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Transforming Education: The Power of ICT Policies

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Foreword

In all regions of the world, the penetration of Information and Communication Technologies (ICT) in schools has led to a major transformation of the education landscape. Although there is no consensus as yet regarding the actual benefits of technology in ensuring quality learning, ICT are increasingly seen as an integral part of modern education systems. Policy-makers are thus attentive to the need to ensure alignment between the development of ICT in society, their integration in schools and their use in pedagogy.

While recognizing the potential value of ICT in education, many countries face significant challenges in transforming the promises of technology into tangible benefits for learning. Many of these challenges are related to costs or infrastructural and technical issues, such as lack of access to technology or poor connectivity. This is particularly the case in low-income countries. Other barriers include the lack of relevant content in a language understood by the user and limited access to open education resources. However the main challenge, including for the most advanced education systems, lies in teachers' capacities to use technology effectively in the classroom.

International experience shows that conditions for the effective use of technology in education vary from country to country. Indeed, formulating a policy on ICT in education requires taking a set of variables into account such as objectives, the availability of technologies, applications and content, and teacher capacities. These are defined as a combination of competencies, motivation and the characteristics of teachers' working environment.

Technology is not neutral; the penetration of ICT in schools can eventually transform pedagogy and the creation of knowledge. As a result, ICT are contributing to building new relationships between schools and their communities, and to bridging the gap between formal, non-formal and informal education. Eventually, technology may also lead policy-makers to rethink the skills and capacities that children need to become active citizens and workers in a knowledge society.

UNESCO has contributed to the ongoing debate on technology and learning by launching a programme of studies, consultation and exchange on policies on ICT in education. This publication is the result of that work.

It is hoped that beyond providing useful information on contemporary challenges for and approaches to public policies in the field of ICT in education, the publication will offer useful insights into the experience of specific countries and offer road maps to help policy-makers better plan the integration of technologies in education. In so doing, it will enable them to make the best use of ICT potential to transform learning and, ultimately, the relationship between school systems and society.

This publication is the product of a collective effort. It was edited by Robert Kozma, in collaboration with Shafika Issacs and includes contributions by Tayseer Alnoaimi, Juan Enrique Hinostroza and Siew Koon Wong. The book is part of a UNESCO programme on ICT in education policies directed by David Atchoarena, Director, Division for Planning & Development of Education Systems (ED/PDE) in collaboration with Francesc Pedró, Chief, Section for Policy Advice & ICT (ED/PDE/PAD)

Qian Tang, Ph.D
Assistant Director-General for Education

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1 Authors appear in alphabetical order.

Preface

Information and Communication Technologies (ICT) constitute a topic of growing importance for public policies, notably in the field of education. The integration of ICT in our everyday life transforms our relationship to information and knowledge. It also modifies citizens' engagement with public services and the interaction between schools and learners.

The opportunities offered by the use of technology in education are many. It transforms the pedagogy and can lead to an improved and more engaging learning experience. These effects are not limited to the classroom, for example, the transformation of distance education into e-learning and blended learning offers new options for delivery and new opportunities for in-service teacher training and support. The capacity of ICT to build borderless networks represents possibilities for innovative peer learning across territories and countries. In addition to redefining access to knowledge and instructional design and provision, the penetration of ICT in all dimensions of economic, social and cultural activities has far-reaching implications in terms of the skills required to become an active member of society. The ability of students to utilize ICT has become a new requirement for effective education systems.

Beyond education, ICT can also represent a new source of economic growth and a powerful tool for social transformation. Hence, through their economic and social effects, ICT contribute to creating a knowledge society and economy.

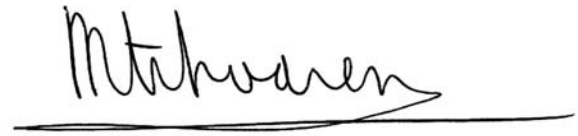
In this context, a major concern for policy-making relates to the modalities for designing and implementing plans and strategies likely to produce such results. This publication aims at addressing precisely this question by illustrating, on the basis of case studies analysis, the importance of having clear policy goals, and of their translation into appropriate strategies and plans. The country experiences reviewed in this publication suggest that effective ICT in education policies depend on three main pillars, namely: access to ICT infrastructures and equipment; teacher capacities; and monitoring.

Access to equipment, networks and quality resources is a prerequisite for the deployment and utilization of ICT. Therefore the integration of technologies in the education system requires a supportive environment. This underlines the importance of policy consistency and the need to take advantage of a broader movement of ICT infrastructure development. In many countries this also implies forging innovative alliances between the public sector and private companies which often control the ICT sector. In that respect ICT in education policies offer a rich example of the potential for public-private partnerships.

Once the technological infrastructure is in place, a major challenge relates to the capacity of teachers to take advantage of the tools and new teaching opportunities offered by ICT. This involves developing teachers' professional capacities but also to establish adequate support mechanisms. Furthermore, beyond technical competences and coaching, effective utilization of technologies in the classroom ultimately depends on the motivation of teachers. The major challenge always remains to transform teacher training into improved teacher practices in the classroom. The best incentives for teachers come from the evidence of improved and more efficient teaching practices. Yet, addressing this challenge often involves a cultural change for teachers which cannot always happen rapidly.

Effective implementation of public policies requires proper monitoring. The introduction of technologies into the education system on a large scale involves setting up mechanisms and tools to monitor implementation processes and outcomes. In particular, it is essential to develop approaches and indicators to monitor how ICT investments and policies affect teaching practices and students' abilities and knowledge. In other words, policies on ICT in education require the complementing of existing educational management information systems (EMIS) by specific data and indicators.

The cases analysed in this publication are taken from different regions of the world – Africa, Arab region, Asia and Latin America – illustrating the global dimension of the changes that ICT bring to education systems and policies. The wide diversity offered by the selected countries - Jordan, Namibia, Rwanda, Singapore and Uruguay – in terms of economic and educational development, suggests that the issues at stake are not limited to a particular group of privileged countries. ICT can have a transformative effect on education regardless of the economic conditions, in very advanced school systems as well as in poorly resourced ones. The choice of the policy mix varies according to particular circumstances but the vision and the potential of ICT to transform education is universal. This is the key message that this publication attempts to articulate.



David Atchoarena
Director, Division for Planning
& Development of Education Systems, ED/PDE

Chapter 1

The Technological, Economic, and Social Contexts for Educational ICT Policy

Robert B. Kozma

Introduction

The dissemination and use of information and communications technologies (ICT) in schools has come to be seen by education policy-makers as a significant opportunity. They are attracted to the prospect that ICT can improve student achievement, improve access to schooling, increase efficiencies and reduce costs, enhance students' ability to learn and promote their lifelong learning, and prepare them for a globally competitive workforce. As the power and capability of computers have increased, as they have become interconnected in a worldwide web of information and resources, as they provide a conduit for participation and interaction with other people, as they have become linked to other devices, and as their costs have come down, policy-makers, particularly those in developing countries, have come to see ICT as a viable, and even dramatic, way of responding to the multiple challenges that they face.

