Benchmarking of the Smart School Integrated Solution

EDUCATING HEARTS AND MINDS

THE MALAYSIAN SMART SCHOOL

Conducted for

Multimedia Super Corridor

Multimedia Development Corporation, Malaysia

Ministry of Education, Malaysia

Commissioned by

Multimedia Super Corridor

Multimedia Development Corporation, Malaysia

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Table of Content

CHARTS:

TABLES:

BACKGROUND

The Smart School Project was conceptualized in early 1996, with a brainstorming session by the Ministry of Education on the smart school concept and the implications it may have on the country's education system. By the end of the year, Smart School had become one of the seven flagship applications of the Multimedia Super Corridor (MSC) project, promoted by the Multimedia Development Corporation (MDC). Under the Smart School Project, the government aimed to capitalize on the presence of leading-edge technologies and the rapid development of the MSC infrastructure to jump-start deployment of enabling technology to Malaysian schools.

In July 1997, The Malaysian Smart School – A Conceptual Blueprint was produced by a project team, which consisted of industry representatives, officials from the MDC, and the Ministry of Education. A joint venture company, Telekom Smart School Sdn Bhd (TSS), was incorporated in June 1999 with the objective of transforming the Malaysian education system into a technologically advanced process. The joint venture partners were Telekom Multimedia Sdn Bhd, Sapura Telecommunications Bhd, Educational Trend Sdn Bhd, DEMC Anzagain Sdn Bhd, Digital Technologies Sdn Bhd, Custommedia Sdn Bhd, Multi Media Synergy Corp. Sdn Bhd, BT Multimedia (Malaysia) Sdn Bhd, Electronic Data Systems IT Services (Malaysia) Sdn Bhd and NIIT Malaysia Sdn Bhd.

The government awarded the TSS the contract for implementing the Smart School solution at ninety pilot schools nationwide. The pilot was completed in December 2002. Eventually, the country hopes to rollout the Smart School Integrated Solution (SSIS), developed by the Ministry of Education and TSS, to all of Malaysia's over 9,000 schools by the year 2010. The pilot schools are expected to serve as the nucleus for the eventual nationwide rollout of SSIS, which included the teaching concepts and materials, skills and technologies. TSS has signed The Main Licensing Agreement with the Government of Malaysia to globally market SSIS and its licensed materials.

The main components of SSIS that have been developed and implemented are:

- Teaching-Learning Materials in the form of courseware and printed materials for:
    - Bahasa Melayu
    - English Language
    - Science
    - Mathematics
- The Smart School Management System comprising software for management and administrative functions
- Technology Infrastructure comprising hardware, software, systems software, and non- IT equipment
- Systems Integration to ensure integration in the following areas:
    - Between the Smart School Management System, the Teaching-Learning Materials, and Technology Infrastructure in the project schools and the Data Center
    - Within the processes in the Smart School Management System
    - Within the processes in the Teaching-Learning Materials
    - Between the Smart School Management System and the Teaching-Learning Materials

  - Provision of data integrity and a secure environment,
  - Between the Smart School Integrated Solution and other applications in the other Flagship Applications of the Multimedia Super Corridor project.
- Support Services comprising Help Desk services and Maintenance and Support for the smart schools.

The Broader Vision

While the immediate objective of the Smart School Project was to reinvent the teaching-learning process with the aid of information and communication technology (ICT), it also fitted into the broader scheme of objectives outlined by the MDC. All the flagships adhered to a broader vision:

- To jump-start the development of MSC
  - by providing business opportunities for companies to participate in
- To make MSC a global test-bed for innovative solutions
  - thereby attracting web-shapers & service providers
- To increase Malaysian productivity and competitiveness
  - by creating the environment/ infrastructure for E-Business, E-Gov/Education/Healthcare, Financial systems and other key areas
- To reduce Digital Divide.

Acknowledgement

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BENCHMARKING OF THE SMART SCHOOL INTEGRATED SOLUTION

Executive Summary

As a society, we cannot separate our goal to be a leading economic competitor from our duty and responsibility to educate all youngsters...

- Unknown

The Context

Over the past few years, educationists and policy makers the world over have been debating on how information technology can facilitate a scientifically correct teaching process that encourage innovation and creativity in the learning process. There can be no doubt that information and communication technologies (ICT) are important in modern society. However, the popular hype that technology is the panacea of education has now given way to more reasoned consideration. Today, we look at technology more as an enabler, a powerful medium of delivery. Technology can be used to deliver content, provide interaction, and facilitate communication. The presence of technology, then, does not ensure effective learning. Instead, it presents many opportunities for an enhanced learning experience.

Built on these principles, the Malaysian Smart School Project attempts to reinvent the teaching learning process in an effort to meet the country's broader goals of transforming from a predominantly industrial economy into a knowledge economy. The project continues to remain a critical component of the Malaysian government's Multimedia Super Corridor (MSC) initiative that envisages the creation of high-value jobs in the country, achieve high and consistent growth driven by exports, improve national productivity and competitiveness and achieve value creation. All these would eventually translate into economic growth, wealth creation and competitiveness for the country.

The Smart School Integrated Solution (SSIS) was rolled out to 87 pilot schools in the country at a cost of about $78 million (RM 300 million). The project, admittedly, has several significant achievements to its credit.

The benchmarking study, the first of its kind to be conducted for MSC's flagships, compares the merits of the SSIS and its components with similar implementations, if any, in the world. The operative words here are 'if any' because none of the initiatives in the countries chosen for the study offered an apple-to-apple comparison. We took up a total of 8 countries (Australia, Britain, Canada, Ireland, Japan, New Zealand, Singapore, and USA) to benchmark their best practices in ICT-mediated education with that of Malaysia. Of these, broader benchmarks were defined for 6 countries—the ICT infrastructure available in schools, the communication links for schools, efforts made at the national and regional levels to promote ICT mediation in education to realize the broad goals of innovative learning and teaching, student-centered learning process etc.

Two more countries, Ireland and New Zealand, were taken up to benchmark each of the 9 components of the Smart School Integrated Solution in Malaysia. These countries were chosen as they had achieved a fair bit of maturity in ICT-mediated education and their initiatives were the closest to what was happening in Malaysia. Despite this fact, startling differences emerged between these independent initiatives.

The SSIS and its 9 components were benchmarked against comparable components that have been implemented in Ireland and New Zealand. These are:

- Smart School Management System
- Teaching Learning Material
- Change Management
- Infrastructure and Technology
- Support Services
- System Integration
- Interoperability
- Project Management
- Security

Broader Benchmarking - Key Findings

Significant Difference in the Smart School Approaches

The approaches to achieving ICT mediated education in the countries chosen have been vastly different to those of Malaysia's. The learning revolution in these countries happens in pockets. The small waves combine to make a larger wave. Initiatives at the school level, at the community level and the district level are characteristically the small waves. The government's role is that of an *agent provocateur*. It sets the vision. However, it is not a vision shared only by the decision-makers at the national level. It is a vision that is shared by one and all - the schools, communities, public and private sector entities, district level education authorities and many others. Everyone contributes their mite, and understandably so, because without such large-scale enthusiasm, educational reforms are next to impossible. A number of initiatives are bottoms-up initiatives. In Ireland, the schools integration project or SIP just planned for 25 projects involving about 200 odd schools. What they ended up achieving was over 75 projects involving the participation of over 600 schools. In New Zealand, cluster schools come together not just on the basis of their geographic location, but also on the basis of a common goal. The schools themselves, interestingly, set the goals. The government just validates them and allocates funding. Chart A-1 and A-2 illustrates the approaches common to other countries and Malaysia.

Chart A-1: Common Smart School Approach – Sequential Approach

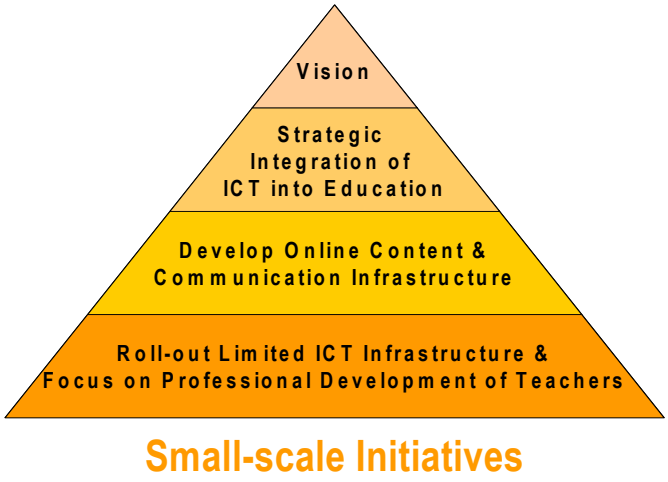
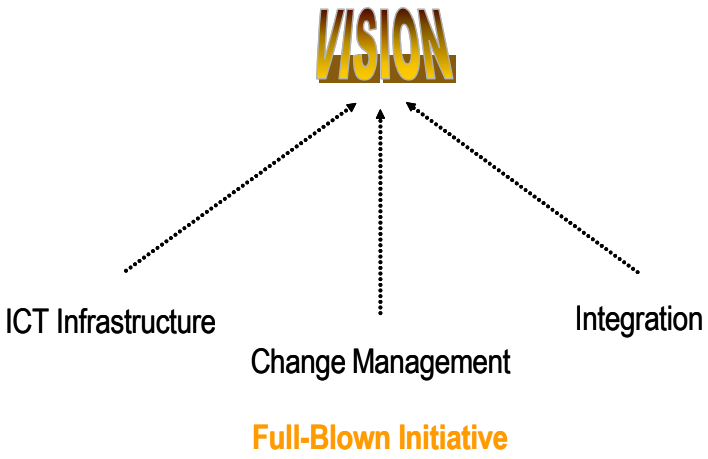


Chart A-2: The Malaysian Smart School Approach – Simultaneous Approach



In a number of countries that were taken up for the study, ICT-mediation began as small-scale projects. This started with building some sort of ICT infrastructure in schools accompanied by professional development of teachers. It was followed by the development of a communication infrastructure and online content. A meaningful integration of ICT with education followed. There are several examples that go to illustrate this approach. All the member countries of the Eurydice network in the European Union followed the sequential approach. All these countries are now poised on the verge of the transformative phase—to transform the way in which people learn.

In the US, ICT initiatives for education have been on for more than 18 years now. In countries like Ireland, the initiatives started in 1997, but much has been achieved so far. Both Ireland and New Zealand started their initiatives at about the same time as Malaysia did. Of the two, a more meaningful integration of ICT in education is happening in Ireland. The projects-based approach in Ireland to ICT mediation helps young people to be at their creative best, to express themselves and to gain confidence as effective learners. They learn how to conceptualize a project, how to troubleshoot when things go wrong and how to learn and teach.

PC and Internet Penetration – Key Success Factors

All the countries studied for benchmarking had achieved certain level of nation-wide infrastructure in terms of PC and Internet penetration, and broadband connectivity. We also compared the expenditure per student as a percentage of per capita GDP in these countries. A comparison of such resource availability shows how difficult it is for developing nations such as Malaysia to achieve ICT-mediation in education. Table 1 shows the GDP per capita of countries and the annual expenditure for education for each pupil in terms of percentage of the GDP. While the US spends a high 18% of its GDP per capita on education, the closest comparison to Malaysia here is Ireland, which spends about 11.6% of its GDP per capita on a student. However, Ireland's GDP per capita is about 6 times as high as Malaysia's and the number of schools at 4,000 for a population of 4 million. Malaysia has more than double the number of schools. Table 1 shows a comparison of the various parameters defined for the benchmarking study.

Table 1: Key Success Factors for Smart School Implementation – A Comparison

	Macro Economic		Expenditure per Student	Ratio			Penetration		
Country	GDP	GDP/Capita		Student : Teacher	Student : Computer		Computer	Internet	Broadband
	(US$ Billions)	(US$)	(% of GDP/Capita)		Primary	Secondary	(%)		
Malaysia	96	4236	10.7	20	43	26	11.3	24.4	0.09
Singapore	92.3	22343	16.5	25.3	17	5	64.4	48.4	6.05
USA	9800	34348	18	15	6	3	62.3	74.6	60.9
UK	1400	23810	17.2	18.7	12	6	46.8	46.7	2.3
Canada	687.9	22132	17	15	11	9	69	54.7	29.3
Australia	390.1	19957	14	17	15	8	66.4	54.4	1.9
New Zealand	49.9	12964	16.6	15.4	20	10	61.8	37.7	1.7
Ireland	93.9	24459	11.6	21.6	14	4	44.2	56.3	3.4

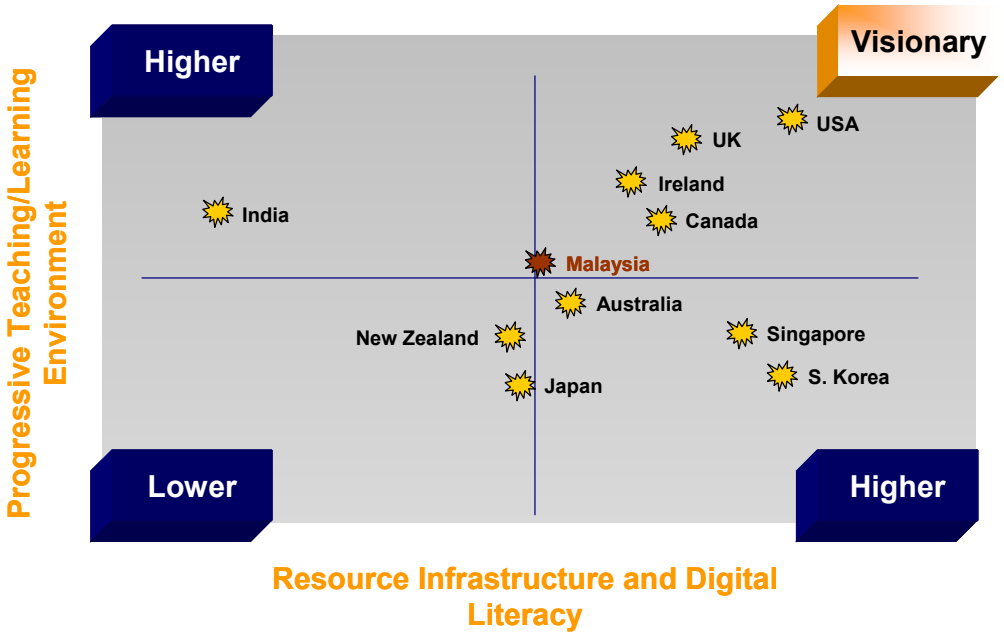
Malaysia's student to computer ratio is 26 to one in secondary. Ireland is moving toward a teacher to computer ratio of 1:1 through its latest laptop program and so is NZ. The two countries are also planning to achieve a student to computer ratio of 2:1 in secondary schools. This is no mean task, given the fact that even countries such as the US are struggling to increase their number of computers in schools. (Ireland has an average of 44 computers per school.) Despite concerted efforts on the part of the US, the ICT infrastructure in its schools is still very unevenly distributed. Yet another example to show that ICT mediation in education is not going to happen overnight. In the US, it has taken over 18 years and in Ireland about 5-6 years.

Would the number of computers in schools or any other new technology guarantee innovation in the learning process? The answer, not surprisingly, is they cannot. In a number of countries new technologies have been used only to reinforce our outmoded learning process.

However, computers are a medium through which people can create and design things. And, research in the past has shown that learning happens best when we can create things—example create music using the computer instead of downloading MP3 files, create games instead of playing them. At the end of the day, the computer's contribution depends on one thing—how it is being put to use—which is why a number of countries have marked teacher training and professional enhancement as their number one priority.

Based on the factors illustrated in Table 1, country clusters were created (Chart B) after assigning weighted average scores to the defined parameters.

Chart B: Country Comparative Matrix



SSIS Benchmarking with Ireland and New Zealand – Key Findings

Smart School Achievements, Significant and Many

Malaysia, a Model for Developing Countries

Malaysia today presents a model for ICT-mediated education in developing countries. These countries can look to Malaysia to figure out what can be possible, to predict the problems that they may eventually face and learn how to overcome them.

SSMS, One of a Kind

The Smart School Management System (SSMS) is one of its kind. It is true that similar solutions are available in the market elsewhere. But, when it comes to implementation, no single package has found such nation-wide implementation.

Malaysian Smart School – No Comparable Implementation

None of the countries studied had contemplated automation of the entire school processes. Such implementations are common only among rich, residential schools. The Malaysian achievement is all the more significant as it had brought such initiatives within the reach of government schools.

Government Funded Initiative Vs Government-Community-Private Sector Funding

In Malaysia, building an ICT infrastructure in schools is entirely funded by the government. Whether the government can sustain such investments for the rollout to 9,000 schools is by itself a significant topic for discussion.

In New Zealand, schools bear a bulk of the burden for creating and maintaining their ICT infrastructure, but not without the support of the community. In Ireland, the government contributes only up to 50% of the total infrastructure expenditure for schools while the rest is derived from the community. There are a number of private initiatives in both the countries to build the ICT infrastructure in schools. Intel, in fact, runs Ireland's ScoilNet, the Web site for schools. A number of such initiatives are described in the report.

All the three countries are planning to enhance ICT infrastructure in their schools. While Malaysia plans to roll-out the smart school initiative to 9,000 schools, NZ is embarking upon an integration project, where it will attempt to connect all the schools, develop a comprehensive repository of curriculum objects, and put in place policies (that cover all schools). Ireland will invest about $96 million (£60 million) to increase computer penetration. Both the countries are planning a host of broadband initiatives to bring in high-speed Internet into the classrooms. These efforts too will see support from the respective national carriers, Eircom and Telecom NZ.

Professional Training and Change Management, a Priority

Both NZ and Ireland have acknowledged that professional training is a prerequisite for any smart school implementation. The highest resistance for ICT mediation normally comes from teachers who have put in the most years of experience in schools and hence occupy some of the most powerful posts in schools. They are so steeped in the traditional ways of teaching and learning, that they pursue ICT as a threat.

Teachers are intimidated by technology and would revert back to their traditional teaching methods at the slightest instance. Change management, in this context, becomes compulsory.

In both Ireland and NZ, change management is happening in waves. Role reversal, parent involvement, involvement of retired employees from ICT and telecommunication firms, and knowledge transfer from the corporate community to schools are not uncommon. Ireland has allocated $33.6 million (€30 million) between 2001 and 2003 for professional training.

Teacher training is not a one-off event, but a sustained effort where the teacher gets the support of students, colleagues, the ICT administrators and the government. In Ireland, along with teachers, librarians too undergo regular training under the New Opportunity Fund. Their progress is benchmarked against the Expected Outcomes.

Security and Support Cannot be Overlooked

ICT infrastructure and online security needs of schools grow in tandem. It is relatively easy to get computers into schools. But, to keep them working is a bigger challenge. As one of the teachers engaged in the Irish Schools Integration Project remarked "The government gave us a lot of money to build the ICT infrastructure. But, this came at a price. Teachers were made to double up as ICT coordinators. They did troubleshooting, repaired systems, and maintained them." This in fact, eats into the time allocated for teaching, which would eventually beat the purpose of ICT mediation. Schools in Ireland and New Zealand source a variety of support mechanisms, including managed services. National and regional help-desks help schools to a certain extent. Community support in maintenance and troubleshooting is also not uncommon.

Increasing threats of viruses, worms, Trojans, hackers and crackers call for professional security measures and personnel. Malaysia has put in place a comprehensive security policy to ensure network security. None of the other countries have a nation-wide security policy governing school networks.

SSMS, No Parallel in Other Countries

SSMS, as said earlier, is one of its kind, with no comparable systems being used in any of the countries studied. The governments in NZ and Ireland stipulate a minimum level of automation (for example student databases) so that information can be passed on from school to school and from school to university. Automation of school processes is piecemeal and left to the discretion of schools. SIP schools in Ireland and Smart Schools in NZ have achieved a degree of uniformity in automating their processes. Here too, the lead schools (for SIP) boast of a more sophisticated ICT automation.

NZ is now developing Basic Education Learning Tool Set (BELTS), which is being beta tested in select schools. This will seek to automate administration, content, class and lessons. NZ is a member of the Australian learning federation, which attempts to create common curriculum objects that can be shared by all schools.

ICT-Mediation, a Must in Teaching and Learning

Even in countries where ICT-mediation is more or less a bottoms-up initiative, the governments stipulate a certain level of ICT mediation in the curriculum. For example, in Singapore, it is 30 percent. NZ and Ireland too have similar systems in place and measures to ensure that it is being followed. NZ achieves digital learning material standardization through its alliance with the learning federation. Both Ireland and NZ have a central repository or exchange for learning objects, from which schools access learning material. Apart from this, their school web sites Te Kete Ipurangi (TKI) and ScoilNet also host curriculum objects that schools can access online. Pedagogy is normally based on competencies, personal competency in ICT, subject and teaching.

Gaps Identified

A comparison between the Malaysian Smart School initiative with similar practices in New Zealand, Ireland and 6 other countries brought out some significant gaps. These are listed below.

