to try it out...

(R:18.6.00.2)

The pro-technology culture at Rajawali not only gave her emotional support but also provided her with an avenue for venting frustrations, sharing ideas and celebrating successes. This sustained her efforts at innovation and paved the way for the creation of core groups of like-minded technology champions (Carstens, 1995), multiplicative agents (Hodgson, 1995) and opinion leaders (Rogers, 1995) who will actually drive the technology adoption process. Almost all the teachers in the case study schools highlighted the importance of having colleagues with whom they could bounce ideas off as a key factor in promoting technology adoption.

Staff development opportunities. Continuous staff development activity was observed to be another plus factor in promoting technology adoption, as cited in many research studies (Brady & Barth, 1992; Maddux, 1991; Pantiel & Petersen, 1984). Field observations showed staff development activities conducted on a regular basis in the four case study schools. At Rajawali, 10 technology-based workshops were held in the
academic year 2000 alone while at Gemilang, sessions were held every alternate Saturday morning. The teachers were generally keen to enhance their technology competencies:

In a school like ours which is supposed to be a high technology thing, teachers should be well informed and well skilled to handle the technology. If they are not, they should get some training...

(R:21.8.00.9)

Interviews with teachers revealed that those who regularly attended staff development sessions were more confident and more creative in integrating computer use in the classroom.

**Syllabus mandates and time constraints.** Another important factor which impacted upon the technology adoption process was the curricular factor, in particular, syllabus mandates and time constraints. Syllabus-wise, some teachers perceived certain subjects as less suitable for technology integration. A clear example was Bahasa Malaysia for which the use of technology, especially web-based instructional materials, was generally perceived to be scarce and “of limited use” (S:18.3.00.1). Similarly, another teacher expressed her opinion that science should not be technology-based but experiment-based:

I feel it’s not so suitable... for Science, better for them to pegang (hold) ... hands on (is) more effective...

(T:8.8.00.1)

All these perceptions, justified or otherwise, affected the teachers’ decisions concerning technology adoption.
Time constraints is another facet of the syllabus factor. Time constraints have been constantly cited as inhibiting technology adoption in literature (Becker, 1991; Cuban, 1993; Dwyer et al., 1991; Marcinkiewicz, 1995; Salmah Yunus, 1994; Strudler & Gall, 1988; Wiske & Zodhiates, 1988). Almost all the teachers in the case study schools perceived time constraints as a major obstacle to technology adoption. A teacher explained how she was so discouraged by time constraints that she eventually gave up on the idea of technology use:

Initially I liked the technology, I find that I was so excited by it but I found that you need (time) to prepare. From experience, I find that you need to prepare so that you actually teach within that 80 minutes, (so) students learn something. You need to have different kinds of input. The smarter ones need to have certain activity, the weaker ones tend to be lost if you give them the same level of activity. Technology needs to be planned technology and that takes time. We (also) have to find the technology to help them pass the exam. That’s the constraint.

(S:4.3.00.2)

Technology-integrated instruction often required students to participate in problem-solving projects. In Singapore, the scope of the syllabus has been reduced by some 30% (Singapore MOE, 1998) to free time for in-depth investigations into research issues but this has not yet been carried out in Malaysia, at least not within the research time frame. The result is that teachers who wished to integrate technology into their lessons found themselves fighting a lop-sided battle against time constraints. The time constraints problem was felt in different ways:
We install (CDs) and that takes time. Training gives ideas but implementing ideas takes time, preparation to use IT lab takes time too...

(T:10.8.00.3)

Technology also took away valuable instructional time:

The thing is, to use it (technology), to actually use it in class would take a lot of time. If you have to ask them to browse in class, I think double period also not enough...

(S:16.3.00.1)

Consequently, many teachers ended up letting technology slide:

I don’t think I’ll use it (technology) lah unless I can finish my syllabus earlier, then I’ll think about it lah...

(S:16.3.00.1)

Even school principals advised their teachers to be cautious about technology adoption because they were not prepared to compromise on student performance outcomes. As one of them put it:

At the end of the day, people always judge us by how many per cent (passes) in each of the subject.

(R:20.9.00.3)

Perhaps ambivalent technology-user Anna has the last word when she said that:

(I won’t integrate technology) unless we have nothing else to do. I’m teaching 27 periods a week, 5 periods a day. Can you imagine the tons of worksheets I need to prepare, if I want to teach using technology? The task sheets, I mean. Then, if they use technology, I’m afraid they will not complete the task sheets. They’ll have no time, they’ll be handing up empty ones...

(T:15.8.00.1)
Teacher level factors

Teachers’ technology competencies. At teacher level, the technology adoption process in the four case study schools was affected by the teachers’ technological competencies. This is consistent with the findings of research studies (US Congress, OTA, 1988; Wiske & Zodhiates 1988) which state that the teachers’ low technology competencies, compounded by computer phobia and a lack of confidence, were major inhibiting factors in technology adoption (Geisert & Futrell, 2000; Heywood and Norman, 1988).

Interviews with the teachers revealed that many had rejected technology use because they felt they lacked the technological skills. Some were so lacking in confidence that they did not even want to think about the computer, much less adopt it. “I’m not very good at technology…” (G:13.6.00.2) was their usual lament. One teacher elaborated on her fears: “No, no, I’m not mechanically inclined… I’m not going to be able to create the stuff” (S:29.2.00.3). Another said:

By golly, I can’t see myself leading them into like Flash and Authorware, I don’t see myself being able to lead them in that direction… maybe students can fill in or somebody else can fill in…

(S:27.6.00.3)

Clearly, low technological competencies – perceived or real – inhibited the teachers’ inclination to adopt technology in the classroom.

Teachers’ perceptions of computer efficacy. Although research findings suggest that technology enhances learning outcomes (Kulik & Kulik, 1987), many
teachers in the case study schools were reluctant to fully embrace technology-integrated instruction because they were not convinced about the efficacy of computers in schools. Some cited research findings which pointed out that enhanced learning outcomes in technology-based classrooms stemmed not from the technology itself but from the pedagogy adopted with the technology (Thompson, Simonson & Gargrave, 1992). Consequently, many teachers preferred to adopt a ‘wait-and-see’ attitude. As Mei put it:
“... (even) if I don’t enter (computer) lab, lesson still goes on as usual. No problem” (S:18.3.00.1).

Some of the teachers’ doubts about the efficacy of computers stemmed from negative feedback from students. One student gave the thumbs down on technology-integrated instruction, saying that such lessons “…become slower and (we) actually don’t get what is actually the teacher are (sic) going to teach us...” (ISS: S11). Another told the teacher that she preferred “…something tangible, like structure, real stuff” (S:10.4.00.1). Consequently, many teachers regarded technology as a ‘filler’ which needed to be replaced by serious learning when exams approached:

> Exams are coming soon and I have to give them serious stuff. I find that with computers, sometimes, the children don’t take things seriously so now, I have to give them serious assignments... (R:10.7.00.2)

Okolo, Bahr and Reith (1993) also cited the lack of efficacy in computers as one of five major factors inhibiting technology adoption in their 10-year retrospective study on computer-based instruction in schools. Maddux et al. (1997) suggested that a possible reason for this lay in the “negative impact of inflated claims” which resulted from the
backlash of opinion against technology due to over hype, especially when examination results plunged, seemingly as a result of technology use, as happened in the case study schools:

(Teachers are) very worried. Maths results have dropped since February, March, April...

(R:18.6.00.1)

Witness how even a school principal had second thoughts about technology use after examination results dropped drastically:

The results plunged from 95 straight As in 1998 to 66 in 1999. I have to put a stop to this...

(S:29.2.00.1)

Mei explained her uneasiness:

When I give them (students) work, (they) look up information but when I give questions to answer, they cannot (answer). They print out information but they cannot read it, they cannot absorb it, cannot use it for recall... they just keep all the information...

(S:13.4.00.2)

Consequently, many teachers found themselves caught in the back swing of the pendulum syndrome when overly optimistic expectations alternated with disappointment and disillusionment (Slavin, 1989).

Teachers' previous experience with computers. The teachers' previous experience with computers also affected their inclination to adopt or to reject technology use in the classroom. Ling, for instance, had previously worked as a freelancer for a
software company and found that this experience helped move her beyond personal concerns and gave her mastery over the technology. Consequently, she was very comfortable with technology and willingly prepared technology-based show lessons for visitors, even at short notice.

Another teacher described how previous positive experiences with technology had also made her more receptive to technology use:

I'm very pro-computer technology... I did my first degree... and my final presentation was through video conferencing. I didn't get to see my lecturer. I was evaluated by a group of lecturers by remote control. I was in Malacca, I was (living in) Kuala Lumpur but the system was down, so (I) went to Malacca. It was a wonderful experience, that video conferencing... I would like to try it sometime with my students...

(S:7.3.00.2)

Her positive experiences had made her so pro-technology that she insisted students email assignments to her whenever possible:

I ask students to write reflections after every topic... took (them) some time to get used to it (emailing the reflections) but now that I've tried it, I'm glad I did it...

(G:12.6.00.1)

Client level factors

Students' response to technology. And finally, at client level, the students' response to the teachers' novice efforts with technology affected their decisions regarding continued technology adoption. For instance, if students responded negatively to technology-integrated instruction, the teachers soon rejected it. Conversely, when students responded positively, the teachers were quite unabashed about using the
technology as bait to lure students to class. Anna was won over to technology use by her
students’ enthusiasm:

Students like the PC; it’s new, it’s cool, it’s trendy, students love it.
They look forward to it every time...

(G:13.6.00.3)

Many teachers commented that their students paid more attention in class when
technology was adopted because they saw technology-integrated instruction as
“...something very different” (R:4.7.00.4), so much so that they often forgot the time
when engrossed in technology-based projects:

_Tak perasaan pun dua masa... Ini tengok, dia orang tak mahu
keluar pun..._ (Didn’t notice the double period. Look, they still don’t want to
leave the classroom...)

(R:2.5.00.5)

In short, the students’ responses to technology impacted upon the technology adoption
process by acting on the teachers’ morale.

**Parental support for technology.** Research shows that teachers tend to retreat
from innovations resisted by parents (Sheingold, Hawkins & Char, 1990). Interviews and
field observations suggested that this factor also affected technology adoption in the case
study schools. A teacher shared her experience:

One mother came to ask me, ‘What’s the _bestari_ about?’... I told
her about technology and self-directed learning and thinking skills.
She was not very receptive. She was more concerned about
whether it’ll prepare her child for the skills she needs to succeed in
exams...

(G:12.6.00.1)
Another parent related how she felt “pressured” into buying a computer for her son:

_Bestari_ causes pressure. Last year, I didn’t have Internet at home, pressure for my son and me, he feels the lack. Finally, I had to install, pressured to install, colour cartridge, scanner... it’s costly...

(T:21.4.002)

When these parents voiced their unhappiness to teachers, the teachers were discouraged from continuing with technology use. After a parent-teacher meeting, a dejected teacher voiced doubts that technology-integrated instruction would ever catch on:

Ideally, _bestari_ means students can sit at home and learn from materials posted on the web to learn. I don’t see Malaysian parents as ready for it. They want children out of their homes for a few hours...

(R:10.7.003)

**Conclusion**

To sum up, this chapter looked at the primary concerns of teachers involved in the technology adoption process, examined their levels of use of technology and investigated factors which impacted upon technology adoption in the case study schools. The results suggest that more teachers were beginning to integrate technology in instruction although levels of use remained low. A host of factors seemed to have been responsible for this.

At policy or bureaucratic level, the perceived lack of a shared vision seemed to have been a stumbling block as teachers proved discerning about the use of technology and only showed enthusiasm when they understood the vision, shared it to some degree
and had some say in its implementation. Inadequate support systems and financial constraints also inhibited the technology adoption process.

At school or institutional level, effective leadership, availability and accessibility to technology, the school climate or cultural ethos, staff development opportunities, curricular considerations and time constraints played key roles in promoting or inhibiting technology adoption. At teacher level, teachers’ technological competencies, perceptions of computer efficacy and previous experience with computers affected their inclination to adopt technology. And finally, at client level, the students’ responses and parents’ reactions to the teachers’ novice experimentations of technology seemed to have impacted upon the technology adoption process as well.

The interplay of all these factors is summarised in Figure 11 on the following page. However, while these factors explain, to a certain extent, why teachers in different settings responded differently to the use of technology in instruction, they are unable to account for variations in the responses of teachers within the same physical, cultural and technological setting where external factors like school leadership and access to technology are held constant. The factors are also unable to explain, why, after having initiated technology adoption, some teachers are able to sustain their efforts while others rejected technology soon after. This will be dealt with in the next chapter.
Factors at policy level:
1. Shared vision & information dissemination
2. Support systems
3. Financial allocation

Factors at teachers' level:
1. Technological skills
2. Previous experience with computers
3. Perception of computer efficacy

Factors at school level:
1. School leadership
2. IT infrastructure
3. School culture – collaboration, collegiality
4. Staff development
5. Curricular considerations

Factors at clients' level:
1. Parental support
2. Students' response

Figure 11: Factors which impacted upon the technology adoption process
CHAPTER 6

Report of findings: Technology diffusion

The diffusion of an innovation refers to its spread. Before an innovation can be fully institutionalised, it has to be diffused so that the majority in an institution accepts it. This means that if we wish to successfully implement technology-integrated instruction in schools, it is not sufficient for a mere core group of teachers to adopt it; efforts must be made to diffuse the innovation to others so that it will be more widely accepted in the school milieu.

This chapter investigates whether or not the teachers specially trained in the 14 Weeks' In-Service Training Programme for Teachers of Smart Schools acted as diffusion agents in the school milieu. It also describes the evolutionary phases teachers went through as they slowly moved through the diffusion process, and the problems they encountered. And finally, the chapter explores some of the factors that might account for variations in the teachers' responses towards technology, especially among those serving in the same physical and technological setting.

Passing the baton: Diffusion efforts

Research findings suggest that efforts to promote technology diffusion are generally more successful if there are teachers acting as technology champions to initiate other teachers into either novice, or continued, technology use in the schools (Carstens, 1995).
Field observations showed that most of the teachers who had attended the 14 Weeks’ In-Service Training Programme for Teachers of Smart Schools readily involved themselves in this aspect. These teachers formed an early ‘critical mass’ of technology users (Markus, 1987) who devoted time to help other teachers acquire technology skills as well as strive to improve technological facilities in the school milieu. A teacher at Rajawali even loaned the school her computer modem, scanner and printer.

In order to determine the extent of the case study teachers’ involvement in diffusion efforts, the teachers were asked, in an addendum attached to the second SoCQ administered in August 2001 (Appendix 2bii) to list down the number of times they had conducted or assisted in technology-related staff development activities. The results are tabulated as in Table 14 below.

<table>
<thead>
<tr>
<th>Involvement in technology-based staff development activities</th>
<th>Number of responses from teachers in schools</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>0</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1-2 times</td>
<td>3</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>3-5 times</td>
<td>6</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>More than 5 times</td>
<td>2</td>
<td>15</td>
<td>37.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11</strong></td>
<td><strong>40</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 14: Teachers’ involvement in diffusion efforts
As indicated clearly in Table 14, almost all the teachers who had attended the *14 Weeks’ In-Service Training Programme for Teachers of Smart Schools* appeared to have conducted technology-related staff development programmes in their respective schools, either directly or indirectly.

About 25% of the teachers reported having conducted technology-related training sessions at least once within the research time frame, 27.5% at least three times, and 37.5% more than five times. This means that a total of 90% of the teachers had participated in staff development initiatives to diffuse the innovation of technology-integrated instruction. As one of the teachers put it:

> In-house (activities) is running well, I cannot remember all the details but I remember I did (conduct in-house training)... All of us did...

(T:10.8.00.2)

Ling for instance, was observed conducting three multimedia workshops, on March 1, July 17 and August 21 in the year 2000 alone. She adopted a minimalist approach, teaching basic skills and encouraging teachers to use pre-prepared templates:

> I taught teachers how to use Hot Potatoes, templates, content-free. We don’t have to create our own templates, so we can fill in (the content) quickly...

(R:2.5.00.7)

Similarly, at Temasik, the case study teachers were observed participating in at least 10 in-house training sessions, both at school and state level, within the research time frame. At Gemilang, staff development activities were conducted every alternate Saturday morning. Sendayan, too, had regular in-house activities which were temporarily
put on hold when the school made arrangements to move to its new premises. When the 10% of teachers who had reported no involvement in any technology-related staff development activities were interviewed, they explained that they were merely awaiting their turns.

To conclude, questionnaires, interviews and field observations showed that the majority of the teachers who had attended the *14 Weeks In-Service Training Programme for Teachers of Smart Schools* participated in diffusing technology-related skills to their colleagues in the case study schools within the research time frame. Those who were techno-savvy conducted the training whilst those who were less technologically competent helped with the organizational aspects. In the words of one of the teachers who fell under the latter category,

> I have been giving in-house training to others – all the half-cooked teachers training the others, the reluctant training the rebellious…
> (G:21.4.00.1)

**The diffusion process**

**Evolution, not revolution**

Recent diffusion research described the technology adoption-diffusion process as "evolutionary rather than revolutionary" (Meyrowitz, 1995) and suggested that it was slow, better “...measured in years or decades rather than months” (Gilbert, 1996).

The SoCQ supported this, showing the teachers in the case study schools struggling with different concerns over time. Field observations also highlighted the evolutionary nature of the technology adoption-diffusion process, showing teachers
gradually becoming more comfortable with the technology, more proficient in its use and
more innovative in integrating it into lessons as time went by. Interestingly, instead of a
linear progression, the adoption-diffusion process seemed to comprise peaks, troughs and
plateaux as teachers' enthusiasm and efforts surged, ebbed and consolidated in turn.
Consequently, five distinct stages or phases were identified.

Stages of instructional evolution

Entry: Preparatory use. When field work commenced in January 2000, most
of the teachers were in the entry stage of the instructional evolution cycle, that is, they
were preparing to use the technology. Although fully aware of the innovation, they
reacted differently to it. Some were wary and uncertain; others plainly excited! The
former adopted a 'wait-and-see' attitude towards technology while the latter were caught
up in frenzied preparations—unpacking boxes, untangling cables, formatting disks,
checking out computers and generally trying to establish order in the new layouts in
classrooms and labs. This stage also saw many instances of "fire-lighting" (Passley &
Ridgway, 1994) when technology lovers tried to convince fence-sitters of the benefits of
technology use.

Early adoption: Novice use. After the initial excitement heralding the arrival of
the computers had somewhat abated, the teachers were observed experimenting with the
technology. They struggled with new hardware and software, technical glitches and
discipline problems. Mistakes and blunders were made but the teachers persisted in their
efforts. However, technology use was disjointed as teachers concentrated on problems
related to classroom management rather than on instructional innovation. Despite some spill-over novelty effect, the morale of teachers was observed dipping when teething problems associated with novice use of technology escalated.

Crisis: Learning to get by. As most teachers seemed to encounter problems grappling with the innovation after the honeymoon euphoria of initial novice use had settled a little, this phase is best described as the ‘crisis’ or ‘learning to get by’ phase. In order to cope with the multitude of problems at this stage, various strategies were devised by the teachers.

For instance, students were trained to troubleshoot and to handle technical glitches. At Temasik, the Cyber Brigade became so good at this that teachers even sent their personal computers to the students for repair. Another coping strategy was the setting up of a bank of backup lesson plans in case of power failure. At Gemilang, Chin even threatened to withdraw computer privileges when students misbehaved. All these strategies met with varying degrees of success.

The teachers’ experiences during this stage were crucial to determining whether or not they continued with their efforts at integrating technology. When their coping strategies failed, teachers were discouraged and the adoption-diffusion process entered implementation dips or troughs as teachers retreated from technology use, usually for short spells. These dips were especially prominent in the middle of the year 2000 due to perceived lack of top-down support and disenchantment with the technology: “Mula-mula rebut guna IT (Initially, we fought to use the technology) but now (usage) dropped because of empty promises” (R:12.6.00.4).
However, in instances when the crises were satisfactorily resolved, both the coping strategies and new instructional pedagogies were internalised into the teachers’ repertoires of skills.

Adaptation: Routine use. Once the storms and stress of the ‘crisis’ stage were over, teachers usually found themselves coming to new terms with the technology. The pace of use increased as routines with technology were set up although teaching remained essentially teacher-centered. A teacher noted:

You can actually see the students, really like the lessons and using the technology. They become so creative and they’re so motivated and enthusiastic…  
(S:18.2.00.1)

Thus, this stage was characterised by increased satisfaction for students,

Children look forward to (technology)... they are happy. They are very enthusiastic, so much so they cannot stop. Keep saying, “No, no, we are not ready (to hand in work), we want to do better”. I think it helps them with leadership skills and increases their motivation…  
(T:14.9.00.8)

as well as for teachers:

The advantage is the motivation... the students get so motivated... you need a lot of time to get a little skill but once you get the skill, you can use it in so many ways... if you have a very sleepy boy in the class, put him in front of the computer, he wakes up, what he does is another thing but he does wake up…  
(R:21.8.00.9)
Invention: Creative use. The final phase in the instructional evolution cycle is the invention stage when teachers moved away from routine use to more creative and innovative ways of technology integration. Just as in the 100th monkey phenomenon (a Japanese folklore which described how sweet potato became the staple diet of monkeys only after 100 monkeys had nibbled at it over many years), teachers who reached this stage experienced a turning point in their beliefs and attitudes towards technology, almost a psychological threshold so to speak, and became imbued with new mastery over the technology.

Sandholtz et al. (1997) described this stage as appropriation, when teachers used technology effortlessly to collaborate in new ways which made classrooms ‘buzz’ and come alive. Unfortunately, however, no teacher was observed comfortably settled down at this stage within the research time frame although there were times when Ling and Shah hovered here in the later part of the research time frame.

Summary

To sum up, most of the teachers seemed to have contributed positively to the diffusion of technology in the case study schools. The teachers actively participated in conducting technology-based staff development activities and were observed going through distinct phases in the diffusion process, encountering and resolving problems at every stage but more so at the ‘crisis’ stage. Successful resolution of problems led to internalisation of practices while unsuccessful resolution resulted in rejection of the innovation. This cycle of instructional evolution is represented diagrammatically as in Figure 12 on the following page.
Figure 12: Stages of instructional evolution
As no study on technology adoption and diffusion would be complete without an attempt to allow the respondents to share with the reader the experiences they went through, the problems they encountered, the pain they experienced and the pride they felt as they confronted the innovation in the school, this section makes way for the respondents' voices to be heard. To ensure that the voices offered as broad a perspective as possible, the voices of school principals and students were captured as well as those of teachers.