Once policy-makers consider making significant investments in ICT, a host of questions emerge: How many computers are needed in a school? Where should they be located? How should the network architecture be structured? How should the computers be distributed equitably? What additional resources are needed to support their use? What kind of training do teachers need to take advantage of these resources? How can they use them in their teaching? Are these uses effective? Are these even the right questions?

The position taken in this book is that while these questions represent important implementation issues, they are not the questions that should frame ICT policy. ICT can have a greater impact when the policies and programmes designed to implement them are crafted in the broader context of social and economic goals and when they are implemented in support of coordinated change of all the components of the education system, aligned to a vision of economic development and social progress – that is, when ICT policies and programmes support educational transformation.

The world is experiencing a major shift from an economy and society based on mass production to one based on knowledge creation. This shift has significant implications for the development of human resources and for changes in all of the components of the education system, not just the use of ICT. Within this context, the driving questions that frame ICT policy are: What is the nation's vision of how education can support economic and social progress, and what are the potential roles of ICT in supporting educational transform aligned to these goals?

The book examines the range of educational experiences, practices, and issues and presents them in a way that can be used by decision makers crafting ICT policy in education. However, with this chapter, the book begins by considering the broader technological, economic, and social trends that have been sweeping the globe and moving toward an information economy and knowledge society. It examines the dramatic increase in capabilities and use of ICT and their related social and economic impact – positive and negative – in both developed and less developed nations. The chapter then examines research on the impact of ICT on education. So far, ICT have had much less impact on education systems than they have had on the economy or society, as a whole, in large part because the education system, in general, is now out of sync with ICT-based economic and social developments. The chapter ends with a call to transform education in a way that will advance the social and economic development goals of a country.

The second chapter goes on to consider the implications of these global technological, social, and economic trends for educational transformation and the use of ICT to support these changes. Building on earlier work (UNESCO, 2002; Kozma, 2005; UNESCO, 2008; Kozma, in press), the chapter presents a framework – the *Knowledge Ladder* – that provides educational decision-makers with a way of thinking about policies that integrate ICT plans and programmes with other components of the educational system (such as curriculum, pedagogy, teacher training, assessment, and school organization) and with national policies, in a way that addresses the broader social and economic goals of the country and moves toward an information economy and knowledge society. Finally, the chapter reviews the policy development process and provides decision-makers with recommendations and suggestions for how they can coordinate ICT with the broader development goals and education reform agenda.

Five subsequent chapters review the policies, programmes, and experiences in range of regional and developmental settings – Jordan, Namibia, Rwanda, Singapore, and Uruguay. The final chapter draws on issues introduced in the early chapters, analyses the findings across case studies, and considers their implications for educational policy, change, and transformation.

This publication is an offering of the UNESCO Division of Education Strategies and Capacity-Building. The education programmes of the United Nations and UNESCO address many of the diverse purposes and goals that confront education policy-makers. For example, the Millennium Development Goals (MDG), Education for All (EFA), the UN Literacy Decade (UNLD), and the Decade of Education for Sustainable Development (DESD) all aim to reduce poverty and improve health and the quality of life and view education as an important contribution to these goals (UNESCO, 2005a). All of these aim to increase the equality of women and men and advance the human rights of all, particularly minorities. All are based on the belief that education is a key to development and a way of enabling people to fulfill their potential and take increasing control over decisions that affect them. The EFA and DESD place emphasis on the quality of learning. UNLD and EFA both place an emphasis on literacy as central to basic education and future learning. Beyond a high-quality basic education, the UNESCO International Commission on Education for the 21st Century (Delors, et al., 1999) contends that learning throughout life and participation in the learning society are essential for meeting the challenges of a rapidly changing world. Furthermore, ICT holds the unique promise of providing equal and universal access to knowledge in support of sustainable development (UNESCO, 2005b). Within this context, UNESCO has also produced a number of resources for policy-makers considering the use of ICT in education, such as ICT *in Education* (UNESCO, 2002), the ICT *in Education Toolkit*[1] and the ICT *Competency Standards for Teachers* (UNESCO, 2008). UNESCO has also produced a world report entitled *Towards Knowledge Societies* which recognizes that ICT have the potential to enable many individuals, firms, communities, in all regions of the planet, to address economic and social challenges with greater efficiency and imagination (UNESCO, 2005b). This book complements and builds on these and is yet another resource for education decision-makers to help them craft policies and programmes that address their educational goals and priorities and advance social and economic development.

Historic Development of ICT and Recent Trends

Many of the momentous economic and social changes that have been experienced in the late twentieth and early twenty-first centuries have been facilitated by or are directly due to a dramatic increase in the capabilities and availability of information and communications technologies. The remarkable uptake of ICT has not only affected the technology and telecommunications sectors but rippled through nearly every aspect of the economy and society in many countries. How is it that this technology could have such a broad impact on the world?

The Dramatic Increase in the Power of ICT

First, the increased impact of ICT is due to a dramatic increase in its power. ICT cover a broad range of technologies. While commonly associated with computers, the term also includes other informational media, such as handheld devices, television, radio and even print. To these information technologies can be added communications technologies, such as telephones and networks. While this definition hardly leaves anything out, the power of the term comes from the convergence of the ever-increasing information processing capabilities of computers and the information exchange capabilities of networks. It is the combined processing and networking power of contemporary ICT that has launched a global socio-economic paradigm shift when other, earlier technologies like radio and television did not.

1 ICT in Education Toolkit, UNESCO Bangkok, www.ictinedtoolkit.org

Initially, the processing capabilities of computers were very modest, their applications limited, and they were accessible to very few. The E*lectronic* N*umerical* I*ntegrator* A*nd* C*omputer* (ENIAC) is considered the first general purpose, programmable electronic computer and it was developed in 1946 at the University of Pennsylvania for the US Army to compute artillery firing tables. In 1951, the Sperry Rand UNIVAC I was introduced as the first commercially produced computer at a price of about US $1 million.[2] It used 5,600 vacuum tubes, weighed 29,000 pounds, occupied 3.5 m^2 of floor space, and performed 1,900 operations a second. A total of 46 were eventually built and sold to government agencies and large corporations. It was made famous in 1952 by allowing the early prediction of who would win the US Presidential election.