Chart C: Gaps Identified

Malaysia	New Zealand	Ireland	Others
SSIS	No single system	No single system	No single system
Components: 9	6 to 8	4 to 6	10 to 12
Teaching & Learning: Govt. directed	Restricted govt. role	Restricted govt. role	Restricted govt. role
Infrastructure & Technology: Streamlined	Disparity between schools	Uneven distribution of ICT infrastructure	Uneven distribution of ICT infrastructure
Fully integrated, interoperable systems	Systems disparate, though standards based	Systems disparate, though standards based	Systems disparate, though standards based
Extensive security policy	Limited security policies	Limited security policies	National level Internet security policies
Centralized project & risk management	Not available	Managed by teachers in lead schools and private	Not available

		sector	
Change Management: Low Priority	High Priority	High Priority	High Priority
Support services: Nationwide	School, District & National level	School, District & National level	School, District & National level

Key Takeaways

Develop Mechanisms to Encourage Initiatives at the School Level

An initiative of this stature cannot be implemented by the ministry of education alone in any country. In the US, such programs are largely district level; in NZ it is cluster-level; in Australia, it is state-level; in India, it is at the community level. It is just too big a task to be implemented by a single entity.

Collaboration between public and private sector and educational institutions is not uncommon. However, the governments refrain from interfering in their commercial dealings. Its role in defining the framework and constituents of such consortia is very limited. This approach has encouraged the private sector, including commercial institutions to come forward and propose a number of projects.

The Midland Broadband Consortium is one such example. The benefits of such an alliance are shared differently by different participants. In India, the government of Karnataka tied up with NIIT to provide ICT labs in 700 schools in a matter of just 45 days. In return, NIIT got a 5-year training contract, and was allowed to use the premises for its private training courses.

Consortia models work. Though differences arise between consortia participants, in cases where these were not forced marriages, the disagreements have been settled amicably and quickly.

Training, Training, Training

All the countries taken up for the study have identified teacher training as a top priority. Lack of training has now forced policy makers to shift focus from bridging the digital divide to bridging the fluency divide—the absence of digital fluency that prevents people from putting computers to innovative use. If teachers are not trained in the usage of ICT, the infrastructure is in danger of remaining idle and unused. To prevent this from happening, professional training is a prerequisite for any successful smart school implementation.

Assigning IPR, an Unresolved Issue

Under normal circumstances, content providers assign IPR and copyright to the government. However, this may not be a very sustainable model. Though content and infrastructure providers have been persuaded by governments to waiver their IPR in the past, there is lingering doubt as to whether this is a sustainable model in a larger context.

There are several reasons that back this conclusion. IPR and copyright negotiations raise a number of issues, which is why commercial developers are still to be convinced of the benefits of associating with a national educational resource pool

Proprietary Software is Expensive. But, is Open Source the Solution?

Proprietary software is expensive, but countries persist with it. In Ireland, it is Apple Mac and Microsoft. In NZ, it is Microsoft. In fact, NZ has entered into a 2-year, $10 million deal with Microsoft to use its software. Ireland holds the largest single software license for MS products after Singapore and NZ.

Experimentation is on in pockets in the use of Open Source systems. However, authorities in Ireland report that they need to tackle two issues when implementing open source software: 1) The popular perception that as it is free, it necessarily has to be inferior to proprietary systems and 2) The hidden costs in terms of training and change management. Deploying and managing OS software also calls for a certain level of sophistication in skills as ICT administrators need to be on top of what is happening in terms of development of new patches etc.

Managed Services a Good Option if Schools Wish to Focus on Core Competence

Ireland began its experiment with managed services in 2001 through its CLASSROOM 2000 project valued at $482.6 million (£300 million) to deploy over 40,000 managed desktops in 1,227 schools in Northern Ireland. A recent $102.4 million (€90 million) deal with Sx3 involves providing 23,000 computers and maintaining them for a period of 5 years. Such deals, covering the entire ICT infrastructure of schools and their maintenance, have proved to be a big compensation in bridging the gap in terms of skills for managing the huge ICT infrastructure in schools.

Exportability of SSMS High, but Content Low

Exportability of SSMS is high, but content is low. For proof, we just have to look at the number of courseware available in the market, their level of interactivity and multimedia content. However, Malaysia can export its expertise by taking up offshore content development projects. Malaysia, which has developed a skilled pool, can become an attractive outsourcing option to countries where the cost of professional expertise is high.

Conclusion

"Computer-mediated education in developing countries takes time, money and dedication. But there is pay-off eventually."

ICT-mediated education throws up enormous challenges and opportunities. Countries that gear up to face these challenges encourage participation from all walks of the society—from the local private sector, from international investors, and from the community—all of whom need to display a certain degree of imagination and daring to make it a success. It is not just technology, but social contacts that determine the success of such initiatives.

I

INTRODUCTION

"A continuous search for, and application of, significantly better practices that lead to superior competitive performance" (Watson, 1993).

This study attempts to benchmark the Smart School Integrated Solution (SSIS), which forms the bulwark of Smart School, a flagship project promoted by the Multimedia Development Corporation (MDC) under the Multimedia Super Corridor (MSC) initiative of the Malaysian Government. The benchmarking study, commissioned by MDC for the Ministry of Education (MoE), Malaysia, offers a comprehensive comparison between the Malaysian Smart School Integrated Solution with similar implementations, if any, in two other countries—New Zealand and Ireland. The study also offers a broader framework of best practices in ICT-mediated education in secondary schools in a number of other countries—Australia, Britain, Canada, Singapore, and USA—where ICT-enabled education has reached a considerable level of maturity.

The benchmarking study attempts to identify and document the strategies and tactics adopted by various ministries of education to bring in significant improvements in the standards and performance of students, teachers, the support staff and the management team in schools. It is apparent that the integration of Information and Communication Technology (ICT) could play a much greater role than merely easing the administrative burden on teachers. It has been proven by a number of countries that ICT could potentially broaden the learning opportunities for pupils. What is even more compelling is the fact that it can create a "Knowledge Web" by facilitating interaction and knowledge sharing among schools.

Why ICT?

One trend that was unique to all countries researched for this report is that the move toward ICT-enabled education was prompted by three major factors—economic, social and pedagogical. The economic rationale is all too obvious. There is a growing realization among countries that there is an inevitable need to increase the number of ICT-skilled personnel to cater to the demands of industries that are rapidly integrating ICT into their processes. The social thrust stems from the belief that ICT is today more a "life skill" than a mere add-on. For example, in countries that have a mature e-Government in place, almost all the public services extended by the government and its affiliates can be accessed online. This means that citizens of that country need to possess some basic skills in the usage of ICT.

There are compelling pedagogical reasons too. The traditional classroom method has proved to be more teacher-centric, forcing the learner to follow the rigorous patterns of learning set out by the teacher. Education, as a result, has been tied down to the classroom and student progress to examinations.

World over, ICT is changing education from these two perspectives. In the countries that were studied for benchmarking, there is a great trend toward adopting ICT across all subjects, enriching the learning environment. In some countries, students have achieved tremendous ease working in ICT-enabled environments. In fact, Canada has successfully experimented with a training project that envisages role

reversal between the teacher and the learner, where the most ICT-savvy students help their teachers come to grips with the intricacies of ICT usage in classrooms. Students have become experts in using ICT to do some or all of the following:

- Work in groups, sharing curriculum and non-curriculum related activities
- Create and deploy work materials that add variety to the learning process (for example, students in NZ use Robotics to demonstrate their science projects, Irish students create Web sites to showcase their individual and group projects)
- Nurture their skills and processes, which play a greater role in ICT-mediated learning

Teachers too tend to contribute more in terms of selecting from a variety of ICT-based teaching-learning resources and employ ICT for cross-curricular use. However, an interesting point to note is in most of these countries, getting the complete involvement of teachers in ICT initiatives has been an uphill task.

Schools that actively employ ICT to enhance the learning process have made considerable progress in:

- Offering individual learning opportunities including tailor-made task assignment, and assessment
- Popularizing computer-based assessment that help in assessing the students on their processes and skills, which are never captured by the paper-based examination methods
- Effectively disseminating information about student progress to the parents
- Fostering effective communication between parents, mentors, the school authorities and the community.

Benchmarking Methodology

The benchmarking was done at two different levels. At a broader level, the study identified select best practices from a number of countries that have achieved certain degree of success in integrating ICT into their learning environment to foster a richer, and a more diverse and independent learning process in their schools. While Canada was selected for its successful SchoolNet implementation, the choice of the US was more due to the diverse approaches presented by the country for achieving better education for its vast learning community. Singapore had adopted a phased approach toward integrating ICT into the learning process. However, this sequential approach to ICT adoption in education was a common phenomenon across all the countries that were taken up for this research. Japan was selected because of the high penetration of ICT-based learning in the curriculum.

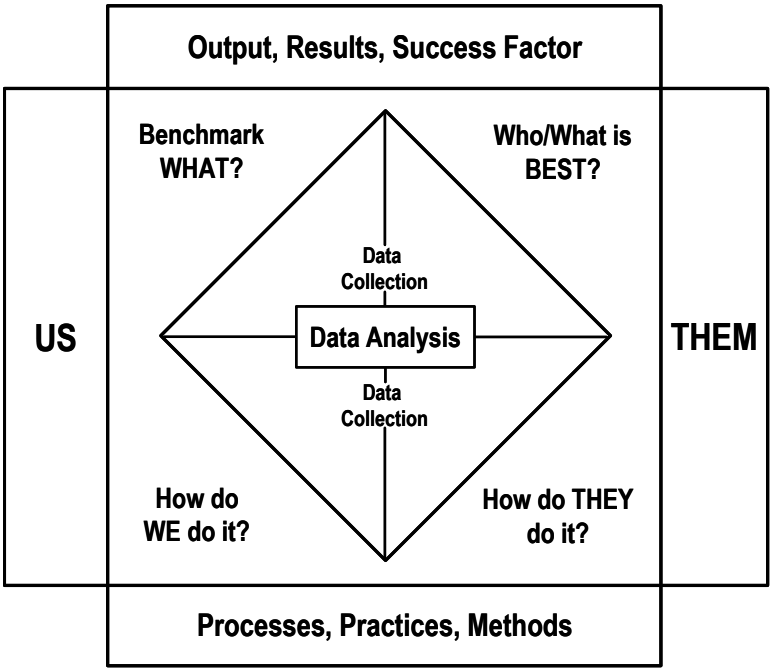
The components of the SSIS were benchmarked against similar implementations in two other countries, Ireland and New Zealand. The choices of Ireland and New Zealand were based on the fact that these two countries have progressed well beyond the foundation stage when it comes to implementing ICT-mediated education to bring about a significant degree of innovation into their teaching-learning and training systems.

The process of making comparison involves focusing on the issue of what we can learn from such a comparison, and how the learning can be made and systematically incorporated into our existing set-up. Watson (1993) says that the process of benchmarking involves four key questions. These are:

- What should we benchmark?
- Whom should we benchmark?
- How do we perform the process?
- How do they perform the process?

The following chart shows the benchmarking process keeping the above-mentioned questions in mind.

Chart I.1: Benchmarking process



Once the benchmarks are defined, a scorecard can be created using the weighted average factor condition method so that the countries can be actually plotted on a scaled graph. The two major determinants that affect the implementation of smart schools in a country are, progressive teaching and learning environment and resource infrastructure and digital literacy.

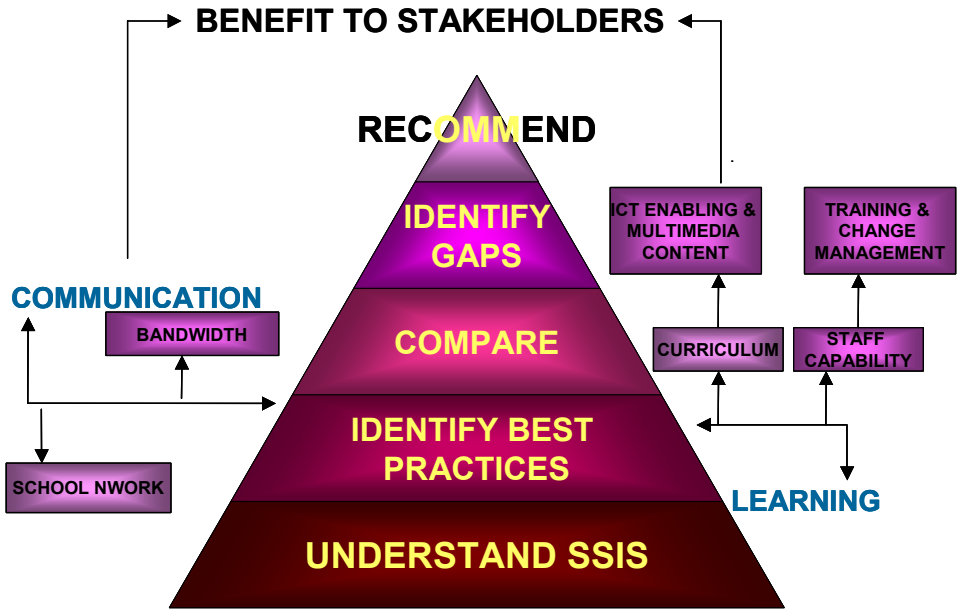
Each determinant can be further broken into many small factors. In this benchmarking study, Frost & Sullivan assigned a weight for each factor based on its importance in facilitating a smart school environment.

The major factors under each determinant are as follows:

1. Resource infrastructure & digital literacy
    a. Computer penetration
    b. Internet and broadband penetration
    c. High-speed data infrastructure

2. Progressive teaching and learning environment
    a. Experience of teachers in applying right pedagogy
    b. Teacher to pupil ratio
    c. Depth of the curriculum
    d. Variety of curriculum resources (both ICT and non-ICT) available

Chart I.2: Benchmarking methodology for this study



Frost & Sullivan took part in a 4-day workshop organized by the Ministry of Education (MoE), Malaysia, which had the participation of the key stakeholders in the Smart School Project, to understand the phases in which the flagship project was developed. During the workshop, Frost & Sullivan addressed the following questions for gauging the capabilities of the Smart School Integrated Solution (SSIS).

- What is the solution capable of doing today?
- Does it enhance the breadth and richness of learning?
- Student-centric learning
- Self-paced learning
- Skill and knowledge transfer
- Does it foster new approaches to school management and organization?
- Does it encourage community participation?
- Does it bring flexibility into the education process?
- Is there room for continuous and sustained innovation?
- Will there be long-term returns on investment?

Smart School – Where Are We Today?

Some of the key achievements of the Smart School project, as revealed by the workshop, are listed as follows:

- A fully integrated school management solution that addresses all components of the teaching-learning process
- Comprehensive courseware
- A knowledge bank consisting of teachers, students and administrators who have been empowered by ICT
- Pool of local talent capable of addressing the needs of the Smart Schools in terms of:
    - Understanding and managing the technology – concept and operations

- Planning and managing student learning environments by using ICT
- Managing the social, ethical, legal and human issues surrounding the use of technology

- Processes that are based on and revolve around:
  - Leadership and vision
  - Learning and teaching
  - Productivity-oriented and professional practices.

II

COMPARISON OF SMART SCHOOL INITIATIVES

This chapter compares some of the best practices adopted in promoting ICT-mediated education among 8 different countries— Australia, Canada, Ireland, Japan, New Zealand, Singapore, the UK, and the US. The chapter outlines the major initiatives in each of these countries to achieve the following: i) Better ICT infrastructure in both primary and secondary schools ii) Foster collaboration between national and regional education authorities, schools, communities, and private enterprises iii) Create a well-defined framework for sharing best practices in teaching and learning from within and outside the country and iv) Integrate the initiatives in education with a broader e-Government framework to create 'Smart Societies'.

In this chapter, we explore in detail the efforts of two nations in promoting the role of ICT to further the cause of learning. And discuss one best practice from six other countries.

IRELAND

The Irish initiative began in 1997 with the government announcing its intentions to "modernize the society for the new millennium" through a major drive to "grow and improve the access to employment by raising the skill profile of the people". The government acknowledged that the country was facing a major challenge of developing the education system to address the needs of the changing society and economy.

Five years down the line and a string of concerted efforts on the part of both the government and the community, Ireland is now among the handful of countries that have achieved excellence in education through ICT mediation. The Schools IT 2000 program was initiated with an overall government investment of £40 million, of which £25 million was from the Education Technology Investment fund.

In 1997, it was accepted that Ireland lagged significantly behind its European partners in the integration of information technologies into its schools. The launch of "Schools IT 2000 – A Policy Framework for the New Millennium" was the first step in changing this. The core objective of the program was to ensure that pupils in every school have the opportunity to achieve computer literacy and to equip themselves for participation in the information society. The government would support teachers in developing and renewing their professional skills, which will enable them to utilize ICT as part of the learning environment of the school.

The government had formulated a set of strategies for achieving these broad goals.

Strategizing for a Learning Society

The strategies proposed for achieving this objective were:

Development of a technology infrastructure that includes:

- Ensuring that there are at least 60,000 multimedia computers in Irish schools by the end of the year 2001

- Connecting of every school to the Internet by the end of the year 1999.

The development of a skills infrastructure included:

- The establishment of a flexible and cost-effective ICT training program for teachers
- The provision of professional skills development in ICT to at least 20,000 teachers through in-service training
- The introduction of pre-service training in the use of ICT in education for all student teachers

The development of a support infrastructure envisaged:

- The introduction of curriculum innovations to enhance learning through the use of ICT in the classroom
- The establishment of a national network to advise and support schools in developing their own ICT in education plans
- The setting up of a national framework to support the development of multimedia tools and products tailored to the curriculum in Ireland
- The creation of appropriate curriculum resources for schools during the course of the project

Implementation

Development of a technology infrastructure:

- During 1998, every school (a total of 4,200) in the state received a multimedia Internet ready computer from Telecom Eireann (Eircom)
- The Department of Education and Science issued grants for the purchase of ICT equipment, to all schools in the free education system. This grant totaled about £15 million. *A similar amount was generated from the community to support the initiative*
- As a result of these actions, it is estimated that there are now about 50,000 additional multimedia computers in schools. Thus the target of 60,000 computers in schools by the end of 2001 was not only achieved but was significantly surpassed
- All schools are connected to the Internet since early 1999, almost a year ahead of schedule

Development of a skills infrastructure:

- A comprehensive and flexible cost-effective ICT training program for teachers has been put in place
- About 65,000 places for ICT training have been made available to teachers so far. All the 44,000 (approx) teachers in the system will have been provided with the opportunity to participate in skills development programs relevant to their needs
- All teacher-training institutions are ensuring that all student teachers receive training in the use of ICT in education.

Development of a support infrastructure:

- The National Centre for Technology in Education (NCTE) has been established to implement Schools IT 2000
- 20 ICT Education Advisors have been appointed to the network of full-time Education Centers. They will actively advise and support schools in the integration of ICT into learning and teaching

- Through the Schools Integration Project, 600 schools in 75 projects are exploring curriculum innovations for enhancing learning through the use of ICT in the classroom. It is significant that these projects involve 28 partners from the commercial sector and 58 project partners drawn from third-level institutions, local communities and other agencies
- A software Advisory Group has been established to support the development of software and multimedia tools for Irish education
- ScoilNet, the website for Irish education, has been established with the help of Intel Ltd. ScoilNet is playing a key role in identifying multimedia content suitable for use in Irish schools. It is working in partnership with teachers, content owners and the software industry to develop high quality multimedia software products. ScoilNet will also support the delivery of distance learning on ICT via the Internet as appropriate

Partnership

- The concept of partnership runs throughout the Schools IT 2000 initiative. This involves schools, parents, local communities, and third-level colleges together with public and private sector organizations in helping to meet the project's ambitious objectives. In doing this, recognition is given to the immense contribution already made by groups who have been to the fore in developing IT policies and programs
- There is major ownership of the Schools IT 2000 initiative at local level. This is due, in no small way, to the decision by the Minister for Education and Science to issue grants to all schools for the purchase of ICT equipment rather than to provide it through a tendering process. Approximately £15 million was issued to schools and it is estimated that a similar amount was provided at local level as a result.
- Irish teachers have taken to the training program with enthusiasm. At least 70% of all ICT training courses have taken place outside normal school hours. Teachers have been very generous in giving their own time to this
- Organizations from the public and private sectors have given significant support to the Schools IT 200 initiative. This is evident from the contributions of Eircom - Information Age Schools, IBM - Wired for Learning, Intel - ScoilNet, the many organizations involved in the SIP and from many other partnerships still being developed.

NEW ZEALAND

New Zealand's ICT initiatives in the education sector stems from a strong belief that information technology skills will improve an individual's chances of gaining employment, the commercial interests of businesses who will benefit from the supply of information technology to schools, and the incentives for schools to use information technology for their internal management.