The voices of the teachers were captured via interviews and an addendum distributed in the second SoCQ (Appendix 2bi) towards the end of the research time frame, which required them to list down perceived problems or obstacles to technology adoption. The results (tabulated in Table 15 on the following page) indicated that the teachers perceived various problems as obstacles to technology diffusion in the case study schools. When ranked in descending order of frequency cited, the main problems were time constraints (cited by 80% of the teachers), lack of exemplary practices of technology (68%), student indiscipline (50%), lack of IT skills (40%), limited access to technology (35%), doubts about the efficacy of technology (35%), lack of confidence (25%), lack of collegial support (15%) and lack of support from the school administration (8%). These problems were encountered by the majority of the teachers during the research time frame but the list was not exhaustive as other less prevalent problems were also encountered in isolated cases. These will surface in the course of the discussion. Let us now hear the respondents speak.
Table 15: Teachers’ perceived problems of technology-integrated instruction

<table>
<thead>
<tr>
<th>PROBLEMS PERCEIVED</th>
<th>CITATIONS BY TEACHERS (N = 40)</th>
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<td>G</td>
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<tr>
<td>Lack of time</td>
<td>6</td>
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<tr>
<td>Lack of examples on how to integrate technology</td>
<td>4</td>
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<tr>
<td>into the subject taught</td>
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<tr>
<td>Student discipline problems</td>
<td>5</td>
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<tr>
<td>Lack of IT skills</td>
<td>2</td>
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<tr>
<td>Lack of access to technology</td>
<td>1</td>
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<tr>
<td>Doubts about the efficacy of technology-</td>
<td>2</td>
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<tr>
<td>integrated instruction</td>
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<tr>
<td>Lack of confidence to implement technology-</td>
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<td>integrated instruction</td>
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<td>Lack of support from colleagues</td>
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<tr>
<td>Lack of support from school administration</td>
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</tbody>
</table>

The teachers’ voices

Time constraints

Time constraints was the most pressing problem cited by teachers as they confronted the innovation in the classroom. This is consistent with other research studies which identified time as the critical factor affecting teachers’ decisions regarding technology integration (Wang & Chan, 1995).

One teacher explained:
But (technology) takes so much time... sometimes you get so much more done if you just use chalk and talk...

(T:14.9.00.9)

Another described how she had difficulty covering her syllabus after she began integrating technology into instruction:

We tried (integrating technology) this year... (we were) left behind, one-and-a-half chapters behind... it's related to technology because we're following group paced (which requires) more time for exploration...

(T:21.2.00.2)

At Temasik, Anna observed:

(technology) ... drag the lesson too long... (because students are) very competitive (and) want to produce excellent work

(T:28.7.00.2)

Time constraints were also experienced at Sendayan. A teacher voiced her frustration and concern:

We started fully with the IT and the new (smart) syllabus and all that and sad to say, we couldn't finish the syllabus. We couldn't finish the syllabus and it's two-and-a-half topics (left behind). Altogether, we had six topics to finish in Form One and two and a half topics were not finished. We just couldn't finish... it's that slow... a lot of things to cover (we) tried our level best to finish and we couldn't. And the Form 2 syllabus is worse, it's the longest (syllabus) of the three years, so now, the major topic (in Form Two) and another two topics (from Form One) have to be covered this year. So, it's going to affect the Form 2 syllabus now...

(S:30.3.00.3)

This problem was aggravated by the fact that some teachers did not have personal computers and could not prepare instructional materials at home:
I have the idea, it's just that I don't have the time to implement it, time meaning I have 10 classes, so I don't have time during school time to prepare... I still don't have any Internet (at home), so I can only prepare in school... when are free (sic), have relief classes; stay back in the afternoon and sit down a moment, start co-curriculum... We are busy...

(G:12.4.00.1)

And even when computers were available in schools, teachers were not given release time to access the technology:

(I) can use the Internet in the teachers’ room, it's free, but I seldom go because I have work to do...

(G:13.6.00.3)

The picture which emerged from field observations was that of a group of extremely over-worked and tired teachers in the case study schools, the majority of whom were functioning in survival mode. Comments like “I’m tired out” (G:13.6.00.5); “I’ve no time... it’s just do this, this and this” (G:12.6.00.2); “...I’ve stopped using technology for the time being. Rushing, rushing, rushing to finish the syllabus” (S:16.3.00.1) and “Too much exams... no time for technology” (R:18.4.00.3) were commonly heard.

The problem of time constraints was exacerbated by the fact that teachers shouldered a myriad of responsibilities besides teaching. At Rajawali for instance, teachers stayed back almost every day of the week – Monday was Staff Development Day, Tuesday was Academic Day; Wednesday was Weekly Meeting Day and Thursday was Co-Curriculum Day.
As a teacher put it: “...time is a big problem, where got time for technology?”

(R:25.4.00.2). Clearly, time constraints was a serious factor acting against the diffusion process.

Lack of exemplary practices of technology

The next problem that emerged clearly from the teachers’ voices was the lack of practical, exemplary practices of technology that could be implemented in the classroom. Interviews with the teachers revealed that many did not really know how to effectively integrate technology into their respective subjects. Mei voiced her problem:

I really don’t know how (to integrate technology into classroom instruction), only can (ask students to) find list of this and that only, for example, Trigonometry, other than that, I also don’t know...

(S:20.4.00.1)

Chin was equally frank. She admitted: “Honestly, I still don’t know how to plan using a lesson on Internet” (G:3.7.01.1). Her colleague ruefully agreed:

We don’t have enough computer-based lesson plans. I don’t really know how to use computers to teach...

(G:13.6.00.8)

Several teachers even took the MOE to task, pointing out that the 14 Weeks’ In-Service Training Programme for Teachers of Smart Schools should have provided teachers with more exemplary practices of technology which they could emulate when teaching their respective subjects. Instead, the teachers complained that many course facilitators did not even bother to use the technology themselves during the training programme:
(the course was) disappointing... I was expecting the lecturers are practising the bestari (smart school) ways and I can emulate (them)... I'm disappointed, they not practising what they teach, they have no examples of bestari work, they are not bestari ...

(L:19.8.99.1)

Ling too talked about the dichotomy between the ideal state that was propounded during training and the harsh realities found in the school milieu:

The course was very ideal but when we come back to the school, we land with a bump, you know, on this earth. It’s not that well equipped and we face constraints like exams, and there’s nothing we can do about it... so we try to, what do you call it, compromise lah...

(R:29.8.00.3)

The teachers’ desire for exemplary practices of technology-integrated instruction to benchmark against has been highlighted in various research studies (Gilbert, 1996; Lee, 2000). Gilbert’s (1996) study, for instance, confirmed that teachers were more likely to embrace technology if there were good practices for them to emulate. Watson (1993) also blamed the lack of exemplary models for uncreative uses of technology which “complement rather than change” existing pedagogical practices in most schools.

The need for exemplary practices in the case study schools was best summed up by a teacher who said succinctly:

I’ve learnt the how, but not the actually using it in the classroom. I know what it is, what it can do but how do I use it, teach, that would be the next step...

(S:27.6.00.4)
Student indiscipline

The third most commonly voiced problem was student indiscipline. Most teachers readily acknowledge that there is a greater element of disruptive potential inherent in technology-integrated instruction than in traditional instruction because computers divert the teachers’ attention from students at least part of the time and require the teacher to surrender, at least for short periods, control of the classroom. A teacher summed up this dilemma when she said:

It (the technology) is nice and interesting but difficult to handle the class because in my class of 30 students, when they sit in groups of 3 or 4, one person would be doing the work, the others would be chit chatting or else, very busy distracting their friends, do this and do that... the class become very noisy and when they find something, they become very excited and they call their friends and they’ll be jumping from one station to another station, you know, from one PC to another looking at friends’ work... after one class, you’ll find yourself very exhausted... (G:12.4.00.1)

Another teacher added: “If they listen (and) do this when I say ‘do this’, (it’ll be) ok... but they don’t listen” (G:13.6.00.5). At Gemilang, Chin readily admitted to difficulty in controlling her students whenever she tried to integrate technology into her teaching:

...it’s much easier to have them in class to do work (or) have them in the lab to do experiments rather than handle class in the multimedia room, I find that very difficult, to manage the lesson and to organise the students would take most of the time... (G:12.4.00.2)

Again, some teachers levelled criticism at the 14 Weeks In-Service Training Programme for Teachers of Smart Schools for not providing them with sufficient input on techniques of managing technology-based classrooms:
In the course, we were taught to do the package, when there’s no CD, we use the PC to learn Excel, Powerpoint applications, the IT part. We were not taught how to control the class. But we were not taught to control group by group, six groups, different pace. My class... one very fast, one very slow, four about the same. At the same time, the four groups will be calling ‘Cikgu! Cikgu!’ (Teacher! Teacher!)... (I) don’t know how to handle... (ii) all the pupils go through the same lesson structure, easier to control class and preparing materials...

(R:19.6.00.2–3)

To sum up, the teachers were reluctant to integrate technology into classroom instruction when they perceived that problems with student discipline might jeopardise the smooth progress of their lessons. As Mei put it:

Discipline is important. I see the students first, their discipline first. If I see that they are like very wild like that, I won’t bring them (into rooms with computers)...  

(S: 7.3.00.3)

Inadequate IT skills

Given the steep slope of the technology learning curve, it is hardly surprising that 40% of the teachers (as shown in Table 15) perceived their technology skills as lacking and voiced this as an obstacle to technology diffusion. A teacher expressed her frustrations:

(I’m) not skilled, (I) need help from others... If only we have an assistant...

(G:13.6.00.7)
Another teacher elaborated on the problem, emphasizing the need for teachers to have adequate technical back-up support in the classroom to ensure that lessons were not needlessly disrupted:

We don’t have a technician. We teachers are not technicians when it comes to all this, yet to a certain extent, we can handle it you know but certain things like fixing the Internet so that it’s online to six or seven computers, we try and cannot get through, we need a technician, isn’t it? We need a good technician to handle the whole thing. We can’t be all prepared to go to the classroom and something goes wrong and we cannot have the lesson on... I cannot be spending time to check out the problem... I always have this problem. I want to try things out but something goes wrong and I can’t... If only a technician is here, how wonderful it is.

(S:30.3.00.3)

The teachers’ anxiety over their low technology competencies was further compounded by the fact that so many things had the potential to go wrong in technology-based lessons:

Technology lesson, I feel like a lot of problems. PCs cannot use, no sound card, no video card. Simple problems but I cannot take. We need some good technicians. I’m wasting my time because it’s not running smoothly.

(S:23.5.00.1)

Lack of access to technology

Many teachers also encountered problems with access to the technological infrastructure in the case study schools. Although pilot smart schools were scheduled to have better IT facilities than other schools, these amenities were not completely put in place or made fully available for much of the year 2000. The lack of hardware meant that
computers had to be shared and this posed problems to teachers attempting to integrate technology into classroom instruction:

Teachers fighting to use the room and they cannot get the room because of time table clashes and that’s the time they want to use it so there are constraints to abilities (sic) to use the room. I wish we can have more so that teachers can have more access. We have to slot our times so there’s a lot of pre-planning and adjustment necessary...

(T:14.9.00.8)

Another teacher grumbled:

Only one PC, not enough. Maybe there’s LCD somewhere but I have to look for it, borrow it, waste time lah, students crowd round one PC, difficult...

(T:8.8.00.2).

At times, the lack of access to hardware even resulted in ill will among teachers, especially when some of them had to go through bureaucratic red tape just to access the technology: “...sign this form, sign that form, ah, forget it!” (G:15.2.00.1). Underlying the issue of access were more complex issues of trust and equity which sometimes led to, and created, tension and resentment among the staff:

Nothing can go wrong with... (the IT coordinator) where she’s (HM) concerned... He has so much power... If he’s not around, the room is closed...

(G:13.6.00.5)
The end result was bottled-up anger which led to occasional outbursts of frustration – “You know-lah; it’s his room. He’s in charge...” (S:13.4.00.5) – and even rejection of the technology:

We will use technology in the end when he’s (the IT coordinator) not so sensitive but at the moment, it’s his baby...

(G:25.1.00.1)

[Note: The tension over access to technology was particularly prevalent in schools which adopted the lab model of technology use – namely Temasik and Gemilang – but less obvious in the two-level ‘A’ smart schools which adopted the classroom model. This raises an interesting issue – perhaps the diffusion of technology-integrated instruction might be easier if computers were made easily available in classrooms rather than in labs.]

Doubts about the efficacy of computers in instruction

The teachers’ voices also revealed that many of them were plagued by doubts and uncertainty concerning the efficacy of computers in instruction. One teacher questioned the wisdom of introducing an extra element – technology – into lessons when students lacked even basic language skills:

The weak students, even if they surf, don’t know what to look for, what to pick out, what’s relevant, what’s not (relevant), waste of time to surf the Net, they don’t know the language (well)... I was teaching question tags... drills and drills but still they cannot do it. (I) taught again and again – is, are, isn’t he, aren’t he... (I even) speak (in) Malay to them... but even then, they cannot answer questions, so tell me, how can I just let them surf the Net?

(G:13.6.00.4)
Chin also noted that her students did not seem to derive any benefit from the integration of technology into lessons:

I'll achieve more if I stay in the class. (Technology) just make the subject more interesting. (Students) don't have the initiative to understand the subject. 'Macam tengok wayang' (like watching a show)...

(G:11.4.00.3)

Chin's experience was not an isolated one. Teachers at Rajawali had similar tales to relate:

When (students) use the computer, they are like more like playing, they don't listen to you, they don't really pay attention to the exercise you ask them to do, or they don't how to do... I think it's because when they use the computer, they are so happy, so excited when they go back, they forget everything... they forget to do the work... then sometimes, what they learn from the computer, they don't really understand... put them into groups... they copy the whole thing from the computer, they drag everything, the whole thing, then write word by word but I don't know whether they understand...

(R:30.8.00.1)

A teacher opined that technology-integrated instruction helped students acquire technology skills but not subject content:

I force them to write notes when they read tutorial... if not, they'll be clicking back and forth, because they like that particular piece of music. What they are learning is not the content, the ILO (intended learning outcome) not achieved, the learning outcome becomes how to click the mouse, (they) just click the answer to the question...

(G:3.7.01)
Anna too noticed this 'clicking syndrome': "The other class just click... click... click, don't bother to ask (questions)..." (T:19.6.00.4). She noted that her students wasted lots of time when they used technology to wander in cyber space:

A world out there full of information but get there not so easy. Most of the time, cannot get what we want. *Indah khabar daripada kata* (sounds better than it actually is)... students have high hopes but (in the end) very tired. I see that in my students...

(T:21.4.00.2)

Even trailblazer Shah noted that constant use of technology-integrated instruction seemed to result in de-skilling among students:

The students type on computer but in the exam (which is) paper format, find they cannot do. Could be lack of practice using pen and paper... part of it may be stupidity, lack of writing skills, reading skills, education is not an ABC thing... not sure if it's the computer but (I) believe it's part of the reason, slows down (learning)...  

(R:12.6.00.3)

In the end, many teachers wondered if the students learnt anything at all with the technology. One said,

Even when they (students) click correct answer, I don't know if they really know answer...

(G:2.8.01.2)

Consequently, even after the smart school software was installed, some teachers remained sceptical about the effectiveness, and cost-effectiveness, of technology use. Chin spoke her mind on this matter:
Yesterday, half the computers hanged because so many students accessed... (so) I could not conduct a lesson, they self-access and went to the virtual experiment on how to read a thermometer. Drag and drop thermometer to beaker of hot water and ice, and read the temperature. If we do (the experiment) in the science lab, it'll cost less than RM10 instead of the millions of ringgit on the courseware...

(G:23.4.01.1)

To sum up, the teachers' voices indicated that while an increasing number may have adopted the technology within the research time frame, many were not really convinced that it was an effective mode of instruction.

Lack of confidence to cope with technology

Another problem encountered was the teachers' lack of confidence in their ability to handle the diverse demands of technology-integrated instruction. For technology was demanding.

Firstly, there were technical glitches to cope with. These ranged from simple problems like viruses and disabled disk drives to system conflicts. Lightning surges disrupted technology use at Gemilang at least three times within the research time frame. Although technically the responsibility of the IT coordinator, the teachers were often left to resolve these technical glitches themselves. Thus, technology-using teachers had to be able to troubleshoot and think on their feet. At times, the problems seemed endless, so much so that some teachers wondered if the technology was worth the effort: "If not this problem, then that problem" (S:17.4.00.2).

Several teachers attributed their lack of confidence to inadequate IT skills to handle the multi-level tasking, simultaneity of activities and immediacy of response
required of technology-based classrooms. In the words of one teacher: “We have to keep switching our minds to help (the students)...” (G:2.5.01.4).

Then, there were problems with the software. Even after Release One and Two of the smart school software was launched, problems continued to haunt the teachers and to undermine their confidence in their ability to use the technology effectively:

We have the (English) software in the system but it can’t be launched, most of it anyway... and we can’t do anything about it... (T:18.8.01.1)

The teachers’ lack of confidence abated slightly with time and training but was never fully assuaged and remained a background problem throughout the research time frame as the teachers tried to acquire technological skills while “running after the syllabus” (G:10.002).

Lack of support from colleagues and the school administration

Rounding up the list of perceived problems and obstacles was the lack of support from colleagues. Fortunately, the number of teachers citing lack of support from colleagues was only 18%. Teachers like Ling readily acknowledged the crucial role that emotional support from peers and colleagues played in encouraging them in their technological forays:

(We) are very interested in what challenges have been brought by this new revolution in technology, we get excited when we see something new, try it together... (R:21.8.00.7)
And finally, last on the list of perceived problems was the lack of support from the school leadership. Fortunately again, only a small number of teachers (8%) perceived that there was a lack of support from the school head. Instead, comments like “HM is supportive...” (T:28.7.00.3) were often heard among technology-using teachers who cited that supportive principals motivated them in their adoption efforts by setting clear boundaries, crystallizing the school’s stand and altogether acting as a cohesive force to drive the technology implementation initiative in the respective schools.

So spoke the teachers. Let us now tune in to the voices of the school principals.

The principals’ voices

Semi-structured interviews (please refer to Appendix 5 for interview schedule) were held with the school principals to tap into their experiences with the innovation. Analysis of these voices revealed an interesting phenomenon, that is, all four school principals perceived the obstacles to the success of the technology implementation initiative as stemming from a single factor – readiness! Two major strands to the issue of readiness were identified – the teachers’ readiness to adopt the innovation and the system’s readiness to support their efforts.

The teachers’ readiness

The right mindset. The school principals perceived the teachers’ mindset or readiness for change as the main obstacle to the innovation. They were unanimous in
their opinion that technology could be institutionalised in the classroom if the "change-versus-homeostasis" equation was tipped in favour of the former.

'Homeostasis' is the tendency of schools to repel change and move back to previous states of equilibrium after being disturbed by external forces (Senge, 1990). For an innovation to diffuse effectively, the forces of homeostasis have to be overcome so that change may take place. Unfortunately, research findings suggest that computers sometimes tended to support stasis rather than encourage change in the educational system. Whitaker (1993) for instance, likened the homeostatic tendency in schools to an "inheritance factor" which made teachers reluctant to jettison inherited practices for new and untested modes of instruction. The principal of Temasik readily agreed:

The problem is NOT not having an appropriate smart classroom. In reality, the problem is getting students and teachers to use these facilities, (that's) the real problem. Overall, teachers will avoid using IT except for certain few learning activity. I mean, it's not in their culture yet. They don't see that it's natural to go there and use the facilities. IT is old in the world but in our system of education, it's new. And when it's new, there's lots of new things that we have to handle... Many of them don't find it so useful because they cannot yet utilize it properly. We have simulation rooms, (that's) not a problem. We can set up classrooms to give the teachers the opportunity to access the Internet, other facilities like OHP, audio thing... we can put there and other things in one room... not that much of a problem. But readiness, readiness is the most important factor to push technology (and) the teachers are not ready...

(T:15.8.00.1-2)
The principal of Rajawali also agreed, pointing out that the right mindset was crucial to the success of the technology implementation initiative:

(The) most important factor to ensure success is the teachers’ mindset must be right. They must be positive about it and on top of that, be prepared to go all out...  

(R:20.9.00.5)

To her, the right mindset could overcome all problems because

If you’ve set your mind to something, to learn something, you would do it, you would do something...

(R:21.8.00.9)

Consequently, all four principals in the case study schools strove to inculcate and to promote a pro-technology mindset among the teachers as they wanted them “to have the culture of IT” (S:18.2.00.1) and to move away from “the old way of doing things…” (T:19.8.01.3).

**Low morale.** The readiness of the teachers to adopt technology use and to diffuse it to others was also affected by the low morale of the teachers observed within the research time frame. This low morale affected their readiness to take up new challenges and to embark upon major changes in the school milieu. Initial interviews suggested that this low morale might be the spill-over from the down swing of the pendulum syndrome (Maddux et al., 1997), resulting from the delay and the scaled-down scope of the smart school project which, after all the hype and fanfare that had heralded it, did result in massive disappointment for many teachers.
Even a principal noted that her teachers were disheartened: "...sudah tawarlah (disillusioned)" (G:5.6.00.2). Another principal felt that the teachers’ disappointment and frustration were due to the numerous delays in providing schools with the software and learning packages. Interviews with the teachers confirmed that all these were factors which aggravated the low morale of the teachers. A disgruntled teacher said:

I was on the leading edge of technology when I was teaching outside. When I came to this smart school, it’s like I am in a cocoon. (The) closest to technology (in this school) is powerpoint...  
(R:10.7.00.3)

Another complained bitterly:

(There is) no such thing as smart school. Show me one. We told the whole world (of our smart schools) and we have nothing...  
(R:21.8.00.3)

However, by the end of the research time frame in mid 2001, another reason behind the teachers’ low morale had emerged – the demands the technology made on their time.

A school principal admitted that technology initially increased the teachers’ work load: “…they will feel that they are being overloaded…” (T:16.8.01.2). Interviews with the teachers showed this to be true. A teacher revealed how the technology had not made her work paperless but had, instead, increased the paper work:

(I) stay back till 4pm for at least two afternoons a week… (technology) is not paperless, it’s increased our burdens...  
(T:16.8.01.2)
Her colleague added:

(We are) fed up because have to spend hours in front of the PC to do all the things. I have to spend two afternoons a week to fill in lesson plans. What about attendance? We cannot rekod mengajar (fill in teaching record book) at home... if I have the same lesson on Tuesday, (I) cannot cut and paste it on Wednesday, (I have to) type everything in...  

(T:16.8.01.2)

Similar complaints were heard from teachers at Gemilang. Witness the following exchange as three teachers keyed their students' particulars into computers. The exchange clearly highlighted some of the reasons for the teachers' low morale:

A: Two hours just to key in two (student) profiles.
B: The person who designed this management courseware don’t teach I think, don’t understand our problems...
A: Not user friendly-lah. Cannot delete when we key in the wrong name.  
   Aliyah, I’ve given an Indian father to this (Chinese) boy... (burst of laughter)
A: I’ve given my boy two fathers... (more laughter). This is not the teacher’s job, clerk’s job...
B: You think they care?
A: If I have two years to finish the syllabus, ok! Two periods to cover what I usually teach in 20 minutes... And now this... (grimace)  
   (G:2.5.01.5)

Clearly, the technology made strong demands on the teachers’ time and this contributed to the decline in their morale.

A final point to make concerning the low morale of the teachers. An exacerbating factor appeared to be the debilitating impact of the contra reward loop observed in the school system which loaded hard-working teachers with even more work instead of rewarding them for their efforts. Little wonder that the teachers felt short-changed:
What did I get from the course? More work, more responsibilities, and not even a pat on the back...

(T:28.3.00.1)

Another teacher expressed her distress:

_Tak boleh tahanlah. Semua sekali sekarang jatuh balik pada guru sekolah_
(I can't stand it anymore. Everything now falls back onto the school teacher)...

(T:14.9.00.6)

Perhaps Anna got to the root of the problem when she said plaintively:

_Too taxing, this bestari thing. Because the focus is not more on the students, I mean, it's more on the teachers_

(T:14.9.00.6)

Over at Gemilang, another teacher complained that she was actually 'penalised' for attending the course:

(I'm) very upset... I do all these donkey jobs (but) don’t get appreciated... It's bad enough to be in a profession where you have to be defensive, have to fight even for respect. At least in the school, give me some recognition. Teaching 10 years, don’t tell me I haven’t contributed. I was so busy, holding so many posts, nobody wanted to go for the course so HM asked me to go, so I went. I have been teaching the upper forms before the course but because I went for the course, I have to teach Form One because they are the bestari classes... Then, because I teach Form One, I’m regarded as having less responsibilities and I don’t get promotion. I didn’t even ask to go for smart school (training). We all work so hard. A junior teacher got promotion, only confirmed last year... I feel penalised for going for that stupid course. The consequence of that, I have to teach Form One. I know it's over but I have to express how I feel... At this rate, I might as well leave...