The introduction of transistors to replace vacuum tubes in the mid-1950s dramatically reduced the size and cost of computers, increased their performance, and created a technological revolution. Current laptop computers typically weigh less than 3 pounds, performs more than 60 billion instructions a second, cost less than $600, and the size is determined by how large a screen is desired. Handheld computers are even smaller than laptops and, although less powerful, are more powerful than the earlier, much larger desktop computers. On the cost side, the One Laptop Per Child XO machine and low-cost computers from other companies cost about $200, some less.[3] Now a school child in developed countries typically has access to more computing power than the astronauts did when they landed on the Moon. The dramatic increase in power from 1,900 to many billions of operations per second and the corresponding drop in price from $1,000,000 to $600 or less and the reduction in size and weight are all a demonstration of "Moore's Law," which states that the number of transistors that fit on a computer chip double every two year. The law is expected to hold at least through 2015[4] and as the power of computers continues to increase it will continue to change the way people work, play, learn, and live around the world.

From an informational perspective, it is the processing capability of computers that gives them – and us – the power to change our lives. This processing capability makes it possible to use, change, or transform information in a way that is unique, compared to previous information technologies, such as print, radio and television, which merely distribute or broadcast information in one form or another (Kozma, 1991). The computer's capability to transform information depends on the programs that are used with it. Appropriately written programs can perform mathematic, logical or graphical operations on a range of input. Early programs could take numerals as input, run calculations, and present the output as a set of tables. Or a user could enter text, rearrange it on a page, and print it out in various formats. The power of these early spreadsheets and word processors was sufficient to launch a dramatic uptake of computers in businesses in the 1980s.

As the power of computers increased, programs could be written that generated graphical output, simple diagrams at first but ultimately more sophisticated, realistic animations. Consequently, numeric, text, and other forms of input, such as joy sticks and styluses, could be used to control dynamic simulations. These faster, more powerful computers could also process sound and video so that information in these forms could be presented or created in response to user interests and needs. Consequently, users could manipulate or produce, as well as consume, multimedia content. The convergence of computers and multimedia significantly increased the use of the increasingly small computers for both home and educational purposes and, again, the uptake increased.

The second reason for the impact of ICT is their increased availability. As the capabilities of computers increased exponentially, their sales rose exponentially as well. In 1977, 48 thousand personal computers were shipped. In 2001, 125 million were shipped. By 2008, the number of personal computers in use worldwide was 1 billion.[5] This is an astounding number, particularly given that in 1943, Thomas Watson, Chairman of IBM at the time, predicted that the total market for computers worldwide was, perhaps, five.[6]

2 http://archives.cnn.com/2001/TECH/industry/06/14/computing.anniversary/
3 http://www.olpcnews.com/sales_talk/price/olpc_uruguay_205_dollars_laptop.html
4 http://news.cnet.com/New-life-for-Moores-Law/2009-1006_3-5672485.html
5 http://www.gartner.com/it/page.jsp?id=703807
6 Cited in the President's Committee of Advisors on Science and Technology (2000), p. 3.

Telephones

Communications technology, the other component of ICT, has a longer modern history than do computers. The telephone was invented in the late nineteenth century and came into common use in developed countries during the early twentieth century. Initial sales of telephones were poor, as there were very few others to call. But when sales took off, the growth was again exponential. Bell Telephone began selling phones in 1877. A year-and-a-half later, only 778 phones were in use. But by 1900, there were 5 million telephones in the USA.[7] In 1979, the mobile cellular phone was introduced, which dramatically increased the range and flexibility of use of the telephone. By 2006, there were a total 4 billion telephone subscribers worldwide, 1.27 billion on a fixed line and 2.68 billion mobile subscribers.[8]

The internet and World Wide Web

The convergence of computers and communication came relatively early in the development of computers. As soon as the technology enabled computers to connect with phones, developers began to think of ways that one user could communicate with others. Email was devised in 1961, prior to the development of personal computers, to allow multiple users who dialed into a large, mainframe computer from a remote teletype terminal to store and exchange information with other users of the same computer. This along with bulletin boards and newsgroups allowed hundreds – or even thousands – of users within a company or university to communicate and share information with others. Later, protocols were developed that allowed computers to connect and pass information from a user of one computer to users of another computer. These applications were early precursors to the Internet and the World Wide Web. In 1968, Douglas Englebart, a scientist at Stanford Research Institute, demonstrated the use of experimental technologies, such as the mouse, hypertext, and shared screen collaboration that would become standard features in future computer applications.[9] The first two nodes for what was to become the Internet were established in 1969. By 1990, Englebart's vision of a system for exchanging cross-linked, hypertext documents was established among scientists at a research laboratory in Switzerland. This would turn into the World Wide Web (or "the Web"), a system for posting and sharing multimedia documents with users around the world. As mobile phones became "smart", acquiring some of the power of computers, as computers became wirelessly connected to the Internet and other multimedia devices, and as data rates of networks increased, access to and use of the Web increased dramatically. As of April 2010, the Web consisted of over 118 million websites[10] and at least 20 billion pages.[11] Not only does this network of devices allow people to produce, access, exchange, and share multimedia content and applications, it connects people to each other, synchronously and asynchronously. This capability allows people at distributed locations to communicate and collaborate with each other, while taking advantage of a rich, multimedia, body of digital content and has spawned a global network of social connections, communications, and information sharing, often referred to as the *knowledge society*. UNESCO recognizes that ICT have created new conditions for the emergence of knowledge societies. For UNESCO, knowledge societies have the capability to identify, produce, process, transform, disseminate and use information to build and apply knowledge for human development and suggest that the knowledge societies are a source of development for all, especially the least developed countries. For this reason, UNESCO calls for inclusive knowledge societies (UNESCO, 2005b). Part of this call is in recognition also of the uneven access to ICT around the world.

The Distribution of ICT around the World

The information processing and connectivity of ICT can enable and enrich people's lives only if they have access to it. While the growth of ICT has been exponential, it has not been evenly distributed within societies or around the world. An examination of data from the World Bank on the use of ICT across a select group of countries shows significant regional and national differences (See Table 1).

7 http://www.ideafinder.com/history/inventions/telephone.htm
8 http://www.itu.int/newsroom/press_releases/2007/20.html
9 http://sloan.stanford.edu/mousesite/1968Demo.html
10 http://www.domaintools.com/internet-statistics/
11 http://www.worldwidewebsize.com/

The penetration of computers in high-income countries is quite high (67 computers per 100 people, as of 2007) but very low in Eastern European and Central Asian countries (11 per 100), Latin American countries (11 per 100), East Asian and Pacific countries (6 per 100), and Middle Eastern and North African countries (6 per 100). They are particularly low for South Asian (3 per 100) and Sub-Saharan African countries (2 per 100). Differences are even greater for Internet access. While Internet penetration is still rather modest even in high income countries (26 per 100), it is very low in other regions: Eastern European and Central Asian (14 per 100), East Asian and Pacific (9 per 100), Latin America (4 per 100), Middle East and North Africa (2 per 100), South Asian (1 per 100) and Sub-Saharan Africa (1 per 100).