The government has acknowledged that its interest in using information technology in schools was driven primarily by the following factors:

- New Zealand needs information technology skills to compete successfully in the global market place (an economic rationale);
- The education system should prepare students to participate fully in the world in which they live (a social rationale);

- Information technology has the potential to raise student achievement across the entire student curriculum (a learning effectiveness rationale); and

- Information technology can help to overcome problems of distance and isolation, especially for small rural schools (an efficiency rationale).

Each of these four rationales supports each other. Together they make a compelling case for the government to consider its role in providing strategic direction on the introduction and use of information technology in schools.

Ever since the government launched the first New Zealand Information and Communication Technologies Strategy for schools in October 1998, the country has made some major strides in developing school ICT infrastructure and capability and building content.

Achievements

- The focus had been consistently on teacher training and change management. As of today, all principals have attended ICT planning workshops
- Almost all schools developed an ICT plan and received an ICT grant
- Many schools accessed funding for ICT professional development and network cabling
- 73 ICT professional development clusters, representing over 600 schools, began 3-year collaborative programs to enhance ICT use
- Te Kete Ipurangi – The Online Learning Centre bilingual education website was developed
- Successful partnerships were built between schools, Mäori, community and business
- An ICT Helpdesk providing advice to schools on ICT planning and use is in operation
- A principals leadership program, which includes the provision of laptops, a dedicated website - Leadspace, and a facilitated network using Oracle's Think.com has become operational
- Recycled computers scheme initiated
- Almost all schools now have access to the Internet (98% primary and 100% secondary)
- New Zealand primary schools have more access to the Internet than UK primary schools (98% c.f. 88%). In terms of networking within schools, New Zealand primary schools are significantly more advanced with 74% being networked compared with only 52% of Britain primary schools
- The ratio of computers to students is now one computer for every 6 secondary students, and one computer per 10 primary students. In Mäori Medium schools, the ratio of computers is one computer per 10 students
- Use of Te Kete Ipurangi (TKI) web site has significantly increased from 19% overall in 1999 to 79% and 78% for secondary and primary schools, respectively, in 2002.

CANADA

Canada's SchoolNet (SN) has been a key element of the federal government's *Building a More Innovative Economy* strategy, tabled originally in 1994. SchoolNet has been extremely successful in meeting its original objective of facilitating the electronic connection of Canada's public schools, First Nations, schools, and public libraries (LibraryNet). In large part, the success of SchoolNet is a function of innovative delivery mechanisms, which have involved provincial partners, and a wide range of other educational, business, and professional organizations. Through these partnerships, SchoolNet has been able to leverage significant resources, measured in terms of both level and impact that have allowed the overall project to be developed far beyond the federal involvement of roughly $40 million. Indeed, partnerships and leveraging relationships can be viewed as the backbone of the SchoolNet initiative.

Best Practice - Federal Involvement and Partnerships

There is a clear sense that federal involvement in the form of a national connectivity strategy was both necessary and legitimate in the eyes of affected parties in the educational system. This is not to say that jurisdictional tensions have been absent. However, these have been resolved with relative ease. In large part, this a reflection of the common desire held by all participants to facilitate the use of information and communications technology in Canadian schools, a desire that transcends jurisdictional boundaries.

Federal-provincial cooperation was enabled through a healthy mix of decentralized administration (all the way down to the school and even classroom level), combined with a federal role that was more of a facilitator. Apart from Industry Canada, the active participation of provinces and School Boards/Districts has been crucial. There are also several specific examples where the federal role has been crucial, especially in the areas of acting as a focal point to develop a collaborative national vision, and in addressing some technical issues within information and communications technology that are within the federal mandate.

UNITED KINGDOM

In United Kingdom, the government has committed to an ongoing program of investment in ICT up to year 2004. In a White Paper titled *Schools Achieving Success*, the government has assured that 'investment in ICT will continue, to make sure that all schools are able to take advantage of the potential of new technology'.

In school-based education, the policy envisages working with:

- The ICT supply industry
- Local education authorities (LEAs)
- The Teacher Training Agency (TTA)
- The British Educational and Communications Agency (Becta).

Along with literacy and numeracy, ICT is seen increasingly as a key skill. In recent years, a number of government initiatives have sought to establish ICT within the curriculum of the compulsory phase of education by linking it to, and integrating it with, other subject areas.

The specific elements of the ICT curriculum can be found on the National Curriculum Online website (2002). In particular, 75% of pupils are expected to reach a specified level of achievement in ICT (the

'expected' level) by 2004 and 85% by 2007. Schools may offer General Certificate of Secondary Education (GCSE) examinations at the end of compulsory secondary education (age 16) in ICT as a short or a long course. They may also offer the General National Vocational Qualification (GNVQ) in ICT at different levels.

Best Practice - Funding

There are a variety of ways in which funding reaches schools in the country. Most of it comes from central government and is distributed to local authorities via the Department of Transport, Local Government and the Regions (DTLR). The local element comes via the Council Tax, a local property tax that accounts for about 20% of the funds spent by local authorities on service provision. Most of the funds from the DTLR are allocated to local authorities via the Revenue Support Grant. Thus, state-funded schools receive most of their funds via their local authorities although the principal source of these funds is central government. General provision for ICT in schools comes from central government via this route. In addition, government channels additional funds to schools and local education authorities.

An important channel in which funds reach schools for targeted support is through the Standards Fund – and this includes the funding for ICT. For the financial year 2002-03, there were a total of 60 grants under the Standards Fund, which fall into six main categories. One of these is for 'capital and infrastructure'. This category is designed to help raise standards through effective investment in school buildings and infrastructure, including the capacity to use Information and Communications Technology (ICT).

A key fund is the National Grid for Learning (NGfL) Standards Fund. Between 1998-99 and 2001-02, the government supported £657 million of expenditure on ICT through this grant. This provides funds for networking, infrastructure, hardware, software and training. It also provides information and assistance with purchasing ICT equipment.

In making funds available through the Standards Fund, the government expects all schools to have achieved a minimum level of provision in 2002. This is defined as:

- Access to ICT for teaching and learning purposes equivalent to a computer to pupil ratio of at least 1:11 in each primary school and 1:7 in each secondary school
- A secure connection to the Internet in each school, with at least 20% of schools connected at broadband level
- At least one networked computer with Internet access in each school for management and administrative purposes.

UNITED STATES OF AMERICA

When the United States released its first plan of integrating ICT into education, it focused on what were seen as the four pillars such an integration. These related to:

- Teacher training and support
- Access to modern multimedia computers in classrooms
- All classrooms being connected to the information superhighway
- Effective software and online learning resources being part of every school's curriculum.

Federal funding programs supported these objectives. A review of progress in 2000 showed substantial progress in achieving these objectives so that the new plan of December 2000 set out more ambitious objectives. These were:

Goal 1: All students will have access to IT in their classrooms, schools, communities and homes
Goal 2: All teachers will use technology effectively to help students achieve high academic standards
Goal 3: All students will have technology and information literacy skills
Goal 4: Research and evaluation will improve the next generation of technology applications
Goal 5: Digital content and network applications will transform teaching and learning.

Best Practice: Bridging the Digital Divide

The best example of this approach has been the American E-rate scheme, which provided US $5.676 billion between 1998 and 2000 to facilitate access to ICT by poor schools and libraries. The Universal Service program for schools and libraries commonly known as the E-rate, is a federal initiative that provides discounts on telecommunication and Internet technologies to elementary and secondary schools, and public libraries, across America.

The program provides discounts ranging from 20 to 90 per cent, with the poorest schools and libraries receiving the greatest discounts. The discounts apply to Internet, telecommunications, and Internet connection services. The E-rate program was authorized by Congress as part of the Telecommunications Act of 1996 to bring affordable access to the Internet, distance learning, and other telecommunication-based learning technologies to America's school students and library users.

The program is built on the concept of universal service, previously applied in making telephone services widely available and affordable across America. The program is administered by the Schools and Libraries Division of the Universal Service Administrative Company. Expenditure is capped at $2.25 billion a year in discounts.

A preliminary analysis of the program by the Urban Institute for the US Department of Education showed that the bulk of funds had gone to the poorest schools and that the program had brought benefits to rural, urban, private schools and libraries. In addition to the E-rate, a number of American departments have funding programs for poor communities to access technology. These include Broadband Connections, Internet Hire Access Program, and Technology Opportunities Program.

Other countries have provided assistance to disadvantaged communities, in particular in rural and remote areas, through grant programs such as the Australian Networking the Nation program with its focus on infrastructure. Canada in 1997 set the bold target of making "the information and knowledge infrastructure available to all Canadians by the year 2000" with the Connecting Canadians programs.

SINGAPORE

Singapore's Masterplan for IT in Education is the blueprint for the integration of IT in education to meet the challenges of the 21st century. The Plan involves ambitious targets to be achieved by 2002 in areas such as infrastructure, teacher professional development, and the use of computers in schools, which would make Singapore a world leader in the use of ICT in education.

There are four key dimensions in the Plan: curriculum assessment, content and learning resources, physical and technological infrastructure, human resource development. The Plan envisages that by 2002 pupils will spend 30% of curriculum time using IT. To achieve this, a pupil-computer ratio of 2:1 is targeted for every school by 2002. All schools will be linked through a Wide Area Network, which will eventually be connected to the high-speed backbone of Singapore One.

Best Practice: Teachers' Education

A four-tier fan model of professional development was put in place to train teachers in every school by 1999. The fan approach generates a multiplier effect enabling the sharing of expertise and cultures between schools. The Singapore Masterplan illustrates the possibilities for systematic ICT development in a compact area. Under the four-tier fan model, 60 Senior IT Instructors formed the first tier of training. The Senior IT Instructors trained schools in Phase 1 of implementation, comprising 22 demonstration schools. Heads of Department (HODs) in charge of IT and selected teachers from each of these Phase 1 schools adopted and co-trained 3 to 4 schools each, together with the Senior IT Instructors, in Phase 2 of implementation. These schools in turn trained those in the final phase of training.

The fan approach generates a multiplier effect, enabling the sharing of expertise and cultures between schools. The HODs and teachers in the earlier phases who were selected as part-time instructors for other schools had one-third of their teaching duties off-loaded in their schools. The Senior IT Instructors were the key trainers and mentors for all schools coming on-stream during the planned implementation. They themselves continued to be on a learning trajectory, gaining experience as they fan out to schools.

The Masterplan also envisages the involvement in schools of 'academic coaches' from the Institutes of Higher Learning (IHLs), IT firms which have had association and expertise in education, and committed IT professionals. These participants formed partnerships with schools so as to lend their professional expertise, advise schools on their technology strategies, and help assure a continuous flow of ideas and practices that could be used by schools.

JAPAN

In January 2001, the e-Japan strategy was mapped out by the ICT Strategy Headquarters, which was set up within the Cabinet. In the strategy, there are descriptions about the measures, which the government must implement speedily and preferentially as national policies for the establishment of a society based on advanced telecommunications networks. In the descriptions, there is a reference to the bridging of the digital divide in Japan.

Japan's push to computerize the classroom debuted with its School Net program in 1999, which wired more than 1,000 schools for Internet connectivity. Subsequent efforts continue to push to hook up all 40,000-plus schools and 500,000 classrooms. Currently there is an average of 27 PCs installed at each school nationwide. In terms of training, about 80 percent of teachers from primary through high school knew how to use personal computers by March 2001, up from 60 percent in 1999. By March 2002, all teachers were trained on PCs.

Best Practice: Not identified

AUSTRALIA

The Australian Action Plan was developed as a collaborative Commonwealth/State project coordinated by the then Australian Department of Education, Training and Youth Affairs. The Plan is distinctive in containing separate sectoral plans for school, vocational education and training and higher education, as well as an overarching action plan. It is focused around five action areas, which are repeated in each of the sectoral plans. These are: People, infrastructure, online content, applications and services, policy and organizational framework and regulatory framework.

Best Practice: Teachers Education

A number of Australian States have implemented policies to assist teachers to acquire the necessary skills by providing templates or minimum standards for the required skills, and advice on ways of acquiring them. Victoria has adopted this approach with its Teachers Capabilities Statement and Skill Development Matrix which was distributed to schools to support school and teacher professional development planning. Three skill stages were identified with related professional development. Self-paced packages were made available to assist teachers in acquiring identified skills. Queensland adopted a similar approach to its Minimum Standards for Teachers in Learning Technology.

The standards are in four areas: IT skills, curriculum opportunities of IT, school planning, and standard central learning and teaching (http://www.education.qld.au/curriculum/learning/technology/sinnst.htm).

Best Practice: Collaboration between Education Systems

The Australian Learning Federation initiative provides a good example of this form of collaboration. This initiative involves collaboration between the Commonwealth, States, and Territories to develop a national pool of online curriculum resources that address national priorities, support cultural identify, and nurture innovative skills in young people.

The initiative also contributes to the development of supporting mechanisms for sharing resources across school systems and advancing the development of a national market in quality-assured Australian online school resources.

Some of the key findings common across the different countries taken up for the study are as follows:

Shared Vision

In almost all the countries, the government's role was restricted to that of *agent provocateur*, while the micro-management was left to the schools themselves. Interestingly, all the initiatives for fulfilling the national vision come from the key stakeholders, through a bottoms-up approach. In the US, private sector partnerships have contributed significantly to the development of best practices in education. In Ireland, schools themselves played a key role in setting up goals for promoting ICT-mediated education. In New Zealand, communities play a key role in funding and supporting school initiatives. Governments in all these countries have tacitly acknowledged the fact that any sustained, nation-wide initiative in the education sector calls for responses from a variety of participants. Without such partnerships, any government vision will remain just that—a vision.

Such governments continue to entrust a fair amount of the decision-making authority with the schools themselves—be it the formulation of an ICT strategy or sourcing funding through partnerships.

Rapid Response to Changing Times

Countries that have successfully ushered in best practices in teaching and learning through ICT mediation were the ones that have been quick to respond to the needs of a society that is in a constant state of flux. A particular challenge for ICT policy in all countries has been how to deal with the pace of change, both in the impact of new technologies and in socio-economic shifts. While strategic planning and review have been given prime importance, all the countries had begun with a broad policy framework that underwent frequent modifications, in keeping with the changing demands. In federal systems this has sometimes led to strengthened partnership between the levels of government, as in both Australia and Canada. In Canada, where there is no federal power over education, this has led to innovative forms of partnerships.

The Consortia Approach

The dominant feature of the higher education scene is the role of consortia of universities and other partners addressing their infrastructure requirements on a collaborative basis. These consortia are also typically involved in the development of advanced network systems for their members, so that member institutions benefit from ongoing technological advance. The consortia also provide a mechanism to broker partnership arrangements with other relevant organizations, so that the role of these consortia is one that fosters innovation, partnership, and technological advance.

All the countries studied had experimented with different models of partnerships at one stage or the other. These include:

Cross sector collaboration: University and further education partnership under the British JANET scheme and the Digital California Project

Public/private partnership: The British University for Industry and National Grid for Learning, the Singapore edu.Quest, Australian IT Hub, and Irish Schools Integration project

Partnership in local and regional development: Canadian Smart Communities and British Wired-up Communities

Initiatives by groups of firms: The American CEO Forum and European e-Learning Summit

Collaboration between groups of universities and colleges: The Swedish Internet University and in consortia such as JANET, CANARIE, Internet2, CENIC, and AARNet.

Let us briefly discuss two of the most popular consortia arrangements here.

Consortia – Commercial and Educational Model

There has been an increasing number of public/private partnerships in growing online educational markets. Such partnerships take a range of forms with frameworks such as the British National Grid for Learning (NGfL). A two-pronged goal for developing such alliances is set out in Becta's corporate plan for 2001-2004: that government should assist the commercial sector to understand the needs of the education sector and the development of viable educational markets.

Public/private collaboration has been stimulated by the fact noted by OECD that "the educational market, while potentially huge, has developed only slowly", and by concerns at the poor quality of much early online content for schools where online content "have not necessarily matched well with the curriculum objectives and pedagogy."

Like Britain, Singapore too has recognized that the software industry should be actively involved in developing and offering content and related services, such as CD-ROMs and materials, identifying and mirroring relevant Internet sites, and sourcing off-the-shelf software from abroad.

In fact, the UK has a program for developing a significant portion of its digital content in Singapore.

Consortia – Educational Institutions

The consortia described in this section share a range of common characteristics. However, there are also sharp differences that exist between them in terms of funding, research role, and other functions.

- **CANARIE** in Canada
- **JANET** in the United Kingdom
- **Internet 2** in the United States
- **CENIC** in California
- **AARNet** in Australia

CANARIE

CANARIE Inc is Canada's advanced Internet development organization, established in 1993, which works with government, industry, and the research and educational communities to enhance Canada's advanced Internet infrastructure, operations, development and use.

CANARIE's mission is to accelerate Canada's communications infrastructure and to stimulate next-generation products, applications and services. CANARIE is distinctive in that it also serves as a cornerstone of the Canadian Government's Connecting Canadians program so that it has a broad national societal role in addition to its more commercial role in meeting the needs of its members.

The organization is supported by Industry Canada and has 120 members and over 500 project partners. It is governed by a 26-member board with equal public and private sector representation.

A key aspect of CANARIE's role is to stimulate the development and use of advanced Internet infrastructure in Canada. It collaborates with many partners in undertaking this role. A key aspect of this role focuses on the development of its state-of-the-art national optical Internet network CA*Net3 which has received government funding.

CANARIE has succeeded in enhancing Canadian research Internet capability by a factor of about one million since 1993 and has funded over 2000 advanced Internet applications (http://www.canarie.ca).

JANET

JANET is the British equivalent of CANARIE and AARNet serving British universities, further education colleges, and research bodies. JANET is administered by a consortium of members which trades under the name UKERNA and which operates under a Service Level Agreement from the Joint Information Systems Committee (JISC) of the UK Higher and Further Education Funding Councils. The FE Funding Council role has now been replaced by the new Learning and Skills Council which funds further education in Britain.

This is a complex structure, which reflects the fact that JANET receives funding from both the higher education and further education funding bodies. The fact that British further education colleges participate in both JANET and JISC is distinctive when compared with the Australian situation where the Australian equivalent of further education colleges (TAFE) has not been enabled to participate in the AARNet scheme up to now, with some minor exceptions.

The UKERNA objectives, as set out in its Memorandum of Association, are somewhat similar to those of CANARIE in that it is responsible for the networking program of the education and research community in Britain, as well as to research, develop and provide advanced electronic communication facilities for use in that community and in industry.

The Joint Information Systems Committee (JISC) has adopted a strategic approach to its task, which is reflected in the JISC Five Year Strategy for 2001-2005. This has included funding research and development to ensure that the higher education, research, and further education communities have a very high bandwidth network through JANET connecting all institutions.

In undertaking this role JISC builds and extends partnerships, including extending partnerships with commercial Internet suppliers and the telecommunications industry in furthering its vision of "a single, world-wide information environment." This ongoing development work has produced Super JANET 4 directed at the particular needs of the research community for very high bandwidth (http://www.jisc.ac.uk).

Internet 2

Internet 2 is the American equivalent of the British and Canadian developments discussed above. It is a consortium led by 180 universities working in partnership with government and industry to develop and deploy advanced network applications and technologies accelerating the creation of future Internet technologies. This network extends across all American States.

In addition to building leading edge network capability and revolutionary Internet applications, the mandate of Internet 2 also includes ensuring the rapid transfer of new network services and applications to the broader Internet community. This mission is significant in that the benefits of technological advance will flow down to all sectors of education.

Internet 2 has received government funding for its development and is envisaged as the world's fastest and most advanced research network. Various private firms have collaborated with the consortium in the development of Internet 2 (http://www.i2x.org).

CENIC

CENIC (The Consortium for Education Network Initiatives in California) is another consortium model, which links California's universities and research communities in "achieving robust, high capacity, next generation Internet communication services." This consortium includes Stanford, the University of California, California State University, California Institute of Technology, and Information Sciences Institute.

As the first step in reaching its vision of the next generation of data connection services, CENIC built the California Research and Education Network (CalREN-2) as the most cost-effective advanced communication service available to all Californian higher education.

The CENIC model and CalREN-2 is significant as CalREN-2 is now being extended to all Californian schools under the Digital California Project, which commenced in 2000.

The Californian initiative illustrates how the benefits of higher education/research consortium initiatives can be extended to schools and VET (http://www.cenic.org).

AARNet

AARNet is the Australian equivalent of the higher education/research consortia discussed above. It is, however, distinctive in that it does not receive direct government funding but is funded by its members who include most Australian universities and the national research organization, CSIRO.

AARNet operates through regional hubs located in each State and Territory with Regional Network Organizations (RNOs) responsible for development within the areas covered by each hub, and for the delivery of services to members.

Up to recently, TAFE and other Vocational Education and Training (VET) institutes have not been members or clients of AARNet. However, with changes to regulations under the 1997 Telecommunications Act, AARNet now holds a carrier license under the Act, and the previous restrictions on VET access, or that of schools no longer apply. AARNet has an access policy with decisions on access taken by the Board.

There are current indications of AARNet broadening its client base with a current initiative in Canberra including the Canberra Institute of Technology (a TAFE institution) and the Australian War Memorial and with Australian Archives and the National Library due to connect shortly using fiber connections put in place by AARNet using its carrier status.