(G:2.5.01.1)

Even techno-savvy Ling confessed to “running out of energy…”  (R:25.4.00.2).
Chin was equally, if brutally, honest:

Our contract is finishing. We are trying to get out of it, got nothing of this, no support. I want to run away... (I’m) too old to be doing all this, asking us to go to courses, attend workshop... nobody’s heart is in it... (I’m) very tired. We feel abused... treat us like a chess piece... so disheartened, we are an abused lot... we prepared, we prepared again... we never saw the package again, now they ask us to do it again... (we’ve) all decided that we’ll do what they ask but not put our heart in it... (other) teachers get the same pay... we (get) the Jabatan (Education department) breathing down our necks and implying we’re not doing a good job... If they ever ask us to leave our family again, (I) may even take no pay leave...

(G:8.6.00.1)

In a nutshell, the teachers’ low morale contributed to their lack of readiness and willingness to spearhead pedagogical changes in a committed manner. In a way, this research finding is hardly surprising as past research studies have often suggested that teachers whose workloads were increased without corresponding tangible increase in rewards usually suffered from low morale (Collis, 1988; Herzberg, 1966).

Cultural compression. Aggravating the teachers’ low morale was the cultural compression (Wolcott, 1973) that teachers were subjected to as they underwent intense, microscopic scrutiny from the constant stream of visitors to the case study schools. School records showed that in the year 2000 alone, teachers at Rajawali played host to visitors from Thailand, Bangladesh, Sri Lanka, Cambodia, London, the United Kingdom, Indonesia, Myanmar and the Philippines. Gemilang, Sendayan and Temasik were not spared the high ‘hit’ rate either. A principal conceded that the constant visitors were a problem and exacted a mental toll on the teachers:
Teachers do voice out problem with too many visitors as extra responsibilities. I cannot handle them (the visitors) alone so I need their help. We have several groups under different KJ’s (heads of departments) but I handle (the) briefing. Sometimes, in a week, we have 3 to 4 sets of visitors, sometimes every day. They want to have a look at the infrastructure and the type of teaching going on... we are the focus of attention, we are the show-case for e-learning and the smart school... when we are the show-case, then we have to show everything that we have in a case...

(R:20.9.00.5)

A teacher remarked candidly:

I feel sick... we have so many pelawat (visitors) every month, sometimes twice a day. We have 4 teams, 7 teachers one team, just to prepare for visitors ... (to prepare) special lessons using technology...

(R:18.6.00.3)

Another teacher described her discomfiture over constantly being in the limelight:

Are the bestari teachers running away? Tak enjoy (I don’t enjoy) my work since I became a smart school teacher. I don’t feel I could do what’s expected, everybody is looking at us, expecting us to do wonders, expect us to do everything, expect us to use our discretion, we want to run away...

(T:26.7.00.4)

The unwelcome attention and scrutiny led to added stress for the teachers – “We’re in a zoo” (R:25.6.00.6) – and made them hesitate about wholeheartedly embracing the technology in the school. Ultimately, this acted against the diffusion process.

Brain drain. The principals’ voices also warned of a worrying trend in the case study schools. As teachers upgraded their technological competencies, they found themselves increasingly sought after by the private sector. Hence, a subtle brain drain
occurred as techno-savvy teachers filtered out of the school system. At Rajawali, a teacher who had been trained to lead in the technology initiative left to join a public university. At Temasik, four star teachers left within a year – one joined a private software company, another assumed a post in a college while two were absorbed by private universities. This brain drain did not include the large number of teachers leaving the case study schools for further studies. A school principal expressed his frustration and helplessness to stem the brain drain:

We lose our best teachers. They go to the smart school projects, they join swasta (private sector). They apply for lectureship somewhere. It's a serious brain drain. It’s a real problem. The problem is especially serious in this school. Maybe it’s because this school is being focused by many sectors and many levels… This year, I’ve lost five ‘smart’ teachers out of those who went for the 14 weeks’ training. For English, we have only one (teacher) now. It’s a big problem, a very serious thing… (I’ve) so very little control over the problem. It’s a big problem and I feel astonished why this thing has been going on, you know, like that. It’s a very serious thing…  

(T:5.8.00.3)

The problem was compounded when the teachers who left were not replaced by similarly technology-trained teachers:

We are supposed to be leading school towards smart teaching and learning, and they’re not sending (IT trained) teachers, so teachers going out and no ‘smart’ teachers coming in and they send fresh (graduates), from the U. don’t know what to do… and I have seven Form One smart classes…

(T:15.8.00.4)

Interviews with the teachers suggested multiple possible reasons for the brain drain. However, a few pinpointed the technology initiative as the catalyst for leaving:
I cannot last at the rate I’m going, I’ll burn out. If the smart school project had been better implemented, I don’t think they’d lose so many teachers...

(T:30.3.00.1–3)

The school principals were in a dilemma as they were helpless to prevent teachers from leaving but duty-bound to try. A principal related his attempts to salvage the position by negotiating the time of departure so as to minimise the adverse impact on the school:

When they ask me, ‘Shall I ask this opportunity? Put in my application?’… I’ll say, ‘Why not? Don’t tell me you want to rot here.’… I tell them like that but this year, after so many going out… I told them, ‘The rest, well you have to sign MOU with me. This (leaving the school) will be done only at the end of the year. So then, we can reorganize and we can do the retraining very early…”

(T:15.8.00.3)

The system’s readiness

**Inappropriate evaluation system.** Apart from the teachers’ lack of readiness, the principals in the case study schools also perceived a lack of readiness on the part of the education system to support the technology implementation initiative. For instance, right till the end of the research time frame, the school evaluation system remained unchanged – exam-oriented and at odds with the liberal mode of evaluation advocated by technology-integrated instruction. This lack of readiness on the part of the system also made many teachers hesitate over technology adoption.
One such teacher demanded to know when the evaluation system would be revamped in line with the use of technology:

How about the exam? We were told (year) 2001, exam would be bestari style but (this has not happened)... we don't want our students to be victimised you know. We are doing (technology) fully, okay, we are going into all this thing, syllabus is definitely different but what's going to happen to our kids? Definitely, if they want to change the exam, major exam, they have to do something. We have to prepare the students. We don't want our results to be affected...

(S:30.3.00.4)

Another said:

Definitely we acknowledge that we need technology because of the era we are moving into but at the same time we have to acknowledge we also have a responsibility. Like our hands are tied. It's not that we don't want to but it's because of the exam system...

(T:15.8.00.1)

The school principals were equally worried:

At the end of the day, (students) would be assessed on the exam results. They have to fall back on the old system... They have to go back to KBSM, without utilizing full computer facilities...

Over at Gemilang, the principal commented: "As long as we have exams like now, we cannot really afford to use the technology..." (G:12.6.00.3). The principal of Sendayan observed: "It's the academic we have to worry about, otherwise the parents will be after us..." (S:26.2.00.1). Perhaps the principal of Rajawali summed it up best when she said:
The bottom line is exams – that’s the most important thing the school has to worry about. How many As, Bs or Cs the students get... The (Smart School) Conceptual Framework touches on evaluation but the evaluation there seem to be so ideal, you evaluate students according to their own pace but at the end of the day, you talk about PMR, you talk about that one shot kind of exam; fix the day, fix the time, whether you know, whether you don’t know, that’s it. Sit for it and carry the results for life, forever...

(R:30.9.00.3)

In other words, principals found themselves faced with a tough decision – they had to fit technology-integrated instruction into old mode exam-oriented classrooms. It was almost as if the policy-makers wanted to move with the times but were afraid to let go of the present system which had served so well for so long. There was little room for negotiating this deadlock.

The teacher appraisal system was another facet of the lack of readiness on the part of the education system which acted as an obstacle to the successful implementation of technology-integrated instruction. Traditionally, teacher appraisals exalted student performance and rewarded teacher compliance rather than the risk-taking and experimentation valued by the constructivist mode of instruction. Thus, teachers were disheartened when their performance appraisals followed this traditional mode and sidelined technology even after the pilot smart school project was launched. Listen to what a teacher had to say:

Head of Department came to observe me, specially asked me not to have PC, (she) wants conventional teaching, I don’t know why, she may be afraid that with PCs, won’t be much teaching, hard to evaluate us. They have a standard observation form given by the Department with lots of criteria which don’t touch on smart school way or technology...

(G:13.6.00.2)
To sum up, the principals' voices singled out the lack of readiness on the part of the evaluation systems – both student evaluation (public examinations) and teacher appraisal systems – as obstacles to the technology implementation initiative, pointing out that both had not been adapted to accommodate technology-integrated instruction. Retaining old modes of evaluation in new mode classrooms was akin to asking the teachers to teach the skills of tomorrow with the tools of today and the evaluation criteria of yesterday.

**Lack of support systems.** The education system was also not ready with appropriate technical, backup support systems. Although a Help Desk had been set up at the Education Technology Division by the end of the research time frame, help was not always forthcoming when the teachers needed it. A teacher related her experience:

We showed them (the Help Desk people but) no results, *siapa nak bertanggung jawab?* (who wants to be responsible?) ‘Help desk is 24 hours,’ they say *saja* (just talk only)…

(T:16.8.01.2)

Then there was the issue of the schools’ readiness to provide support for the security problems presented by the new technology. The principal of Gemilang expressed her concern:

Moral values are slowly decaying. *(Students today) are not afraid of the police because they have lawyers. They take advantage of the law because it can be manipulated. I worry (about the computers), I have that niggling thing ‘What will happen?’, I can’t be staying here (in the school after school hours) but of course, I worry. We cannot afford a fireproof room, we have to put our PCs in the prison to prevent theft…

(G:5.6.00.6)
The principal's fears were not totally unfounded as within the research time frame, arson occurred in the school twice. In the second incident, about 20% of the teachers' room was razed, the computer lab was totally disabled and several students detained for questioning ('What's happening in schools?' July 9, 2000). A few days later, a similar case of arson broke out at Temasik in the wee hours of the morning but fortunately, this was discovered before much damage was done (T:26.7.00.2). Cases of petty theft involving computer peripherals were often reported, including an instance when a brand new computer was carted away from the teachers' room at Gemilang in broad daylight (G:23.4.01.4).

To sum up, the gist of feedback from the principals in the case study schools showed that they perceived the lack of readiness of teachers as well as of the system as having a negative impact on the diffusion of the innovation. Despite this, however, they remained convinced that technology was an inevitable part of the future and thus continued to promote its adoption and diffusion. Perhaps the principal of Temasik best summed up the sentiments of his counterparts when he noted ruefully that:

The school is part of the nation and our nation is talking about technology and making sure our country is at par and competitive. We are moving that way. So, for good or for bad, we are going to carry on with the technology...

(T:15.8.00.6)

The students' voices

Thus far, research findings suggest that teachers and school principals had slightly different perceptions of what constituted the primary obstacle to the technology implementation initiative. The teachers' voices revealed that teachers perceived the time
constraints problem as central to the issue of technology adoption while the principals’ voices showed their worries were centred upon the issue of readiness. But what of the students’ voices? As the targeted end users of the innovation, the students’ voices also need to be heard and heeded before the innovation can be truly institutionalised.

Attempts to tap into the students’ voices were made via an interview schedule (Appendix 6) administered to 233 students in mid-August 2000. The results of the open-ended interviews (tabulated in Table 16 below) shows that the students had a wide range of opinions and perceptions of the innovation. However, one primary concern was uppermost in their minds – good academic results! Hence, it is only fitting that in this study, the vocalisation of their voices is heard via their responses to three key questions, all centred round the issue of academic excellence.

Table 16: Students’ perceptions of technology-integrated instruction

<table>
<thead>
<tr>
<th></th>
<th>Enjoyable</th>
<th>Difficult/ boring</th>
<th>Easy</th>
<th>Not sure</th>
<th>Effective</th>
<th>Creative</th>
<th>Waste of time</th>
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</tr>
</tbody>
</table>

*Total 143 (61%) 32 (14%) 11 (12%) 25 (11%) 19 (8%) 11 (5%) 8 (3%)

*Responses are based on number of times comment was mentioned, hence total may not add up to 100%
Do we have time for technology?

This was the priority question that emerged clearly from the students’ voices. Most of them were performance-oriented and wanted to excel in examinations. Although Table 16 indicated clearly that the majority of the students (61%) found technology-integrated lessons ‘enjoyable’, follow-up interviews revealed that many were concerned about the time expended on technology. Tune in to the following verbatim feedback from the students:

Group work with the help of the computer helps make group activities cool. But, we students seem to take up most of our time doing these work… (ISS:S12)

It’s kinda wasting time, decorating the pages, making it interesting… (ISS:S13)

It is interesting but sometimes (sic) it is a waste of time because there are not enough computers for us to use… (ISS:S14)

Not suitable for the Malaysian education system because it is time-consuming and we have a syllabus to catch up. We have too much syllabus to keep up with and computer work takes up twice the time the teacher can teach… Maybe the ministry might consider shortening the syllabus!! (ISS:S16)

It is more time-consuming: one has to master using the PC and the input we receive isn’t installed in our brains. The talk and chalk method proves to be more effective for understanding and memory based lesson… If this (technology) is to be implemented when I was in primary, I don’t see the problem. But now, it’s pretty tough because we have to keep up with the syllabus (sic) especially if we’re sitting for a ‘big’ examination, it sometimes takes a lot of time and energy, it is pretty hectic for the Form 3 and 5s… (ISS:S15)
In other words, feedback from the students’ voices revealed that although many enjoyed technology-integrated lessons, they worried about the time spent and were reluctant to wholeheartedly engage in it.

Does it work?

The students’ voices suggested that they would willingly embrace technology in the classroom if it improved their grades. Table 16 clearly shows only 8% of the students believed in the efficacy of computers in instruction. The voices captured below underlined their anxiety:

Sometimes it is fun to use computers for some subject such as English, BM. But not for the serious subjects like Math, Add Math, History that need more concentration and we must understand more about it. (ISS:S14)

It (computers) can’t really ‘teach’. It can only be used to type up work and do presentations. (ISS:T63)

When we write English essays, the computer will correct the grammatical errors. This will not train the students grammar… (ISS:T75)

I find that looking at the computer screen for a long time irritates my eyes and the information does not really sink into my head. (ISS:S22)

It’s fun but it might distract us from our studies, I think computers will only make us become lazy… (ISS:G36)

We should actually do the experiment rater (sic) than look for the results from the net or whatever… (ISS:G37)

We need to understand more and need to study first before facing the having a lesson using computer, while the normal lesson, we can understand more because all the points are being explained orally. (ISS:S14)
Using the computer, we have to think hard ourselves to find what is actually the teacher is teaching and it really pressure (sic) us when we failed to think properly. For me, I prefer the normal lesson that when the teacher just talk and talk and give us as much information we need and it make us understand better…

(ISS:S11)

Can the teachers do it properly?

And finally, as Table 17 below shows, the students’ voices indicated that about 25% of them had doubts about their teachers’ ability to engage in, and effectively manage, technology-integrated instruction.

<table>
<thead>
<tr>
<th></th>
<th>Management of learning</th>
<th>Sharing hardware</th>
<th>Time constraints</th>
<th>Technical glitches</th>
<th>Lack of IT skills</th>
<th>Clashes</th>
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<tr>
<td>*Total</td>
<td>58 (25%)</td>
<td>46 (20%)</td>
<td>29 (12%)</td>
<td>27 (12%)</td>
<td>13 (6%)</td>
<td>10 (4%)</td>
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*Responses are based on number of mentions

Listen to the students’ voices:

Most of the time it’s very disorganized. (ISS:G63)

We are actually the one who teach the teacher how to use or run the program… (ISS:S8)
I hate sharing with my partner! She conquers every single thing on the desktop and the teacher lets her!!

Sometimes is a waste of time and some teachers dunno how to teach (with technology).

The class is going to become more noisy and sometimes when there isn’t enough computers, people quarrell (sic) on who will control the computer...

I know it is unfair for me to say this, but most of the students already know how to use the computers and it gets pretty boring if the teacher decides to go slow for the other students who don’t know how to use the computer...

Teachers are too fussy and scared to let us use the computer because they think we do not know how to use it

Certain teacher become more draggy then (sic) ever

I think teachers are not very exposed to the wonders of IT and where it can lead us. It will be globally used but it might take quite some time (before) it goes in full swing in Malaysia and Asia...

Summary

To summarise in conclusion, this section tried to give voice to the participants directly confronted with the innovation in the school milieu by capturing their perceptions of the problems encountered. The obstacles which emerged from these voices were able to explain why different teachers responded differently to the innovation in different school milieus but could not really account for variations in their responses in the same setting. To understand that, we need to delve a little deeper – as we will in the next section – into the psyche of the individual teachers ‘shadowed’.
Variations in teachers' responses to technology in the same setting

A literature review into the reasons why teachers in the same school, enjoying the same physical, cultural and technological advantages, varied in their responses to the use of technology suggests that the most plausible factor lay in the teachers' innate predisposition to change (Harvey, Kell & Drexler, 1990; Honey & Moeller, 1990; Saye, 1994). Extensive observations of the teachers over a longitudinal time frame coupled with intensive interviews, reading of related literature and personal reflections upon the issue suggest that four factors might have played crucial roles in affecting the teachers' predisposition to change in the case study schools.

Teachers' belief systems

The first factor which possibly, and most probably, influenced the teachers' predisposition to change was their belief system. Research studies have consistently pointed to deeply-held beliefs as pivotal to change (Baldrige & Deal, 1975; Cuban, 1986), especially in places of great uncertainty like schools (Nespor, 1987). Field observations of the case study teachers indicate strong support for this proposition.

To understand the impact of belief systems on teachers' responses to technology, it is necessary to review the main tenets of two different instructional paradigms – the traditional and the constructivist. The traditional paradigm exalts the teacher as the sole leader and authority in the classroom, who holds the locus of classroom control in her hands as she paces out instruction. The curriculum in such classrooms is usually
presented in the form of discrete facts in teacher-centered fashion, with assessment focused on performance measured by student reiteration of facts.

The constructivist paradigm, however, advocates student-centered classrooms with less emphasis on structure and control, and encourages multiple sources of authority. Learners work side by side to solve authentic problems and assessment is focused on process outcomes.

When the case study teachers’ mental beliefs of what constituted good teaching practices were matched and compared against their responses to technology use, an interesting pattern emerged as there appeared to be a link between the teachers’ belief system of what constituted good instruction and their eventual preferred pedagogical practice. It was found that teachers who leaned towards the constructivist paradigm were more receptive to technology adoption. Typical examples were trailblazer Shah and beacon Ling who both had very progressive mental beliefs about the changes sweeping through the country and were keen to adopt technology in the classroom:

We know it (technology) is coming and we’re all looking forward to it...

(R:20.9.00.5)

In contrast, teachers like Mei who clung strongly to the traditional paradigm appeared to resist, and even to fight, technology use. Intensive discussions with Mei suggest that her rejection of technology probably stemmed from her mental belief system that good instruction is synonymous with telling and listening, as epitomised by the ‘sage on the stage’ spouting knowledge in front of the classroom. Consequently, Mei (and teachers like her) rejected technology because of her mental belief system that the old ways were best and that it was what students wanted:
These teachers preferred to teach as they themselves had been taught, persuaded by their belief system that this was what good instruction was all about:

I don’t see much use for technology. Students prefer the teacher-centred way, they like to be bossed around, told what to do...

In other words, field observations, interviews, reading and reflection upon this issue suggest that the teachers’ belief systems might be pivotal to influencing their attitudes towards technology. This factor probably accounted for variations in the responses of teachers towards technology adoption, especially among those teaching in the same physical and technological setting.

Risk tolerance levels

In-depth interviews with the case study teachers suggest that the second factor which might possibly account for variations in their responses to technology was their ability to take risks and accept challenges in the classroom. Doyle (1983) defined risk as the likelihood of being able to meet the standards by which a task is judged. Taken in this context, the risk factor in technology-integrated instruction refers to the teachers’ perception of their ability to meet the standards set by technology as they go about trying to achieve instructional objectives. Clearly, technology-integrated instruction has more
inherent risks than traditional modes of instruction since technology-based classrooms have many elements beyond the teachers’ control.

I posit a linear relationship between a teacher’s risk tolerance level and technology adoption as technology high-flyers like Ling and Shah appeared to possess high risk tolerance levels. These teachers were not discouraged by the uncertainties shrouding technology-integrated instruction; instead, they perceived technology-related problems as mere “hiccups” (G:9.4.01.1) to be ironed out.

On the other side of the risk tolerance coin is the challenge tolerance quotient. Both Ling and Shah were not only able to tolerate risks but also appeared exhilarated by the challenges of technology. Even Chin later reluctantly admitted: “(Technology) made me excited about teaching all over again…” (G:2.5.01.4).

Conversely, low-technology users were heard making comments like “(I’m) not an adventurous person…” (G:12.3.01.1) and “(I’m) full of inertia…” (G:12.6.00.3). Compare this attitude with a technology high-flyer who explained why she adopted technology-integrated instruction: “I thrive on challenges. I cannot imagine being on a plateau…” (G:3.1.00.1).

To sum up, field work suggests that the teachers’ risk tolerance levels affected their ability to handle the uncertainties inherent in technology-integrated instruction and affected their responses towards change and ultimately, technology use.

Teaching goals

The third factor that might possibly have affected the teachers’ predisposition to change and caused variations in their responses to technology lay in the teachers’
teaching goals. Many researchers have propounded a definite relationship between teaching goals and technology adoption (Ginsberg and Zelman, 1988; Saye, 1994). Intensive observations of the teachers at Gemilang and a look at the subsequent chain of events there seemed to support this proposition.

For much of the research time frame, teachers at Gemilang were observed struggling with student discipline problems. Teachers talked in hushed tones about suspected arson in the school in 1997 and 1999 (G:2.7.00:1). In early 2000, the car of the discipline teacher had been set alight, supposedly by students although this was never proved (G:11.4.00:4). Then, four students were mysteriously detained by the police for questioning (What’s happening in schools? July 9, 2000). Given this kind of a school setting, it is hardly surprising that some teachers at Gemilang were reluctant to adopt technology use as they worried about a method of instruction which required them to transfer the locus of control over to the students. Consequently, two different responses to technology were observed among the teachers.

One group totally rejected the notion of technology adoption because they did not want to relinquish classroom control. Their primary goal in teaching was to retain power and control over the students and they could not reconcile themselves to a pedagogy which required them to do just the opposite.

No technology! (Students are) rowdy, careless, rebel, have no sense of responsibility at all

(G:15.2.00.1)

Even when finally coerced by top-down pressure to bring their students into the computer lab, the teachers held tightly onto traditional pedagogies and continued with teacher-
centered instruction as they systematically moved students through the technology. In short, the technology was merely an add-on.

Another group of teachers, however, did just the opposite – they warmly embraced technology use despite problems with student discipline. When interviewed, these teachers revealed that their decision in favour of technology was primarily due to the fact that they had very different teaching goals.

If I don’t care about my students, I won’t do anything. But some of my students are very keen, they like it (technology) and have the potential. I still try to lay some foundation for them…

(G:8.6.00.2)

In short, these teachers adopted technology use because they saw that their students enjoyed playing around with the technology and derived benefits from it. Thus, despite the perceived discipline problems, they were willing to relinquish some of their control over the students in the hope that this would help the students.