Table 1: Information and Communication Technologies Indicators for Selected Countries

Country	Population (Millions)	Economic Category[1]	Per Cap GNI[2]	% Households with TVs	Telephone Lines per 100	Mobile Subscribers per 100	Personal Computers per 100	Internet Subscribers per 100
Hi Income Group	1,056		37,572	98	50	100	67	26
Finland	5	H	44,300	87	33	115	40	27
France	62	H	38,810	97	58	90	65	28
Germany	82	H	38,990	94	65	118	66	24
Hungary	10	H	11,680	101	32	110	26	15
Italy	59	H	33,490	98	46	151	37	30
Israel	7	H	22,170	92	43	124	24	27
Korea, Rep. of	48	H	19,730	100	46	90	58	30
Singapore	5	H	32,340	98	41	129	74	42
Sweden	9	H	47,870	94	60	113	88	44
UK	61	H	40,660	98	55	118	80	30
US	302	H	46,040	95	54	85	81	62[3]
Eastern Europe and Central Asia	446		6,052	96	26	95	11	14
Poland	38	UM	7,107	89	27	109	17	10
Russian Federation	142	UM	7,530	98	31	115	13	22
East Asia and Pacific	1,912		2,182	53	23	44	6	9
China	1,318	LM	2,370	89	28	42	6	11
Indonesia	226	LM	1,650	65	8	36	2	1
South Asia	1,522		880	42	3	23	3	1
India	1,125	LM	950	53	4	21	3	1
Latin America	561		5,801	84	18	67	11	4
Brazil	192	UM	5,860	91	21	63	16	4
Chile	17	UM	8,190	97	21	84	14	8
Mexico	105	UM	9,400	98	19	63	14	6
Uruguay	3	UM	6,390	92	29	90	14	7
Middle East, North Africa	313		2,820	94	17	51	6	2
Egypt	75	LM	1580	96	15	40	5	4
Jordan	6	LM	2840	96	10	83	7	4
Sub-Saharan Africa	800		951	18	2	23	2	1
Kenya	38	L	640	39	1	30	1	1

Country	Population (Millions)	Economic Category[1]	Per Cap GNI[2]	% Households with TVs	Telephone Lines per 100	Mobile Subscribers per 100	Personal Computers per 100	Internet Subscribers per 100
Namibia	2	UM	3450	41	7	38	24	4
Rwanda	10	L	320	2	0	6	0	0
South Africa	48	UM	5720	59	10	88	8	9

1. http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20487483~menuPK:1192714~pagePK:64133150~piPK:64133175~theSitePK:239419~isCURL:Y,00.html
2. H, high; UM, upper middle; LM, lower middle; L low, based on Gross National Income per capita.
3. Gross National Income: GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.

Source: World Bank, 2007[12]

Television

The penetration of television (TV), a more mature technology, is more even across countries. High-income, Eastern European and Central Asian, Middle Eastern and North African, and Latin American countries all have more than 80% of their households with TV. Even South Asian countries have a 42% penetration rate. However, as a group Sub-Saharan African countries have only an 18% household penetration rate of television.

Mobile phones

Telephones provide an interesting example of how countries can sometimes skip over technologies. The newer mobile telephones have exceeded the penetration of traditional land lines in most countries. In high-income countries, there are 100 mobile subscribes per 100 people, while there are only 50 land lines per 100. The difference is more pronounced in developing countries, where the growth of land lines was slow. For example, in South Asia there are 3 land lines per 100 but 23 mobile subscriptions. And in Sub-Saharan Africa there are only 2 land lines and 23 mobile phone subscriptions per 100. Admittedly, the mobile phones in developing countries are not likely to be high-end smart phones that provide access to media-rich content on the Web, but mobile technology represents a significant opening for ICT advancement in developing countries.

Rates of hardware and connectivity penetration are not the only difference between developed and developing countries. There are significant differences in content available on the Web. A 2002 survey of 2,024 million Web pages determined that by far the most content was in English: 56.4%; next were pages in German (7.7%), French (5.6%), and Japanese (4.9%).[13] Very little content is available in languages indigenous to developing countries.

Differences in access to computers and the Internet extend to groups within (and across) national boundaries that include those based on income, education, minority status, age, and gender and these differences limit the ability of these groups to participate in and benefit from technology-based economic development (Sciadas, 2007). For example, in a review of studies conducted in the USA, Warschauer and Matuchniak (2010) found significant gaps in home access to digital media, as well as inequalities in technology usage and outcomes between a number of groups. A study by the Pew Internet and American Life Project shows the following demographics using the Internet and email: 90% of those between the ages of 18 and 29, 91% of all college graduates, and 95% of those making $75,000 or more. This compares with only 59% of Black Americans, 53% of those making $30,000 or less, 44% of those with no high school degree, 35% of those 65 or older, and 32% of Spanish-dominant Hispanics who use these technologies.[14] In many countries of the Organisation for Economic Cooperation and Development (OECD) there is a gap between women and men in their access to computers that ranges from about 35% in Luxemburg to close to zero in Iceland and the United States and slight positive differences favoring women in Hungary and Ireland (OECD,

12 http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20487483~menuPK:1192714~pagePK:64133150~piPK:64133175~theSitePK:239419~isCURL:Y,00.html
13 http://www.netz-tipp.de/languages.html
14 http://www.slideshare.net/PewInternet/degrees-of-access-may-2008-data?type=powerpoint

2007). Parallel gender differences exist in the use of the Internet. The gap increases with age, with a smaller gender gap in access to computers existing among younger women than among older women. But the gap has been closing in many countries over the years, in part due to the increasing number of people who have been exposed to ICT in their youth.

The Economic and Social Impact of Technology

Historically, going back at least as early as the water-mechanized industrial revolution in eighteenth-century England, certain technologies have not only improved processes within the sector in which they were introduced – they went on to have a transformative impact across the economy and society (Freeman and Louca, 2001; Perez, 2002). These technologies were transformative in that they came to be associated with a new paradigm (Perez, 2002) – an interdependent and synergistic set of industries, infrastructure networks, organizational structures, and business and social practices which they supported and upon which they depended. Historically, waves of such technologies – steam power, electrical power, mass production, and now computers – each brought both creative and disruptive forces, forces that restructured the economy and rippled throughout social institutions and practices. The existing paradigm, tuned to a different set of technologies, was not able to cope with or take advantage of the potential offered by new technologies and, consequently, the new technologies were a disruptive force that worked against the current paradigm. Conversely, the new possibilities could not be fully realized until their required enablers were in place and the system became highly tuned to the new paradigm. As the new paradigm emerged, it spun off a whole host of corollary businesses, social arrangements, and cultural practices. In this way, the new technologies were extremely creative forces, as well. Over time, infrastructures, industries, structures and practices became highly tuned to the affordances of the new technologies. These structures and practices also grew to be highly embedded in the economy and society and became the commonly accepted way that things were organized and done. Thus each paradigm shift came to entail a set of all-pervasive principles that became the new "common-sense" basis for organizing any activity and for structuring any institution, be it government, business, entertainment, or education.