AARNet shares the capacity of CANARIE and JANET to innovate and evolve so that the role of AARNet meets the bandwidth requirements of Australian education and training (http://www.aarnet.edu.au).

Role of the Consortia Model

The evolving roles of consortia such as CANARIE, JANET, Internet 2, CENIC, and AARNet demonstrates the value of having partnership arrangements where the costs of the research and development effort are shared, and where a mechanism exists to foster innovation and collaboration. Bringing stakeholders together is one of the chief merits of this model, as well as the role of keeping stakeholders informed of technological advances.

The option of the benefits of consortia initiatives flowing down to other sectors of education and training is demonstrated by developments across these consortia:

- The Midlands Broadband Consortium plans to promote the availability of broadband among schools in the UK
- A significant aspect of the Schools Integration Project (SIP) in Ireland is that it had attracted substantial partnership support with about 28 commercial partners and 58 partners from communities and agencies participating in phase I itself
- British further education colleges are already participants in JANET, and receive bandwidth for this source
- The CENIC CalREN-2 network is now being extended to all Californian schools under the Digital California Project

In all the consortia, especially the ones involving commercial organizations, the respective governments have been careful not to interfere with the business arrangements.

Bringing in ICT-mediated Curriculum to the Classroom

As most of the countries have adopted a sequential approach to promoting ICT-mediated learning, there has been limited allocation of resources to developing content that would meet the needs of the curriculum. Schools that are committed to digital learning techniques have been buying software and course material from commercial providers. There has been limited effort at the national level to commission the development of learning material. Most countries have begun doing this on a very small scale, to meet the specific needs of schools as well as to kick-start the commercial market. In countries such as the UK and the US where the commercial market for learning software is strong, schools have a choice of a range of software to choose from. Specific initiatives on the part of the government to encourage the production of digital content have been taken in Japan where the government has commissioned consortia of businesses and educational institutions to develop multimedia-rich learning objects.

Tackling Issues Relating to Copyright and Intellectual Property Rights

Securing Intellectual Property Rights (IPR) and Copyright of digital content has become important in a scenario where technology evolution far outpaces the changes taking place in any given country's legal framework. Networked environments, which are becoming increasingly ubiquitous, offer ways of transmitting digital content across a world without boundaries. Such digitized material can also be

manipulated in a number of ways and replicated through a variety of storage mechanisms. Worldwide, projects commissioned by the government for generating digitized content have seen the assigning of IPR and copyright to the government by all infrastructure and content providers. This has become a more or less standard approach on the parts of governments to secure IPR in a number of countries including Australia, the UK and Ireland.

Though content and infrastructure providers have been persuaded by governments to waiver their IPR in the past, there is lingering doubt as to whether this is a sustainable model in a larger context.

There are several reasons that back this conclusion. IPR and copyright negotiations raise a number of issues, which is why commercial developers are still to be convinced of the benefits of associating with a national educational resource pool.

III

BENCHMARKING: SSIS & COMPONENTS

The SSIS and its 9 components were benchmarked against comparable components that have been implemented in Ireland and New Zealand. These are:

1. Infrastructure & Technology
2. Change Management
3. Support Services
4. Smart School Management System
5. Teaching and Learning
6. Security
7. Systems Integration
8. Interoperability
9. Project Management

These are dealt with in detail below.

1

INFRASTRUCTURE & TECHNOLOGY

Introduction

Achieving a consistent level of ICT infrastructure in schools has been one of the biggest challenges facing most of the countries taken up for this research. Even in the US, where the government has been making a concerted effort toward achieving excellence in education through ICT mediation, there is enormous disparity in the level of ICT infrastructure and its usage among schools. Reducing the teacher-computer and the student-computer ratios, building a secure network within the schools and eventually connecting these schools are the major thrust areas for most countries. All the countries studied for the benchmarking had adopted a phased approach toward strengthening the ICT infrastructure in their schools.

The study of the eight countries revealed some common goals behind the choice of technology and infrastructure chosen for the schools. These are:

- Establishing, maintaining and developing the infrastructure of hardware and connectivity in a sustainable manner and in a way in which their operation does not distract teachers from their teaching
- Ensure that the infrastructure enables staff to access valuable content – the information and resources for teaching and administration, including tools for planning, assessment and recording as well as productivity tools and curriculum materials
- Develop and sustain practice, including ongoing training and curriculum development such as the progressive integration of ICT into schemes of work.

The dominant feature of secondary education in New Zealand and Ireland is the role of consortia of educational institutions and other partners addressing their infrastructure requirements on a collaborative basis. These consortia are also typically involved in the development of advanced network systems for their members, so that member institutions benefit from ongoing technological advance. The consortia also provide a mechanism to broker partnership.

The involvement of multinational companies in furthering ICT infrastructure in schools has contributed significantly to furthering the cause of ICT-mediated education in these countries. In Ireland, Intel, Apple, Microsoft and IBM have sponsored individual programs that address the different needs of schools like hardware and software requirements, need for connectivity and data warehousing and storage.

One of the remarkable factors common to the countries taken up for this study, including New Zealand and Ireland, is the steady increase in the number of computers in schools, coupled with planning in some cases to increase the number further.

New Zealand for instance has lowered its computer to pupil ratio from 12:1 in primary schools in 2000 to 11:1 in 2002 and from 7:1 in secondary schools to 6:1. Ireland has done exceedingly well in this area, having lowered its ratio in secondary schools from 8.28:1 to 6:1 in the same period.

The planning targets of these countries show even more dramatic improvements. Ireland has set a pupil to computer ratio of 2:1 in secondary schools to be achieved by the end of 2003. It plans to improve its teacher to computer ratio from the present 2:1 in its secondary schools to 1:1 through a laptop-provisioning plan.

The schemes for providing equipment for schools, pupils and teachers are different in different countries studied. In Ireland and New Zealand, grants are made from the national government to local authorities for the purchase of equipment to supplement purchases made by local authorities (municipalities, Local Education Authorities, school districts) from their own resources. In Britain finding is provided from the Standards fund for hardware, software, and training in enabling schools to connect to the National Grid for Learning (NGfL).

In this chapter, the term infrastructure covers both devices, cabling and associated software. Devices supporting technology in schools include specialized equipment (such as switches, routers, modems, or codecs) that link computers or video hardware to networks. Infrastructure also refers to cabling, whether wire, fiber optic, or coaxial. In newer systems, links between computers are wireless, in which case infrastructure refers to receivers and transmitters.

Local Area Network (LAN) & Wide Area Network (WAN)

Network connections in the schools in New Zealand and Ireland fall into three broad characteristics. These are:

- Standalone computers
- Computers and peripherals connected through a LAN
- Connectivity between schools and school districts through a WAN

Both the countries have begun experimenting with Wireless LAN for connecting hard-to-wire schools in remote and difficult terrains. Connection to a school LAN gives users access to shared-resources such as printers or shared memory, or to electronic mail, or to specialized instruments or computing devices. These can support collective work and increase the efficient use of resources.

Chart 1.1: Comparison between the types of networking technology used in schools

Description	New Zealand	Ireland
Network Technology in Use	LAN/WAN/WLAN	LAN/WAN/MAN/WLAN, about 1300 WAN sites in the country
Network Topology	Star Network Topology for wire-line networks; peer-to-peer, point-to-point, point-to-multipoint and mesh networks for wireless	Star Network, Internetwork topologies. Client/Server, Thin client and peer-to-peer networks in use
Network Equipment in Use	Network servers (Pentium III & IV class). Networking software: Novell, Windows NT, Windows 2000 and Linux. Workstations (486 and above) from diverse vendors, NetPod cluster	IBM mainframes for core data processing activities, routers, and switches for Ethernet connectivity. Mac OS X, Windows XP, Windows NT, Windows 2000 and Linux Workstations PI and PII, Apple Macs.

	machines consisting of a server supporting up to 8 workstations. Mostly Intel processors. AMD also in use 10 MB-100 MB ports, 8-, 16- and 24-port hubs	 Intel, AMD 24xRJ45 10/100Mbps Ethernet switch comprising a minimum of 8 x RJ-45 ports, configurable via browser interface. Network interfaces: Token Ring, Ethernet and Switched Multi-megabit Data Service (SMDS)
% of schools that have LAN	95% of secondary schools and 74% of primary schools. 49% of all schools fully networked (80% of the classrooms are connected)	78% of all schools have some form of a network. 12% of schools fully networked
% of schools connected to WAN	School clusters (total 73 consisting of over 600 schools) have schools interconnected through a WAN using fiber optic cables	80% post-primary schools connected with WAN. Schools within metropolitan limits connected via MAN
% of schools connected to the Internet	99% secondary schools and 92% of primary schools have at least one computer connected to the Internet. 40% of secondary schools have ISDN while 5% have satellite connection. The rest of the schools access via dial-up	100% of schools connected to the Internet. 97% of post-primary pupils connected and 79% of primary pupils connected. 50% of post-primary schools and 25% of primary schools have a Web site. 72% of the post-primary schools access through ISDN and 21% through a dial-up

Key Messages:

- Both the countries studied had a range of programs involving the government, the private sector and community groups to resolve issues relating to networking in schools.
- There were also programs aimed at bringing computers into homes, and/or making computer connections affordable for low income groups
- There were significant efforts to expand web-based services to the public as part of public libraries' standard range of services

In New Zealand, the school districts are establishing community access centers or tele-centers to assist those students without computer access at home. The beneficiaries of this effort included pupils from rural communities, Maori and Pacific people.

In Ireland, there has been a concerted effort from district school authorities and service providers to establish Metropolitan Area Networks (MANs) that offer schools high-speed regional networks enabling data transmission, data conferencing, videoconferencing, video, telephony and streaming multimedia services.

- Ireland's physical communications network infrastructure is currently adequately served by BT and Cellnet, Cabletel, Mercury and Vodafone. In addition, the Universities are connected to the SuperJanet UK Academic Network. A number of schools have also developed their own intranets. To compensate for the inadequacies of twisted pair offering limited bandwidth, the government actively pushed for the setting up of Metropolitan Area Networks (MANs), linking educational establishments, businesses and service providers in a much more effective way. The backbones of MANs comprise high-speed broadband networks, interlinking LANs and WANs to act as a data communications bridge between the two.
- The MANs are not generally owned by a single organization but by either a consortium of users or by a single network provider who sells the service to the users. The level of service provided to each user must therefore be negotiated with the MAN operator, and some performance guarantees are normally specified.

Hardware

Ireland's Technology Integration Initiative in 1998 had aimed at achieving two things. Under the first strand, the government assisted schools in putting up at least one multimedia-ready computer system with Internet access. This project was completed in 1999. By 2001, schools had built up a substantial ICT equipment infrastructure and there were 60,000 multimedia-ready computers distributed among the 4,000 schools in Ireland.

In New Zealand, the distribution of ICT equipment was uniform with schools averaging about 28 computers each. Thanks to government support and initiatives of local communities, the gap in terms of ICT infrastructure between 'rich' schools (i.e., schools that had access to funds) and the rest has narrowed down considerably.

Chart 1.2: Comparison between the types of hardware being used in schools

Description	New Zealand	Ireland
PC Configuration	50% of secondary schools and 33% of primary schools have computers that meet the basic configuration (Pentium I, 166 MHz 64 MB RAM, 2 GB hard drive). Desktop PCs and Apple Macs	About 40% with Intel Pentium I & II configuration, 12% with less than Pentium I configuration and the rest with Pentium III & IV configuration. Desktop PCs and Apple Macs. Average of 4.4 laptops per school. Apple Mac Server for SIP schools • Power Mac G4 • Minimum 933MHz PowerPC G4 processor • 256MB RAM • 80GB ultra ATA HDD • CD-RW Drive • ATI Radeon graphics card with 32MB of DDR SDRAM • Built-in 10/100/1000BASE-T Ethernet (RJ-45 connector) • Mac OS X Server Unlimited-Client License

		• 15" CRT Monitor
Other hardware equipment	Facsimile machine Telephone for one-to-one conversations Digital camera with USB interface, 8-16 MB memory card Scanner – General purpose and Creative Arts Color printers (inkjet and laser) Speaker phone for audio-conferencing Audio-conferencing equipment (e.g., SoundStation) CD burner Audiographics for distance learning Videoconferencing equipment (e.g., PictureTel/Polycom) Web camera with USB interface Interactive Whiteboard • Passive pen and Active pen • approx range of 47-72 inches diagonal	Low/Medium volume color inkjet printer High volume color inkjet printer • Internal Print server • Black and 3 color cartridges Medium volume black & white laser printer Color laser printer General purpose flat-bed scanner Creative Arts Flat-bed scanner Digital cameras (min 2 million pixels sensor, USB interface, minimum 8 MB memory card) Web cam (Minimum 30 frames per second at 176 x 144 resolution) and USB interface Projection equipment Interactive Whiteboard • Wall-mounted, floor-stand and carry-case • Passive and active pen • approx range of 50-72 inch diagonal
Student:Computer	10:1 in primary schools and 6:1 in secondary schools	11:1 in primary schools and 6:1 in post-primary schools
Teacher:Computer	2:1	1:1 (Each teacher equipped with a HP laptop)
Age of computers	3 years	3.6 years

Key Messages:

- Ireland has initiated a £60 million infrastructure deal in 2003 to equip its schools with 23,000 PCs. The project envisages installing Pentium-based desktops and servers running Windows 2000
- Ireland in tie-up with Sun Microsystems has set up a central server for hosting of school websites. The project has come up with models for the development of secure Internet access and use by schools and Education Centers
- In New Zealand, a bulk of the funding for infrastructure comes from the schools themselves and the community. This explains the high number of initiatives from the private sector and the community to help schools acquire new ICT infrastructure. For example, CANZ (Computer Access New Zealand) Trust helps cash-strapped NZ schools by providing them with recycled computers at one fifth of the cost of new computers with comparable configurations. Shop for Schools, a campaign initiated by the retail store chain Westfield Group and Apple, has raised over $1.66 million (NZ $3 million) to equip the top 10 schools in the country with computers. Compaq initiated the Unitec New Era Learning Initiative (UNELI) as a pilot project involving 11 Auckland primary and secondary schools aimed at improving the quality of teaching and learning through electronic collaboration
- The Irish initiative IT2000 has achieved significant success in increasing the number of computers in schools. The average number of computers in schools in Ireland is about 44, thanks to a number of initiatives by the government with the support of companies such as IBM and Intel.

- Among computer peripherals, color printers and digital cameras were the most commonly used equipment though interactive whiteboards are gaining in popularity

In New Zealand, the 2020 Trust set up by the Ministry of Education, had launched a program for recycling used computers and offer them to schools at 20% of the cost of new computers. The Computer Access New Zealand Trust, which spearheads the initiative, has three accredited recycling companies and a number of donor organizations as its members.

In Ireland, the Dublin Inner-city Schools Computerization (DISC) Project will upgrade 20 inner city schools with high-spec multimedia computers over a period of 3 years. About 4,500 pupils will benefit from the program implemented in collaboration with Siemens Information and Communications.

Software

Both in New Zealand and Ireland, the ICT initiatives in schools are funded by a variety of sources including the government, private sector, the community and others. As schools move toward increasing their ICT infrastructure, they have continuously been confronted with the question of meeting escalating expenditure for using and maintaining expensive commercial systems. The stability factor and issues relating to using and supporting proprietary platforms (mostly Microsoft) which demand increasing amount of processing power, memory and storage capacity are getting to be a big challenge before schools. Both the countries have begun exploring the possibilities of finding alternative systems that would translate into lower maintenance and upgrade costs. In both the countries, pilot projects have been initiated to try out open source software. The adoption of Linux by common computer retailers and the growing number of support personnel have spurred corporate adoption. However, in the education sector, especially in Ireland, the authorities have to contend with the popular perception that open source is inferior to proprietary systems. Apart from this, the demand for training from new Linux users have also given rise to questions about the hidden costs involved in deploying open source software. However, there have been a number of arguments in favor of Open Source from companies that have been backing the movement. (**http://www.computeractive.co.uk/News/1138230**)

Chart 1.3: Comparison between the types of software being used in schools

Description	New Zealand	Ireland
Operating System	Windows NT, Windows 2000, Mac OS, UNIX	Windows NT, Windows 2000, Mac OS, UNIX, Linux,
Software Applications	IIS, productivity tools (MS Office, MS Works, MS Publisher), Kid Pix, Creative Writer/Fine Artist, Claris Works/Apple Works, Hyper Studio, Front Page, Corel Perfect Office, SmartSuite (Lotus, AmiPro), Visual Basic	Star Office, MS Office Suite, Claris Works, iMovie2, Quicktime and AppleWorks
Internet Browser	Microsoft and Netscape Internet browsers	Microsoft and Netscape Internet browsers

Key Messages:

- The Irish government has initiated a $100 million Classroom 2000 (C2K) project that envisages the creation of e-mail addresses for each of the 350,000 children and teachers in Northern Ireland's 1,200 schools. The project will also give them access to digital resources including virtual classrooms and online libraries of curriculum content. The 10-year project will see tone of the largest implementations of Microsoft Exchange
- Northern Ireland holds the third largest Microsoft license for its school systems in the world, after Singapore and New Zealand
- Ireland has initiated a pilot project involving a cluster of schools to experiment with the usage of Linux as the operating system. The country already uses Star Office, an open source office suite, in a number of its schools
- In New Zealand, the government has negotiated a 2-year contract with Microsoft for sourcing Microsoft-licensed software for use in all government and private schools

The C2K project is also one of the largest outsourced infrastructure deal in the country's history. Under the project, post-primary schools in the provinces will receive the machines running Windows XP, which will give children access to up to 200 learning applications based on the National Curriculum. The outsourcing company Sx3 will deliver and operate the infrastructure for a period of 5 years.

In both Ireland and New Zealand, the governments have decided to continue with the use of proprietary operating systems and software in schools. Though both the countries have initiated investigations into the use of open source software, the ministries concerned admit that the transition, if there is one, may not be easy.

While New Zealand is evaluating software such as 'Blackboard', that promotes virtual learning environments, large educational institutions across Ireland have already implemented the software in their premises. Blackboard creates a series of virtual classroom environments where learners can access individualized programs of work. Blackboard gives instant feedback to learners and creates records for both teachers and learners. The software, which equips teachers with the basic ICT skills, also offers powerful tools to produce Web pages for their own courses.

Protocol

The popular LAN protocol used in both the countries is the 802.3 Ethernet protocol. Select schools located in the remote parts of Ireland and New Zealand are experimenting with the 802.11 standard for their wireless LANs.

The Internet connectivity in schools has been increasing at a frenetic pace as both the teachers and the learning community realizes its potential for education. A common trend across the countries researched for this project shows that Internet penetration and usage was much higher in secondary schools than in primary schools. Most of the government initiatives too has been targeted at improving the connectivity in secondary schools and hence stimulate the use of the Internet. However, until 2001, most of the schools accessed the Internet either through a PSTN line or an ISDN line. The usage of the faster ISDN was again more common

among secondary schools than among primary schools. In Ireland, 100% of the schools are connected to the Internet, while in New Zealand, the Internet penetration is 99% in secondary schools and about 92% in primary schools.

The TCP/IP (Transfer Control Protocol/Internet Protocol), HTTP (Hyper Text Transfer Protocol), which defines how messages are formatted and transmitted and how servers should respond to commands, the FTP (File Transfer Protocol), used for uploading and downloading files from a server, are the most popular protocols being used by schools in both the countries. However, Ireland has also begun experimenting with SOAP (Simple Object Access Protocol).

Benchmarking Technology & Infrastructure Component of SSIS

In terms of existing technology and infrastructure, the Malaysian initiative is comparable to that of Ireland and New Zealand. However, there are some key differences between the three countries when it comes to funding and risk sharing.

Funding and Decision-making: In Ireland and NZ, the government contributes about 50% of the total funding required for any new ICT infrastructure development projects in schools. The rest of the funding is derived from private participants, community and other entities such as non-profit organizations. In Malaysia, the funding has entirely been derived from the government. There is a wide range of difference in the funding and decision-making practices of these countries. When it comes to the choice of purchasing hardware and digital material for schools, the decision-making is predominantly at the school level in NZ and Ireland, though the government does act as a facilitator and shares a portion of the risk.

Performance Goals for ICT Infrastructure: As the existing infrastructure is being far outpaced by the growing needs of the school community, clear long-term goals have been set in both NZ and Ireland for upgrading the existing ICT infrastructure as well as ensuring that it is future-proof. The governments have played a key role in facilitating dialogue between school communities and infrastructure companies to improve the range of hardware and software available to schools. Local authorities play a key role in negotiating license agreements between individual schools and the vendors. Guidelines are available from the ministries of education in the respective countries as to the minimum infrastructure required by the schools in order to fulfill the nation-wide vision for education. Both the countries have collectively implemented a number of programs aimed at improving the availability of computers to pupils and teachers, ensuring classroom-level connectivity, networking between schools and generally improving the quality, range and availability of ICT infrastructure. All these have been done with voluntary participation from schools and communities.