In other words, the teachers’ responses to technology were influenced by differences in teaching goals – whether they rated retaining the locus of power and control over students in their hands as higher or lower than student empowerment and intrinsic rewards in teaching.

Technology quotient

The fourth factor which might have accounted for variations in the teachers’ predispositions to change and affected their decisions regarding technology use was their
technology quotient or ability to cut to the heart of the smart school vision and see the possibilities and potential offered by the technology.

Different teachers were observed experiencing differing degrees of difficulty in translating the smart school vision into operational goals, a task made more difficult by the fact that at the time of the research study, there was no concrete model of a smart school in the country from which they could model. Consequently, all the teachers had different notions of what technology-integrated instruction entailed and even where technology stood in the smart school equation. As a teacher put it:

Some say technology is *bestari* (smart). Others say drills are not *bestari* but nobody knows exactly what it is. Many of the teachers in my school think the package is *bestari*...

(G:12.6.00:2)

One teacher even decided that technology had no place in the smart school vision until she was persuaded otherwise by the school principal:

I felt that smart learning don’t need to be computer based. That’s what we were taught but here, the HM equate smart learning with computers. Like he said, if smart learning does not require computers, why does the government want to spend so many billions of *ringgit* on computers, all that hardware?

(T:8.8.00:2)

Yet others linked smart learning only with learning packages and were “...holding on to their packages like bibles...” (T:1.3.00:1).

Conversely, there were teachers who had clear technological visions despite the lack of models. One such teacher cut to the heart of the dilemma faced by teachers in the case study schools very early in the technology implementation initiative:
On the one hand, we have to finish the syllabus and (do) some work related to computers. Example, lens, (we) do the actual experiment and have software for students to explore lenses on the computer. Another school of thought (is) we teach lens, then students use IT to do presentations, graphs and to churn out some product. If we follow this school of thought, then, some schools can easily use IT. But I think we follow the first school of IT, I teach this part of the lesson, my IT also something to do with lens. But at this stage, we can only do the second school. Private schools are more down to earth; (they) go for the second option... no crying for software....

(S:17.2.00.2)

The presence of such teachers provided a locus for technology adoption in the schools. Their ability to grasp the smart school vision quickly and zoom in on core issues helped them come to grips with shortcomings and close the gaps between what was needed and what was possible. Besides acting as focal points to synergise attempts at technology adoption, their high technological quotient also made them technologically driven individuals who worked under their own steam. In this way, high technological quotients also affected and accounted for variations in teachers’ responses towards technology.

In a nutshell, four factors – teachers’ belief systems, their risk tolerance levels, teaching goals and technology quotients – appeared to have impacted upon the teachers’ decisions regarding technology use in the schools, possibly accounting for variations in their responses within the same technological and physical setting. These factors determined whether the teachers became the ‘accidental tourists’ engaged in conserving behaviours, or the ‘voyageurs’ who experimented with new modes of instruction highlighted by Saye in his study (1994).
Conclusion

To summarise, this chapter confirmed that teachers trained to lead in the technology implementation initiative helped to diffuse the innovation. It highlighted phases in the diffusion process, from preparation to early adoption, crisis, adaptation and ultimately, invention. The chapter then gave voice to the major players in the technology initiative so that they could recount the problems encountered in the schools. And finally, the chapter investigated the factors that caused variations in the teachers' responses to technology, especially among those serving in the same setting. Four factors were highlighted – the teachers’ belief systems, their risk tolerance levels, teaching goals and technological quotients. When this is superimposed on the profile of teachers developed in an earlier section (Figure 5 on page 110), a more complete profile of the technology-using teachers is drawn, as represented by Figure 13 below.

![Figure 13](image_url)

**Figure 13**: The continuum of technology-using teachers (revised)
In conclusion, suffice it to say that the technology diffusion process seems to be complicated as the teachers’ responses to technology appear to have been affected by the complex interplay of factors at bureaucratic, school, teacher and client levels, which were then subjected to a teacher filter of mental beliefs, diverse teaching goals, different risk tolerance levels and varying technological quotients. All these variables appear to have affected the teachers’ predispositions for change and resulted in them opting for preferred patterns of pedagogical practices, some of which will be described in the next chapter.
CHAPTER 7

Report of findings: Use of technology in instruction

This chapter examines teachers' patterns of practice with technology in the four case study schools. It begins by determining the frequency of technology use as reported by teachers and students, and then looks at the typology of technology use by the teachers. Sample lessons are also described. The chapter closes with feedback from the students regarding teachers' practices of technology in the schools.

Frequency of technology use

In order to determine the frequency of technology use in the case study schools, all 40 teachers in the sample at the end of the research time frame were asked to self-report their intensity of use in the second SoCQ administered in August 2001 (Appendix 2bii). The results were then tabulated and represented in Table 18 on the following page.

Table 18 shows clearly that the majority of the teachers (44%) reported using technology one to four times a month. Another 38% said they integrated technology into instruction one to four times a week. Only 8% claimed to use technology every day while 10% admitted they seldom used technology, not even once a month.
Table 18: Teachers' self-reported frequency of technology use in August 2001

<table>
<thead>
<tr>
<th>Teachers' self-reported frequency of technology use in classroom instruction</th>
<th>Number of responses</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every day</td>
<td>R 3 T 0 G 0 S 0</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>1-4 times a week</td>
<td>R 4 T 1 G 0 S 10</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>1-4 times a month</td>
<td>R 3 T 2 G 4 S 8</td>
<td>17</td>
<td>44</td>
</tr>
<tr>
<td>Very seldom (not even once a month)</td>
<td>R 0 T 3 G 0 S 1</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>R 10 T 6 G 4 S 19</td>
<td>39*</td>
<td>100</td>
</tr>
</tbody>
</table>

*One of the teachers was promoted to the post of full-time IT coordinator and had no teaching periods towards the end of the research time frame*

When this frequency of usage was collapsed into three main categories – namely high, mid and low level users – and the results tabulated, the picture that emerged (as shown in Table 19 below) was a preponderance of mid-level users (82%) with only 8% high-level users and 10% low-level users.

Table 19: Category of technology use (based on teachers' self-reports) in August 2001

<table>
<thead>
<tr>
<th>Category of use</th>
<th>Frequency / intensity of use</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level users</td>
<td>Every day</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>At least once a month</td>
<td>32</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Not even once a month</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>39</td>
<td>100</td>
</tr>
</tbody>
</table>


The teachers' self-reports confirmed reports made by 233 students in August 2000 (tabulated in Table 20 below) which indicated that in August 2000, there were 17% low-level technology users, 83% of mid-level users and NO high-level users.

Table 20: Frequency of technology use (as reported by students)

<table>
<thead>
<tr>
<th>Category of use</th>
<th>Frequency / intensity of use</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High level users</td>
<td>Every day</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mid level users</td>
<td>At least once a month</td>
<td>193</td>
<td>83</td>
</tr>
<tr>
<td>Low level users</td>
<td>Not even once a month</td>
<td>40</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>233</td>
<td>100</td>
</tr>
</tbody>
</table>

In other words, feedback from both students and teachers tallied, indicating that from August 2000 through August 2001, the majority of the teachers were mid-level users of technology. The next section attempts to put together a typology of the teachers' usage of technology in the case study schools.

**Typology of technology use**

To come up with a typology of technology use, the teachers were asked to specify their mode of technology use in the addendum of the second SoCQ administered in August 2001 (Appendix 2bii). The results were then tabulated and ranked in descending order of frequency cited, as shown in Table 21 on the following page.
Table 21: Teachers’ ranked, self-reported typology of technology use

<table>
<thead>
<tr>
<th>Rank</th>
<th>Profile of use</th>
<th>Citation of Use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Electronic presentations</td>
<td>92</td>
</tr>
<tr>
<td>2.</td>
<td>Internet</td>
<td>74</td>
</tr>
<tr>
<td>3.</td>
<td>Word processing</td>
<td>67</td>
</tr>
<tr>
<td>4.</td>
<td>Email</td>
<td>56</td>
</tr>
<tr>
<td>5.</td>
<td>Drills and practice (CDs)</td>
<td>41</td>
</tr>
<tr>
<td>6.</td>
<td>Desktop publishing</td>
<td>41</td>
</tr>
<tr>
<td>7.</td>
<td>Computer games</td>
<td>41</td>
</tr>
<tr>
<td>8.</td>
<td>Simulations</td>
<td>38</td>
</tr>
<tr>
<td>9.</td>
<td>Web-based instruction</td>
<td>38</td>
</tr>
<tr>
<td>10.</td>
<td>Tutorials</td>
<td>33</td>
</tr>
<tr>
<td>11.</td>
<td>IT as white board</td>
<td>33</td>
</tr>
<tr>
<td>12.</td>
<td>Spreadsheets</td>
<td>33</td>
</tr>
<tr>
<td>13.</td>
<td>Problem-solving projects</td>
<td>28</td>
</tr>
<tr>
<td>14.</td>
<td>Database</td>
<td>13</td>
</tr>
<tr>
<td>15.</td>
<td>Collaborative projects with other schools</td>
<td>13</td>
</tr>
<tr>
<td>16.</td>
<td>Video conferencing</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 21 above shows that the most common mode of technology use within the research time frame was electronic presentations (cited by 92% of the teachers), followed by Internet use (74%), word processing (67%) and email (56%). Drills and practices, desk top publishing and computer games tied for fifth place (41%) while simulations and web-based instruction ranked eighth (38%). Sharing tenth place was use of technology as a white board, tutorials and spreadsheets (33%). Then came the use of technology for problem-based projects (28%). And finally, bringing up the end of the list were database and collaborative projects (13%) and video conferencing (5%).
Patterns of practice

This section attempts to weave for the reader a pattern of teachers' practices with technology in the case study schools by describing actual lessons observed. These descriptions focus on four main uses of technology – as a productivity tool, teaching tool, networking tool and mind tool. It is important to bear in mind that the lessons described are not benchmark practices of technology but mere documentations of what was observed in real-life classrooms. However, it is hoped that their descriptions will stimulate reflection on the issue and pave the way for the notion of optimal uses to be crystallised later.

Technology as a productivity tool

Electronic presentations. As indicated clearly in Table 21, much of the teachers' practices with technology during the research time frame revolved around its use as a productivity tool. About 92% of the teachers reported frequent use of electronic presentations software, in particular, Powerpoint:

Students are quite used to this kind of thing. They're very interested. The good ones are good. One girl actually got pictures from the Internet and put it into her powerpoint presentation. She put in a lot of effort, the response was very good…

(R:29.8.00.2)

Witness the following Bahasa Malaysia lesson conducted in a simulation room at Temasik. The number of students was 25. 'T' refers to the teacher and 'S' the students:
(The simulation room, painted a calm shade of blue, was fully air-conditioned and well equipped. Whiteboards lined two walls. Shelves held the students' folios and task sheets. There was even a self-access corner and a cupboard for dictionaries. A 29-inch television set took pride of place at the front, presiding over the four stand-alone computers, the mobile COW (computer-on-wheels) and OHP. Tables and chairs were arranged in six clusters to facilitate group activities. The teacher started the lesson by asking the students the date.)

S: August 1.
T: Yes, August. What does August remind you of?
S: Merdeka! (Independence)
S: Holidays! (chorus of answers).
T: How old are you now?
S: Born in 1987.
T: Then how do you know about Merdeka?
(There was a show of hands.)
S: Books!
S: Sudirman's songs.
S: Internet!
T: Yes, yes... now I'm going to give you a task sheet about Merdeka — there are pantun, syair and peristiwa. Read them carefully and prepare a presentation on the computer on its meaning; include your reflection.
(The teacher gave more instructions. As she finished talking, the boys broke into groups and rushed to the computers. A few went to the adjoining room which was empty. They were enthusiastic and at ease with the computers. A boy opened a Word program and started clicking, drawing circles. His friends gathered round and offered advice.)
S: Make it a dull colour.
S: No, make it blue.
(In another corner, several boys read through the pantun as their leader keyed it into the computer, prompted on by another boy who heaped advice upon him.)
S: Take tools, change font, make it bigger.
(As he finished, his friends clapped — the slide was really quite well done.)
S: Click auto shapes.
S: What are you doing?
S: Give me, give me... let me show my professionalism. (He clicked on the rotating tool and tilted the arrow on the computer screen. The teacher walked from group to group. The students were hard at work — every group had one or two boys working at the computer while the others sat at the table and looked up the meanings of words.)
S: Let me and Faizal do on the computer.
(Tasks were delegated via the game 'scissors, paper, stone'.)
S: Ok, we start from this one. (A boy read the poem aloud.)
S: Ah, I know... independence is the result of other people's efforts.
S: *Canik!* (Beautiful!)
S: Ok, write down.
(A question sailed across the room.)
S: What's *panji*?
S: Read the sentence.
S: Spell it.
S: P-a-n-j-i.
S: There's a dictionary next door. *Ambil!* (Take!)
T: Remember, one representative to read.
(The boys selected their representatives.)
S: Me.
S: Me.
S: Let's *jiunkin* (toss for it).
S: Whoever can read better okay?
S: How to do shading?
S: Go to tools.
(The teacher helped a group struggling with the word *berkorban*. She pointed out that sacrifice did not necessarily entail death and threw them a question.)
T: What can youths sacrifice? How do they sacrifice?
S: When we sing *Negaraku* (national anthem).
(The others laughed. At the end of the period, teacher gathered the students round the TV set for the presentation.)
S: Us first!
(As the group went to the front of the class, the others dragged their chairs nearer.)
S: I'll handle the PC, you do the talking.
(As the boy Daniel started speaking, there was a good-natured jeer from the others.)
S: Why like this? Why are the words so light?
S: Slide show *lah*.
S: Sorry, used Word.
S: Powerpoint *lah*!
S: *Aiya*... didn't say so earlier. We did in Word.
(Daniel explained what was written on the computer screen as the others watched eagerly.)
T: Do you understand?
S: Yes.
T: Okay Ahmad, what do you understand by what was presented?
(Ahmad stood up and summarised.)
T: John, you explain what you understand.
(John talked about the torture experienced by people during the Japanese Occupation: "Tongue cut out, eyes come out", he mimed the action to the word.)
T: What other effects?
S: Money hard to get.
S: Economy.
T: Look at their presentation. Can you comment?
S: No flag.
S: Programme not suitable. Use powerpoint lah – so many slides.
S: Compare before and after Independence.
S: No conclusion.
T: How about the colour?
S: Cannot read.
S: Increase the font size.
T: Any other comments?
S: Grammar wrong.
(The students listened as teacher went through weaknesses in the content and presentation format)
S: Teacher, we want to make corrections.
T: Ok, hand up tomorrow.
(A student asked if he could put in sound effects so that students need not speak during presentation but the teacher reminded him that the computers in the simulation room had no speakers.)
S: Teacher, comment.
(The teacher offered suggestions for every presentation. When one student said, “See, I told you”, the teacher reminded the class that everyone had to accept criticism and comments positively. Lesson ended on a happy note as students hurried out after saving their work on diskettes.)

(Note: The above lesson was a typical example of the use of electronic presentations in the classroom. Such lessons were frequently observed throughout the research time frame. As there was no content inherent in electronic presentations, this use of technology has tremendous potential for developing leadership and creativity by serving as a scaffold for learning. This use of technology also encouraged the development of management skills as students negotiated and delegated tasks and duties, and voiced ideas and reacted to proposals. Notice how comments from friends often became prompts to modify, express and defend ideas. And more importantly, the students had fun...
in the process. Unfortunately, more sophisticated uses of electronic presentations like
graphing software were not observed in the schools within the research time frame.)

Word processing. As indicated in Table 21, word processing was carried out by
67% of the teachers and ranked third in the teachers' typology of technology use. Field
observations showed both teachers and students engaged in word processing tasks
frequently. At Temasik, students often stayed back in the Multimedia Room till late
evening to use the word processors. Likewise, the students at Gemilang, Rajawali and
Sendayan. The following is a description of a lesson in which Ling integrated word
processing skills to hone writing skills:

(The lesson was held in a classroom with six clusters of tables and chairs,
each holding a computer linked to a 29-inch TV mounted on the wall in
the front. As there were only 14 students, they worked in pairs and
three's. There was also a computer on the teacher's table. Ling's objective
was to hone writing skills via text reconstruction exercises she had
developed from the template 'Hot Potatoes'. She began by asking the
students their experiences with Internet Relay Chats. After ensuring that
they knew what 'ICQ' and 'chats' meant, she asked them to read a
newspaper article about con men who had preyed on unsuspecting Internet
surfers. She explained the meanings of words, and proceeded to test the
students' comprehension of the passage by asking questions.)

T: Whom did she meet?
    What did she do?
    What is the meaning of the word 'seduce'?
    What do you know about the man?
S: He is a con man.
T: How do you know that? Which word says that?
(This started a discussion on adjectives which led to a discussion on moral
values.)
T: Why did the girl fall in love with him?
    If you were the girl, what would you do?
(Ling then asked the students to access a file which had a summary of the
newspaper article but with key words blanked out. She gave instructions.)
T: The aim of this exercise is to develop your writing skills. Study the
passage carefully and fill in the blanks. Read the passage again and again,
look for contextual clues to help you. Try to recall information from the passage. Then type in the word you think best fits the blank. You can ask the computer for clues.

Initially, the students keyed in words at random, beginning with common articles like ‘a’, ‘an’, ‘the’ but as more blanks were filled and the passage began to make sense, they were observed scrutinising the passage in order to select words based on context. The students became totally absorbed in selecting words and identifying sentence structures. Suddenly, there was a whoop of joy.)

S: We’re first, we’re first (Quickly checked scores on the computer).

(When all the students had completed the exercise, they were asked to write a short essay on the steps to take to protect themselves on the Internet, using ideas from the passage. The students worked in pairs, one keying in sentences whilst the other contributed ideas and edited as words appeared on the computer screen).

S: Careful! Don’t tell your real name on computer.

S: You forgot ‘the’. (She inserted the word.)

S: Don’t trust a man.

S: Not man lah – don’t trust strangers.

S: Talk to your parents before meeting someone on the Net.

S: Talk or tell?

(A moment’s hesitation, then the word ‘talk’ was replaced with ‘tell’). The students worked at their essay while the teacher walked round. At the end of the lesson, they saved the work on a diskette and submitted it to the teacher).

[Note: Most teachers readily acknowledge the value of word processing in increasing the productivity of students involved in the writing process. In traditional writing classes, students sit and think about a topic, pen an outline and then try to develop it.

Writing and editing is tedious, slow and often messy, with words, phrases, whole lines and even paragraphs crossed out and inserts in all directions. Some students end up writing several drafts and spending hours on their work.

Word processing removes some of this drudgery by reducing the amount of time required. As a student put it: “I don’t have to waste my time writing and I could do my work faster” (ISS:G14). Word processing also makes work neater, more legible and better organised, and this facilitates the flow of ideas.
It also develops higher order thinking skills as illustrated in the lesson described above which showed students learning FROM as well as interacting AROUND it. The students had to scan the passage to catch the drift of its meaning, hypothesise on possible words to fill in the blanks and make choices. Immediate feedback forced them to reanalyse options and consider alternatives when these choices were rejected. This constant cycle of analysing contextual clues, synthesising information and choosing alternatives honed logical and critical thinking as well as writing skills, and enhances the technology as a tool for instruction.

Desktop publishing. Within the research time frame, about 41% (as shown in Table 21) of the teachers participated in desktop publishing activities in the schools. Students were observed selecting and preparing articles for their school magazines and bulletins, a process which required them to analyse and break down problems into small parts, make decisions as well as design creatively with technology. Although time-consuming, this practice of technology was described as mentally challenging and rewarding by the majority of the students interviewed.

Technology as a teaching tool

The white board. After the smart school software was installed in the school computers, technology was increasingly used as a teaching tool. The simplest example of this typology of use was when technology became simply a white board, a means to display information, a screen which students learnt from rather than learn with. The
following lesson – a Geography lesson at Rajawali – best illustrates this mode of technology use.

The 20 students were seated in six groups with a computer per group. The teacher’s computer was linked to an LCD panel which projected the screen onto the white board in front of the classroom. The teacher started by showing a slide presentation depicting symbols used to represent land use such as rubber, paddy, swamps, etc. She then asked them to access a file on the computers. A grid table flashed on. It was divided into three columns headed ‘topography’, ‘soil type’ and ‘vegetation type’ and was attractively laid out, with each column filled in a different colour. The teacher read aloud the information in the table and explained the characteristics of land use associated with each topography type. She used the computer like a whiteboard and then set the students a task – they had to come up with a mind map or concept map on the computer, explaining the importance of natural resources to a country’s economy.

The students soon settled down to the task at hand. They chose a leader to deliver the presentation. Then, some started sketching out the mind map while others looked up facts in the textbooks. There was an air of light-heartedness as the students moved around and peered at each other’s work. Jokes were bandied about and occasional bursts of laughter filled the air, but overall, the atmosphere was orderly.

The teacher walked round the classroom, helping students where necessary. Later, they took turns to make their presentations. At the end of each presentation, feedback was given and changes to the mind map made.

The teacher then summarised the main points of the lesson, again referring to the grid on the LCD screen. She collected the diskettes from the students so that hard copies of their mind maps might be printed and distributed for future reference.

[Note: The emphasis in the above lesson was on using the computer as an electronic whiteboard. Although this mode of technology use may be considered trivial by some people as the computer could easily have been replaced by a blackboard or OHP without adversely affecting the impact of the lesson, the technology nevertheless served an important purpose – it captured the students’ attention and turned the lesson into something high tech and ‘cool’. The technique of getting students to come up with mind
maps was frequently observed within the research time frame. While there was merit in
training students to create mind maps and thereby hone thinking skills (Gordon & Gill,
1989), no concept mapping software like MindMan, VisiMap, Inspiration and Activity
Map were used by the students who depended on limited word processing software.
However, what makes the above lesson really commendable was the fact that Geography
was not earmarked for technology integration in the first phase of the technology
implementation initiative and thus, the teacher's efforts were entirely her initiative.

Drills and practice. Computer-based drill and practice exercises were frequently
used by the teachers to reinforce skills after a topic had been taught, especially in
Mathematics. Below is an illustration of a lesson incorporating drill and practice
exercises:

The lesson started with a brief recapitulation of the previous lesson. The
students were asked to review the page entitled Imbasan Sejarah
(flashback to history) and then tested via simple, knowledge-level
questions. The teacher directed their attention to the graphical
representation of '25%' on a pie chart and explained what it meant. Later,
students accessed the drill and practice exercises in their groups, writing
down their answers – with the correct working – on separate sheets of
paper. Soon, the students were working earnestly together. They
discussed the mathematical problems and worked out the solutions.
S: Click on the answer lah.
The girl seated nearest to the computer clicked on the answer. There was
a jubilant cry when they saw that their answer matched that on the screen.
S: Saya tak dapat, macam mana? (I don't get it. How did you do it?)
The first boy looked over quickly at the paper with the working and spotted the student’s mistake.
S: 

* Ini salah, bodoh! (This is wrong, stupid!)*

The computer screen showed a score and advised them to move on to the next page where another short exercise followed. The students worked through the problems quickly as the teacher walked around, checking on the groups as they worked. She noticed a student having problems, glanced at his working and pointed out his mistake.

T: *Itulah yang salah tadi* (That’s where you went wrong just now).

As the exercises were self-paced, some groups finished earlier. They checked their scores on the computers and moved on. Group Anggerik completed both the drills on the computers ahead of the others.

S: *Habis, cikgu! (We’ve finished, teacher!)*

T: Self-access.

The student leader walked over to the self-access corner and picked up the task sheets for the day. She distributed copies to her group members who started working on them individually. When the bell rang to signal the end of the lesson, the teacher collected the answer sheets from the students.