The "creative destruction" that occurs in the early phases of a paradigm shift can be violent and painful, as earlier industries, businesses, practices and jobs are displaced or destroyed. New organizations are put in place, new ways of interacting are instituted and new skills are needed, as the desirability of old ones decline. There can be significant dislocation and social inequity. The new wealth that accumulates among the innovators is often more than counterbalanced by the poverty that spreads at the other end, as a result of disruptive forces, and inequity within society increases. Perez's historical analysis argues that as organizations, practices and people are realigned; the new paradigm fosters a quantum jump in productivity that modernizes and regenerates practically all economic activities. This can result in full employment and the economic and social benefits of the new system become widespread. Socially, a new style of living begins to diffuse from innovators to others, often in more popular versions and variations.

Perez contends that the most recent shift has been from a mass-production paradigm to a paradigm based on ICT and knowledge creation. That is not to say that manufacture, or even agriculture, no longer play a role in the modern economy, but that ICT and knowledge creation have eclipsed manufacture as the primary productive factor. Individual countries, companies, and people may differ in the degree to which or the way in which they are able or choose to participate in this shift and the impact of the shift will differ across them. But as with previous technological revolutions, the destructive and creative impact of the current shift has been profound, as documented by a series of macroeconomic and microeconomic studies.

On the macroeconomic side, every one of the world's 25 largest economies has shifted from the manufacture of goods to the provision of services. In these countries, services either account for more than 50% of the GNP or they are the largest sector in the economy (Kamarkar and Apte, 2007; Apte, Kamarkar and Nath, 2008). But an even more significant shift within many economies has been from the provision of material goods and services to the provision of information and knowledge. For example in the USA, the manufacture of material goods (such as automobiles, chemicals, and industrial equipment) and the delivery of material services (such as transportation,

construction, retailing) accounted for nearly 54 % of the country's economic output in 1967. By 1997, the production of information products (such as computers, books, televisions, software) and the provision of information services (financial services, broadcast services, education) accounted for 63% of the country's output. Information services alone grew from 36% to 56% of the economy during that period. This shift has created new industries, companies, products, services, and jobs, some of which were unimaginable only a few decades ago. People all over the world now use eBay, Google, and Yahoo! every day. None of these companies existed 15 years ago yet they now have a combined market value of more than $200 billion. The proliferation of information products and services is a phenomenon that has come to be called the "information economy". This information economy has been defined as an economy wherein the production of information goods and services dominates wealth and job creation (Cogburn and Adeya, 1999).

While manufacturing has decreased as a portion of the economy in developing countries, it has increased dramatically in China, Thailand, Malaysia, and Indonesia. The availability of manufacturing jobs in these countries has pulled millions of people out of abject poverty (Sachs, 2005, 2008). At the same time, development in these countries has created significant problems related to economic inequity, urbanization, pollution, and environmental degradation.

Macroeconomic studies have been complemented by microeconomic studies in the USA (Stiroh, 2003), the United Kingdom (UK), (Borghans and ter Weel, 2001; Dickerson and Green, 2004; Crespi and Pianta, 2008), Canada (Gera and Gu, 2004; Zoghi, Mohr, and Meyer, 2007), France (Askenazy, Caroli, and Marcus, 2001; Maurin and Thesmar, 2004), Finland (Leiponen, 2005), Japan (Nonaka and Takeuchi, 1995), and Switzerland (Arvanitis, 2005), which have found parallel changes at the industry or firm level. Across these studies, highly productive companies have become have become organizationally flatter, decision-making has become more decentralized and participatory, information is widely shared, workers form project teams within and across organizations, and work arrangements are flexible.

These changes in organizational structures and practices have been enabled by the application of ICT for communication, information sharing, and simulation of business processes. But this was not the situation initially. It is important to note that early studies showed an insignificant or even negative relationship between the uptake of technology and productivity, what came to be termed the *productivity paradox* (Brynjolfsson, 1993). In retrospect, it is perhaps not surprising that new technologies would make little difference early on in corporations or even entire economies if they are used to do the same thing. Indeed, one might anticipate an initial decline in productivity as workers figure out how to use new technologies, such as electronic spreadsheets and word processors, to perform tasks that were previously routine. It was only when ICT investments became connected to changes in organizational structure and business practices that productivity gains were realized. Indeed, a major factor in the success of highly productive, innovative firms is the use of ICT as it is associated with a pattern of mutually reinforcing organizational structures, business practices, and employee skills that worked together as a coherent system (Pilat, 2004; Gera and Gu, 2004). For example, a US Census Bureau study (Black and Lynch, 2003) found significant firm-level productivity increases that were associated with changes in business practices that included re-engineering, holding regular employee meetings, using self-managed teams, improving employee skills and encouraging use of computers by front-line workers. In Canada, Zohgi, Mohr, and Meyer (2007) found a strong positive relationship between both information sharing and decentralized decision-making and a company's innovativeness. Murphy (2002) found productivity gains when the use of ICT was accompanied by changes in production processes (quality management, lean production, business re-engineering), management approaches (teamwork, training, flexible work and compensation) and external relations (outsourcing, customer relations, networking). In these firms, ICT was a lever that launched organizational and behaviour changes that brought the practices of these firms into alignment with the new technological, economic and social information technology paradigm.

Changes in organizational structure and business practices and the pervasive use of ICT have resulted in corresponding changes in the skills needed of workers and the hiring practices of companies. A Massachusetts Institute of Technology study (Autor, Levy, and Murnane, 2003) of labour tasks in the workplace found that commencing in the 1970s, routine cognitive and manual tasks in the US economy declined, and non-routine analytic and interactive tasks rose. This finding was particularly pronounced for rapidly computerizing industries. The study found that as

ICT are taken up by a firm, computers substitute for workers who perform routine physical and cognitive tasks but they complement workers who perform non-routine problem-solving tasks. Because repetitive, predictable tasks are readily automated, computerization of the workplace has raised demand for problem-solving and communications tasks such as responding to discrepancies, improving production processes and coordinating and managing the activities of others. The net effect is that companies in the USA and other developed countries (Lisbon Council, 2007; European Commission, 2010) are hiring workers with a higher skill set. In the twenty-first century economy and society, the memorization of facts and implementation of simple procedures is less important; crucial is the ability to respond flexibly to complex problems, to communicate effectively, to manage information, to work in teams, to use technology, and to produce new knowledge capabilities that have come to be called *twenty-first century skills* (Partnership for the 21st Century, 2005; International Society for Technology in Education [ISTE], 2007; Kozma, 2009; Trilling and Fadel, 2009; European Commission, 2010).