Chart 1.4: Comparison between the ICT infrastructure in schools (Malaysia, NZ, Ireland)

Description	Malaysia	New Zealand	Ireland
Network	LAN , WAN, Limited WLAN & Satellite Communication Network	LAN / WLAN, WAN, Satellite Communication Network	LAN / WLAN, WAN, MAN, Satellite Communication Network
Hardware	*Server Configuration:* P II *PC Configuration:*	P II / III	P III / IV

Brands	P II / III HP	P I / Athlon HP / IBM / Dell / Compaq / Apple Mac P III Laptops	P I / II / III / IV/Athlon Apple Mac / HP / IBM / Dell HP P IV Laptops
Software	Microsoft	Microsoft / Linux / Mac OS	Microsoft / Linux / Mac OS
Protocols	*Networking:* 802.3 *Internet:* TCP/IP, HTTP, FTP	 802.3, 802.11 TCP/IP, HTTP, FTP, Apple Filing Protocol (AFP)	 802.3, 802.11 TCP/IP, HTTP, FTP, Apple Filing Protocol (AFP)
Model School	1:1 student to computer ratio in full classroom model, 5:1 limited classroom model, 2:1 laboratory model Projectors Computer Labs	2:1 student to computer ratio (secondary) 2:1 teacher to computer ratio Interactive Whiteboard, projectors and videoconferencing equipment Multimedia Labs (number of computers not available) Teacher rooms with minimum of 20 computers	1:1 student to computer ratio (secondary) 1:1 teacher to computer ratio Internet to classrooms Interactive Whiteboard projectors, videoconferencing equipment Multimedia Labs with at least 20 computers
Storage & Data warehousing	Data Center	Centralized server for Web-page distribution No other centralized data centers	Centralized server for Web-page distribution Lead schools in SIP have data warehousing facility
Communication Infrastructure **a. Internet** **b. Intranet & Extranet**	100% Internet connectivity in Smart Schools	99% Internet connectivity (all schools) School clusters have an intranet (73 clusters)	100% Internet connectivity (all schools) Schools under the Schools Integration Project have intranets (about 80 in number)

2

CHANGE MANAGEMENT

A new epoch is dawning. Ahead of us lies the knowledge society. An almost completely unknown continent, but full of possibilities. If we learn to understand and dare to respond to the changes now sweeping the world we have a unique chance of becoming an important motive force of development.

- Swedish IT Commission, 1998

Introduction

One of the most significant outcomes of this benchmarking study is the stark contrast in the approaches to change management, and education and training of key stakeholders in the smart schools projects across the world. In almost all the countries studied, and especially in NZ and Ireland, teacher training and education remained a key area of focus. This is the result of a strong conviction on the part of the governments that no project of such magnitude, which calls for such sustained enthusiasm, can be implemented by the nation's policy makers alone. In Ireland and NZ, the smart schools projects were the results of a shared vision of building a knowledge society or a 'smart' society.

Against such a background, it is not surprising that the school initiatives in these countries were predominantly bottoms-up initiatives. The Irish Schools Integration Project (SIP) for instance, initially planned for about 25 projects involving about 200 schools in the country. The authorities in fact ended up receiving proposals for no less than 75 projects from about 600 schools. In both New Zealand and Ireland, the schools come up with specific project proposals, which are put forward to the government for funding, after evaluation by the local councils or school district authorities. The government evaluates the merits of each project and allocates funding accordingly.

However, it is to be noted that the keen enthusiasm shown for increased ICT-mediation in education was not an overnight phenomenon. The policies in all the countries studied for this benchmarking project demonstrate the prominence given to people aspects in the role of ICT in education. The policies have also broadened their scope from an initial focus on professional development of teachers to broader social and economic objectives that would ensure ICT skills for all.

Teacher training institutions and faculties of education across the country acknowledge the changing roles for teachers as IT tools become more widely adopted in education requires. As the US Congress OTA Report acknowledged in 1995, teachers have emerged as the crucial link between students and technology. Without their guidance and enthusiasm, technology in schools will be in danger of being largely under-utilized.

A report from the Organization for Economic Cooperation and Development (OECD) says that the "teacher must play a central and crucial management role regarding the use of ICT in schools." The teacher in fact, according to the report, becomes the manager of the learning environment—a creative, interesting, demanding and professionally rewarding role. ICT in fact enhances the role of the teacher in the teaching-learning environment and can have considerable resource implications in terms of staffing and professional development needs. The better quality-learning environment offered by ICT mediation is dependent on a critical success factor—the ICT literacy of the teacher. The more the capability of the teacher in the area, the less reluctant he/she will be to move away from the traditional classroom-bound teaching methods. The level of teacher innovation and experimentation using ICT is solely dependent on how sustained the teacher education process is.

"Allow the children to run past us"

Another important facet of change management is to make the teachers comfortable in working with students who have ICT skills surpassing their own. In fact, in a number of countries, teacher education in ICT involves a role reversal whereby students with exemplary ICT skills engage in training teachers. A number of national initiatives in OECD countries have ensured comprehensive ICT skill development among students. These include:

- National testing of ICT skills for students
- Incentives for using ICT for both students and teachers
- Programs to increase the number of computers in schools and improve Internet connectivity

Peer Collaboration

Collaboration between teachers is also a must in furthering their ICT skills. Studies show that in many countries teachers continue to work in isolation, despite the presence of facilitating mechanisms for collaboration, such as e-mail. Initiatives such as the Northern Ireland Network for Education have been encouraging teacher interaction using conferencing facilities. Ireland has now made it mandatory for teachers to use this facility as part of the initial training program.

While new entrants into the teaching profession bring with them a certain degree of ICT skills, countries have been facing maximum resistance from teachers aged 40 years and above—teachers who had begun their career when there was little penetration of computers in schools. As these teachers often occupy the more senior and influential posts in schools, the resistance to ICT-mediated education is all the more pronounced.

The Ireland Initiative

Ireland, under its Three Year Strategic Action Plan 2001-2003, has allocated €29.2 million for teacher training alone. The New Opportunities Fund, a £300 million fund for teacher training available in the UK has been linked to the Education Technology Strategy in Ireland. A managed service, NINE Connect Service, to provide hardware, software and connectivity networks in all Northern Ireland schools was rolled out in 2000. The NINE Connect service provides a virtual staff room and other on-line services.

Continuous training has been extended to teachers at two levels—programs specifically targeted at the principals (for both planning and training) and those for the teachers. Under the Action Plan, workshops will be conducted for all principals in order to help them make studied decisions on:

- Evaluating the ICT infrastructure in their schools
- The optimum ICT infrastructure required by their schools and
- On how to develop a comprehensive ICT strategy for their schools.

Principals are provided with information packs with general advice and guidance and a wide variety of fact sheets with information about the supports and options available in terms of equipment and services. They are also informed of the training options. Principals are generally entrusted with the task of analyzing the ICT training needs of their own schools. This information will be used by the National Center for Technology in Education (NCTE) to prepare tailor-made ICT training courses to meet the school's needs.
All the Education Centers across Ireland play a key role in educating the teachers in the effective usage of ICT.

The teacher training initiatives in Ireland are aimed at achieving the following objectives:

- Using ICT to enhance teaching, for lesson preparation and the choice and organization of ICT resources
- Assessing pupils' work when ICT has been used;
- Using ICT to keep up-to-date, share best practice and reduce bureaucracy

Separate Expected Outcomes have been developed for school librarian training. These focus on information handling and communication skills needed by those with the crucial role of supporting pupils' learning. Training sessions are mostly school-based, normally conducted in the classroom or the school library. The training programs were formulated in such a way that off-site training was kept to a bare minimum, to ensure little disruption in the learning activity. These training programs were closely linked to the National Grid for Learning and NINE-Connect. Teachers share best practices through NINE-Connect as well as via online conferences held in the UK.

In both UK and Ireland, the governing bodies have stipulated that only trained service providers, with a proven track record in offering training, material and expertise, will be allowed to train school teachers. The selection of trainers was usually left to the discretion of schools. Schools were allowed to claim up to £500 per teacher or librarian to meet the goals of Expected Outcomes under the New Opportunity Fund. Training providers were allowed to use a range of teaching methods including online classrooms, face-to-face interactions and distance learning methods using ICT and paper-based course materials. Schools need to fulfill a certain level of criteria to qualify for government assistance in their training needs. These include adequate availability of ICT infrastructure, and a comprehensive ICT policy. Finds from the NOF cannot be used by schools on initiatives other than training, such as hardware acquisition. At the end of the training period, the teachers must meet the Expected Outcomes of the training, which are derived out of the Education Technology Competency requirements for teachers in Ireland for the use of ICT in subject teaching.

The New Zealand Initiative

New Zealand has developed a 3-year professional development action plan to manage school-wide change and ICT integration. The first ICT Professional Development Clusters Project saw the involvement of teachers and principals from a number of schools. One of the very first projects that focused on training and change management in the country was 'Principals First: First Principles', which were one-day workshops designed to equip the principals with the ability to plan and manage the implementation of ICT in their schools. The workshops honed the principals' skills in:

- Establishing a strategic ICT plan
- Writing a school ICT policy
- Contracting additional technical support; and
- Establishing ICT-specific professional development policies

Roughly two-thirds of all principals had attended such programs in the first 12 months of their launch. In 2002, the Ministry of Education announced that it plans to spend $3 million over the next three years on such professional development programs in some secondary schools. The government spends $34 million every year on in-service teacher training, which includes training them in the use of information and communication technology.

The New Zealand Association for Learning with Educational Technology (LET) supports teachers in their use of new learning technologies in the classroom, and attempts to promote the wider dissemination of theory and research findings to schools. LET offers a range of services and has the following features:

1. Formal affiliation with the International Society for Technology in Education, which would give a number of direct benefits to teachers
2. A number of moderated Listserv discussion groups for teachers to share information on specific types of educational technology and problems on their classroom use
3. An extensive Home Page on the Internet for members, which would include up-to-date information on research, theory and good classroom practice, a host of useful sites and suggested activities for teachers
4. Promote sponsorship deals that would allow annual scholarships for teachers to undertake further study in the area, and would make possible a number of regional and national awards for schools engaged in innovative practice
5. Work closely with major hardware and software suppliers and work to develop sound advisory and consultation services for schools
6. Hold regular national LET conferences.

3

SUPPORT SERVICES

Introduction

Providing support to schools has been one of the major concerns of educational authorities in countries that have been intently pushing for ICT mediation in education. In both New Zealand and Ireland, the ministry of education restricts itself to providing a broad framework of guidelines for procuring ICT equipment and the accompanying software, ensuring that the systems acquired would be capable of talking to each other. This has resulted in an infrastructure that is vastly diverse. In such a scenario, providing a centralized support service for such infrastructure becomes a challenging task. The Ministry of Education has set up a centralized help-desk that addresses the maintenance issues relating to the ICT infrastructure in New Zealand schools, handling queries relating to a wide range of hardware, software and communication equipment. The help-desk is centrally funded and operated and the services offered free of cost to the schools.

Support Framework in Ireland

In Ireland, apart from a central help-district, all school districts operate a district-level help-desk that caters to the support requirements of schools in their districts. In Ireland, the government is also experimenting with outsourced/managed services for its C2K project. Under the scheme, the contracted outsourcer will supply and maintain the ICT infrastructure for a period of 5 years.

Typically, in-house support in the schools begins with the ICT coordinator. About 82% of all schools have recruited an ICT coordinator. A third of the post-primary schools have ICT coordinators appointed via a special duty post. More importantly, about 25% of the schools had ICT coordinators appointed at the assistant principal level and about 14% at the principal level, which shows the level of importance accorded to the role of the ICT coordinators in schools.

Apart from the ICT coordinators, schools had access to ICT advisors, who helped in anticipating and identifying the needs of the school and the staff. Education Centers, which employed these ICT Advisors, play a pivotal role in supporting the delivery of the government's ICT Action Plan at the local level. These ICT Advisors deliver back-up planning and advice services and provide training programs for teachers in accordance with their identified needs.

Nearly 70% of the Education Centers had ICT advisors. Apart from these, there are a number of support groups that offer an opportunity for teachers to collaborate and share their experiences and expertise and provide one another with feedback, support and assistance. ScoilNet (www.scoilnet.ie), which is the official website for schools in Ireland, offers a 'click-to-talk' facility that extends interactive support to schools.

As early as 1999, Ireland had appointed ICT advisors linked to each of its 20 Education Centers through the country. These full-time ICT Advisors, who were seconded teachers with a proven track record in ICT, offer training, advice and support on ICT within specifically defined areas.

Support Framework in New Zealand

Since the beginning of 2002, the New Zealand Ministry of Education has been operating an ICT Helpdesk, which offers help and assistance to schools around NZ. Leaders, teachers and administration staff in schools can use this free service to assist them to install and use hardware and software, to resolve problems, or to make decisions about the suitability of products and services.

Apart from the help-desk, each school has its own ICT support staff. The Te Kete Ipurangi (www.tki.org.nz) or The Online Learning Center (TKI) offers ICT Resources which showcase practical examples of how ICT can be used to add value to the learning experience. Schools also negotiate standard maintenance contracts with vendors which would typically include the following:

On-site Technical Support

A support service generally offered to schools that have networks of up to 50 workstations on-site. The service involves having regular weekly on-site visits by members of the technical team from the support company to cover all ICT equipment in the school. Normally, schools will also be asked to invest in the service provider's Intranet shell, which would include a link to the company's help-desk so that teachers can log calls with the technical staff prior to them arriving onsite. All calls are prioritized and attended to. The priority ranking is set in consultation with the school.

The standard services offered are:

Server Maintenance

- Weekly checking of server to ensure the integrity of the data back ups and anti virus updates
- Applying of latest server patches and security updates
- Adding and deleting of users as necessary
- Cleaning of temporary files

Network Support

- Checking of all connections on the network
- Checking integrity of switches and hubs
- Checking ISP connections.

Server Support Agreement

For schools whose infrastructure is not large or complex, support service providers offer entry level support. This covers schools with less than 50 workstations on their school-wide network. Such agreements typically cover:

- All maintenance of servers to ensure their performance integrity
- Remote accessing and managing of servers and
- Updating of software currently installed, which includes applying the latest Microsoft security patches to the server, maintaining and updating virus software, checking on back up logs and data protection and updating of both new users onto the network as well as the regular deletion of users who have left the school.

Chart 3.1: Comparison between the support services available for schools in New Zealand and Ireland

Support Services	New Zealand	Ireland
1. ICT Committee/Action Group	Establishing a strategic ICT plan Writing a school ICT policy Establishing a ICT-specific professional development policy	District level coordination committees formulate the ICT policy framework for school districts.
2. School IT Coordinator	Teacher with a proven experience in ICT. Responsible for supporting all issues related to ICT equipment, the LAN and the communications equipment in schools. Responsible for conducting periodic training and demonstration for teachers and students in installation, maintenance and troubleshooting of ICT hardware and software. Source technical advice to support ICT use and increase the effectiveness and efficiency of school infrastructure, through the ICT Helpdesk and Te Kete Ipurangi. Join nationwide Support Groups to form a peer-to-peer network for sharing ideas, and experiences and source support	School ICT Coordinators are appointed at different levels. A substantial number of them are in the grade of assistant principals and principals. ICT Coordinators have access to the services of ICT Advisors in the 20 Education Centers in Ireland. These Advisors offer consultative services on the installation, use, and maintenance of ICT infrastructure in schools. ICT coordinator evaluates the software and interactive content for use in schools. ScoilNet, an on line forum for offering information, advice and support to schools, has a click-to-talk (BUZZPower) facility.
3. ICT Technician	Attend to the day-to-day maintenance of the school networks and intranet. Coordinate with the support service provider	Appointment of Schools Integration Project (SIP) coordinators and technicians at the 600 schools that participated in the project. These coordinators and technicians had the necessary skills to tackle the problems arising in the high-tech SIP environments.
4. ICT Help-Desk	8:00 AM to 5:00 PM Monday to Friday (Excluding Public Holidays)	The NCTE Helpline was discontinued in 2002.

	Troubleshoot and resolve where possible, any suspected faults with installed products. Support for non-mainstream products with additional investigation or referral to third party service providers.	
	The National ICT Helpdesk provides guidance on the use of installed products. This may include, but is not limited to, referrals to web sites, training material or manuals.	Creation of support groups for ICT support and a variety of online support systems by the NCTE
	Regional ICT Helpdesks offer support services to ICT school clusters. These are set up with the support of hardware and software suppliers, local internet & technical support companies and parent-teacher associations.	About 50% of the schools had a tie-up with an external agency for phone-in and online support services.
	ICT Advisory Service offered through School Support Services for ICT professional development and support.	The Technology Integration Initiative has been entrusted with the task of developing a variety of models for offering support services to schools. Under this, the Irish government is investigating outsourced/managed services for the support needs of its schools.
	Distribution of support material through CDs.	
5. Escalation Services	The ICT Helpdesk troubleshoots any suspected warranty claims in line with the manufacturer's guidelines. Where an item is deemed to be faulty then the Helpdesk will logs the request with the manufacturer on behalf of the school.	Unresolved problems at the school level are escalated to the help-desk. The regional help-desks in turn escalate the unresolved problems to the National help-desk or to the product supplier.

Managed/Outsourced Services Model:

Education authorities in both Ireland and New Zealand are exploring the option of adopting a managed services model for offering a range of ICT-related services to their schools.

A managed service is defined as any network service in which a service provider operates, monitors, and maintains a network infrastructure including customer located equipment (CLE), access, transport, capacity, performance and quality of service (QoS). Under a traditional voice or data service, CLE installation, monitoring, and maintenance duties are the responsibility of the customer. In a managed service arrangement, these duties become the responsibility of the managed services provider.

Managed services encompass a range of network solutions, from frame relay or ATM-based wide area networks to local area networks, security services, PBX management, and more. Typically a managed services provider

supplies the platform, products, services, features and support to deliver guaranteed quality of service to business customers.

Some managed services can be provided as options on existing services. For example, providers may offer a managed frame relay service that includes frame relay transport, plus the CLE needed to connect to it, and all associated network management. Alternately, these service providers can hide the network components and technology from the customer. For example, some providers simply supply a customer with a "network connection" which includes access, CLE, and network management, without the customer being aware of the underlying network technology.

Managed services offer an attractive support option to operations that function out of multiple locations. School districts in fact can benefit vastly from such arrangements. In fact, the C2K project in Ireland is already experimenting with the managed services model by outsourcing the entire systems and services contract to a private company for a period of 5 years.

4

SMART SCHOOL MANAGEMENT SYSTEM

Introduction

The most striking aspect of the Malaysian Smart School initiative is the deployment of a single integrated school and learning management system in all of the 87 pilot schools, encompassing a whole range of school functions including school governance, student affairs management, educational resources management, financial and technology management. The initiative has no parallel in any of the countries taken up for this benchmarking study. Automation of school and learning management systems are at best a piecemeal initiative in most of the countries with none of the school districts or cluster schools achieving 100% automation of their management systems.

However, there is growing inclination among countries to move toward school management systems that are capable of supporting a learning community. Such systems should also be capable of providing the platform for the enterprise's online learning environment by enabling the management, delivery and tracking of blended learning (i.e., online and traditional classroom) for employees, stakeholders and customers. A robust system should integrate with other departments, such as human resources, accounting and e-commerce, so that administrative and supervisory tasks can be streamlined and automated and the overall cost and impact of education can be tracked and quantified. The Smart School Management System promises all these and more.

Just contrast this with the scenario in New Zealand and Ireland. Apart from stipulating the automation of certain school functions such as assessment, student records and learning resources, the respective governments have left it to the discretion of the respective schools on what to automate and what not to automate. This has resulted in schools possessing uneven levels of ICT integration with respect to school and learning management.

In Ireland, the Schools Integration Project works on the basis of specific project goals aimed at fulfilling certain ICT integration aspirations of schools. For example, schools that face a collective need for fulfilling a given aspect of ICT integration (ex: intranets, videoconferencing, wide area networks etc.). In New Zealand too, cluster schools focus on very specific projects. In fact, in Ireland, schools come together not on the basis of their geographic location but on the basis of a common need or a goal. The projects implemented by these schools are highly customized to meet their specific needs.

Some of the common trends in school and learning management systems observed in these countries are:

1. There was no standard learning/school management system that was adopted across all the schools. This is mainly because all the hardware and software buying decisions were entrusted with the schools. The role of the educational authorities at the national level was limited to educating the key stakeholders on the government vision, setting forth a broad policy framework for its realization and

streamlining grants, and facilitating the implementation. The micromanagement was left to the school authorities themselves
2. Typically, not all of the administration management systems were linked with the learning management systems
3. Schools buy packaged, off-the-shelf learning management systems with room for very little customization
4. The most common standards adopted were SCORM/IMS
5. Software and server players provide a generic LMS. Example: Microsoft, Sun, Oracle
6. The average lifespan of the LMS system was around 2 to 3 years, which proves to be the biggest obstacle before a nation-wide rollout of a single school and learning management system.