T: Those of you who have not done the task sheets, please collect them from the self access corner and do them for homework. Any problems? No, then, you may go for rehat (break).

**Note:** Most teachers appeared comfortable with drill and practice software, especially ‘wraparound’ software which ran parallel to curriculum and textbooks (Snyder, 1986).

The students seemed to enjoy this mode of technology use because information was presented in a linear fashion and thus, easy to follow. Unfortunately, the exercises did not really accommodate individual differences as all students followed the same path of learning.

Drill and practice exercises have often been criticized for promoting rote learning and low level thinking skills (O’Brien, 1994; Salomon, 1985), and for fostering automaticity in students and trivializing subject matter (Vockell and Schwartz, 1992). They have also been slammed as boring (Geisert & Futrell, 2000). Several teachers at Rajawali agreed that such exercises were “dry” (R:27.8.00.1), especially since these exercises were based on behaviourist principles which emphasized skill reinforcement.
rather than new learning. Classroom interactions tended to follow a fixed sequence, that is, the computer initiates, the student replies, the computer evaluates and then the cycle starts again. Although about 41% of the teachers reported engaging in drill and practice exercises, many said they were not particularly enamoured of this use of technology.

Tutorials. Tutorials differ from drill and practice exercises as they are based on cognitive rather than behaviourist principles. They diagnose students’ skills before presenting information and testing their understanding, and follow this up with instruction to correct errors. In other words, the students learn from the computers.

Witness the following Science lesson conducted by Chin at Gemilang.

(The students filed excitedly into the computer lab which was equipped with 20 Internet-ready computers. As there were 31 students, they paired off.)

T: Every student must have a piece of paper. You may now log on.
(As the students excitedly logged on, an LCD panel projected the screen from the teacher’s computer onto the wall in front of the classroom. Using that as a white board, the teacher gave instructions on how to access the Smart School Programme.)

T: After you enter (the menu for) Science Form 1, wait. Be patient! Wait for your friends. (The students chattered excitedly.)
T: Access the topic ‘Heat’.

Any problems, put up your hand. You may use headphones.
(Immediately, a hand shot up – a student could not launch the program on his computer.)

You must all do the pre test.
(Some students wrote the answers on pieces of paper while others keyed the answers directly into the computer. A student moved the keyboard so as to get more space. Chin copied out several questions on the white board and directed the students to look for the answers as they went through the tutorials.

Question 1: What is heat?
Question 2: What’s temperature?
Question 3: List four types of thermometers
Question 4: Write a summary of what you have learnt
A student nudged her partner.
S: Salin nota tu, nanti cari jawapan (copy the notes, look for answers later.)
T: Don’t worry about copying the notes. Try to answer the questions.
S: Rising ni. (This is too loud.) The boy gestured to the headphone. Unfortunately, no one could figure out how to reduce the volume of the sound.
S: Dapat ini, sekarang mana pula? (Got that, now what?)
S: Teacher, teacher, is thermometer mercury a type of thermometer?
T: What does the computer say?
S: Teacher, what’s my password?
(There was a loud “clang!!” whenever someone clicked the right answer. The computer’s response to wrong answers was even more jarring — “like an alien”, a student noted. A student grabbed the headphone from his partner. They had to share as they worked in pairs.)
S: Aiyo, (the computer) so slow one.
(The tutorial taught students the correct way to read temperature. A thermometer was pictured, immersed in a beaker of water and heated gradually; the students had to record the temperature on the computer screen before and after the heating process. Several students finished answering the questions and asked for permission to access their email. A boy started exploring other sites.)
T: Those who have finished, send me an email and tell me your reflections on what you have learnt today.
A student was observed sending her email to the teacher: “Teacher (sic) you balas (reply) me, U know, please balas me” (G:2.5.01.4).
T: Boleh log off. (You may log off.) Just then, the bell rang.

[Note: Two points emerged clearly from the above lesson. Firstly, the students exerted less control over their learning as in the archetypal tutorial. Despite having their entry level skills determined at the start of the lesson, they went through the same tutorial, regardless of their entry level skills. Secondly, the computer controlled the amount of instruction, moving the students through the tutorial much like they would have been moved through a textbook with a human teacher. There were few opportunities for students to explore the software which followed a typically linear sequence. Consequently, there were limited opportunities to construct meaning. Instead, students merely digested inert information and selected from the interpretations posted on the
software. A further point to note about tutorials is that although only 33% of the teachers have adopted this pattern of practice (as shown in Table 21), this mode of technology use is likely to increase in the near future once the smart school software is fully ready.

Technology as a networking tool

Asynchronous communication: Email. Email was the most common form of asynchronous (delayed) communication observed in the schools within the research time frame. About 56% of the teachers (Table 21) reported using this means of communication to liaise with students. Anna mentioned that her students regularly emailed greeting cards to her during festive seasons. At Sendayan, a teacher interacted with her students regularly via email: “I ask students to do refleksi (reflections) in email and send to me. Then I’ll send back to them” (S:7.3.00.3). She explained that email helped her to know her students better and this transferred into better rapport in the classroom. Another time, when a teacher from Sendayan had to take emergency leave to care for her husband stricken with dengue fever, she emailed daily instructions to her students regarding class assignments (S:17.2.00.2).

A check on email exchanges showed that the majority dealt with the supervision of project work, calls to hand in assignments, scheduling of meetings, etc. There were no tutorial exchanges conducted via email within the research time frame. But the email did offer students personal access to the teacher and allowed them to vent their feelings on personal matters, thereby enhancing rapport and paving the way for more egalitarian participation in the classroom.
However, not all teachers liked using email. One described how she felt email to
be an invasion of her privacy:

I see technology as blurring the line between my workplace and
my home. For example, I’m supposed to email my students when
I’m at home. I’m supposed to relate to them and I have to set them
homework. I don’t like that, I don’t like that and I see that
happening increasingly not only in my workplace but also in all
our lives. That means, blurring of lines between what I consider
my work and what I consider my private life... I love my work
here but I won’t love my work if it’s an invasion. I’m not unhappy
about the changes. I realize they’re necessary. I’m going to a part
of the world and the computer is going to be there and I can’t run
away from it but I want to have control. I’m not willing to think
about technology the way the sellers of technology want us to
embrace it...

(S:27.6.00.1)

Thus, it would appear that the easy accessibility offered by email was a double-edged
sword. Apart from email, other forms of asynchronous communications such as bulletin
boards and list serves were not observed used by the teachers within the research time
frame. However, teachers like Ling subscribed to list serves for personal updates on
lesson plans.

Synchronous communication: Video conferencing. A video conferencing
session involving four schools in Malaysia and a school in New Zealand was held in
September 2000. Four students from Rajawali participated in the conference. As this was
a pioneer effort, the teachers helped the students prepare the script for the conference.
Students and teachers were observed, staying back after school almost every day for
about a week, discussing, writing, taking snapshots of the wetlands and scanning pictures
into the computer.
Obvious benefits were derived from the video conferencing session. One was the sense of unity and teamwork the students experienced as they collaborated on the project. Feedback from the students included “We enjoyed (the) teamwork” and “I learnt to cooperate with the other members and I learn to control my temper” (R:8.9.00.1). A student mentioned developing interpersonal skills and tolerance when working with team members:

I practised some people skills, like when someone says ‘I can’t come, well, I stay in… (far from the school) and I can come and I don’t understand at first (why others couldn’t come) but I learn to be more patient…

(R:8.9.00.1)

Another student credited the project with increasing her general knowledge – “I learnt from the conference…” (R:8.9.00.1). She expressed a sense of pride: “I feel glad I could participate in an international show… at least, I’m exposed to what’s happening about Christchurch” (R:8.9.00.2). A side benefit was the enhancement of ties between the school, the students and their parents:

When teacher told me, I felt like it’s nothing much. But my dad saw the Principal and she told my father I had been chosen and my father was very proud. I could see it in his eyes. I was so happy because he was happy. Other then my exams, I never see him so happy, he was so proud and he started to tell everyone about it…

(R:8.9.00.2)

The project also provided an opportunity for the students to get to know their teachers better:
I also learn to know my teachers better... she doesn’t teach me, I
never knew her but she was in charge of all this, I learn she was a
nice person when we work together. I learnt how she felt about the
project, but more about her. She was really concerned because we
had such a short period, a very caring teacher. I feel good...

(R:8.9.00.2)

Even students who were not techno-savvy became more comfortable with technology
after participating in the conference. One student said:

At first, exams were coming soon and I thought it would interrupt
my studies. I wanted to drop out but my teachers and friends
persuaded me. I learnt all this technology stuff... wasn’t interested
much at first, so I watched. Feel closer to computers now. And I
think it’s cool. You get to know other people better, closer ties to
other countries you wouldn’t know. It’s cool because you get to
see people on the screen and it’s different, one thing we learnt is to
speak with confidence in public. This will stick in my mind.

(R:8.9.00.2)

On a more cautious note however, it must be pointed out that many teachers had doubts
about the viability of using video-conferencing as a teaching resource due to the high
costs incurred and the cumbersome user interface. A review of research into some of
these initiatives confirmed this (Maddux, 1989). Riel and Levin (1990) stressed the need
for active commitment by an enthusiastic project manager before video conferencing can
be truly effective. Turnbull and Beavers (1989) highlighted the problem of compatibility
of interacting communities. Keep (1991) felt that much energy was required just to
sustain student interest. In short, the consensus seems to be that this use of technology
can only be effective if it is embedded in a larger framework of cross-site communication
and concerns.
Besides video conferencing, the students at Temasik also reported networking with friends in chat rooms and over the ICQ, especially when working on collaborative projects. A student was observed at home, discussing the features for a super bike he had designed with other members of his group who sent ideas and suggestions online, via downloaded files.

**Technology as cognitive / mind tools**

**Problem-based projects.** Throughout the research time frame, students were observed to be engaged in various problem-based projects. Utilising technology to get students to solve authentic problems is actually harnessing the potential of technology to act as a mind tool. Jonassen (1996) defined mind tools as “computer-based tools and learning environment... developed to function as intellectual partners with the learner in order to facilitate critical thinking and higher order learning”.

In other words, mind tools are computer-based learning environments that amplify cognitive functioning by providing scaffolds to higher order, critical thinking. Given the information explosion today which sees knowledge doubling every three years (Salisbury, 1996), technology definitely gives students an edge by enabling them to tap global sources of information and engage in conversations with external partners and online experts. Witness the following Science research project conducted at Sendayan:

(The students collaborated to produce a folio on different aspects of the topic ‘Reproduction’. They worked at the project on their own time and were given one month to produce the folio. The culmination of the project was a presentation, held in one of the simulation rooms which housed 16 computers and a LCD.)
A group leader introduced the members of her group and began her presentation prepared on powerpoint, with 3-D pictures downloaded from the Internet. She used a marker to indicate the location of the bladder, urethra, vagina, etc., and showed the front and side views of the human reproductive system. Interactive elements were introduced as the students were virtually shown the impact of conception on various parts of the reproductive system. They watched in rapt attention as the group representative explained.

When she had finished, another member of the group took over and talked about the menstrual cycle. She presented an interactive pie chart on the components of vaginal discharge and showed the effects of a imbalance in these components on the human body. “Wow!” was one girl’s reaction. Giggles were heard when the topic touched on personal hygiene. A hand was raised – the student wanted to know the difference between menstruation and period, and when one should consult a gynaecologist.

The next group had researched the first trimester of a pregnancy. The students listened spellbound as the leader presented her findings of the development of an embryo. There was even an ultrasound scan of a foetus in various stages of development and a slide presentation of a woman in various stages of labour, complete with sound effects and a running commentary.

As another team member talked about amniocentesis, the students were observed listening intently. When the presentation touched on the topic of breast-feeding, the students complained that the words on the slide were too small.

At the end of the presentation, the teacher commended the students on their efforts and highlighted some of the weaknesses and strong points of the presentation.

[Note: This lesson demonstrated clearly how interactive multimedia can take a lesson outside the walls of the classroom as the students learnt so much more – and vividly too – than they would have if the lesson had been conducted the traditional way. Thus, the power of the Internet to “shrink the world and bring knowledge, experience and information…” (LaQuey and Ryer, 1993) to the students was seen. Unfortunately, the full potential of the use of technology as a mind tool was not tapped in this project due to time constraints and inequitable access to technology. Nevertheless, the lesson did illustrate some of the potential possibilities offered by technology.
Several interesting observations were noted from following the students around on this project. Firstly, field observations showed the students working mainly on their own at their delegated tasks, with limited communication between students or teacher.

Secondly, whatever communication that did take place between students and teacher was centered mainly on the product – the folio – rather than on the research process. In fact, the teacher played a really minimal role in the discovery process, coming in only at the end as a commentator on the product. Clearly, more efforts to ‘share’ the project from conception to conclusion are needed if benefits are to be optimised.

Thirdly, the success of the research project was found to vary greatly, depending on the ability, background and experience of the students. In groups where students were bright and techno-savvy, the technology worked effectively as a mind tool, sharpening research and thinking skills. However, a particular group of weak students was observed mindlessly downloading a virtual smorgasbord of information which they just cut and pasted into the folio.

And finally, although several students managed to successfully pursue divergent strands of information offered by the Web, there was insufficient guidance from the teacher to help students manipulate data effectively.

Simulations. Very few lessons with computer simulations were observed within the research time frame, perhaps due to the high cost of acquiring good simulation software. However, when properly carried out, this mode of technology use is not only
highly effective but also provides tremendous user satisfaction. Witness the following

Science lesson conducted in a science lab with one computer at Temasik:

(It was a double period. The subject was Science, Form One and the topic was the atomic structure of matter. The Science teacher had already spent four lessons explaining the atomic structure of solids, liquids and gases and explained the differences between an element, a mixture and a compound. However, she sensed that some of the students had not fully grasped the concept and were unable to visualize the arrangement of the atoms in such structures. So, she decided to show a simulation to deepen the students' comprehension.)

The group of 30 boys sat on the floor of the science lab, gathered round a single computer. The software started by showing the difference in the arrangement of atoms in solids, liquids and gases, and then simulated what happened to the atoms when certain variables were manipulated — for instance, when heat was applied or temperature reduced.

There were cries of “oohs” and “ahhs” as students tried to outguess the computer in determining what the changed state was.

The students were then asked to nominate a leader from their groups to represent them in a quiz.

Five group leaders were chosen. They sat near to the computer as they had to manipulate the mouse.

The first group leader clicked onto the first question. A simulated arrangement of atoms (in the form of coloured balls) flashed onto the computer screen — the group had to determine whether the atomic structure depicted was that of a solid, liquid or gas. The representative clicked on the answer “Solid” and was rewarded with 10 points by the computer.

A change in atomic structure was then simulated and the group had to again determine the change in state.

The screen then showed an arrangement of different coloured balls and asked the students to determine if the simulated atomic structure depicted an element, mixture or compound.

The group representative was responsible for clicking on the answer. When his answer was wrong, the question was opened to the other members in his group. However, no marks were awarded save for correct-on-first-attempt answers.

Only after all the questions related to the simulation were answered could the second group representative take over and move on to the next set of questions.

At the end of two rounds, the scores were tabulated and the winning group was given a rousing cheer.
(Note: The above lesson is testimony to the fact that even single computer classrooms can be effective. The development of higher order thinking skills was clearly emphasized in the lesson as students analysed and applied knowledge to new situations and hypothesised on what might happen under certain circumstances, in this case, when variables were manipulated. Both teacher and students appeared pleased with the outcomes of the lesson – the boys lauded the interactive approach while the teacher was pleased with the enhanced learning outcomes resulting from use of the simulation software).

Summary

To summarise, this section examined teachers’ patterns of practice with the technology in the school milieu by describing actual lessons observed. The objective was to come up with a typology of technology use commonly adopted by teachers in the case study schools within the research time frame. The resultant typology which emerged from field observations categorises teachers’ practices of technology into four groups – as a productivity tool, teaching tool, networking or communications tool and mind tool. This is graphically represented as in Figure 14 on the following page.

The next section compares the perceptions of both teachers and students regarding the effectiveness of technology-integrated instruction.
Teachers' Practice of Technology

Technology as a subject matter

- Computer literacy
  - History
  - Society
  - Hardware
  - Software

- Computer science
  - programming

Technology as a tool

- Instruction
- Administration
- Storage of information

Productivity tool
- Presentation tool
- Word processing
- Databases & spreadsheets
- Desktop publishing

Teaching tool
- Drills & practices
- Tutorials
- IT as whiteboard

Networking/communications tool
- Email
- Video conferencing
- Web-based instruction

Mind tool
- Research
- Authentic problem-based projects
- Collaborative projects
- Games & Simulations
- Hypermedia

Figure 14: Typology of teachers' technological practices
The teachers’ perceptions

To find out how teachers perceived the effectiveness of different modes of technology use within the research time frame, the teachers were asked to rank their practices of technology according to perceptions of effectiveness. This feedback was analysed and the results tabulated as in Table 22 below.

<table>
<thead>
<tr>
<th>Pattern of practice</th>
<th>Total number of 'effective' citations</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet</td>
<td>19</td>
<td>48</td>
</tr>
<tr>
<td>Powerpoint presentations</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Desktop publishing</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Simulations</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Drills and practices (CDs)</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Word processing</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Computer games</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Email</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

As Table 22 above shows, the modes of technology use ranked by teachers in descending order of effectiveness were the Internet, powerpoint, desk top publishing, simulations and drills and practice CDs, word processing and computer games, and lastly, email.
However, Table 22 seems to suggest that the teachers do not generally perceive the use of technology in schools as effective, at least not within the research time frame. Even the top-ranked mode of technology use in terms of effectiveness – the Internet – was perceived as effective by only 48% of the teachers. Powerpoint presentations were rated effective by one third (33%) of the teachers while desktop publishing gathered 13% of the votes. Subsequent modes of technology use received the thumbs up from only a minority of teachers – simulations and drill and practice software (8% each), word processing and computer games (5% each) and email (3%).

Anna explained why she did not find the Release One of the English software effective:

(The) Form One software is very simple, one sentence fillers, one word fillers, you’ll laugh. May help weaker students but for the boys here, I think not much of a challenge. The Form Five topics are more interesting. And we have to proceed along the exercises accordingly, we cannot jump and it’s quite boring. Maybe the second software’ll be better. The first one is boring. We went through it like students and felt bored. Most of the teachers felt it was too simple for urban school students. It’s linear, cannot branch or jump topic, we have to follow; the Form Five software is okay, we have to know and understand the text, comprehend it before answering the questions but the Form One software is just too simple...

(T:18.8.01.4–5)

Over at Gemilang, Chin also found the Science smart school software disappointing. She described the students’ responses to the software:

After about an hour, they got bored and asked for permission to go to the Internet, I gather they were bored.

(G:23.4.01.2)
She elaborated:

One same sentence (for) several pictures, for example, heat from the sun supports life; six pictures and the picture takes a long time to come out, but fact is too simple (and) picture served no purpose (only) aesthetic, new. Students, they just sit and enjoy. They said the music is so stupid, not ‘black metal’ [laughs]…

(G:2.8.01.1)

The layout and graphics of the software also came in for criticism:

The graphics are quite attractive but the sounds are very disturbing. Is there anyway we can shut off the sounds or not? I think there are hot spots – a row of five to six buttons and the minute we touch on (sic) it, it goes crannkkkk! It’s irritating!

(G:23.4.01.2)

However, she realised that the smart school software was new and that it should, given time, improve: “Give them three years, (things) should be much better…” (G:2.8.01.1).

The dismal placing of email was due to the fact that some of the students’ English proficiency was horrendously low and teachers did not know how to use email to enhance learning outcomes. A teacher showed the following email sent to her by a student at the end of an English lesson and moaned that she did not know where to begin to help her students:

\[\text{ok u ada dapat kad tak i send you} \\\	ext{ok u boleh send balik} \\
\text{(ok, did you get the card I sent you)} \\
\text{(ok, you can send back a card)}\]

(G:23.4.01.1)
The students' perceptions

The students' perceptions of technology use have been tabulated in Table 16 on page 189. To recapitulate, Table 16 shows clearly that although 61% of the students perceived technology in the classroom as 'enjoyable', only 8% believed it to be effective. Another 11% of the students were unsure how they felt about technology-integrated instruction while 3% insisted it was a waste of time. In other words, the students had very mixed reactions to the use of technology in instruction, and a seemingly low opinion of its effectiveness.

Given the exam-oriented nature of our education system, these mixed reactions were hardly surprising. Interviews with the students cast more light on their responses. A student who found technology-based lessons enjoyable explained that the technology livened up otherwise dull lessons:

I like to use the Microsoft Powerpoint which we may design our page plus animation on our presentation...

(ISS:S7)

Another student said that he enjoyed technology-integrated lessons because it offered opportunities for group work:

I feel that using the computer in school is better because it encourages teamwork in groups. It also increases our creativity using the software in the computer. Learning in groups also encourages friendship in groups. Learning in groups help people overcome their weaknesses by learning from others. Aside from that, we can grow closer to our friends and teachers.

(T:18.8.00,1)
However, the students’ low opinion of technology’s effectiveness as a tool for instruction was interesting. To gauge if the students understood the impact that technology would probably have on them in the near future, they were asked if they perceived technology as relevant to future careers. The majority of the students (92%) perceived technology as relevant, a minority (5%) felt it was irrelevant while 3% admitted that they did not know (shown in Table 23 below).

<table>
<thead>
<tr>
<th>Responses of students</th>
<th>Number of students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No, it’s not relevant</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Yes, it’s relevant</td>
<td>213</td>
<td>92</td>
</tr>
<tr>
<td>I don’t know</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Total (N)</td>
<td>233</td>
<td>100</td>
</tr>
</tbody>
</table>

Interestingly, despite the large number of students (92%) who perceived technology as relevant to future careers, only 72% (as indicated in Table 24 on the following page) wanted their teachers to integrate technology into lessons in the classroom. About 17% of the students preferred teachers to stick to traditional modes of instruction while 11% wanted teachers to combine both instructional modes.
Table 24: Students’ preferred mode of instructional strategies

<table>
<thead>
<tr>
<th>Students’ preferred instructional strategies</th>
<th>Number of students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional mode</td>
<td>39</td>
<td>17</td>
</tr>
<tr>
<td>Technology-integrated mode</td>
<td>168</td>
<td>72</td>
</tr>
<tr>
<td>Both</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td>Total (N)</td>
<td>233</td>
<td>100</td>
</tr>
</tbody>
</table>

Summary

To sum up, research findings suggest that although teachers have started integrating technology into classroom instruction and the typology of technology use which emerged (Table 21) shows electronic presentations at the top of the list, the teachers and students do not, as yet, appear to have faith in the effectiveness of technology. Despite this however, 92% of the students perceived technology as relevant to future careers and 72% wanted teachers to integrate it into classroom instruction.

A further observation was noted during field work. In schools where students’ responses to technology were positive, the teachers appeared more motivated to innovate, often thinking up ways to incorporate marks for technology projects into assessment grades. This encouraged students to devote more time to technology projects and eventually paved the way for a cycle of inter-sustaining reinforcement to be set into motion (as depicted in Figure 15 on the following page) where the students’ positive reactions to technology spurred teachers to greater efforts and this in turn, encouraged students to spend even more time on technology.
The converse happened when the students' responses to technology were negative as teachers then reduced efforts to integrate technology into class assessment, and this ultimately caused students to turn away from and to reject technology.

Figure 15: The cycle of inter-sustaining reinforcement in technology adoption
Conclusion

To conclude, this chapter examined technology use in the four case study schools within the research time frame. It investigated the frequency of use as reported by teachers and students and found that most teachers were mid-level technology users who integrated technology into instruction at least once a month.