The pervasiveness of ICT has had a significant social impact, as well. The widespread availability of computers has changed the way people access and use information, as well as communicate with others and create new knowledge and cultural artefacts. Studies in North America and Europe show that large numbers of people use the Internet regularly and do so to conduct online purchases, conduct banking transactions, use online chat or messaging, download music or movies, play games, exchange email, and search for information. In Europe, 82% of adults between the ages 45 and 54 use the Internet for email and 91% use it for finding information and online services (Eurostat, 2009). In the USA, according to the Pew Internet and American Life Project, more than half of all Americans turn to the Internet to find answers to common problems about health, taxes, job training, and government services (Fallows, 2008). ICT use is particularly prevalent among the youth. In Europe, 95% of youth between the ages of 16 and 24 use the Internet to find information and online services and 84% use it for leisure activities related to obtaining and sharing multimedia content (Eurostat, 2009). In the UK, 49% of the children between the ages of 8 and 17 who use computers have an online profile; 59% use social networks to make new friends (Ofcom, 2008). A study of online teens in the USA found that 64%, principally girls, participated in at least one form of digital content creation (Lenhart, Madden, Macgill, and Smith, 2007). Indeed, today's youth are so engaged in the use of technology that they have come to be called the *new millennium learners* (Pedro, 2006). As well, the broad impact that ICT has had on the world has been captured by the terms *information economy* or *knowledge society*, terms that characterize the paradigm shift associated with the information technology revolution.

The global shifts occurring in contemporary economy and society have been usefully characterized and well documented (Friedman, 2006). But Perez (2002) provides a particularly insightful summary and contrast between the technological, economic and social paradigms associated with the mass production and the information technology revolutions:

Mass Production Paradigm	Information Technology Paradigm
Economies of scale and mass markets	Segmentation of markets/proliferation of niches
Horizontal integration	Decentralized integration/network structures
Standardization	Heterogeneity, diversity, adaptability
Functional specialization/hierarchical pyramids	Inward and outward cooperation/clusters
Centralization	Globalization, interaction between local and global
Synthetic materials, energy intensity (oil based)	Knowledge as capital/intangible value added

The primary distinction between these two paradigms is the shift from the production of objects to the production of knowledge. But there are a number of corollary characteristics that support the paradigm. The hallmark of the mass production model is standardization. Standardization of production processes and outputs is necessary to maintain the quality of produced goods, as well as achieve the economies of scale that leads to productivity gains and profit. The standardization of processes and outputs rests on an organizational structure in which a relatively small number of decision-makers and managers direct the efforts of a large number of skilled, semi-skilled, and unskilled workers. In contrast, the hallmark of the information technology paradigm is personalization. Rather than providing a large number of high-quality but identical products to a mass market, the information technology paradigm provides customized services that meet individual needs and preferences. Consequently, the

organization structure shifts to make decisions closer to the customer and more responsive to customer diversity and demands. Productivity gains are achieved by increasing the skill of the workforce and distributing operations to lower overhead costs.

The role of ICT is also quite different in these two paradigms. In the mass production paradigm, the information and communications technologies of an earlier time – print, radio, and television – are used to support the dissemination of information from centralized authorities and to foster the consumption of mass produced goods. In the information technology paradigm, ICT serves primarily a productive function, as more people have access to the multimedia, information processing capabilities of computers and are able to use them to create new knowledge. These capabilities allow for a market based more on the personalization and customization of products and services than on standardization and mass production. Networks are used to access and share information and they both enable and reinforce the collaborative relationships that are characteristic of the new paradigm.

Implications for Less Developed Countries

While developed counties are engaged in the shift from the mass production to information technology paradigm, the economies of many less developed countries are pre-industrial and based primarily on agriculture. Often these countries suffer from low agricultural productivity, poor coverage of infrastructure and public services, and small amounts of exports, all concentrated in a narrow range of commodities (produce, cotton, etc.). For example, 70-85% of the workforce in most Sub-Saharan African countries is engaged in agriculture while at the same time, Africa is the only continent in the world that has experienced a net decline in per-person food production during last two decades of the twentieth century (Borlaug and Dowswell, 2001). In these economies, living standards are near subsistence or below and most smallholder farm production goes for immediate use rather than to the market. There is little exchange of money and little margin for savings or taxes. Consequently, there is little capital available for private investment or for public financing of the infrastructure needed to foster economic development and the country can be stuck in what economist Jeffery Sachs (2005, 2008) calls the "poverty trap." According to Sachs, the challenge for policy-makers in such countries is to acquire the resources from other sectors, perhaps from natural resources, foreign aid, or tourism, to create the conditions under which crop yields increase to the point where smallholders can take outputs to market, improve their living conditions, save, and participate in the formal economy. With increased economic participation, resources become available to lay infrastructure – roads, power grid, ports, primary schools and health system – that sets the stage for further development.

As development continues, savings and investments can increase. Such investments support the development of basic manufacturing capacity that draws on low-skill, low-wage labour and that takes simple, local inputs such as raw fibre and produces low-value products, such a woven fabric or assembled clothing. As industry grows, more people enter the workforce, save and pay taxes. This is the point at which the country can begin to participate in the mass production, manufacturing economy. Capital accumulation is still the challenge in this phase, attracting the large amounts of foreign direct investment that is needed to build a modern manufacturing base that will move up the value chain and provide for a higher standard of living. If successful, these resources can serve as the foundation for even more development and entry into the global economy.

The Role of ICT, Knowledge, and Education in Development

The United Nations Industrial Development Organization (UNIDO) describes a *high-road* approach to economic development, in which less developed countries use competitive advantages, create a stable macroeconomic structure, liberalize trade, develop human capital and infrastructure, and attract transnational corporations, foreign direct investment, and imported technology (UNIDO, 2002/2003). The approach builds on these investments to move up the value chain and initiate a virtuous cycle of development in which productivity growth, equity, poverty eradication and security can all reinforce one another. Knowledge, education and infrastructure all play particularly important roles in the *high-road* approach.

Knowledge has some special economic properties and plays a particularly important role in this development (Stiglitz and Walsh, 2002). Unlike raw material, it can be used multiple times without depreciated value, and unlike equipment it can be used by many people at the same time – that is, it is *non-rivalrous*. Knowledge can also be shared widely at little cost. These facts open the possibility of a productivity factor with compounding rather than diminishing returns – that is, additional investments in knowledge creation can lead to continuous growth. Reviews of macroeconomic studies confirm a strong positive relationship between the investments in knowledge inputs, such as research and development, the generation of knowledge outputs, such as patents, and economic growth (Ulku, 2004; Lederman and Saenz, 2005).