New Zealand

Until now, the ICT infrastructure development in New Zealand schools was happening in pockets with no standard school or learning management system. There were obvious reasons for this. Every NZ school has its own management structure and a governing body. Schools have so far acted independently while developing the local communication infrastructure and school-wide ICT/computer networks. Only now, the ministry of education (MoE) is trying to set the standards for network infrastructure in order to facilitate interaction among schools as well as to make transfer of student information including assessments and grades from school to school (in case of student transfer) and from school to university. To facilitate such seamless transfer of data, the MoE is now formulating certain standards for automating the school administration process, to ensure that these systems talk to each other as well as interact with the network of the MoE and those of other ministries as part of a larger e-Government initiative.

In New Zealand, funding for ICT infrastructure for schools is minimal, averaging about $15 per pupil per annum, which is one of the reasons why the government has not been able to dictate that schools should adopt specific school management systems. In terms of learning management system, the government is establishing a national learning management infrastructure for NZ. This will allow every school access to learning objects from a central repository. Currently, the government is in the process of putting together a strategic plan to establish this nationwide infrastructure.

The MoE is in the process of doing a scoping study, which would evaluate the adoption of learning management systems such as the Blackboard nationwide. NZ is also a part of The Le@rning Federation of Australia that contracts the creation of digital learning objects. This project is aimed at creating thousands of learning objects, which would include those created by teachers as a part of their day-to-day work. These will be stored in a central repository and delivered via a learning management system to schools. The Le@rning Federation content will be viewed within the Learning Management Systems (LMS) and web browsers. Currently, no LMS or web browser supports all of the content model requirements. However, it is anticipated that this situation will change in the near future.

Though the ministry is evaluating the prospects of adopting learning management systems such as Blackboard, WebCT or First Class, these will undergo a considerable degree of customization before they are carried nationwide. Currently, WebCT and Blackboard are the two most popular LMS being used by cluster schools in the country. The Computer Curriculum Corporation's integrated learning management system, Success Maker, has also achieved a fair degree of popularity among primary and secondary schools in New Zealand.

Selecting an LMS is, however, not an easy task. In all likelihood, it will be lengthy, intricate, and costly. Considering that the life-span of a typical LMS is only two years, coupled with the rapid changes and developments taking place on the content side, makes the task of choosing a single LMS very difficult.

While considering a single LMS, the MoE is keen on a system that would support content from different sources and hardware/software solutions from multiple vendors. Hence, it is essential that the LMS should be based on open industry standards for Web deployments (Extensible Mark-up Language or XML, Simple Object Access Protocol or SOAP) and supports major learning standards (AICC, SCORM, IMS and IEEE).

Strictly speaking, there are no school management standards available today. Instead, there are groups developing specifications – protocols – that an entire school network can support. Once a group compiles its work, it submits its proposed protocol to its official governing body, which then decides on whether to sanction the specifications and create a standard for schools.

To date, none of the specifications outlined by any of the workgroups have been formally adopted as a standard. This does take time, because of the very thorough process required for the creation of an accredited standard guarantees a high level of quality in whatever is specified in the standard, unlike less formal specifications that may be ambiguous or more easily changed.

The immediate focus of the MoE is to establish a school administration system and certification process. A number of NZ schools have student management systems, mainly used for student roll data returns. However, it is of note that approximately a third of primary schools and a quarter of composite schools do not have a student management system.

About 2,000 schools in the country had implemented Musac, an integrated IT-based management system for schools developed by the Education Center for Research and Development at Massey University. However, the system works in isolation, with no means for online integration.

Apart from Musac, New Zealand schools have a variety of school management systems—Flexi-School, IES, Kidbase, Kowhai Schoolmaster Series, QuickFlex, School Database (Karant), and 3D Achieve. The latest Smart Schools sponsorship offer comes from a company called Contact Group International Ltd which produces a top-end library software package called the .eLM Library System.

The Le@rning Federation has developed an e-learning toolset called BELTS (Basic e-Learning Tool Set) that will enable education systems and sectors to provide content access to select schools. Commencing January 31, 2003, The Le@rning Federation has started providing one BELTS demonstration installation per State/Territory for education systems and installations for the New Zealand system and the independent and Catholic school sectors. The four specific functional modules in this release of BELTS are:

- Administration (user management)
- Content management (download content from the Exchange)
- Class management (groups of people)
- Lesson management (sequencing learning objects).

Additional functionality will be added to BELTS in future releases. BELTS will allow schools to access the learning objects developed by The Le@rning Federation and accessed through a central repository (the Exchange) infrastructure.

Ireland

In Ireland too, there has been no single school and learning management system that has been adopted across schools for reasons stated above. WBT Systems, which began life in a department of University College, Dublin, has been recognized for its role in formulating the Learning Content Management System (LCMS), which is a mix of traditional e-learning and knowledge management. Another learning management systems provider who has made considerable headway in the Irish educational sector is Intuition, an international e-learning solutions and services provider.

The only nationwide database that the country's schools have and share with the community is one on school accommodation. However, there is limited sharing among schools in terms of specific projects implemented under the Schools Integration Project. Schools tend to buy learning and content management systems from a variety of software vendors including Avaltus, Learning Space, Gemini Learning Systems, Generation21, IBT Technologies, Knowledge Mechanics, LeadingWay Technologies, LearningByte International, MindLever, Peer3 and WBT Systems.

In the absence of a common learning management system in any of the countries benchmarked, this study attempts to compare the functionalities of three most popular LMS packages that are widely used in the countries studied.

Chart 4.1: Comparison between three popular Integrated Management packages used by the educational sector in Ireland and NZ

Features	Learning Space	Blackboard	WebCT
Method of access	In order to administer a course in Learning Space, the instructor must have the Lotus Notes client program loaded on their computer. The students access the class via a web browser such as Netscape or MS Explorer. The instructor can also get into the class via the web to look at what students see or participate in a discussion in the CourseRoom.	The only thing one needs to either administer or take a Blackboard class is access to the web and a web browser such as Netscape or MS Explorer.	The only thing one needs to either administer or take a WebCT class is access to the web and a web browser such as Netscape or MS Explorer.
Structure of the course	There are five major areas to a Learning Space course. Whether the instructor uses all of them or only some of them is their choice. They are the **Schedule**, the **MediaCenter**, the **CourseRoom**, **Profiles**, and **Assessments**. The **Schedule** acts in many	There are 9 major areas in a Blackboard class. Most of these areas may be turned off if the instructor doesn't want to use them. The **Announcements** section is the first page a student sees within a course; it displays announcements relating to assignments and	Because WebCT is entirely configurable, there is only 1 major area; this is the front page of your class. The instructor can make a large number of choices about which set of functionalities to use and the appearance of the class. An instructor could use WebCT

	ways as the backbone or main trunk of your course. You could have documents, links to websites, links to **MediaCenter** content (i.e. a short video), or links to the **CourseRoom** where a student can join a discussion or turn in an assignment. The **Profile** section contains both a mini-homepage for each student in addition to a personal portfolio where a student's grades are kept for his or her perusal. The **Assessment** area is where the instructor builds quizzes and tests, grades tests and other assignments, and keeps a grade book.	tests, or anything else the instructor feels needs announcing. **Course Information** could contain items such as the syllabus, or perhaps a reading list. **Staff Information** is a place for information about the instructor(s). **Course Documents** could have readings, links to websites, etc. **Assignments** contains assignments. When a new assignment is added, a new announcement is added to the **Announcements** page. **Communication** gives both the instructor and students the ability to send email, read the student roster, see the class-based homepages of other students and student groups, and join a discussion or chat. **External Links** is a specific location within the class where the instructor may post links to external websites. **Student Tools** is an area where students may turn in assignments, edit their course homepages, change their information, check their grades, look at the student calendar, and read a student manual. Visible only to the instructor is the **control panel** which is where the instructor adds content and controls the course	simply as way to post the grades from an in-person class or as the foundation of an on-line class.
Communication	Instructors and students can email each other by clicking on the email links in the Profiles area. The CourseRoom area	The Communications Center provides many avenues of communication. One can send email to everyone connected	Because WebCT is completely configurable, there is no central Communications Center. Mail can be

	provides the opportunity for instructors and students to have threaded discussions.	with the class, all instructors, all teaching assistants, all groups (creation of groups is discussed later), individual people, or individual groups. The Discussion Board area allows the instructor to create multiple discussion boards which might focus on different parts of the course. The Virtual Chat area allows for real time communication between course participants. The Group Pages are actually a mini-communication suite of their own; there are group discussion boards, virtual chat rooms, a file exchange area, and an email link all for the benefit of instructor created groups.	sent to either an individual or several people all at once. The Bulletin Board function allows the instructor to create multiple bulletin boards (called "forums") which might focus on different parts of the course or belong to specific groups. The Virtual Chat function allows for real time communication between course participants. Each class has 6 chat rooms. Room 1 - 4 can be archived, which mimics the behavior of a bulletin board. Room 5 is not archived, and room 6 is both not archived and open to all WebCT participants.
Groups	Groups in Learning Space are created by the instructor in the CourseRoom. Once the group is created, members can post items private to the group to the message board in the CourseRoom. Members can also send all members of their group an email. The instructor can grade group projects, giving all members of the group a grade at the same time.	The groups in Blackboard are created by the instructor via the Control Panel. Group members can exchange files, use a group message board and chat room, and send or receive group emails. There doesn't seem to be a way to give a group grade; instead each member is graded individually.	The groups in WebCT are created by the instructor. Group members can exchange files, use a group message board, and create a group presentation
Tests: Question types	Multiple choice, true-false, essay/short answer, or multiple choice/multiple answer	Multiple choice, true-false, fill in the blank, multiple answer, matching, ordering, short answer/essay.	Multiple choice, matching, calculated, short answer, paragraph. True and false questions can be simulated by using a multiple choice question with two choices (one true, the other, false). Multiple answer questions can be

			created by setting more than one answer in a multiple choice question as correct.
Tests: Use of question pool	One can create a question pool, but an entire question pool can not be imported.	One can create a question pool, but an entire question pool can not be imported from a format outside of Blackboard CourseInfo.	One can create a question pool, but an entire question pool can not be imported from a format outside of WebCT.
Tests: Use of randomized questions	Supports use of randomized questions	Supports use of randomized questions	Supports use of randomized questions
Tests: Grading, records, and returning results to students	All question types except short answer/essay are auto-graded. In addition, the entire test may be set to be auto-graded; however, the instructor must begin the grading process either by choosing to grade all the tests in the queue if auto-grading has been selected for the test or specifically grading each test. Graded tests are kept in the graded assessment database. The students can see their grades in their portfolio. Once the test is graded, the results are available in the portfolio.	All question types except short answer/essay are auto-graded. If the test consists entirely of auto-graded questions, than the entire test will be auto-graded when it is turned in. Short answer/essay questions must be hand graded by the instructor. If the instructor chooses, the students can see the results of any questions as soon as they are graded. On the other hand, the instructor can keep the test results back until a predetermined time. The grades for all assignments can be kept in a grade book; the students can view their grades as the instructor makes them available.	All question types except paragraph are auto-graded. If the entire test consists of auto-graded questions, than the entire test will be auto-graded when it is turned in. Paragraph questions must be hand graded by the instructor. If the instructor chooses, the students can see the results of any questions as soon as they are graded. On the other hand, the instructor can keep the test results back until a predetermined time. The grades for all assignments can be kept in a grade book; the students can view their grades as the instructor makes them available
Adding course material	The instructor adds new material via the Lotus Notes client program. Material can include images, movie clips, or documents.	The instructor adds new material via the Control Panel of the course. The material can include images, movie clips, documents, or HTML files.	The instructor adds new material via the file management set of tasks. The material can include images, movie clips, documents, or HTML files.
Use of the "grade book"	Any assignment which has been created within the Lotus Notes environment can be assigned a grade. All graded items appear in the Assessment database. This	Any assignment, whether it was created in Blackboard or not, can be entered in the gradebook. The gradebook can be exported to a text file which is easily imported	Any assignment, whether it was created in WebCT or not, can be entered in the gradebook. The gradebook can be exported to a text file which is easily imported

	information can be exported to a text file or a Lotus 1-2-3 worksheet and from there put into an Excel spreadsheet, but this is not a neat, easy process.	into an Excel spreadsheet. Blackboard even gives you step by step instructions on the procedure.	into an Excel spreadsheet.

Source: University of Wisconsin-Superior

5

TEACHING AND LEARNING

Powerful tensions exist between traditional curricula based on well-defined content and rules for students to learn and to be able to reproduce – and the open, skills-based, student-centred approaches supported by ICT.

- OECD

New Zealand

Curriculum

New Zealand operates an autonomous, decentralized system of education, in which responsibility for education lies largely in the hands of the schools and teachers who are interacting with the learners. The role of central, or government agencies is limited to providing basic funding and overall policy.

The New Zealand Curriculum Framework describes the mandated content areas that schools must teach. It contains 7 Essential Learning Areas and 8 Essential Skills. Technology education is one of the 7 essential learning areas.

The Ministry of Education in its 2020 Vision, says that education will have a profound impact from the rapid advances in the information and communication technology arena. Information and communication technology will be a part of everyday reality and an essential tool in teaching and learning. Teachers and learners at every level will have easy access to information and communications technologies. Information and communications technologies will provide an enormous diversity of learning opportunities from which teachers and learners can make choices.

These technologies will also enable the establishment of widespread learning communities, and create opportunities for learning in collaborative contexts. They will provide meaningful learning through active participation and application of their knowledge.

The following describes the basis for curriculum development in New Zealand in future: Learning in 2020 will have relevance and an immediacy that fosters enquiry and excitement in the learner. Learning styles and learning needs are individual and dynamic. Quality teaching will deliver timely responses to those needs. Learners will develop an understanding of their cognitive skills to enhance their further learning. Learning management will ensure that learners can apply the skills to transform data and information into knowledge and personal wisdom. As a consequence, students will develop a sense of security, self-esteem and identity. Students' access to information and communication technologies will require skilful guidance and management by teachers.

In New Zealand, each board of trustees is responsible through the principal and professional staff for the effective management of the curriculum through programmes that are planned, and delivered according to the National Curriculum Statements and evaluated based on the assessment of student achievement. The Education Review Office has studied the effective management of curriculum in New Zealand and found more than 81 percent of the schools were satisfactory in 2000. Some of the major bottlenecks include poor planning, either in some classes or school wide, for some subjects, ineffective use of assessment/achievement information in terms of monitoring the achievement of groups of students, identifying barriers to learning, programme evaluation, inadequate curriculum review and insufficient coverage of some areas of the curriculum. Technology was the major area of concern in terms of failure to fully implement the required curriculum.

The New Zealand Curriculum Framework defines essential learning areas, essential skills, and attitudes and values. In this context of curriculum it is worth noting a problem about the development of many of these attributes of learning (such as self-management and competitive skills, social and co-operative skills, and work and study skills) identified in the curriculum.

The most striking feature of New Zealand curriculum documents from an international perspective is the provision of parallel documents in Maori and the system of schools and sections of schools promoting learning in Maori. Few systems have responded to different cultural groups in their society in this way.

The development of a curriculum would ideally encompass the simultaneous development of an assessment programme that fulfilled the intentions of the curriculum. In this way the curriculum and the assessment processes would enhance each other.

Pedagogy

New Zealand schools aim to create a learning environment that enables students to develop attitudes, knowledge, understandings and skills to enable them to succeed in the modern competitive economy and to participate effectively as responsible and informed citizens in New Zealand society. The government, in its education policies, provides an environment in which these aims can be realized. The Information and Communication Technologies Strategy, which was developed in 1998 forms one contribution to this environment.

Of the four objectives outlined in the strategy there are two, which relate directly to the professional development of teachers. The first is to increase the effectiveness and efficiency of teachers and schools by helping them to enhance the delivery of the curriculum and to reduce the time spent on administration. The second objective is to improve the quality of teaching and leadership of schools by helping teachers and principals identify their ICT needs and to develop the skills necessary to meet those needs.

Over the past few years, the Ministry of Education has supported schools to trial curriculum integration as an approach to teaching and learning. Curriculum integration represents an opportunity for schools to take a new approach to curriculum delivery, and to organize and manage the curriculum so that it leads to better learning outcomes for children.

For many schools, the big question is often how to make that approach practical in the school environment. Many primary schools involved in Ministry of Education professional development contracts have already made significant shifts in practice, whereas secondary schools, with their emphasis on discrete subject areas, are slower to change.

Assessment

Promoting children's learning is a principal aim of schools. Assessment lies at the heart of this process. It can provide a framework in which educational objectives may be set, and pupils' progress charted and expressed. It can yield a basis for planning the next educational steps in response to children's needs.

In order to provide appropriate programmes for their students, teachers need to develop high quality information about their current learning. They also need to be able to provide high quality feedback to their students to assist students in recognizing what they need to learn and how they can improve their own work. Educational system in New Zealand strongly links the quality of teacher practice to the overall quality of assessment in the schools. In most cases, the major mechanisms for formal assessment, at least, are provided by school-wide assessment systems. It has therefore not always been possible to separate the quality of individual teacher assessment practices from the overall quality of assessment systems within schools.

Teaching quality impacts on student outcomes. In the absence of high quality standardized information on student achievement, it is difficult to make definitive judgments about the outcomes for students at different schools. While many schools have in place adequate systems for assuring themselves that they are meeting their educational goals, these are not necessarily comparable. In addition, there is a still larger group of schools that are able to provide achievement information for a limited range of subjects (for example, reading comprehension and mathematics) or students (for example, those participating in external examinations in Years 11 and 13).

Teaching and Learning Materials

Content is intimately linked to a vision of the role of education in knowledge and learning society, and to learning strategies and objectives necessary to advance the vision. The openness of digital learning environments is a key characteristic, commonly linked to problem and project centred approaches that were collaborative, communicative, customized and creative. In these ways, digital age content becomes an instrument for pedagogic renewal and for fostering essential digital learning literacy for all.

In developing systems to achieve these purposes, the following principles have been specified by the Ministry of Education, New Zealand:

- Focus on modular resources that can be reassembled and reused
- Capacity to support a distributed environment, including content custodians, metadata, intellectual property and management
- Capacity to meet user requirements for best practice in the distribution, discovery, customization and assembly of online content
- Support education systems in achieving their educational goals and flexibility for systems to provide teacher access to resources that reflect the requirements of their jurisdictions
- Compliance with a standards framework that enables the effective application of pedagogy online.
- Adoption of interoperability standards to facilitate national and international learning resource Exchange
- Scalable, easily upgraded, manageable and maintainable
- Designed for optimum capacity, functionality and flexibility.
- Take advantage of opportunities for economies in the implementation of e-Learning systems
- Optimize synergies with other national online systems

When a contractor is engaged in creating a learning object, the following sequence of events could occur:

- The object is developed, submitted to the procurement system, and tested;
- The quality assured object is transmitted as a package to the Exchange;
- A State education system requests the object from the Exchange as part of its regular updating routine and downloads it;
- A teacher conducts a search on the NZ environment, it is downloaded and included in the e-learning environment the teacher is creating for a group of their students; and
- A request for usage statistics by the Exchange indicates that the object has been used.

In New Zealand, learners have ready access through ICT to a wide and well-focused range of learning resources that are selected, organized, and managed to be responsive to their needs and relevant to the curriculum. Some of the strategies defined by the ministry for schools, government and other stakeholders towards achieving this goal continuously are to:

Continue to develop quality online learning resources for teachers and students, through the ICT cluster programme and curriculum materials development:

- Work in partnership with other agencies and stakeholders to make appropriate resources readily available to schools through Te Kete Ipurangi;
- Participate in the development of digital educational materials and standards for these, through partnership with Australia in the Le@rning Federation project;
- Promote effective and efficient management of learning resources within schools, through the publication of guidelines for school library and information services and successful models of intranet development and use.

Ireland:

Curriculum

Ireland's Schools Integration Project (SIP) has identified and witnessed that integrating ICT into the school curriculum in a meaningful and creative way is a challenge for all schools. SIP analyses the whole issue of ICT and the curriculum can be examined from two perspectives - what is the school's overall ICT policy and what is the school's approach to staff development in the area of ICT? Both of these elements contribute to true ICT integration and it could be said that they are interdependent. Some fundamental questions regarding ICT policy and staff professional development are presented below and schools should aim to address these questions, regardless of their current ICT status, in order to achieve the best possible level of ICT integration over the coming years.

Pedagogy

Developing ICT skills and related competencies at pre-service and in-service phases of teacher education has been a high priority for education policy makers during the last decade in Ireland, both at national and regional levels. Higher Education Institutions (HEIs) that prepare teachers need to address all aspects of their teaching, infrastructural, practical, educational and pedagogic implications brought about by the national policy. Based on an examination of the teaching actions of the tutor and views of his students, traditional pedagogy was adjusted to take into account new ICT expectations.