It also looked at the typology of technology use in the schools and found that electronic presentations, the Internet, word processing and email were among the most commonly adopted practices, with video conferencing bringing up the end of the list.

An attempt was also made to provide thick descriptions of some of the teachers’ practices with technology, drawing on actual lessons of different subjects taught at differing levels of technological infrastructure. Field observations revealed that most of the teachers still stuck to traditional classroom patterns of instruction even when technology was adopted.

And finally, the chapter investigated teachers’ and students’ perceptions of the effectiveness of the innovation. Findings suggest that only about half the case study teachers perceived the use of technology as effective and that the modes of technology use ranked in descending order of effectiveness were the Internet, powerpoint, desk-top publishing, simulations, drills and practice software, word processing, computer games and email.

Surprisingly, only 8% of the 233 students interviewed perceived technology as effective in enhancing learning. Despite this however, the majority (92%) believed technology to be relevant to their future careers and 72% were in favour of teachers
adopting technology-integrated pedagogies rather than sticking to the traditional mode of instruction.

The next chapter attempts to put all the major findings of this research study into a theoretical model to explain teachers' acceptance and use of technology in the classroom, and to examine some of the issues raised and implications which arose.
CHAPTER 8

Summary of findings, discussion and conclusion

This research study deals with the adoption, diffusion and use of technology-integrated instruction in four technology-enriched, pilot smart schools. Input concerning the technology implementation initiative in these schools was obtained via an ethnographic style, qualitative paradigm. Field work was loosely guided by three theories – Rogers’ (1995) diffusion of innovation (DOI), Hall et al.’s (1973) Concerns Based Adoption Model (CBAM) and Weick’s (1976) loosely coupled systems (LCS). This chapter discusses some of the findings and the conclusion of the study.

Roger’s DOI theory posited stages in the adoption process. Field observations supported this, showing clearly that the teachers spearheading technology-integrated instruction in the case study schools also went through distinct stages or phases of instructional evolution. Five stages were observed – entry, early adoption, crisis, adaptation and invention. The first wave of the technology adoption initiative saw teachers reacting differently to the innovation – some were innovative pioneers like trailblazer Shah, some steadfast beacons like Ling, the majority were ambivalent adopters like Anna, several worked the system like shrewd strategist Chin, while a few resisted the innovation all the way like Mei.

The use of the SoCQ in Hall et al.’s (1973) CBAM confirmed the existence of different composite concerns profiles in the case study schools. Ling was preoccupied with management concerns and towards the end of the research time frame, the impact of the innovation; Chin was struggling with personal concerns and managed to overcome
them to move on to management concerns; ambivalent Anna and her friends wrestled with information concerns, while resistor Mei found herself so overwhelmed by personal concerns that she ultimately rejected technology use. However, the overall composite concerns profile which emerged was that of teachers on the threshold or in the early stages of adoption.

And finally, Weick’s (1976) LCS theory proved invaluable in understanding teachers’ attitudes towards change and acceptance of innovations. A literature review of the basic tenets of his LCS theory matched against field observations confirmed that the case study schools had LCS characteristics. For instance, Weick’s contention that LCS were places with “a limited amount of inspection and evaluation” (Weick, 1982) held true for the schools which were subjected only to annual inspections and evaluations by the School Inspectorate. Secondly, Weick said that LCS had little control over the supply and quality of raw material, and therefore “no firm standards to judge the impact of their work” as well as “no clear theory of causation” (Weick, 1982). The schools observed had little control over the supply and quality of students whose diverse backgrounds made it difficult to pinpoint the exact reasons for success (or failure) with the innovation. Thirdly, Weick’s observation that in LCS, “…few (were) constantly involved in everything that happens” (Weick, 1982) was reflective of the scenario in schools where not every teacher was involved in all events. His comment that LCS were “reservoirs of flexibility” (Weick, 1982) was also applicable to the case study schools which enjoyed great autonomy between departments.

Accepting that the four case study schools were LCS, two points raised by Weick (1982) are particularly relevant to this study. One is the observation that leaders of LCS
needed to balance adaptation with adaptability — between “stability to handle present 
demands and flexibility to handle unanticipated demands”. This means that school heads 
needed to maintain a certain degree of stability while remaining open to change. The 
other observation is that changes in LCS occurred slowly, thus making it unwise for 
heads of LCS to depend on single policy incentives in change initiatives if they desired 
quick results. Consequently, multi-pronged approaches were favoured and school heads 
were encouraged to “start projects earlier, start more projects, start projects in a greater 
variety of places, talk more frequently about those projects… and articulate a general 
direction”. In short, school leaders had to be very adept and committed to promoting the 
innovation if they wished to see it institutionalised.

A model for teachers’ acceptance of technology

Chapter 5 outlined in detail the factors which impacted upon the technology 
adoption-diffusion process in the case study schools. To recapitulate, field observations 
and interviews revealed four levels of factors at work.

At the bureaucratic level, a shared technological vision, adequate support system 
and sufficient funding were deemed crucial factors. At school level, effective leadership, 
sufficient hardware and software, a conducive cultural climate, adequate staff 
development opportunities and flexibility to handle time constraints were important. At 
teacher level, technology competencies, positive perceptions of computer efficacy and 
previous experience with computers were predisposing factors. And finally, at student
level, the students’ responses to teachers’ novice attempts at technology adoption and support from the parents of students in the school also played important roles.

Field work suggested that while these factors did set the stage for technology adoption and diffusion, another combination of variables – described in chapter 6 as the ‘T’ or teacher factor – appeared to be more potent in accounting for variations in the teachers’ responses to technology, especially if they were serving in the same physical and technological setting.

Briefly, the ‘T’ factor comprised the teachers’ mental beliefs about teaching, their risk tolerance levels, their teaching goals and their technological quotient or ability to visualise the details of a technology not yet fully put in place. These four components of the ‘T’ factor acted as a sieve which filtered the impact of systemic factors and predisposed teachers to react to the innovation in particular ways. The dynamic interplay of all these factors is put together as a theoretical model which I propose to call the SMaT (System, Mediator and Teacher) model of technology adoption. This is diagrammatically represented as in Figure 16 on the following page.

As shown in Figure 16, once the decision was made to integrate technology into classroom instruction, new practices were either ‘added on’ to traditional paradigms of instruction or took new forms as groundbreaking constructivist practices.

However, if the teachers rejected the innovation, mediating influences in the shape of change facilitators, students and even parents may act on the ‘T’ factor to get teachers to rethink their decisions. Alternatively, the mediators may even act on the system, and the set of factors contained within the system, to make it more conducive to technology adoption. The cycle of decision-making then starts again.
Figure 16: The SmaT model for teacher acceptance and use of computer technology
Levels of technology use

This research study also examined the teachers' levels of technology use in the four case study schools, using the CBAM's LoU as the diagnostic tool to review their practices. However, although the LoU provided a good gestalt of teachers' levels of technology use at the lower levels, the picture was not so clear at the higher levels, in particular, after LoU3 (mechanical use) where the teachers were observed lingering right till the end of the research time frame, with little further progression.

Based on this observation, two inferences are possible.

The first inference is that the diffusion of innovations is indeed very slow and stretches over a long period of time, so much so that the 20 months of field observations in the school setting were insufficient to capture the LoU's higher levels of use.

The second inference that may be drawn is that the decision points differentiating the higher levels of use in the CBAM's LoU were too refined and unsuitable for adoption studies in the local context. If this second inference is accepted, then the implication would be that adjustments to the CBAM's LoU are required.

There seems to be some grounds for accepting both inferences.

Previous research on change and innovation does support the notion that the research time frame of 20 months may be insufficient to fully capture the diffusion cycle which usually takes three to five years to play out (Hall and Hord, 1987).

However, it is also true that the original CBAM's LoU may be less suited to review levels of technology use in Malaysian schools as our education system is extremely examination oriented and offers teachers little leeway to reach the "new goals
for self and the system" (Hall and Hord, 1987, p. 84) stipulated as indicators of higher levels of use in the original LoU. Minor adaptations to the LoU thus seem called for.

Based on this line of reasoning, a review of literature regarding levels of technology use in schools was again carried out. Work by several researchers in this area merit mention. Maddux et al. (1997) for instance, differentiated between Type I (trivial) and Type II (complex) levels of use. Carstens (1995) adopted a similar typology using the terms Level 1 and Level 2, and concluded that it was very difficult to move teachers from mundane Level 1 use to more sophisticated Level II uses. Synthesising these ideas together, I feel that the teachers' levels of use of technology in the four case study schools could perhaps have been more adequately captured by collapsing the eight levels of use in the original CBAM's LoU to only five levels as shown in Figure 17 on the following page.

The adapted LoU model in Figure 17 posits only five levels of use, starting from LoU0 or non-use. This refers to the initial stage when teachers have little or no knowledge of an innovation. At LoU1, the “orientation” and “preparation” stages of the original LoU are collapsed into one level of use as the former is merely a mental version of the latter while the latter is but a physical manifestation of the former.

The next level of use – LoU2 or mechanical use – is characterised by teachers engaged in hands-on management of the innovation in the classroom. Once teachers have got the hang of integrating technology into classroom instruction, they move into LoU3 or routine use which sees them engaging in stabilised uses of technology but making few attempts at innovative practices.
A small number of teachers will eventually venture into LoU4 or creative use. As this level of use emphasises the exploration of alternatives and sophisticated applications of technology as well as promotes collaboration and the creation of new material, subsequent higher levels of use – namely, refinement (IVb), integration (V) and renewal (VI) – are subsumed within this level.

<table>
<thead>
<tr>
<th>Level</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Creative</td>
<td>The user constantly varies use and experiments with design of new materials. Focus is on impact on clients. There is increased collaboration and exploration of alternatives. Creativity rules this level of use.</td>
</tr>
<tr>
<td>3</td>
<td>Routine</td>
<td>Use is stabilised but mundane. There may be minor changes and adaptations but these are introduced with little thought to innovation.</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical</td>
<td>The user is actively working with the technology in the classroom. Use may be continuous or sporadic but is usually superficial. The focus is on the task at hand and resolving user needs rather than client needs.</td>
</tr>
<tr>
<td>1</td>
<td>Preparation</td>
<td>The user has acquired or is acquiring information about computers and preparing, mentally or physically, for initial, first use.</td>
</tr>
<tr>
<td>0</td>
<td>Non use</td>
<td>The user has little or no knowledge of the innovation and is not using it in instruction.</td>
</tr>
</tbody>
</table>

Figure 17: Adapted model of teachers’ levels of technology use
Several criteria – again crystallised from field observations – are adopted to serve as guidelines to differentiate between routine (LoU3) and creative (LoU4) uses of technology.

Firstly, students in LoU4 classrooms should be more *intellectually involved* in the technology than those in LoU3 classrooms who tended to sit at computers and merely clicked on options. An example of LoU 4 was observed when the students of Temasik used Microsoft Publisher to create a class newspaper.

Secondly, students in LoU4 classrooms should exhibit *more user control* over the computer screen. They should not merely move through steps predetermined by software developers, selecting only levels of difficulty and speeds of presentation but should actually manipulate the direction of technology progression by *evaluating* information, weighing options and making decisions on how to convert the data into *relevant* information to solve authentic problems.

Thirdly, LoU4 classrooms should emphasise *creativity and higher order thinking skills* rather than rote learning. They should encourage students to be actively involved in constructing meaning rather than passively ingest information regurgitated by the technology at the click of a mouse.

And finally, LoU4 should offer students an *emotionally empowering* experience with the technology by stimulating them in diverse, multiple ways and providing user satisfaction, thereby urging them, in the long run, towards independent learning.

Interestingly, field observations seem to suggest that LoU4 is more likely to emerge from classrooms where students work independently in small groups around
clusters of technology rather than from labs which see students engaged in mostly linear learning from computers.

To summarise, an adaptation of the CBAM’s LoU is suggested as more appropriate to examine the teachers’ levels of use in this particular research study. The five levels of use in the adapted model are (as depicted in Figure 17) non use, preparatory, mechanical, routine and creative use. The highest level of use, LoU4 or creative use, should be characterised by the following traits:

- More active intellectual development
- User control of almost everything that happens on the computer screen
- Focus on creative instead of rote tasks
- Involve multiple senses and capabilities
- Empower students and teachers alike

Crystallising the notion of ‘optimal uses’

Chapter 7 examined the teachers’ patterns of practice with technology. Field observations showed that although most teachers were able to adapt technology to suit students’ needs, they worried whether they were doing the right thing and repeatedly asked for exemplary practices or optimal uses to benchmark against. This desire for models of good practices was confirmed in a questionnaire where 68% of the teachers (Table 15 on p. 161) quoted the lack of exemplary uses of technology as the primary obstacle to technology adoption.
A literature review suggests that this clamour for optimal uses has long been heard among teachers involved in technology-integrated instruction (Gilbert, 1996; Whitaker, 1993). Whitaker (1993), for instance suggested that:

Good practice by highly effective teachers... (needs to be) held up for emulation by others who have not been informed of the experience and theory underpinning it...

(p. 2)

Unfortunately, the search for optimal practices of technology is made more difficult by the fact that ‘good’ and ‘optimal’ are words loaded with value judgment, as what is good and optimal to one person in one situation may be trivial and mundane to another person in the same or different situation. However, an attempt will be made in this discussion to refine the notion of optimal uses of technology so as to provide guidelines for teachers in their search for benchmark practices. At the very least, it is hoped that my attempt to crystallise the notion of optimal uses will stimulate reflection on the issue.

Based on the ideas that developed from field observations and interviews with people involved with the innovation at grassroots level – and shaped by my readings and reflections on what the desired outcomes of education are – I propose that optimal uses of technology should satisfy four criteria.

Firstly, an optimal use of technology should break down the physical walls of the classroom so that multi-sensory instruction can take place in a borderless learning environment which allows students to access knowledge from anywhere in the world via the virtual global database. Borderless learning also implies that knowledge should no longer be compartmentalised or restricted by physical boundaries.
At the same time, the technology should physically hone students' technological skills so as to prepare them for new challenges at the work place. In other words, technology should not only break down walls in learning but also build bridges for knowledge acquisition by helping students pick up the relevant skills needed for the Information Age.

Secondly, as our education system aims to develop critical and creative thinking skills in students, optimal uses of technology should emphasise and enhance higher order cognition. Field observations show that when students were given the freedom to explore and to innovate with technology, they often surpassed expectations in producing creative work of high quality. All the teachers readily attested to this. An optimal use of technology should therefore allow students to engage in multi-faceted, authentic tasks which unleash creative potential and make lessons come alive in ways not possible with the traditional paradigm.

Thirdly, an optimal use of technology should enhance students' social skills by creating opportunities for collaboration and cooperation in the classroom. Field work suggests that teachers and students alike craved opportunities to socialise and to connect. Optimal uses of technology should therefore create avenues for students to work together towards common goals, either within a classroom and school, or on a wider scale, with global communities online. There is a latent 'we-power' in technology that may, once unleashed, scaffold and enhance learning in zones of proximal development by leaps and bounds.

Finally, an optimal use of technology should provide students with user satisfaction leading to emotional confidence and ultimately, feelings of empowerment.
Field observations highlighted many instances when uses of technology in the classroom achieved this. Based on Whitaker’s (1993) definition of empowerment as the capacity of individuals to assume responsibility for satisfying personal and professional needs, an optimal use of technology should inculcate within students the life-long learning skills necessary to realise professional objectives and bring about personal enrichment.

To sum up, an optimal use of technology in the classroom should exhibit the following characteristics:

- **Physically** extend the boundaries of learning to beyond the walls of the classroom
- **Cognitively** nurture creativity and the development of higher order thinking skills
- **Socially** create opportunities for collaboration and cooperation
- **Emotionally** satisfy and empower students involved so that they are better prepared to cope with life in future.

As an illustration, witness the following lesson when all four criteria for consideration as an ‘optimal use’ of technology appeared to have been adequately met:

(The class: Form One. The topic: Descriptions of Animals. The venue: A simulation room with four computers. Duration of lesson: 90 minutes.)

The students were seated on the floor in the center of the room, gathered around the teacher’s computer which was linked to an LCD panel projecting a screen onto the white board. The teacher clicked on a picture of dugongs and asked, “What is this?”

S: Dugongs.
S: Mermaids.
T: What do they look like? How would you describe them?
S: Rounded.
S: Like rocks...
T: What do you know about dugongs?
S: It’s a mammal.
T: When you say ‘mammals’ what do you mean?
S: Give birth to the young.
T: What do they eat?
S: Herbivorous.
T: What do you mean?
S: They eat grass.
T: Yes, that's why they are called 'cows'. Now dugongs are an endangered species. Do you know what that means?
S: They're going to be out of this world.
S: Extinct.
T: Yes, soon they will not be found in this world anymore. So what should we do about this?
S: Take care of them
S: Preserve them
S: Stop killing them

[Note the use of probing questions to lead students on to higher order thinking – starting from simple comprehension questions, the teacher led them to make inferences and apply ideas to new situations.]

The teacher then clicked on a slide. A passage entitled 'Save the sea cows' flashed onto the screen. The students read aloud the passage. This was followed by a question and answer session during which the teacher highlighted descriptive words.
S: Teacher, are they hard or soft?
T: Look at their ears. What do you think? How do they look? What do they have on their lips?
S: Whiskers
T: Right. There is lots of information here. Let's read the last part.
This was followed by five minutes of chorus reading.
T: So what do you know about dugongs?
S: Gentle.
S: Friendly.
S: Lovable.
T: Do you remember the story of Tenang? Can anyone tell us about Tenang?

[Tenang was a dugong found in Malaysian waters by a fisherman who cared for her. The authorities pressured the fisherman into releasing Tenang into the sea. After much controversy, he did but unfortunately, Tenang died. The case was widely publicized in the press.]

A girl put up her hand, stood up and related the story.
T: Very good. Now I'll give you some tasks to do. Get into your groups.
The students moved to sit in their groups. There were seven groups in all.
On each table, a placard with the words "We need help!" stood ready to be
used to direct the teacher’s attention to the group. A table with task sheets stood in a corner of the room. The leaders collected and distributed them.

Multiple level tasks were set.
Group 1 had to read the passage ‘Save the sea cows’ and identify verbs, nouns and adjectives. The leader brought dictionaries for the students to refer to.
Group 2 had to read a newspaper cutting entitled ‘Tug of war over dugong’ and write an autobiography of the dugong via slide presentations, explaining why Tenang’s death was not in vain.
Group 3 had to refer to the same article and role play an interview with Atan, the fisherman who had caught Tenang.
Group 4 required the students to surf the Internet for information on the dugong and prepare points for a debate on whether the dugong should have been released as soon as it was caught. As the group comprised four students, two proposed while the other two opposed the motion.
Group 5 asked the students to describe a fictitious creature or robot.
Group 6 asked the students to surf the Internet for information about endangered animals based on the following questions:
What are endangered species?
Where are dugongs found?
What do they eat?
How can these animals be protected?
How could Tenang have been prevented from dying?
The students then had to create a poster on a powerpoint presentation on how to save this endangered species.
And Group 7 had to create a poem on their feelings about the dugong, either on the computer or on paper.

The students worked in their groups. Every now and then, the placard was put up and the teacher hurried over to help. At a computer station, a girl keyed in sentences, prompted by her partner who had drafted an autobiography on the dugong:
“Hello, I am a dugong. I am born in Northern Australia and I am related to manatees. I am a mammal…”

At another computer station, the students were seen, surfing for information on endangered animals. A few students prepared a poem on another computer. There were bursts of laughter as they worked.
The teacher walked round the classroom, helping out where necessary.
T: We have half an hour left. Are you ready with your presentations?
The students acquiesced.
Group 4 presented first. The students listened raptly as a representative argued why Tenang should have been released immediately.
“I agree it should have been released because…”
Among the points raised by the proposing team were that it needed sea grass, it needed to learn how to live on its own, it belonged to the wild, it needed its mother as all mammals do, etc.

The opposing team then objected, raising points like how vulnerable Tenang was as it was injured, how mammals had feelings and could develop attachment, how releasing it into the wild was equivalent to leaving a baby on the streets, etc. There was an animated discussion as students exchanged opinions and the teacher had to stop the discussion so that other groups could make their presentations.

When Group 5 presented, there were hoots of laughter as the students showed off their pictures of their imaginary creature or robot.

Group 6 compared the endangered panda and the cheetah and suggested ways to help by building places for them to multiply, breeding them in captivity, etc.

The last group presented their poems on the computer, with the leader using a laser pointer to point to the stanzas as the group members recited them. They were enthusiastically applauded.

The lesson closed with the teacher asking the students for feedback.

The students looked pleased when hard copies of work on the computer were printed out and pasted onto the board at the back of the classroom.

The above lesson can be considered an example of an optimal use of technology in the classroom as it fulfilled all the criteria outlined earlier.

Firstly, learning was extended to beyond the physical walls of the classroom when students were encouraged to surf the Internet for information on the dugong. The students explored different web sites – science, biology and nature – and worked hard, checking multiple sources of information as they reflected on issues and discussed the problem.

Secondly, the students were engaged in higher order thinking as they prepared autobiographies, debates and poems which required them to access, analyse, evaluate and then synthesise information into new forms. The computer was not just a word processor but a mind tool for creativity as the students came up with original poems, as shown on the following page.
Poem 1
I am a dugong,
Big and fat and slow
I swim with my paddle like tail
I eat sea grass and plants.

Although I am fat and defendless (sic)  
You might mistake me for a mermaid  
Stop running over me with boats  
Cause its hurts my head a lot

Being so big  
You might thing (sic) I would roar  
Instead I make little squeaking sounds  
And don’t mistake me for a rock.

Poem 2
Dugong or sea cows are marine animals  
They are a type of herbivorous mammal  
Slow moving and defenceless, this mermaid of the sea  
Is going to be extinct and deserves our pity.

We should feel sorry for these poor things  
Unlike birds, they can’t fly away with wings  
Their lives are in danger and time is running out  
Unless we take action and not pout.

They may look like stones but when you look close  
You might find out more than anyone knows  
Dugongs are endangered and need our care  
Why don’t we help the dugongs there?

The third criteria stated that the technology should promote student-centered collaboration. Field observations showed students actively involved in and collaborating with each other in diverse, multiple-level learning activities centered around the computer as they negotiated and delegated tasks to create new products.

Fourthly, the lesson was emotionally satisfying as confirmed by an interview with the students at the end of the lesson.
Besides honing technological skills, all four language skills of listening, speaking, writing and reading were inculcated. The students appeared satisfied as the technology allowed them to utilise diverse abilities – good students assumed leadership and showed off their talents to the maximum while less proficient ones helped out in other ways and enjoyed success at their tasks. The lesson also gave them the chance to acquire practical research skills.

Since the above lesson fulfilled all the criteria set out earlier, it can be regarded as an example of an optimal use of technology. Many teachers had requested, within the research time frame, such benchmark practices. Clearly, the setting up of a bank of exemplary lessons should facilitate the technology adoption-diffusion process.

A theoretical summary of the study

To recapitulate, the discussion thus far has suggested that teachers’ acceptance and use of computer technology in the case study schools can be explained via a theoretical model referred to in this study as the SMaT model. A five-stage adaptation of the original CBAM’s LoU was also proposed to examine the teachers’ levels of technology use in the case study schools. And finally, an attempt was made to crystallize the notion of what is meant by the notion of optimal uses of technology in the context of this particular research study.