Knowledge creation and innovation depend heavily on high-quality education and a well-developed information infrastructure. The power of this conjunction is witnessed by the 13 countries identified by the Commission on Growth and Global Development (2008) that have crafted policies to create sustained economic growth – an average increase of 7% or more in Gross Domestic Product (GDP) for 25 years or longer. These are countries like Botswana, Brazil, Indonesia, Republic of Korea, Singapore, and Thailand – countries that were poor 35 years ago. Every country in this study put substantial effort into schooling its citizens and deepening its human capital. Indeed, the development of human capital was one of the principal means by which government policy was used to support economic development in these high growth countries. Conversely, the study found that no country had sustained rapid growth without also keeping up impressive rates of public investment in infrastructure and education.

Education earns a high return on investment; this is supported by the results of both international microeconomic and macroeconomic studies. Microeconomic studies focus on the benefit of educational investments to individuals while macroeconomic studies focus on returns to the economy more generally. Microeconomic data from 42 countries found that an average rate of return for an additional year of schooling was a 9.7% increase in personal income (Psacharopoulos and Patrinos, 2002). A cross-country macroeconomic study found that there was an additional 0.44% growth in a country's per capita GDP for each additional average year of attained schooling–a return on investment of 7% (Barro, 2002). Other studies have found returns that go as high as 12% (Sianes and Van Reenen, 2002; Stevens and Weale, 2003). The quality of education has an even stronger relationship to growth than did the duration of school participation; the amount learned was more important than the number of years of schooling. Barro (2000) found higher test scores of one standard deviation equated to 1% growth in per capita GDP. More recent studies bear this out. Hannushek and Woessmann (2009) found strong, independent relationships between increases over time in both basic literacy skill levels and higher levels of cognitive skill and a nation's increases in economic performance. Similarly, Zagler and Zanzottera (in press) found that an increase of 10% in those scoring at the 95 percentile on an international science test would predict a 1.5% higher rate of growth in a country's economy.

Research reviewed earlier in this chapter illustrates the impact that ICT has had on the societies and economies of developed countries. But ICT can make significant contributions in less developed countries, as well, particularly ICT uses that are appropriate to local needs and in local languages (Slater and Tacchi, 2004: Weigel, and Waldburger, 2004; Gerster and Zimmerman, 2005). ICT projects using a range of technologies, including computers, digital cameras, handheld devices, television, and radio, have demonstrated their value in locally-identified areas of need such as health, agriculture, and, of course, education. With these resources, rural women in India form local knowledge networks to specify information needs, locate information resources and write and share diaries and newsletters in the local language (Pringle and Subramanian, 2004). Local youth from poor families in Nepal learn how to produce local multimedia content using a range of online resources, digital tools, and community media through access to the village telecentre, equipped with audio and video production facilities and cable network. Pastoralists in the Sahel use networked computers, GSP, and cell phones to manage grazing and water resources, to search for new pasture and watering points during seasonal flock migrations, and to speed up the exchange of information and provide them with an "early warning system" against pending disasters (Batchelor, et al., 2005). Villagers in Uganda and Tanzania use community radio, computers, and cell phones in local telecentres to access information on markets, farm inputs, crop management and local affairs (Kozma, 2006). Rural Philippino farmers, fishermen, and small and medium owners use cell phones and the Internet to access market prices and to trade products (Batchelor, et al., 2003). Villagers throughout Indonesia use Internet kiosks and CD-ROMs to access information on agriculture, fisheries, animal husbandries, food technologies and recipes, and traditional medicine

(World Bank, 2005). With a national network of Knowledge Stations in Jordanian communities, youth, women, poor, illiterate groups, unemployed and micro- and small-scale entrepreneurs in deprived areas have access to information, training on the use of computer technologies, and ways of utilizing the information available on the Internet to enhance their own livelihoods and capacities (Nusseir, 2005). And Brazilians have access to a range of government services, via the Internet, such that 90% of them submit their annual tax statements online (United Nations Economic Commission for Latin America and the Caribbean, 2002).

However, investments in economic growth do not guarantee equitable, broad-based social development. They could merely benefit the elite of a country and distant owners and executives of transnational corporations. Consequently, there are those who take a profoundly different position than the "New Growth" approach offered by UNIDO and argue that morality as well as economics drives development. Poverty, they contend, will not end without a dramatic, global redistribution of power and wealth that was acquired as a result of centuries of colonialism (Unwin, 2007). Clearly, as the UNIDO report (2002/2003) points out, development also has a *low road*. Confronted with intense global competitive pressures, developing countries may be tempted to take the *low road* and foster development by devaluating exchange rates, disregarding labour or environmental regulations, and reducing wages, only to enrich the few and perpetuate social inequities. But for those policy-makers who choose the *high road*, development policy and programs can build the infrastructure, human capital, and knowledge needed to fuel economic productivity, while promoting social equity and broad-based prosperity.

The Impact of ICT on Education

Apart from research on the relationship between ICT and economic development, education policy-makers want to know the research findings that test the hype and bold claims of technology advocates. They want evidence that justifies the significant financial investments that are needed to integrate ICT into the education system. They want to know if the use of computers makes a difference in teaching and learning.

Many studies have been conducted to evaluate the educational impact of computers. A comprehensive review of this research is beyond the purpose of this paper. But this section provides policy-makers with a sense of what the research says about the impact of ICT on students, classrooms, and schools. However, it is important to keep the broader context of this research in mind. The research conducted so far on the impact of current ICT was done within education systems that, like other components of society and the economy, have become highly tuned to the mass production paradigm. For the most part, research to date has examined the impact of ICT on traditional goals, as it was used in traditional classrooms. Results from this research can inform policies and practices that target the effectiveness or efficiency of the system as it is defined within the current paradigm. But the research to date has relatively little to say about the role of ICT within a new educational paradigm and its role in educational transformation. It is research on what education is, rather than what it could be.

Student outcomes

A primary concern of policy-makers faced with making significant investments in equipment and software is whether student access to and use of ICT will increase the learning of traditional school subjects. Empirical studies to date show an inconsistent relationship between the availability or use of ICT and student learning. Some studies show a positive relationship between computer availability or use and achievement; some show a negative relationship; and some show none. For example, two major studies in the USA found a positive relationship between availability of computers in schools and test scores (National Centre for Educational Statistics, 2001a, 2001b). A study in Australia (Banks, Cresswell, and Ainley, 2003) found no relationship between computer availability in schools and test scores. And two large studies, one an international study (Fuchs and Woessmann, 2004) involving 31 developed and emerging countries, and another using a US sample of schools (Wenglinksy, 1998), found a negative relationship between the availability of computers in the home and achievement scores.

Digging more deeply into these and other student outcome studies, it becomes clear that the connection between ICT and student learning is a more complicated relationship than one based on mere availability or use. Despite an otherwise negative relationship, when Fuchs and Woessmann (2004) compared the use of home computers for communication or educational uses of home computers, rather than for gaming, they found a positive relationship with achievement. In a more recent study in OECD countries (CERI, 2010), there was also a significant correlation between frequency of home use of computers and achievement on an international science assessment, even when socioeconomic contexts are controlled. School use is another matter: in the majority of OECD countries, students of different levels of ICT use in schools all performed similarly on the science assessment. However, it was found that while a majority of students participating in the study were regular users of computers at home, they did not use them regularly in school.