Discussion on the policy requirements regarding ICT training for teachers will form the basis for the tutor's shift from traditional to ICT-based pedagogy. Among the many regional variations that distinguish teacher education in Northern Ireland from national policy, ICT also differs from the National Curriculum for Trainee Teachers in that it is specified in terms of three levels of competence:

- Personal competence in use of specific ICT tools; (personal competence)
- Competence in integrating ICT in teachers' main subject; (subject competence)
- Competence in planning, preparing, teaching, assessing and evaluating lessons which make significant use of ICT; (teaching competence)

Tutors in Initial Teacher Education, expected to prepare teachers in all three levels, face the difficulty of both teaching through ICT and teaching about teaching through ICT.

The study of pedagogy in ICT–based learning has particular relevance to teacher education as what they see and hear of tutors influencing students' pedagogic thinking. It is somewhat surprising that, given the added complexity of the introduction of ICT into teaching and learning, more research has not yielded a generic pedagogic model that illuminates ICT-based pedagogy. However, little has been achieved in Ireland in defining new pedagogic models that take into account new forms of knowledge necessary when integrating ICT into teaching and learning.

Assessment

The Ministry of Education in Ireland understands that effective formative assessment is a key factor in raising pupils' standards of achievement. The following will form the core of ICT-enabled formative assessment, or 'assessment for learning':

- Assessment is embedded in the teaching and learning process of which it is an essential part
- Shares learning goals with pupils
- Helps pupils to know and to recognize the standards to aim for
- Provides feedback which leads pupils to identify what they should do next to improve
- Has a commitment that every pupil can improve
- Involves both teacher and pupils reviewing and reflecting on pupils' performance and progress;
- Involves pupils in self-assessment.

Teaching and Learning Materials

There are eight defining principles education will have to meet in order to satisfy market demand in the knowledge economy with its convergent technology infrastructure. The teaching and learning courseware are to be developed in order to satisfy the following objectives:

These are:

- Lifelong learning
- Learner-directed learning, with the teacher becoming the facilitator, diagnostician and therapist
- Learning to learn so that individuals can plan and realize their own learning
- Contextualized learning
- Customized learning, designed to meet different needs, preferences and cultural practices
- Transformative learning, enabling the changing of belief systems to overcome disability and disadvantage
- Collaborative/co-operative learning
- Just-in-time learning, as individuals choose from the global supermarket of opportunities.

When looking to purchase digital content (on line or CD-ROM), before examining the actual content, there are several key criteria that are important for teachers:

- Clear National Curriculum references with the product
- Teacher's notes and lesson plans
- Cost
- Suitable licensing conditions
- Language levels appropriate to pupils' age ranges
- Recommendations by other teachers and examples of use in classroom situations.

6

SECURITY

Introduction

As schools move toward more automation, security issues too have breached the physical barriers to enter into the virtual world. Most schools now confront the problem of protecting the data on their computer networks. The most sensitive information is the personal data and information regarding staff and students. In the US, student medical records are also considered highly confidential. Apart from this, public information should also be protected to prevent misrepresentation of any staff or student in the school system. To ensure these, most schools resort to implementing perimeter defense measures such as a network firewall or a virtual private network. Use of username and password protection of data that can be accessed through the school network is almost a given in schools that have shared digital resources.

Typically, schools face the need to ensure that the following data are protected:

- Data stored on all mainframes and servers
- All student information stored on clients as well as servers
- All financial information stored on servers
- All student information stored on computers, servers and mobile devices such as laptops and PDAs
- All e-mail messages stored on personal computers and servers
- All web-page files located on servers
- All user files located in home directories on servers
- Any shared files located on either servers that may have private or sensitive information
- All online applications used by the school

Most schools have formulated and implemented a strict policy guideline to be followed by the staff and students. A typical school IT security policy may include all or some of the following:

- Shared responsibility of all personnel and pupil when it comes to safeguarding school information
- Confidential usage of usernames and passwords
- Storing files in safe locations such as home directories, and shared folders on network servers
- Logging off of computers when privileged or administrator usernames are used to log on
- Reporting any violation of the network security policy to the IT administrator, teacher or the principal

In both Ireland and New Zealand, schools have devised independent security policies and mechanisms for data protection. However, both the ministries have set out a broad policy guideline to ensure data protection in school networks. In Ireland, if the network in place has a server, that is a central computer, and the appropriate software or network operating system, various levels of security can be implemented across the network. This means that the network administrator would be called on to set up security features such as:

- Granting access to sensitive documents only to those users who require access
- Providing various groups/classes with access to specific software only
- Restricting user access to certain times during the day
- Recording patterns of usage
- Providing a central backup of all user data
- Controlling when the Internet is available and to what groups or classes

The administration of the computer network involves, among other things, updating software on the computers, managing user information and accounts, and controlling network security. These functions can be performed from any location on the network.

In Ireland, most schools have found that a gradual move to networking has suited them best. Typically, the networking process starts with a number of stand-alone machines, which they later networked in a peer-to-peer network. This enabled them to get to grips with the fundamentals of networking without the considerable learning curve associated with client/server administration. Then, as more computers were added to various locations around the school, they moved to a client/server solution with a server operating system running on the server and more familiar operating systems on the client computers, as this better suited their needs. Eventually, they moved to a full network operating system on the client computers as they found that this gave them a more manageable, robust network.

The National Centre for Technology in Education (NCTE) in Ireland has stipulated that schools form a policy for acceptable use of the Internet in partnership with parents. This policy should address all rights, privileges and responsibilities associated with Internet and online service usage. It should incorporate a code of conduct, which should be agreed by all participants and incorporated in the school's ICT plan. The penalties for breaching the code must be stated clearly to all. The acceptable use guidelines for schools are available on the NCTE Web site (http://www.ncte.ie).

In schools, supervising teachers act as the arbiters of 'netiquette' and their role is crucial in protecting and guiding children during online activities. Schools ensure that they

- Closely monitor children's activities during Internet sessions
- Advise students to use moderated chat rooms only
- Prevent e-mail attachments from unsolicited or unknown sources being opened
- Direct online activities to previously evaluated educational resources or previously sourced safe sites
- Install appropriate blocking/filtering software - this software, while not entirely foolproof, will greatly reduce the risk of deliberate or inadvertent access to undesirable material
- Prohibit registration or the signing of visitors' books at Web sites without permission

In New Zealand, security implementations have been at best piecemeal and restricted to the school level. However, the country has an Internet Safety Group that is made up of a number of community groups and government agencies. These are the Department of Child, Youth and Family Services, New Zealand Police, Department of Internal Affairs - Censorship Compliance, Auckland Rape Crisis, Internet Company of New Zealand (ICONZ), Peace Foundation, the Department for Courts, SAFE Network, ECPAT, Mt. Roskill

Grammar School, Mt. Roskill Intermediate School, Mt. Roskill Primary School, Three Kings Primary School, School Trustees, PTA representatives, parents/caregivers, and teenagers. The National Library of New Zealand has been consulted as well. The Internet Safety Group has developed the Internet Safety Kit, with sponsorship from Child, Youth and Family, and additional funding from the Ministry of Education. The New Zealand Police and the Department of Internal Affairs have also endorsed the Kit.

The Internet Safety Group's objective is to offer schools and libraries resources that will help them educate and protect children and young people, and educate parents/caregivers on the safe use of the Internet. The Internet Safety Kit is a resource to raise awareness and educate children and young people to use the Net wisely. A copy of the free kit is being sent to each school in New Zealand and a modified version to all the libraries.

Schools also use filtering software available from a number of suppliers. Popular ones include Cyber Patrol (primarily for use on standalone computers) and Surf Control (which can also filter email). Products that run on the increasingly popular Linux platform include Squidguard, and Dans Guardian. These are both freeware, but will require some specialized knowledge to install. Some larger high schools have opted for solutions such as Web Marshal from Marshal Software, which provides a more sophisticated level of functionality, at a substantially higher cost.

Chart 6.1: Comparison between the different security mechanisms adopted by schools in NZ and Ireland

Security Components	New Zealand	Ireland
Security management policies and procedures	Ministry of Education sets forth a broad policy framework on school security policies (both physical and virtual) A number of joint private, community, school and government initiatives to offer online privacy to students	Guidelines and policy frameworks set forth by the NCTE, aided by Becta Guidelines have already been issued to all schools on Acceptable Use Policy. The NCTE is participating at European level in the DOT.safe and ONCE projects which are studying methods to further enhance Internet security in schools.
The Security Network **Windows/Mac Security** **802.11**	 Windows 2000, NT, XP security procedures followed Username and password for identification, authentication and access control Server level and client level security measures Use of WEP (Wired Equivalent	 Windows 2000, NT, XP security procedures followed User name and password for identification and authentication Mac OS X security procedures and firewalls MacScan for spyware removal WEP, AirPort wireless networking

	Privacy) protocol, 40- and 128-bit encryption	security solution, Cisco's LEAP (Lightweight Extensible Authentication Protocol), use of remote authentication and dial-in user service (RADIUS) servers for enhanced security
Proxy servers & Firewall	Cisco, Seagate, Microsoft proxy and firewalls	Microsoft, Cisco, Norton personal firewall, Mac firewalls
Virtual Private Networks	Predominantly used by cluster schools, cost proving prohibitive to smaller, cash-strapped schools	Government has a three-year contract was Telecom Éireann (TE) (now Eircom) for a Government VPN service serving the Civil Service, Defense Forces, the Garda Síochána, Health Boards and Local Authorities. The VPN now includes the schools covered by the IT2000 initiative of the Irish government.
Anti-Virus Software	Usage of a diverse range of anti-virus software from Norton, McAfee, Symantec	Sophos anti-virus software used by all schools in Ireland. Acquired directly by schools or through Local Education Authorities
Information Back-up	Done at the school level and school cluster level. Ministry contemplating the setting up of data centers	Lead schools in Schools Integration Project in charge of data back-up Back-up planning and advisory services offered by the ICT Advisors in the 20 Education Centers across the country No centralized data centers
Remote Access	Secure web-based access through VPNs	RADIUS and VPN usage Usage of Public Key Infrastructure (PKI)

7

SYSTEM INTEGRATION & INTEROPERABILITY

Introduction

Unlike Malaysia, schools in Ireland and New Zealand adopt a diverse range of systems and solutions for their schools. However, all the material acquired by the schools conforms to a broad ICT policy guideline set out by the respective ministries. As school management and learning management systems become more automated, the demand for more controlled and shareable systems and objects is also on the rise. Similarly, there has been consistent need for network services that would allow multiple users to share such resources. Integrating standalone networks with community networks, school district networks and national networks has been high on the priority of educational authorities in both New Zealand and Ireland. New Zealand's Smart School project and Ireland's Schools Integration Project have achieved an impressive degree of success in bringing the student and teaching community and the learning objects online.

System integration happens at different levels. These are:

- The development of a common technology infrastructure that allows access for all partners (ex: school intranets and extranets)
- Using Web-based technologies to enhance communication between schools and schools with the wider community

Both New Zealand and Ireland have been using and will continue to use (at least for another 2 years) Windows-based operating systems and software solutions, which ensure easy integration between such systems. Ireland's Schools Integration Project, one of the biggest bottoms-up initiatives in Europe, has successfully integrated 75 projects involving 600 schools. The usage of standardized software and hardware and communication networks was one of the key success factors behind such integration. In New Zealand, system integration is happening at the school level. The Smart School program offers a customization and upgrade program for regular software upgrades, education office/department level options, additional fee-based customization, feedback systems and options for users to customize their interface in an attempt to integrate different networks, educational offices, schools and people.

Interoperability

Increased competition between commercial software providers in Ireland and New Zealand, especially those engaged in the development of teaching learning material, has severely restricted the formulation of common standards. However, as the need for sharing data and learning objects increase among schools, so is the demand for systems and solutions that can talk to each other. In Britain, for example, Becta, the lead agency for promoting ICT mediated education in the country, has acknowledged that there is a growing need for interoperable systems not only for the exchange of resources between schools but also as a means of bringing greater transparency into the education and the government sectors.

Ireland's Information Management Strategy project is in fact aimed at establishing common protocols and standards for collecting and creating educational products. The Ministry of Education in NZ too has created a policy framework that stipulates standards for ensuring interoperability between disparate systems. The Information Management Strategy project, which is common for Britain and Ireland, envisaged achieving agreed standards for school and LEA software and hardware and for technical software support. The project has also formulated agreed standards for electronic information collection and transfer and has set up procedures for handling future changes.

The common basic data set (CBDS) developed by the project provides the basis for establishing standards for transferring data between sites and between different suppliers' systems. Software systems were required to be compliant with the CBDS definitions needed for pupil transfer by March 2001. A target for software exchange has been established and over 40 LEAs have been involved in tracking the electronic collection of the annual school census.

Singapore too presents a unique solution in developing a number of support strategies to ensure interoperability. These include system integrators with a number of pilot programs built into the framework of the national action plan. The country has established the Information Technology Standards Committee Plugfest 2002 (ITSC) for addressing issues such as such as IMS Meta-data and Question and Test Interoperability specifications (http://www.imsglobal.org/question/index.cfm). Singapore has established an IMS Asia Center, which is developing interoperability standards for educational applications.

Britain too has established the British Joint Information Systems Committee (JISC) as a part of its Five Year Strategy for 2001-2005. JISC is striving toward achieving its vision of a single, worldwide information environment, which is deemed necessary if teachers and students should access the requisite information needed for fulfilling their functions effectively. In the US, the Schools Interoperability Framework (SIF) consortium has produced a specification for the major components of the infrastructure supporting US K-12 education.

In Ireland, the CBDS will contribute to the e-Government Interoperability Framework (eGIF) and, in particular, components of the CBDS (the data items) will be included in the Government Data Standards Catalogue (GDSC). The CBDS will evolve over time to meet the demands, priorities and practices of the education sector.

In countries that have developed CBDS, it has been demonstrated that the CBDS will be most effective if it has a global ownership (owned by all the education service stakeholders) rather than it being a government imposition. In the US, the Schools Interoperability Framework (SIF) has the participation of over 80 LMS providers spearheaded by Microsoft.

New Zealand has a Digital Forum that facilitates setting up standards to ensure interoperability between digital objects. These standards facilitate cross-searching, exchange, collaboration, data manipulation, migration (between applications and metadata schemes), longevity, future-proofing, and platform independence.

Chart 7.1: Comparison of the system integration and interoperability standards of Malaysia, NZ and Ireland

System Integration - Components	Malaysia	New Zealand	Ireland
System lifespan	5 years	NA	NA
Upgrading	System can be upgraded to different platforms	Compatible with a variety of platforms and designed for universal accessibility	Focus on access device independent and platform independent learning content
Integration	Between SSMS and TLM	Integration between certain components of school management systems and TLM	Integration between school management systems, TLM and e-Government systems
Data integrity and security	Achieved through data centers	Data centers developed at cluster levels	Data centers developed at lead school levels
Platforms	Web-based, Windows 98	Web-based, Windows 98, 2000 and XP. Content should adhere to the guidelines of Web Content Accessibility Guidelines (WCAG) set out by the World Wide Web Consortium	Web-based, Windows 98, 2000, XP, Mac OS Follows Becta guidelines for developing Web content
Code sharing	Between different government departments	With other e-Government initiatives	With e-Government initiatives, SuperJANET, Eurydice and SchoolNet
Import/Export of data	Limited	Medium	Extensive

- Both Ireland and New Zealand follow the guidelines set forth by the Authoring Tools Accessibility Guideline v 1.0 of the W3C for multimedia content developers
- The countries also follow the generic guidelines prescribed in the User Agent Accessibility Guidelines 1.0 of the W3C for producing content and tools that can be accessed through a variety of devices

The commonly approved authoring tools as stipulated by the W3C include:

- Editing tools specifically designed to produce Web content (e.g., WYSIWYG HTML and XML editors)
- Tools that allow saving material in a Web format (e.g., word processors or desktop publishing packages)
- Tools that transform documents into Web formats (e.g., filters to transform desktop publishing formats to HTML)
- Tools that produce multimedia, especially where it is intended for use on the Web (e.g., video production and editing suites, SMIL authoring packages)
- Tools for site management or site publication, including tools that automatically generate Web sites dynamically from a database, on-the-fly conversion and Web site publishing tools
- Tools for management of layout (e.g., CSS formatting tools).

8

PROJECT MANAGEMENT

Unlike Malaysia, the two countries taken up for benchmarking, New Zealand and Ireland, do acquire non-curriculum courseware materials from different private companies. The two countries have clearinghouses that validate and controls the quality of teaching-learning content developed for schools. As a matter of fact, the absence of common learning and content management system makes the requirement of content quality and specification wide. Especially, in New Zealand, the content for the student has been acquired by the school authorities and clusters. Though the cluster schools follow the standards specified by the Le@rning Federation, the quality assessment is carried out only at the schools. Common courseware and content is hosted by the TKI Web site for the benefit of schools.

In Ireland, the ScoilNet website has been developed as a portal for enabling access to educational information and as a source of curriculum and training materials for teachers. And the Software Central section of the NCTE's website serves the teachers in making decisions on the selection of the software which will be most beneficial for their particular subject, class, age group or ability level.

NCTE broadly outlines the basic quality requirements of the content acquired by the schools. When looking to purchase digital content (on line or CD-ROM), before examining the actual content, there are several key criteria that are important for teachers:

- Clear National Curriculum references with the product
- Teacher's notes and lesson plans
- Cost
- Suitable licensing conditions
- Language levels appropriate to pupils' age ranges
- Recommendations by other teachers and examples of use in classroom situations.

IV

GAP ANALYSIS & STRATEGIC RECOMMENDATIONS

Introduction

Though there is no comprehensive data on ICT adoption in schools available across all the countries studied for this benchmarking apparent, it is clear from these national examples that a growing number of schools is tapping the substantial potentials of ICT in education. There are scattered statistics to show that this is happening, albeit in a phased manner. Unlike Malaysia, countries have adopted a two-phased approach to integrating ICT into the learning process. The Malaysian initiative to jumpstart ICT integration in schools is a bold one and comes with its share of challenges. Even in countries like the US, where there is no dearth of funds from the government or support from the private sector, the innovative changes in the education sector through ICT evolved over a period of time. For example, the US took as many as 12 years to bring its student to computer ratio from 63:1 to 6:1. Countries like Ireland bridged this gap in a matter of five years. It is apparent (be it 5 or 15 years), that reforms in the education sector do not happen overnight.

Success stories are largely scripted through sustained efforts in change management and teacher education, an area of priority for almost all the countries studied. In fact, the sequential approach adopted by most countries involved two aspects:

- Creating the ICT infrastructure, educating the teachers in all aspects of its usage and helping them to react positively to the pace of change
- Integrating ICT into all aspects of education and the society to facilitate a continuously learning society

In this chapter, we compare the Malaysian Smart School Integrated Solution based on a variety of parameters with similar implementations, if any, across the world. An attempt is made to benchmark the solution's components with at least one comparable component elsewhere implemented. It is to be noted that, because of the uniqueness of the solution in certain aspects that a comparison cannot be made on certain parameters. These have been explained in relation to the given context and whenever these parameters are referred to.

Scope and Coverage of the Smart School Integrated Solution

It is to be admitted at the outset that no other country has attempted to implement a complete suite of solutions that attempts to address all the aspects of teaching and learning and school management in any given educational environment. The ICT-mediation processes in all the countries compared were selective in their nature, bringing in ICT into certain aspects of the teaching-learning and school management aspects.

This kind of an initiative has both its pluses and minuses. What Malaysia has today is a comprehensive school management system across 87 schools—systems that are capable of interacting with each other, fulfilling one of the salient goals of education, which is sharing of knowledge.

On the other hand, implementation of such a system may have resulted in making the existing processes in schools redundant, resulting in a need for extensive process re-engineering and change management. Though modular in nature, the tightly integrated solution calls for a full implementation, irrespective of the fact that the schools may not need certain components of the solution.