Thus far, all the research questions pertaining to the ‘what’, ‘why’ and ‘how’ of technology-integrated instruction appear to have been answered. What remains now is to look into some of the implications of this study and suggestions for future directions – the
what next?’, so to speak. This final section thus offers readers a brief, theoretical summary of the entire study together with recommendations and suggested course of action for stakeholders in education serious about imparting technology skills in schools.

Although this study initially began as an exploration into how teachers who had attended the 14 Weeks In-Service Training Program for Teachers of Smart Schools coped with technology-integrated instruction in school, it gradually evolved into a much broader investigation into a whole gamut of issues related to the technology adoption-diffusion process – the teachers’ thoughts about the innovation, their levels of use, variations in responses and their quest for optimal practices.

Right from the beginning, field work hinted at the complexity of the innovation, in particular, the importance of the teacher culture helming it. For that is the crux of the technology adoption-diffusion issue which emerges clearly from fieldwork – that the key lay in the hands of the teacher corps. Although the SMaT model depicted in Figure 16 posits a complex interplay of systemic factors, mediating influences and teachers’ innate predispositions to explain acceptance of technology in schools, the teacher factor appeared to be more potent than the others.

It is true that systemic factors such as the physical environment, cultural ethos, technological infrastructure and the political pulse driving the vision were necessary conditions to encourage technology adoption. Similarly, mediating influences in the form of students, parents and change facilitators were also powerful forces to persuade teachers to think positively about technology. However, field observations revealed that the teacher corps, with their varied juxtaposition of mental beliefs, risk tolerance levels,
technological quotients and teaching goals, were often able to minimise the adverse impact of these factors if they so desired.

Take Chin for instance. Gemilang had all the necessary systemic prerequisites for technology adoption. Yet Chin resisted technology for a long time because of her mental beliefs of what constituted good teaching and her priority goal to retain the locus of classroom control in her hands.

Likewise, over at Rajawali, Ling managed to implement technology-integrated instruction quite early in the research time frame even though the technology was not fully in place. She persuaded a teacher to loan the school a modem for Internet dial-up access, roped in a private company to donate old computers and practised ‘remote control technology’ by getting her students to patronise Internet cafes. She achieved all this because of two factors – her teaching goals (which were pastoral in nature) and her progressive mental beliefs about teaching. The former spurred her to overcome negative systemic factors because she wanted her students to be ‘with her’ and she perceived that they were most “with her” when she used technology in the classroom. The latter motivated her to carry on with her attempts as she perceived technology as the way forward. Both these observations confirmed the pivotal role of teachers in the technology adoption-diffusion process.

Thus, my theoretical construct is that the key player in the technology adoption-diffusion equation is the teacher in the classroom. This theoretical construct was just a suspicion at the beginning of the study but gained momentum as field work progressed. I became convinced of the potency of the teacher factor as I interacted daily with the teachers in schools where technology stared them in the face, to little avail. The
crystallisation of this construct was fuelled by intensive observations over a longitudinal time frame, and then slowly confirmed and triangulated. Research findings from other studies (Honey & Moeller, 1990; Saye, 1994) lent further credence to this construct.

If we accept that the key to technology adoption lay with the teacher corps, then it follows that measures to promote technology adoption and diffusion would encounter only limited success if they focused merely on improving hardware and physical amenities. The implication seems to be that more attention needs to be paid to the larger issues related to the teacher corps – training opportunities to enhance technological competencies, lighter workload, release time to explore and to experiment, lower student-to-teacher ratios, more teacher collaboration and generally more efforts to make schools appreciative of innovation and creativity. In other words, initiatives related to the technology implementation initiative should focus on human resources instead of hardware. For that is where change really begins.

Research findings from this study also suggest that mediating influences, in particular change facilitators, play dual roles in the technology adoption-diffusion equation. They can either try to alleviate the negative impact of systemic factors or strive to promote progressive change among the teacher corps. In both instances, the main vehicle for change is training.

Four areas are identified as possible new areas for trainers to focus on in future training initiatives – teachers’ belief systems, risk tolerance levels, teaching goals and technological quotients. There is much scope for planning staff development activities around these four areas to help teachers re-examine mental beliefs, realign risk-challenge
perceptions, refine technological quotients and redefine teaching goals to bring them more in line with constructivist principles.

However, before new training initiatives are set up, it might be worthwhile, at this juncture, to briefly review and evaluate the effectiveness of the current programme that has been specially implemented to train teachers to teach with technology in the pilot smart schools. Which brings us back to the starting point of this research study – the 14 Weeks In-Service Training Programme for Teachers of Smart School. This study would not be complete without an attempt to at least examine the training programme in question to gauge if it adequately meet the needs of teachers involved in the technology initiative and to determine the type of follow-up training most relevant to our needs. Thus, the concluding discussion to this study redirects the attention of the reader, once again, to the 14 Weeks In-Service Training Programme for Teachers of Smart School.

A qualitative evaluation of the training programme

A quick literature review on evaluation models for assessing teacher development programmes suggests that Carney’s (1998) examination of a teacher development model at the Shoreline Teacher Development Centre offers the most appropriate parallels for a cursory qualitative assessment of the 14 Weeks In-Service Training Programme for Teachers of Smart School. Carney advocated four elements as essential for effective technology-based training.

Firstly, Carney suggested that technology-based training programmes should challenge teachers’ existing frames of reference. Frames of reference are familiar
understandings or beliefs which shape teachers' actions (Schon, 1987). If left unchallenged for a long time, these frames of reference can lull teachers into a stupor-like state and cause them to march unquestioningly to the beat of a fixed teaching repertoire. Thus, in order to get teachers to be receptive to technology adoption, there must be challenges to the teachers' frames of reference so that they are shaken out of their safe mode.

In the case of the *14 Weeks In-Service Training Program for Teachers of Smart Schools*, the call to embrace new technologies did challenge the teachers' frames of reference and caused many to wonder if their pedagogical skills were becoming obsolete. Many feared being left behind if they did not quickly pick up IT skills. Interviews with teachers in the training milieu revealed that many believed they needed to set new goals and strive for new understandings in teaching. All this was evidence that the training programme had, to some extent, challenged the teachers' frames of reference and stimulated them to question their belief systems again.

The second element highlighted as essential for effective technology-based training was *situated learning* (Ball, 1990; Carney, 1998; Jonassen, 1991). Ball (1990) stressed that teachers needed concrete models of what an innovation or vision looked like in practice and practical guidelines on how to get there. Challenging teachers' frames of reference opened up minds but teachers needed to be shown practical ways in which to reconfigure new knowledge and beliefs with real students, in real time, within real classrooms.

In the *14 Weeks In-Service Training Program for Teachers of Smart Schools*, elements of situated learning were contrived at when teachers were asked to create
learning packages based on the actual syllabus and to test these packages in simulated classrooms. Unfortunately however, many of the learning packages prepared within the research time frame were specially created for ideal school scenarios which differed greatly from the harsh reality found in schools.

This problem was compounded by the fact that within the research time frame, there was no existing smart school for teachers to model from. Thus, elements of situated learning, though contrived at, were minimal. This was a weak link in the training programme as suggested by the clamour of teachers’ voices requesting exemplary benchmark practices of technology-integrated instruction which emerged from this study.

The third element regarded as essential for effective technology-based training is collaborative reflection (Hasseler & Collins, 1993). A review of literature suggests that traditionally, teachers have generally lacked opportunities to engage in collaborative projects (Little, 1990; Lortie, 1975) and interviews with teachers confirmed this to be still the case today. However, the 14 Weeks In-Service Training Program for Teachers of Smart Schools did make concerted efforts to promote collaboration among teachers by getting them to cooperate on learning packages. Field observations often showed the teachers engaged in collaborative work and reflective discussions with peers.

And finally, there were indications that the training programme did spawn the long term collegial interaction advocated by Sandholtz, Ringstaff & Dwyer (1992) and highlighted by Carney as the fourth crucial element for effective technology-based training. Interviews with the case study teachers showed that they continued to work closely with each other, long after completion of training. Many maintained contact via email and formed close-knit groups and “communities of practice” (Lave & Wenger,
1991), sharing lesson plans and tips on technology integration although they were emplaced in different schools.

Thus, in retrospect, the elements highlighted by Carney as essential for effective technology-based training programmes appear to have been present in the 14 Weeks In-Service Training Program for Teachers of Smart Schools. These elements acted on the inherent dispositional filter in the teachers’ psyche described as the ‘T’ factor earlier and affected, as well as caused variations, in their responses to technology. For instance, challenging the teachers’ frames of reference stimulated examination of mental beliefs about teaching. Incorporating elements of situated learning in the training programme enhanced technology quotients and opened new possibilities and alternatives with technology. Encouraging collaboration and long-term collegial interaction changed teachers’ risk-challenge perceptions by creating informal avenues of support for experimentation.

Furthermore, the 14 Weeks In-Service Training Program for Teachers of Smart Schools did improve teachers’ technological competencies as indicated in Table 25 on the following page. Table 25 compares the technological competencies of 69 teachers who were asked to self-rate their IT skills before and after participating in the training programme, using Russell’s (1995) Stages of Technology Competencies (Appendix 8). The results show a clear jump in the teachers’ technological skills, with the percentage of teachers at stage E increasing from 15 to 33 and those at stage F increasing from 4 to 23, by the end of training.
Table 25: Teachers’ self-perceived stages of technology competencies

<table>
<thead>
<tr>
<th>Stages of Technology</th>
<th>Pre-Training N (%)</th>
<th>Post-Training N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Awareness)</td>
<td>5 7</td>
<td>-  -</td>
</tr>
<tr>
<td>B (Learning the process)</td>
<td>18 26</td>
<td>2  3</td>
</tr>
<tr>
<td>C (Understanding &amp; application)</td>
<td>19 28</td>
<td>18 26</td>
</tr>
<tr>
<td>D (Familiarity &amp; confidence)</td>
<td>14 20</td>
<td>10 15</td>
</tr>
<tr>
<td>E (Adaptation)</td>
<td>10 15</td>
<td>23 33</td>
</tr>
<tr>
<td>F (Creative Application)</td>
<td>3  4</td>
<td>16 23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>69 100</strong></td>
<td><strong>69 100</strong></td>
</tr>
</tbody>
</table>

To sum up in a nutshell, all five indices adopted as the criteria for effective technology-based training in this research study — challenges to teachers’ frames of reference, situated learning, collaborative reflection, long-term collegial interaction and enhanced technological competencies — suggest that the 14 Weeks In-Service Training Program for Teachers of Smart Schools was effective in preparing teachers in the case study schools to teach with technology.

Implications and future directions

Certain implications can be derived from this research study.

Firstly, since research findings pinpoint teachers as the gatekeepers to technology adoption in the four case study schools, more attention should be given to nurturing their
potential and expanding their roles as change agents in the schools. Towards this end, certain measures can be implemented.

A task force comprising curriculum, technology and change specialists should perhaps be set up to monitor the progress of the innovation and to help teachers involved in the smart school project resolve concerns related to the innovation. It would be ideal if members of this task force can be trained in the use of the CBAM's SoCQ and LoU so that teachers' concerns profiles can be drawn and monitored from time to time, and appropriate intervention measures effected when necessary. This monitoring of concerns would go a long way towards nipping problems in the bud and helping teachers come to terms with technology use as soon as possible.

The monitoring of teachers' concerns should be augmented with frequent visits to schools so that teachers are provided with more site-based assistance and support. Alternatively, members of the task force can be based in the school milieu for short stints so that they may better understand case specific concerns. Field observations show that teachers are usually very busy people with hectic schedules who will not spend time mulling over technology-related problems if they can help it. Providing them with readily available, site-based assistance and experts who can resolve their concerns as soon as these arise would make them more willing to spend time on technology and move them to higher levels of use.

The setting up of a task force linking policy-makers with trainers and teachers in the frontline of the innovation might also facilitate better communication between the various stakeholders involved in the project. However, it must be emphasised that the objective of such a task force is not so much to give technical support (there is already a
Help Desk for this purpose) as to provide a communication channel to help teachers resolve technology-related concerns.

Since field observations suggest that teachers wish to upgrade technological competencies and are looking for optimal practices to emulate, it might be timely to consider liberalising training opportunities for teachers so that they are able to upgrade their technological skills as and when they wish. The lack of equitable access to training opportunities has long been a lament of teachers in schools and a contributory cause to the low morale observed. If teachers were allowed to source for their own technology-related staff development opportunities within pre-determined budgets, the pressure might be taken off central providers of training like TED to constantly come up with diverse training packages to meet different needs. Such a move would not only enable teachers to tap into more sophisticated skill training offered by cash-rich private companies thereby injecting a breath of fresh air into in-service training in schools, but would also give teachers more freedom in charting their career development path.

Many private companies have indicated interest in sharing their expertise. As a case in point, the Multimedia Development Corporation which adopted the Dengkil smart schools has already sponsored teachers for training, both locally and abroad. The recruitment of assistance from the private sector to upgrade teachers’ technological skills has long been lauded in research (Carrs, Grice, Galbraith & Warry, 1991) and should be seriously explored as a viable alternative to centralised staff development on the local education scenario.

Besides liberalising training opportunities, the current ‘en bloc’ approach to training should perhaps be reviewed in favour of more individualised and needs-based
follow-up training. The setting up of training clusters to allow teachers with similar concerns to be trained together might prove helpful. For instance, teachers with peak information concerns can be trained in different clusters from those with peak impact concerns so that the former do not feel ‘lost’ and the latter bored. Likewise, teachers with collaborative concerns would probably benefit more from interaction with like-minded teachers seeking to implement collaborative projects. Such a move would probably optimise training benefits as well as create the avenues for support, collaboration and collegial interaction that teachers crave. Eventually, this could pave the way for a more systematic synergy of teachers’ efforts.

Another implication which arose from the study is the need to look into ways to improve the teaching profession and make it more attractive to teachers. It is not the focus of this study to highlight the plight or low morale of teachers (and no attempt was made to delve into this issue in detail) but the perceived brain drain of techno-savvy teachers – isolated incidences or otherwise – mentioned by principals in this research study is cause for concern as low morale definitely impedes the technology adoption-diffusion process. Clearly, there is a need to explore ways to boost the morale of teachers if policy-makers expect teachers to be progressive and innovative. This issue merits urgent attention.

Research findings also point to the need to set up more technical backup support systems to encourage teachers to adopt technology. The presence of on-site technology coordinators would definitely help but manpower constraints are real. A possible source of manpower is the pool of latent expertise among parents of students in the schools. Encouraging techno-savvy parents to volunteer their services on a rotational basis in
schools is a viable possibility. Perhaps lessons can be learnt from the Japanese education system (I draw upon my observations of schools in Japan where I stayed three years) which invites parents to assist in the instructional process once a month. Parents are, as yet, an untapped source of teacher assistance in Malaysia.

The setting up of technology libraries with item banks of lesson plans and benchmark practices of technology should also boost the technology implementation initiative. Teachers should be encouraged to visit schools involved in successful technology projects so that they may observe techno-savvy teachers in action. Opportunities should be created to allow them to team-teach and to engage in reflective dialogues with peers. Towards this end, lessons can be learnt from the Clear View Charter School in Chula Vista, California, which organizes weekly “technology hours” for teachers to discuss student work, give moral support to each other and share successful technology practices (Conte, 1997). Clearly, efforts must be made to celebrate the teachers’ success stories to boost their morale and motivate them.

Other implications arising from the study include a need to re-examine the current evaluation system in schools to bring it more in line with the demands of technology. If policy-makers are serious about implementing technology-integrated instruction, this issue needs to be addressed quickly. There is little point in pushing for technology adoption if the technology does not add value to the issue closest to the hearts of teachers, parents and students – good examination results! Similarly, the curriculum needs to be reviewed to reduce rote learning in favour of the problem-based authentic approach that is the new wave of the Information Age.
Policy-makers also need to look into ways to give teachers more release time to experiment with technology in schools. Providing release time, even if only for a few hours a month, will improve teachers’ technological competencies by leaps and bounds.

To sum it all up in a nutshell, a four-pronged approach – with emphasis on the teacher corps – seems to be in order if we wish to promote the technology adoption-diffusion process in schools:

1. Help teachers grow professionally

   Training initiatives should be more needs-based. Four new areas have been identified as worthy of attention in future training initiatives -- challenging teachers’ mental beliefs, realigning risk-challenge perceptions, refining technology quotients and re-examining teaching goals. Encourage alternative sources of professional development such as technology mentors, release time, self-renewal programmes, group development hours, technology clusters etc. The keywords are collaboration, networking, team-work, self help and group support.


   Provide teachers with dependable technical back-up support, lesson banks of exemplary practices, lighter workloads, smaller teacher-student ratios, more pastoral care/counselling services to address discipline problems etc.

3. Enhance the image of teachers

   Fieldwork suggests that teachers’ morale in the pilot smart schools is at a disturbing low and this is something we should heed if we wish schools to remain relevant in society.
4. Revamp the evaluation system in schools to bring it more in tune with the demands of technology-integrated instruction. As fieldwork so clearly shows, technology cannot really take off if teachers impart the skills of tomorrow with the tools of today and the evaluation criteria of yesterday.

Recommendations for further research

The following areas are recommended for further research:

Since this is a qualitative study using a naturalistic framework of inquiry which seeks to describe the phenomenon of technology use in schools in order that we may better understand what has happened and is happening in the case study schools, the findings may not be fully generalisable to other pilot smart schools. Thus, it would be helpful if similar qualitative investigations are conducted on a nation-wide basis, especially in smart schools outside the Klang Valley, so that a more comprehensive picture of the progress of the technology implementation initiative can be obtained.

It would also be interesting and illuminative if a national survey is conducted on all pilot smart schools to determine the exact extent of adoption of technology-integrated instruction to date, using the CBAM's SoCQ as a quantitative instrument to differentiate between adopting schools and non-adopting schools. Such a study, somewhat along the lines of Maney's research into K12 schools (1994) would certainly be diagnostic and give policy-makers a pulse on the rate of adoption of the innovation.

Studies which explore the inherent dispositions of teachers as regards technology adoption, especially if conducted with psychometric instruments to test some of the four factors identified in this study or to determine if other factors are involved as well, may
cast new light on the technology adoption-diffusion process. Although this study has highlighted some of the dispositional differences in teachers, it is unable to investigate deeply into these dispositions as they only crystallised and emerged as research findings towards the end of the study. However, a cursory literature review suggests the work of Dweck and Legget (1988) and Katz (1992) may provide guidance for studies of this nature.

Further work on teachers' mental belief systems – perhaps life history work to trace the evolution of teachers' worldviews or ethnographic studies to explore the relationship between belief systems and classroom practices with technology – should also prove useful and interesting. And if quantitative instruments can be developed to complement qualitative approaches, even more information can be gleaned about these complicated relationships.

And lastly, a quantitative evaluation of the 14 Weeks' In-Service Training Programme for Teachers of Smart Schools, perhaps based on Stufflebeam's (1971) Context-Input-Process-Product (CIPP) model, would probably be helpful to pinpoint in detail, new directions and fresh approaches to take in future training initiatives as regards technology-based training. This would definitely prove useful to educationists striving to promote technology use in instruction.
Epilogue

I will end this study by again borrowing from a scene from Chaplin’s *Modern Times*:

It is dawn and we see the Tramp busily fanning himself on a lonely country road with rolling hills in the distance. His girlfriend quietly cries beside him.

“What’s the matter?” he asks gently.

The girl sobs in frustration, “It’s no use. What’s the point of trying?”

The Tramp is as upbeat as ever: “Never say die. We’ll get by.”

He guides her as they continue their trek down the lonely country road.

When the Tramp notices her morose demeanour, he smiles and points to his face, gesturing that she should do the same. She offers him a small, timid smile in return.

Quietly offering each other solace, they walk away from the camera towards the horizon and the new dawn.

This closing scene from *Modern Times* is symbolic as it represents the Tramp’s escape from the troubles of the factory and the city as he turns his back on modern times and heads for the simpler life in the rural countryside.

It is a powerful analogy as it offers lessons to learn in our attempts to move our teachers towards technology adoption. This research study has highlighted the trials and tribulations of the teachers pioneering technology-integrated instruction. It documented their concerns and conflicts as they traded old horse-and-buggy approaches for new, space age methodologies in the classroom. It recorded their pains as they nursed the innovation through its birth pangs. It traced their battles as they, reluctant technology
warriors, some of them, fought to implement the technology as best they could in technologically-enriched environments mired in problems.

The teachers have spoken. It now remains for the authorities to listen to their voices and to set into motion appropriate measures that will help them – and thousands of others like them – as they begin their long and lonely trek towards realising the nation’s technology vision. For lonely the trek is indeed – there are thousands of students and teachers and consequently, thousands of inherent dispositions, mental beliefs, teaching goals which need to be juxtaposed harmoniously into a common education system with common goals. Care must be taken lest, discouraged by the lack of support, they too, like the Tramp, turn away from the innovation and move off in the opposite direction, back towards the traditional paradigm.
REFERENCES


Call for unlimited cooperation among Asia Pacific Economies. (September 2, 1998). *New Straits Times.*


U.S. Congress, Office of Technology Assessment. (1995, April). Teachers and
technology: Making the Connection. (OTA-HER-616) Washington, DC: U.S.
Government Printing Office

McGraw Hill.


computer-aided instruction in Singapore's secondary schools. Computers and
Education, 25 (3), 151-162


technology on children's achievements in primary and secondary schools. London:
Department for Education and King's College London, Center for Educational
Studies.

telecommunications course for teachers. The Journal of Computers in Mathematics

Weick, K.E. (1976). Education organizations as loosely-coupled systems.

Administrative Science Quarterly, 21 (1), 1-19.


Wesley, M.T. Jr. (1996). Teachers' concerns and voluntary adoption activities in
educational technology innovation: A case study. Doctoral dissertation.


Willis, J., Hovey, L., & Hovey, K. (1987). Development and evaluation of a teacher education simulation for the informal reading inventory. Computers in the Schools, 8 (1/2/3).


APPENDIX 1
Criteria For Selection Of Training Milieu For Field Observations

Table I : The Technological Infrastructure in the Training Milieu

<table>
<thead>
<tr>
<th>Facilities available</th>
<th>Name of teacher training colleges</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Computers</td>
<td>/</td>
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<tr>
<td>Air conditioner</td>
<td>/</td>
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<tr>
<td>Multimedia PCs</td>
<td>/</td>
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<tr>
<td>OHP</td>
<td>X</td>
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<tr>
<td>TV</td>
<td>/</td>
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<tr>
<td>VCR</td>
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<tr>
<td>Radio/Cassette</td>
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<td>Windows 95/ 97</td>
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<td>Windows 3X</td>
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<td>Authorware</td>
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<td>Internet</td>
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<td>LCD</td>
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<td>Reference materials</td>
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| Total scores         | 13 | 11 | 14 | 13 | 14 | 13 | 13 | 13 | 10 | 13 | 1 |

Table II: Expertise of Facilitators in the Training Program

Key:  
(i) indicates presence of / usage  
(X) indicates absence of / non usage

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<th>Quality of Facilitators</th>
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<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
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<td>Training in technology</td>
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<tr>
<td>Adequate preparations</td>
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<tr>
<td>Skilled</td>
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<tr>
<td>Able to select stimulating material</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Conducive physical environment</td>
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<tr>
<td>Communicate fluently</td>
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<tr>
<td>Challenge teachers’ thinking</td>
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<tr>
<td>Stimulating materials &amp; activities</td>
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<td></td>
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<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
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<td>9</td>
<td>4</td>
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Table IIIa: Use of smart learning strategies

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<td></td>
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<td>Thoughtful Learning</td>
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<tr>
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<td>4  2  4  3  4  3  4  4  4  1  4  3</td>
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<td>Experiential</td>
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<td>Eclectic strategies</td>
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<td>Smart facilitation</td>
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<td>Technology-assisted learning</td>
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<td>Modular learning</td>
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<td>26 16 28 19 24 23 23 21 26 6 24 18</td>
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Key:
1: Highly unsatisfactory
2: Unsatisfactory
3: Satisfactory
4: Highly satisfactory

<table>
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<th>Elements in the portfolios</th>
<th>Names of teacher training colleges</th>
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<td>Critical and creative thinking</td>
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<tr>
<td>skills</td>
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<td>IT skills</td>
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<td>Learning package</td>
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<td>Total scores</td>
<td>12 12 12 11 15 4 7 16 18 4 6 9</td>
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Key: A maximum score of 3 is awarded if there is evidence of three things—a learning contract, a journal, and peer evaluation.