Chart IV-1: Comparison between SSIS and similar implementations

Malaysia	Ireland	New Zealand	Others
SSIS	No across-the-board management system in place	No across-the-board management system in place	No across-the-board management system in place
9 Components	6-8 components	4-6 components	Range from 10-12 in countries with developed ICT-mediated learning systems to 4-5 components in less developed ones
Smart School Management System with 9 components	Selective implementation of ICT in school management systems.	No end-to-end automated process for school management	Range from no automation to fully automated environments.
Teaching and Learning Entirely government directed	ICT-mediation in curriculum, pedagogy, assessment and TLM decided by nodal agencies such as the Curriculum Development Body. Government role restricted to directing schools on the level of ICT-mediation to qualify for certain grants	Level of ICT mediation largely left to the discretion of school authorities and school districts. Assessments systems in place for the government to evaluate whether schools meet its policy guidelines set out in the National Curriculum Statement Evaluation of curriculum and pedagogy done by Education Review Office	In almost all the countries studied, there is extensive private participation in terms of enhancing the teaching and learning process. Joint private initiatives for creating ICT-enabled curriculum objects, and assessment tools. Partnerships among educational institutions and private enterprises
Infrastructure and technology – government funded,	Disparity between infrastructure and technology used by	Uneven distribution of ICT infrastructure. Limited government	Uneven distribution of technology infrastructure.

and streamlined	schools. Sustained government funding and involvement of private parties has succeeded in enhancing the availability of ICT infrastructure to all schools	funding. Extensive community participation and school level initiatives have resulted in significant infrastructure upgrades.	Extensive private participation and community initiatives.
Systems integration and interoperability – Fully integrated and interoperable	Disparate systems. Integration and Interoperability ensured through standards-based products and solutions	Disparate systems. Integration and Interoperability ensured through standards-based products and solutions	Disparate systems. Integration and Interoperability ensured through standards-based products and solutions
Security – Extensive security policy and mechanisms in place Physical security ensured at school level	Security limited to authentication and access control mechanisms. No nation-wide security policy for educational institutions. Policies formulated at school level Physical security ensured at school level	Policies made at cluster levels and school levels. Usage of VPNs and firewalls limited to certain clusters Physical security ensured at school level	In countries like US, national level security policies in place for physical and Internet safety. Nation-wide watchdogs established Physical security ensured at school level
Centralized Project and Risk Management	Not available	Managed by teachers in lead schools and private sector	School and Private sector participation in project & risk management
Change Management – Initiatives involve teachers and principals in the 87 schools	Change management and teacher development accorded the highest priority. Extensive allocation of funds and resources. Enthusiastic participation of teachers. All teachers have gone through phase 1 of ICT training Regular assessment of teacher skills in teaching and ICT usage All teachers to be equipped with laptops by 2003 end	Different modes of teacher training being experimented. Specific programs targeted at Principals. Training by students and communities. Extensive involvement of private sector for both infrastructure and training Laptop program for teachers launched	Teacher training a priority for a majority of the countries Teachers encouraged to develop ICT-enabled learning objects In UK, government helps in export of courseware developed by teachers in schools
Support Services – National Help-desk, IT Coordinators at school level	National and district level help-desks. Schools mostly manage their support needs Managed services model for sourcing infrastructure and	TKI Help-desk. Support from retired officials and the community. Schools source their own support mechanisms	Variety of support mechanisms in place. Help-desks, school-level IT support personnel, web-based support of facilitating agencies

	support being experimented. IT Advisors in all the Education Centers. Support through ScoilNet and the NCTE Web site		

Key Messages:

The Smart School initiative in Malaysia is one-of-its-kind, as it has achieved all of the following:

- A fully integrated school management solution that addresses all components of the teaching-learning process
- Comprehensive courseware in two languages
- A knowledge bank consisting of teachers, students and administrators who have been empowered by ICT
- Pool of local talent capable of addressing the needs of the Smart Schools in terms of:
  - Understanding and managing the technology – concept and operations
  - Planning and managing student learning environments by using ICT
  - Managing the social, ethical, legal and human issues surrounding the use of technology
- Processes that are based on and revolve around:
  - Leadership and vision
  - Learning and teaching
- Productivity-oriented and professional practices
- Development of a commercial e-learning industry

Gaps Identified

1. Management of the Solutions

1. Management of Implementation:

- Lack of dedicated Smart School personnel in select areas (ex: teachers for courseware development)
- Protracted decision-making process
- Policy changes not occurring in tandem with goal setting
- Adoption by key stakeholders a major hurdle
- Expectations to be set right
- Continuous communication with key stakeholders an issue
- No school clusters to share problems, solutions and best practices

2. Business Structure

- Loopholes in the consortium model
- Absence of social responsibility from participating companies

When comparing the practices across different countries, we found that the consortium model is one of the most popular frameworks for fostering cooperation between government, educational institutions, commercial and non-commercial entities. A case in point is the East Midlands Broadband Consortium in UK and Ireland, which is promoting the East Midlands Broadband Network. Formed by a group pf Local Education Authorities (LEAs), with partnership from Fujitsu, Kingston in Business and Synetrix, it offers broadband connectivity to consortium participants.

Industry Canada, a consortium of industry leaders in Canada, has been instrumental in conceptualizing and implementing Canada's SchoolNet, an initiative to enhance the ICT infrastructure in schools and network them. Ireland's Schools Integration Project saw as many as 58 commercial partnerships. However, the governments in these countries have been careful not to interfere either with the business structure of these consortia or their commercial terms of agreement.

Many of the countries also exhibited a considerable degree of enthusiasm for ICT initiatives in education from private sector participants.

Ireland's ScoilNet project has been implemented by Intel, while IBM has a million dollar Wired for Learning initiative in the country.

In the US, the Cable in the Classroom (CIC) program has seen the participation of 8,500 local cable companies and 39 national cable companies offering free Internet and cable access to schools. The program now serves 81,000 public and private schools and reaches 78% of K12 students. CIC has helped in bringing Internet connectivity to 99% of the 104,000 schools in the country. It delivers dynamic, online video content to 4 out of every 5 students in the US.

2. Technology Component

- Usage of technology more inclined toward productivity enhancement and not for communication enhancement
- Capability of technology for problem solving and decision-making not fully exploited
- Absence of familiarity and usage of technology – a big hurdle for adoption by key stakeholders

- Social, ethical and human issues surrounding the use of technology not fully addressed
- Key stakeholders have not been fully oriented on methods and strategies for applying technology to maximize learning
- Communication infrastructure needs to be enhanced to facilitate networking of schools
- Reliance on a single vendor may have long-term repercussions in terms interoperability, and cost
- Creation of virtual communities
- Need to develop a variety of communication modes among key participants
    - e-Mail
    - Chat
    - Bulletin Board
    - Desktop conferencing

3. SSMS

SSMS

- Robust, closely integrated, one-of-a-kind solution
    - Lacks flexibility
    - Modular implementation difficult
    - Low user-friendliness

- Need to migrate from a client/server architecture to a Web-based model
    - Cost Implications
    - Development time
- Infrastructure implications
- Security
- Develop a comprehensive portal to facilitate interaction between schools
- Change management

4. Migration from Client/Server Architecture to Web-based Architecture

The present Smart School Management System (SSMS) works on a client/server architecture, which is essentially a connected set of computers like a peer-to-peer network but it has a 'master' computer or the server, which uses the network operating system to control what happens on the network. In the case of SSMS, the school needs to have a minimum of 3 servers, for communication, applications and databases. This is an expensive proposition if the architecture needs to be extended to a larger number of schools.

Contrast this with the thin client model, which is already being experimented by select schools in New Zealand and Ireland. This type of client-server network adopts a structure similar to that of the mainframe system. It is not in common use in schools, but some schools are piloting such an option. In a thin client-server system, all the client machines are compact in design, with no hard disks, floppy drives or CD-ROMs.

The concept of this system is that it has the ability to display remote applications and data that run on the server and not on the client. In a school environment, the software may also reside on the server. However, this is either distributed or published to the user. The desktop computer has a part to play in processing the system and application files. Any client machine that runs a program or part of the application is not a thin

client. With the thin client technology, all of the processing is managed by the server; only keystrokes and mouse clicks are transmitted and/or received between the thin client (dumb terminals) and the server.
All of the major hardware is now located in a single location and the software is accessed by dumb terminals. As a result, this makes management more central and secure, and the systems are less likely to be misused by ambitious students.

The main benefit of using thin clients is the ease of maintenance. (With desktop machines, more administrative effort is required when installing new software or to modify client-side configuration options.) The computers used by the staff and pupils are also much cheaper to purchase. In New Zealand, the thin client model is gaining popularity as the government is promoting the use of recycled computers in schools through a major initiative.

In Ireland, some schools have demonstrated a significant reduction in the cost of their ICT infrastructure by opting for thin client networks running Linux.

5. Teaching & Learning

- Development of courseware that fulfilled the curriculum requirements
- Highly customized courseware may limit export opportunities
- Need for transition to international language mediums
- Initial problems in setting standards
- Loose involvement of teachers and domain experts in monitoring content development
- Absence of vertical and horizontal linkage makes self-paced learning difficult
- Low multimedia content – Enhancing this would call for networks capable of carrying large voice and data traffic, especially in a Web-based model
- Quality of evaluation for courseware is highly varied
- Web-based courseware to be developed
- Need for open-ended courseware
- Teachers to be equipped with the ability to develop their own courseware

6. Project Management

- Quality Management – System test, courseware review, Acceptance tests
    - Bottlenecks in terms of test facilities
    - Absence of consistency in SME participation
    - Release and version control management

- Risk Management – Procedures to ensure goals are fulfilled, risk identification and management
    - Periodic audits and risk management plans not fully implemented
    - Security infrastructure not fully developed – Risk awareness low among key participants

7. **Change Management – Communication and training**

- Lack of coordinated communication between project planners and participants
- Need for BPR (Business Process Re-engineering) prior to roll-out
- Setting expectations right
- Training and authority for ITC

- Training for teachers in the use of ICT
- Setting out a stringent IT policy for schools and ensuring adherence
- Define Principal's role and responsibilities for successful implementation
- Tapping teacher training colleges and regional resource centers for enabling ICT usage

8. Infrastructure & Technology

- Absence of a single infrastructure model that would address the need to connect 9,000 schools
- Building the solution and the courseware on a proprietary OS would escalate costs and lead to over-reliance on a single vendor
- Communication infrastructure inadequate to realize the vision of Smart Schools
- Responsibilities for configuration management and security unclear
- Scaling down of budget for security and support has lead to negligible development in these two areas
- Security issues and implications not fully understood by personnel governing security.

9. Support Services

- Help-Desk Services – Offers remote trouble-shooting, event logging, escalation services
- On-site support – Dispatch of service personnel to client sites

- Scale of operations of the help-desk not extensive
- Turnaround time for responding to requests high
- Lack of end-user knowledge adds to the support burden
- Scaling down of budget for support has imposed severe restrictions
- End of contract for companies such as EDS has passed on the burden of security and configuration management to TSS (onus of fulfillment not clearly defined)
- Maintenance restricted to troubleshooting. No preventive maintenance
- Service levels minimal and mostly restricted to technical support. Advanced services not actively offered
- Inadequate number of trained, in-house ITCs in schools

Recommendations

1. Develop Mechanisms to Encourage Initiatives at the School Level

In a number of countries that were studied, there have been concerted efforts to develop and encourage grass-root level initiatives for creating an incisive ICT-mediated learning infrastructure in schools. Granting autonomy to schools in terms of creating and implementing an ICT policy, making hardware and software buying decisions, and sourcing support has clearly been the catalysts of any grass-root movement. In all the countries studied, the bottom-up approaches have proved to be the most effective. Incentive mechanisms in the form of awards, grants and publicity should be in place to encourage active participation from schools.

2. Focus on Change Management and Teacher Training

If policy makers wish to encourage unbridled participation from schools, it is essential to have well thought-out programs in place to help teachers keep in pace with the rapid changes in technology. The change management has to happen both at the school level and at the district and national levels. Change management is a sustained effort and needs the enthusiastic participation of all key stakeholders. Process re-engineering has to be initiated much ahead of implementing change management measures.

3. Consortium Model Most Effective, but Little Government Interference should be Ensured

It has been demonstrated in almost all the countries studied that consortia are most effective for fulfilling and sharing the benefits of any initiative. Consortia of educational institutions, consortia of government and educational bodies, consortia of educational and commercial institutions, consortia of communities, commercial bodies and educational institutions are just a few of the models that have been tried out in different countries. However, the government role in defining the framework and constituents of such consortia is very limited. In fact, governments in Ireland, the UK and the US had exercised enormous caution in forcing marriages between unwilling participants.

4. Teachers want Digital Content that Closely Resemble the Curriculum. But, what about the Learners?

Developing digital content that reflects the curriculum is what the teachers want. This is not just true of Malaysia, but also of Ireland, New Zealand and even the US. Teachers would like to see the courseware being broken down to the level of lesson plans. However, merely replicating the curriculum in a digitized format may not add much value to the learning experience. The Irish schools have come up with innovative courseware that fulfill about 75% of the curriculum requirement, yet has something extra that would stir the learner's interest. In fact, schools participating in SIP have been successful in developing a huge repository of innovative content in the country.

5. Teachers' Involvement in Courseware Development should be Recognized and Rewarded

The UK has programs in place to encourage teachers to design and create ICT-based learning objects. There is a governing body consisting of ICT Advisors, educational authorities and independent educational consultants to evaluate the standard and effectiveness of these learning objects. Once approved, the government not only extends royalty for the objects that get incorporated into the national repository or Exchange, but also help in exporting the courseware developed by the teachers.

6. Migration to Web-based Model may become Inevitable

As Web-based models of communication and learning become increasingly popular, it is inevitable that learning and school management systems should move toward such a model. A Web-based architecture would promote self-paced learning as these encourage two-way interaction between the learner and the teacher in a remote learning scenario.

7. Encourage Business-to-Education Technology Transfers

This is already happening in a number of countries. Intel's contribution to the ScoilNet project of Ireland was enormous, both in terms of extending technology and expertise. In the US, Detwiler Foundation's *Computers for Schools* and *Computers for Children* programs have managed to place more than 40,000 computers in schools across the country. The *Computers for Schools* program in Canada is soliciting donations of obsolete or redundant computers from business, industry, and individuals, and refurbishing them before donating them to schools. A similar project, named CANZ, is operational in New Zealand. IBM, Apple, Intel and Microsoft have several non-profitable programs running in Ireland.

These projects reiterate the fact that no project of such huge proportions as bringing ICT-mediation in schools can happen in isolation without the active participation from all segments of the society.

8. Proprietary Software is Expensive. But, is Open Source the Solution?

Reliance on a single vendor for infrastructure needs will always prove to be expensive. Ireland commonly uses Microsoft and Mac OS platforms, while in New Zealand, most schools operate on MS systems. Experimentation is on in pockets in the use of Open Source systems. However, authorities in Ireland report that they need to tackle two issues when implementing open source software: 1) The popular perception that as it is free, it necessarily has to be inferior to proprietary systems and 2) The hidden costs in terms of training and change management. Deploying and managing OS software also calls for a certain level of sophistication in skills as ICT administrators need to be on top of what is happening in terms of development of new patches etc.

9. Managed Services a Good Option if Schools Wish to Focus on Core Competence

Ireland began its experiment with managed services in 2001 through its CLASSROOM 2000 project, valued at £300 million to deploy over 40,000 managed desktops in 1,227 schools in Northern Ireland. A recent €90 million deal with Sx3 involves providing 23,000 computers and maintaining them for a period of 5 years. Such deals, covering the entire ICT infrastructure of schools and their maintenance, have proved to be a big compensation in bridging the gap in terms of skills for managing huge ICT infrastructure in schools.

V

BENEFITS TO THE NATION

The Smart School Project occupies a pivotal position in the broader scheme of the Malaysian e-government initiative, which seeks to transform the country from an industrial to an information-based economy. This would mean creating a knowledge workforce, which will have among other skills, the ability to develop and use tools and solutions for the information age. Developing a pool of knowledge workers requires an initiative that can systematically reinvent the teaching and learning process and school management to infuse creativity and increase student-teacher participation in the learning process. In an effort to move education beyond the blackboard, the Smart School set the following objectives for ICT-mediated education:

- To produce a thinking and technology literate workforce
- To develop students physically, mentally, emotionally, and spiritually
- To provide opportunities to improve individual strengths and abilities
- To increase stakeholders' involvement
- To democratize education

Given these objectives, let us explore how far the Smart School Project has fulfilled them. The roll-out of the Smart School Integrated Solution (SSIS) involved the concerted efforts of the Multimedia Development Corporation, which operates the country's seven flagships under its Multimedia Super Corridor Project, the Ministry of Education and Telekom Smart School Sdn. Bhd. (TSS). The initiative has made significant inroads in terms of:

- Building a uniform ICT infrastructure in the 87 schools in which SSIS was piloted
- Creating a school management solution and courseware that promise export potential
- Creating an industry and a pool of knowledge workers who were skilled in the following areas:
    - Development of school management and teaching and learning solutions
    - Project management and quality control
    - Support functions such as help-desk
- Creating value for money

Each of the benefits is discussed below in detail.

Building a Uniform Smart School Infrastructure

A variety of studies in the past have shown that powerful technologies are used by powerful people. As the UN Secretary General Kofi Annan remarked while receiving the Nobel Peace Prize, information and communication technologies will be most powerful if, and only if, they can be used for improving the condition of each individual. Though ICT penetration has reached significant levels in the developed

countries, in developing countries such as Malaysia, we are still confronted by the digital divide. There is an ongoing debate on how governments plan to overcome the issues of access and availability.

Even in developed countries such as the US, the ICT infrastructure in schools is unevenly distributed. This is despite the fact that the US has enormous funds at its disposal for the education sector. The following table shows the expenditure toward education in each of the countries chosen for this benchmarking study.

Table V-1: Comparison between the expenditure on education among different countries

	Macro Economic		Expenditure per Student
Country	GDP	GDP/Capita	
	(US$ Billions)	(US$)	(% of GDP/Capita)
Malaysia	96	4236	10.7
Singapore	92.3	22343	16.5
USA	9800	34348	18
UK	1400	23810	17.2
Canada	687.9	22132	17
Australia	390.1	19957	14
New Zealand	49.9	12964	16.6
Ireland	93.9	24459	11.6

Source: World Bank 2002

A comparison of such resource availability shows how difficult it is for developing nations such as Malaysia to achieve ICT-mediation in education. This table shows the GDP per capita of countries and the annual expenditure for education for each pupil as a percentage of the GDP. While the US spends a high 18% of its GDP per capita on education, the closest comparison to Malaysia here is Ireland, which spends about 11.6 percent of its GDP per capita on a student. However, Ireland's GDP per capita is about 6 times as high as Malaysia's and the number of schools at 4,000 for a population of 4 million. Malaysia has more than double the number of schools.

Given the low resources at hand, the Smart School is by itself a very significant effort as it has brought about a level of uniformity in ICT infrastructure in schools—the kind of infrastructure that has been beyond the reach of government schools in any developing country.

Since the commencement of the Smart School Project, the country has also achieved a significant improvement in the student to computer ratio in both the primary and secondary schools and the teacher to computer ratio. However, this ratio is as yet higher than what has been achieved in developed countries. Table V-2 compares the student to computer and the teacher to computer ratios in the countries selected for this study.

Table V-2: Comparison of the computer penetration in schools

Country	Ratio		
	Student : Teacher	Student : Computer	
		Primary	Secondary
Malaysia	20	43	26
Singapore	25.3	17	5
USA	15	6	3
UK	18.7	12	6
Canada	15	11	9
Australia	17	15	8
New Zealand	15.4	20	10
Ireland	21.6	14	4

Source: World Bank 2002

Creating a school management solution and courseware that promise export potential

The development of the Smart School Management System (SSMS) and curriculum has been one of the significant achievements of the Smart School Project. Though there are comparable systems developed through private initiatives in other parts of the world, none of them have been deployed nationwide. Though the curriculum objects developed in English may face competition from off-the-shelf products in the export market, the SSMS may see some demand, especially from developing countries that plan to deploy similar systems in their schools. Moreover, the availability of a management system that has been tailor-made for schools may prove to be its biggest attraction. Thanks to the high degree of automation facilitated by SSMS, some of its modules may be of enormous use in distant learning environments. However, more than the SSMS and the curriculum (which may have a limited export market), there is yet another export potential that has emerged from this flagship. This is discussed below.

Creation of an E-Learning Industry and Skilled Workforce

The Smart School Project has resulted in the development of an e-Learning industry that has proven expertise in the various facets of e-learning, including content and courseware development, school management systems, project management, quality control, standardization and support. With manpower costs in developed countries escalating drastically, Malaysia has the potential to emerge as an outsourcing destination for content development. In fact, countries like the UK have been outsourcing their digital content for schools regularly from some Asian countries. The Smart School Project has led to the development of a vibrant e-Learning industry with 81 companies engaged in developing content and courseware. If these companies can export their expertise through on-shore and off-shore development projects, it would translate into a significant export revenue stream for Malaysia.

Creating Value for Money

The Smart School Project has a number of intangible benefits, as mentioned above. More significant is the fact that a comparison of the expenses incurred with the Smart School Project with similar initiatives around the world shows how much the project has achieved with the limited resources on hand. At an investment of about $78 million (RM 300 million), the project has achieved all of the following:

- Build a Smart School infrastructure in 87 schools that is comparable with those in developed countries. In the process increase
  - PC penetration in schools
  - Internet connectivity
  - Curriculum resources
- Initiate change management and teacher training programs for about 4,000 teachers and principals
- Creation of an industry

This is no mean achievement when contrasted with what other countries are spending for ICT-mediated education. In Ireland, the government has so far spent more than $48 million on building up the ICT infrastructure alone. In 2003, it plans to $96 million to increase computer penetration in schools. In the United Kingdom, federal support for ICT (including networking, training, infrastructure, hardware and software) was $1.053 billion between 1998-99 and 2001-2002 for educational institutions.

APPENDIX

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