Table IIIc: Preparation of Learning Package

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<th>Preparation of Learning Package</th>
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<tr>
<td>Stage 2 implemented in Week 2</td>
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<tr>
<td>Mapping of learning outcomes</td>
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Key: (/) Implemented  
(X) Not implemented

APPENDIX 2
Stages Of Concerns Questionnaire (SoCQ)

Nombor kad pengenalan : .................................................................
(4 digit terakhir)

Sekolah : .........................................................................................

Tariih : .........................................................................................

Arahan:
Soal selidik ini bertujuan menentukan prihatin anda semasa pengajaran-pembelajaran (p-p) berintegrasi komputer di sekolah. ‘P-p berintegrasi komputer’ dalam konteks soal selidik ini merujuk kepada segala penggunaan komputer (termasuk perisian, aplikasi dan teknologi komunikasi seperti emel, halaman web, dll.) dalam menyampaikan kandungan mata pelajaran sekolah.

Sila bulatkan angka yang mencerminkan perasaan (prihatin) anda mengenai inovasi ini. Sekiranya soalan itu kurang relevan atau pun tidak relevan kepada anda, sila bulatkan “0” pada skala yang telah disediakan. Bagi soalan-soalan yang lain, sila bulatkan angka yang PALING menggambarkan perasaan (prihatin) anda mengenai penglibatan anda dalam inovasi ‘p-p berintegrasi komputer’ PADA KETIKA INI. Frasa seperti “inovasi ini”, “pendekatan ini” atau pun “sistem ini” merujuk kepada penggunaan p-p berintegrasi komputer dalam menyampaikan mata pelajaran di sekolah.

Berikut adalah sedikit penerangan mengenai skala petunjuk:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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Kenyataan ini tidak relevan bagi saya.

Sila jawab secara ikhlas. Segala maklumat yang diberi adalah sulit dan hanya akan digunakan bagi tujuan penelitian sahaja.

Terima kasih kerana meluangkan masa dan sudi bekerjasama.
Sila bulatkan angka yang paling menggambarkan perasaan anda mengenai inovasi p-p berintegrasi komputer pada ketika ini.

Skala Petunjuk:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<tbody>
<tr>
<td>Tidak relevan bagi saya</td>
<td>Tidak benar mengenai saya sekarang</td>
<td>Sederhana benar mengenai saya pada masa sekarang</td>
<td>Sangat benar mengenai saya pada masa sekarang</td>
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<tr>
<th>Skala (Sila bulatkan angka)</th>
<th>Perasaan (prihatin) pada ketika ini</th>
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<tbody>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>1. Saya prihatin tentang sikap pelajar terhadap p-p berintegrasi komputer. (I am concerned about students' attitudes towards technology-integrated instruction.)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>2. Sekarang, saya sudah tahu pendekatan lain yang mungkin lebih berkesan daripada p-p berintegrasi komputer. (I now know of some other approaches that might work better.)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>3. Saya tidak tahu apa dia p-p berintegrasi komputer. (I don't even know what technology-integrated instruction is.)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>4. Saya prihatin tentang ketidakcukupan masa bagi mengelola diri saya (berhubung dengan penggunaan teknologi komputer dalam p &amp; p) setiap hari. (I am concerned about not having enough time to organize myself each day.)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>5. Saya ingin menolong guru lain dalam mengamalkan p-p berintegrasi komputer. (I would like to help other faculties in their use of computer technology.)</td>
</tr>
<tr>
<td>0 1 2 3 4 5 6 7</td>
<td>6. Pengetahuan saya mengenai p-p berintegrasi komputer adalah sangat terhad. (I have very limited knowledge about technology-integrated instruction.)</td>
</tr>
</tbody>
</table>
7. Saya ingin tahu kesan meastruktur semula organisasi (ke arah penggunaan p-p berintegrasi komputer) pada status profesional saya.
(I would like to know the effect of reorganization on my professional status.)

8. Saya prihatin tentang konflik antara minat saya dan tanggungjawab saya.
(I am concerned about conflict between my interests and my responsibilities.)

(I am concerned about revising my use of technology-integrated instruction.)

10. Saya ingin membina perhubungan bekerja dengan guru lain di sekolah ini dan sekolah lain melalui p-p berintegrasi komputer.
(I would like to develop working relationships with both our faculty and outside faculties using technology-integrated instruction.)

11. Saya tidak prihatin tentang teknologi komputer.
(I am not concerned about technology-integrated instruction.)

13. Saya ingin tahu siapa yang akan membuat keputusan mengenai p-p berintegrasi komputer.
(I would like to know who will make the decisions regarding technology-integrated instruction.)

(I would like to discuss the possibility of using technology-integrated instruction.)

15. Saya ingin tahu tentang sumber yang sedia ada jika kita memutuskan mengamalkan p-p berintegrasi komputer.
(I would like to know what resources are available if I decide to adopt technology-integrated instruction.)
(I am concerned about my inability to manage all that computer technology-integrated instruction requires.)

17. Saya ingin tahu bagaimana pengajaran / pentadbiran saya harus berubah.  
(I would like to know how my teaching or administration is supposed to change.)

18. Saya ingin membiasakan guru lain dengan perkembangan dalam pendekatan baru ini.  
(I would like to familiarize other departments or persons with the progress of this new approach.)

(I am concerned about evaluating my impact on students.)

(I would like to revise the instructional approach to technology-integrated instruction.)

(I am completely occupied with other things.)

22. Saya ingin mengubah suai pengamalan p-p berintegrasi komputer saya berdasarkan pengalaman pelajar.  
(I would like to modify our use of technology-integrated instruction based on the experiences of our students.)

23. Walau pun saya tidak tahu tentang p-p berintegrasi komputer, saya agak prihatin terhadap perkembangan dalam bidang ini.  
(Although I don't know about technology-integrated instruction, I am concerned about things in the area.)

24. Saya ingin menggerakkan dan memberi motivasi kepada pelajar saya dalam pendekatan ini.  
(I would like to excite my students about their part in this approach.)
25. Saya prihatin tentang masa yang perlu diluangkan bagi menyelesaikan masalah bukan akademik yang berkaitan dengan p-p berintegrasi komputer. 
   (I am concerned about time spent working with non-academic problems related to technology-integrated instruction.)

   (I would like to know what the use of technology-integrated instruction will require in the immediate future.)

27. Saya ingin menelaraskan usaha saya dengan guru lain supaya dapat memaksimalkan kesan penggunaan p-p berintegrasi komputer. 
   (I would like to coordinate my effort with others to maximize technology-integrated instruction's effects.)

   (I would like to have more information on time and energy commitments required by technology-integrated instruction.)

29. Saya ingin tahu apakah yang dilakukan oleh guru lain dalam inovasi p-p berintegrasi komputer. 
   (I would like to know what other faculty are doing in this area.)

30. Pada ketika ini, saya tidak berminat belajar tentang p-p berintegrasi komputer. 
   (At this time, I am not interested in learning about computer technology.)

31. Saya ingin tahu bagaimana saya boleh menambah, meningkat atau mengganti p-p berintegrasi komputer. 
   (I would like to determine how to supplement, enhance or replace technology-integrated instruction.)

32. Saya ingin menggunakan maklumat daripada pelajar bagi mengubah p-p berintegrasi komputer. 
   (I would like to use feedback from students to change the program.)
33. Saya ingin tahu bagaimanakah peranan saya akan berubah apabila saya menggunakan p-p berintegrasi komputer.
(I would like to know how my role will change when I use technology-integrated instruction.)

34. Penyelarasan tugas dan tenaga manusia apabila mengamalkan p-p berintegrasi komputer mengambil terlalu banyak masa saya.
(Coordination of tasks and people is taking too much of my time.)

35. Saya ingin tahu apakah kelebihan p-p berintegrasi komputer berbanding dengan amalan / pendekatan sedia ada.
(I would like to know how technology-integrated instruction is better than what we have now.)

Terima kasih atas kerjasama anda!
APPENDIX 2ai
Addendum To First Snapshot Of SoCQ (Bahasa Malaysia version)

Sila isi butir-butir berikut:

1. Umur: ...................... tahun

2. Pencapaian Academic (Sila pada petak yang sesuai):
   - Sijil perguruan
   - Ijazah sarjana muda
   - Ijazah sarjana
   - Ijazah kedoktoran

3. Jantina:
   - Lelaki □
   - Perempuan □

4. Adakah anda memiliki komputer di rumah?
   - Ya □
   - Tidak □

5. Pernahkah anda menerima latihan dalam teknologi komputer?
   - Ya □
   - Tidak □

6. (Jika jawapan ialah "Ya", sila terangkan jenis, tempoh and tempat latihan)

7. Pengalaman mengajar: ...................... tahun

8. Tugas mengajar bagi tahun 2000:

<table>
<thead>
<tr>
<th>Mata pelajaran</th>
<th>Tingkatan</th>
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<tbody>
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</table>

9. Secara purata, beberapa jam seminggu yang anda guna komputer
   a. bagi tujuan mengajar? ...................... jam seminggu
   b. bagi tujuan bukan mengajar? (peribadi) ...................... jam seminggu

10. Adakah anda mempunyai halangan terhadap penglibatan dalam kajian ini?
    - Ya □
    - Tidak □

Terima kasih atas kerjasama anda!
APPENDIX 2aII
Addendum To First Snapshot Of SoCQ (English version)

Please fill in the following particulars:

1. Age: .............. years ........................................

2. Qualifications (Please check where appropriate):
   Teaching Certificate [ ]
   Bachelor’s degree [ ]
   Master’s degree [ ]
   Doctorate degree [ ]

3. Gender: Male [ ] Female [ ]

4. Do you own a computer at home? Yes [ ] No [ ]

5. Have you received training in computer technology? Yes [ ] No [ ]

6. (If yes, please specify type, duration and source of computer training)
   ..................................................................................................................
   ..................................................................................................................

7. Teaching experience: .............. years

8. Teaching workload for the year 2000 (if known):

   Subjects ................................................................. Form ........................................
   ..............................................................................................................
   ..............................................................................................................

9. On an average, how many hours a week do you spend
   a. using computers for teaching purposes? .............. hours
   b. using computers for non-teaching purposes? .............. hours

10. Do you have any objections to being involved in the research study? Yes [ ] No [ ]

Thank you for your time and cooperation!
APPENDIX 2bi
Addendum To Second Snapshot Of SoCQ (Bahasa Malaysia version)

_Sila jawab soalan berikut secara ikhlas. Jawapan anda hanya akan digunakan bagi tujuan penyelidikan sahaja dan adalah sulit._

1. Adakah factor berikut merupakan halangan / masalah bagi usaha mengintegrasikan teknologi komputer dalam pengajaran-pembelajaran di sekolah anda? (Sila tandakan dalam petak yang sesuai.)

<table>
<thead>
<tr>
<th>Ya</th>
<th>Tidak</th>
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<tbody>
<tr>
<td>a. Kurang akses kepada komputer dan 'software'</td>
<td>...... ......</td>
</tr>
<tr>
<td>b. Kurang kemahiran komputer</td>
<td>...... ......</td>
</tr>
<tr>
<td>c. Kurang contoh baik tentang cara mengintegrasikan teknologi komputer dalam mata pelajaran yang diajar</td>
<td>...... ......</td>
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<tr>
<td>d. Kurang sokongan daripada pihak pentadbir sekolah</td>
<td>...... ......</td>
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<tr>
<td>e. Kurang sokongan daripada rakan sebaya</td>
<td>...... ......</td>
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<tr>
<td>f. Kurang yakin diri untuk menjayakan pelajaran berintegrasi komputer</td>
<td>...... ......</td>
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<tr>
<td>g. Kurang masa</td>
<td>...... ......</td>
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<tr>
<td>h. Kurang yakin tentang keberkesanan pelajaran berintegrasi komputer</td>
<td>...... ......</td>
</tr>
<tr>
<td>i. Masalah disiplin pelajar</td>
<td>...... ......</td>
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<td>j. Lain-lain (sila catatkan)</td>
<td>..................................................</td>
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<tbody>
<tr>
<td>a. Tiada</td>
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<td>b. 1-2 kali</td>
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<tr>
<td>c. 3-5 kali</td>
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<tr>
<td>d. Lebih daripada 5 kali</td>
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</tbody>
</table>
3. Apakah kekerapan anda mengintegrasikan kemahiran komputer dalam pelajaran?
   a. Setiap hari
   b. 1 ~ 4 kali seminggu
   c. 1 ~ 4 kali sebulan
   d. jarang (sebulan pun tidak sekali)

4. Sila tandakan ( ) sekiranya anda mengintegrasikan amalan teknologi berikut dalam pelajaran anda. Biarkan petak kosong sekiranya tidak.

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<tbody>
<tr>
<td>1</td>
<td>Latihubi (melalui CD-Rom dsbnya)</td>
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<tr>
<td>2</td>
<td>Tutorial (melalui CD-Rom dsbnya)</td>
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<tr>
<td>3</td>
<td>Guna skrin komputer sebagai papan tulis</td>
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<tr>
<td>4</td>
<td>Persembahan elektronik (presentations)</td>
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<tr>
<td>5</td>
<td>Pemprosesan kata</td>
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<td>6</td>
<td>Data base</td>
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<td>7</td>
<td>Hamparan elektronik (spreadsheet)</td>
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<tr>
<td>8</td>
<td>Penerbitan (desktop publishing)</td>
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<td>9</td>
<td>Permainan</td>
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<tr>
<td>10</td>
<td>Simulasi</td>
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<td>11</td>
<td>Projek penyelesaian masalah</td>
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<td>12</td>
<td>Emel</td>
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<td>13</td>
<td>Konferens video</td>
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<tr>
<td>14</td>
<td>Projek kolaboratif dengan sekolah lain</td>
</tr>
<tr>
<td>15</td>
<td>Pengajaran berdasarkan halaman web</td>
</tr>
<tr>
<td>16</td>
<td>Internet (penyelidikan)</td>
</tr>
</tbody>
</table>

5. Secara ringkas, terangkan penggunaan teknologi komputer yang anda dapat paling berkesan untuk pelajar anda.
6. Pada pendapat anda, apakah tindakan susulan yang paling penting untuk mempertingkatkan lagi usaha guru dalam mengamalkan pelajaran berintegrasi teknologi komputer? (Sila susun pilihan jawapan berikut mengikut urutan kepentingan (ranking), misalnya, tulis angka 1 di sebelah pilihan yang anda anggap paling penting, 2 untuk pilihan kedua penting, dan sebagainya).

a.Tambahkan bilangan komputer

b. Tambahkan ‘software’

c. Tambahkan latihan

d. Beri ganjaran kepada guru yang mengintegrasikan teknologi komputer dalam pelajaran

e. Beri contoh baik pelajaran berintegrasi komputer (“good practices”) 

f. Ambil kira markah project berdasarkan komputer dalam penilaian peperiksaan awam

g. Tambahkan kemahiran teknologi pelajar

h. Tambahkan kemahiran Bahasa Inggeris pelajar

i. Lain-lain (sila catatkan)

7. Komen / ulasan tambahan:

Terima kasih atas kerjasama anda sepanjang tempoh dua tahun ini.
Please answer the following questions as frankly as possible. All information provided is confidential and will be used for research purposes only.

1. Are the following factors problems or obstacles to your efforts to integrate technology into instruction in your school? (Please tick in the relevant boxes.)

   a. Lack of access to hardware and software
   b. Lack of computer skills
   c. Lack of exemplary practices on how to integrate computer technology into the subject taught
   d. Lack of support from the school administration
   e. Lack of support from peers
   f. Lack of confidence to implement technology-integrated instruction
   g. Lack of time
   h. Lack of confidence in the efficacy of technology-integrated instruction
   i. Student discipline problems
   j. Others (please state) .................................................................

   Yes  No

2. Since attending the 14 Weeks In-service Training Programme for Teachers of Smart Schools, how often have you conducted or helped to organize technology-related in-service training / staff development sessions for other teachers? (Please circle the most appropriate answer.)

   a. Not even once
   b. 1~2 times
   c. 3~5 times
   d. More than 5 times
3. How often do you integrate computer technology into instruction?
   a. Everyday
   b. 1 ~ 4 times a week
   c. 1 ~ 4 times a month
   d. rarely (not even once a month)

4. Please tick ( ) against the technology practice that you use in your lessons.
   Leave the boxes empty if you do not practise the technology use.

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>a.</td>
<td>Drills and practice (via CD-Rom, etc)</td>
</tr>
<tr>
<td>b.</td>
<td>Tutorials (via CD-Rom, etc)</td>
</tr>
<tr>
<td>c.</td>
<td>Using the computer screen as a white board</td>
</tr>
<tr>
<td>d.</td>
<td>Electronic presentations</td>
</tr>
<tr>
<td>e.</td>
<td>Word processing</td>
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<tr>
<td>f.</td>
<td>Databases</td>
</tr>
<tr>
<td>g.</td>
<td>Electronic spreadsheets</td>
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<tr>
<td>h.</td>
<td>Desktop publishing</td>
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<tr>
<td>i.</td>
<td>Computer games</td>
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<tr>
<td>j.</td>
<td>Simulations</td>
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<tr>
<td>k.</td>
<td>Problem solving projects</td>
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<td>l.</td>
<td>Email</td>
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<td>m.</td>
<td>Video conferencing</td>
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<td>n.</td>
<td>Collaborative projects with other schools</td>
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<tr>
<td>o.</td>
<td>Web based instruction</td>
</tr>
<tr>
<td>p.</td>
<td>Internet (research)</td>
</tr>
</tbody>
</table>

5. Briefly, outline the computer technology use that you find most effective for your students.

..................................................................................................................................................................................................................................................................................................................
6. In your opinion, which follow-up action stated below would be most effective to get teachers to increase their efforts to integrate technology into instruction? (Please rank the options provided according to importance by writing 1 in the blank space next to the option perceived as most important, 2 as second most important, etc.)

a. Increase the number of computers
b. Increase software
c. Increase training
d. Provide incentives for teachers who integrate technology into instruction
e. Provide samples of “good practices” or optimal uses of technology
f. Incorporate marks for technology-based projects into public examinations
g. Enhance technology competencies of students
h. Enhance English proficiencies of students
i. Others (please state)

7. Comments:

Thank you for your cooperation over the last two years.
APPENDIX 3
Interview Schedule To Check Teachers’ LoU
(adapted from the CBAM’s LoU protocol)

Are you using computer technology in teaching?

1. If the answer is “no”...
   a. Have you decided to use it?
   b. Are you looking for information about it?
   c. Have you set a date for using it?

2. If the answer is “Yes, in the past” ...
   Why did you stop using computer technology?
   Do you intend to use it again? When?

3. If the answer is “Yes” ...
   a. Can you describe how you normally use computer technology in the classroom?
      How often do you use it? Are you looking for information about it? What do you see as the strengths and weaknesses of using technology in the classroom?

   b. Have you made any changes recently to how you use technology-integrated instruction in the classroom? What kind of changes did you make? Why?
      Are you considering making changes?
      Do you talk with others about using technology in the classroom?
      What do you usually tell them when you talk about using technology-integrated instruction?
      What are the effects of using computer technology-integrated instruction in the classroom?
      Are you evaluating / getting feedback from the students that affects your use of technology in the classroom?

   c. Are you working with others in your use of technology-integrated instruction? Do you meet / discuss with them on a regular basis? What plans do you have for collaboration in the near future?

   d. Are you planning to make major modifications / thinking about replacing the use of technology-integrated instruction?
APPENDIX 4
Overview Of Branching Format Of Lou Focused Interview

Are you using technology-integrated instruction?

Yes
LoU3, 4a, 4b, 5, 6

What kinds of changes are you making in your use of technology-integrated instruction?

Impact oriented LoU4b, 5, 6

Nothing unusual LoU4a

User oriented LoU3

Are you coordinating your use of technology-integrated instruction with that of other users?

Yes LoU5

Are you planning to make major modifications or replace the innovation?

No LoU6

No LoU4b

No

Have you decided to use it and set a date to begin use?

Yes LoU2

No LoU0, 1

Are you currently looking for information about using technology-integrated instruction?

Yes LoU1

No LoU0
APPENDIX 5
Interview Schedule For School Principals

1. Can you tell us something about the history of the use of computer technology in instruction in your school?

2. How do you feel about the use of computer technology in instruction?

3. Based on your experience and observations, what factors have promoted / inhibited the adoption of technology-integrated instruction in your school?

4. What is the most interesting thing that you have seen done with technology in your school?

5. What problems have you encountered in implementing technology-integrated instruction in your school?

6. How did you resolve these problems?

7. In your opinion, what factor/s are most important to help ensure the success of the MOE’s efforts at implementing technology-integrated instruction?

8. What is your vision for this school?
APPENDIX 6:
Interview Schedule For Students

1. Adakah anda menggunakan teknologi komputer dalam pembelajaran anda di sekolah? Jika ya, sila sebut lebih kurang beberapa kali seminggu.
   *(How often do you use the computer in your lessons?)*

2. Apakah perasaan anda terhadap integrasi komputer dalam pengajaran-pembelajaran?
   *(How do you feel about the integration of computer technology in instruction?)*

3. Apakah aspek/bahagian yang anda paling suka mengenai penggunaan teknologi komputer dalam pembelajaran?
   *(What's your favourite part about using the computer in the classroom?)*

4. Bagaimanakah pembelajaran yang mengintegrasikan teknologi komputer berbeza dari pembelajaran secara tradisional?
   *(How are lessons using computer technology different from the normal lessons?)*

5. Apakah aspek yang anda tidak suka mengenai integrasi komputer dalam pembelajaran anda di sekolah?
   *(Which aspect about using computers in the classroom do you dislike?)*

6. Apakah cita-cita anda? Pada pendapat anda, adakah teknologi komputer membantu anda dalam kerjaya anda nanti? Jika ya, bagaimana?
   *(Have you thought about what you want to be when you grow up? Do you see computer technology as helping you later in your profession? How?)*

7. Adakah anda lebih suka belajar dengan komputer ataupun dengan cara lama (tanpa komputer)?
   *(Do you prefer learning with computers or the traditional way?)*
APPENDIX 7.1 a
SoC Mean Percentile Stage Scores Of Teachers At Rajawali (February 2000)

<table>
<thead>
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APPENDIX 8  
Stages Of Technology Competencies

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<th>STAGE</th>
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| A     | Awareness  
       | I am aware of computer technology but have not used it yet. |
| B     | Learning the process  
       | I am trying to learn the basics of computer technology |
| C     | Understanding & application  
       | I am beginning to better understand the process of using computers and can think of ways in which to use them meaningfully |
| D     | Familiarity and confidence  
       | I am comfortable with computers and I use them more and more |
| E     | Adaptation  
       | I frequently use and adapt computer applications in my work and as an instructional aid in the classroom |
| F     | Creative application  
       | I can apply what I know about technology and integrate it into the curriculum in various innovative ways. |