Even these analyses must be qualified. It matters how ICT is used and what is tested. Student assessments were specific to the learning of mathematics and reading in the Fuchs and Woessmann study and of science in the CERI study. But the data collected on computer use was general; even the educational use computers was not specific to math, reading, or science. Some studies have looked at this more-direct relationship between the topic of use of ICT and the topic tested. For example, the Wenglinsky (1998) study cited above, measured the amount computers were used in mathematics classes and scores on math tests. The study found a positive relationship between the use of computers and learning in both 4th and 8th grades. Similar positive relationships were found in more recent studies where computers were used and students tested in mathematics (NCES, 2001a; Cox 2003), science (NCES, 2001b; Harrison, et al., 2003), and literacy (Harrison, et al., 2003). Still, some studies in mathematics found negative relationships between computer use in math and math scores (Angrist and Lavy, 2001; Pelgrum and Plomp, 2002).

Even here, the results of these studies must be qualified. Conclusions in these studies are limited by the fact that they use correlation analyses. This is the most common type of ICT study. But with this type of analysis, factors are simply associated with each other; causality cannot be established. Yet, this is the issue of most concern to policy-makers. It cannot be assumed that positive results in such studies were due to computers because, for example, it may be that the brightest students use computers more than less able students and it is student ability that accounts for higher scores rather than computer use. Causality can only be assured with controlled experiments, where one group uses computers or uses them in a certain way and an equivalent group does not. An example of this type of experimental study was conducted in Vadodara, India (Linden, Banerjee, and Duflo, 2003) in which students in primary schools used computer mathematics games two hours a week and students in equivalent schools did not. The students who used computers scored significantly higher than the comparison students on a test of mathematics. The bottom group of the students benefited most, and girls benefited as much as boys.

Even with experimental studies, conclusions can be drawn with confidence only when results are consistent across a substantial number of such studies. Kulik (2003) looked at a large number of studies in the USA that were carefully designed and he combined the results in a meta-analysis to statistically compare outcomes across studies. His findings across 75 studies can be summarized as follows:

- Students who used computer tutorials in mathematics, natural science, and social science scored significantly higher on tests in these subjects. Students who used simulation software in science also scored higher. However, the use of computer-based laboratories did not result in higher scores.
- Primary school students who used tutorial software in reading scored significantly higher on reading scores. Very young students who used computers to write their own stories scored significantly higher on measures of reading skill.
- Students who used word processors or otherwise used the computer for writing scored higher on measures of writing skill.

Means, et al. (2009) also conducted a meta-analysis of ICT studies. This team examined carefully designed studies of online versus face-to-face learning in K-12 settings published between 2004 and 2008 and identified 51 effects. Across studies, online learning was significantly more effective than face-to-face. Situations that blended online learning and face-to-face learning were even more effective.

Beyond an impact on achievement in traditional subject areas, a number of ICT studies have established that computers can have a positive effect on student motivations, such as their attitudes toward technology, instruction, or the subject matter. For example, the Kulik (2003) analysis found that students using computer tutorials also had significantly more positive attitudes toward instruction and the subject matter than did students receiving instruction without computers. This finding corresponds to that in elementary schools in Japan (Ando, Takahira, and Sakamoto, 2004) in which students who used the Internet for Web browsing and message posting reported increases in positive attitudes toward learning. In a comparative study conducted in physics classes in Kenya (Kiboss, 2000), two randomly assigned classes used computer-based instruction while a third equivalent group did not. Students in the computer sections learned physics concepts better and expressed positive attitudes about their physics learning, as ascertained in interviews at the end of the lessons. Nonetheless, there are few studies that go beyond traditional measures of student learning to include such outcomes as creativity, complex problem solving, collaboration, and the ability to learn and even fewer that do this in the context of developing countries.

Impact on diverse students

An important Millennium Development Goal is to achieve gender equality. If girls are to leave school ready to participate equally in the economy, they, too, will need the benefits of ICT–increased knowledge of school subjects and new skills, including ICT skills. However, much of the research in OECD countries shows a gap such that boys have more experience with technology than girls and that girls are more anxious about technology than boys (Blackmore, et al., 2003). Fortunately, studies also show that greater experience with computers results in improved attitudes among girls. Many technology-supported programs in developing countries focus on including girls' use of computers and data on the impact of these programs often shows no gender gap. For example, girls and boys learned equally from the use of computers in the Vadodara study cited earlier (Linden, et al., 2003). In the World Links evaluation, teachers reported no difference between girls and boys in a wide range of learning outcomes related to computer use (Kozma, et al., 2004). In Andhra Pradesh (India), Wagner and Daswani (2005) reported that poor girls learn more than boys in a non-formal ICT-based literacy programme, when controlled for schooling.

Teacher skills and practices

Many governments are using the introduction of ICT as a way of providing teachers with new skills and introducing new pedagogy into the classroom. For example, teachers participating in the Enlaces programme in Chile received two years of face-to-face training totalling at least 100 hours of contact (Hepp, et al., 2004). As a result teachers acquire familiarity with computers and use them regularly for professional (e.g. engaging in professional circles, e-learning), managerial (e.g. student marks, parental reports) and out-of-classroom tasks (e.g. searching for educational content on the web, lesson planning). In a survey of teachers in 12 countries in Sub-Saharan Africa and South America, Kozma, et al. (2004), found that teachers who participated in a training programme on how to integrate computers into their instruction were much more likely than non-participants to report that their students engaged in a variety of innovative pedagogical practices, such as gathering data for a research project, collecting information about another country or culture, and collaborating on a project with students from another country.

Access, barriers and use

ICT can provide students with access to educational resources that might not otherwise be available. For example, traditional broadcast media, can provide large numbers of students efficient access to lessons and courses, as in the case with educational television used by millions of secondary students in Mexico and Brazil (Wolff, et al., 2002) and millions of primary students in Egypt (Ward-Brent, 2002). Increasingly, networked computers are being used to provide access to instruction for secondary students, although not nearly to the scale of broadcast media. For example, in a virtual high school programme in the USA, thousands of students across many states enrolled in the programme to take a variety of online courses that would not otherwise be available to them in their own schools (Zucker and Kozma, 2003).

However, regular access to networked computers in schools is still limited in many countries, particularly developing countries. A recent international study of educational ICT in 23 educational systems in North America, South America, Europe, Africa and Asia found significant differences between countries in the availability networked ICT in schools (Law, Pelgrum, and Plomp, 2008). For example, in Norway and the Province of Alberta in Canada, nearly 60% of schools had a ratio of less than five students per computer. In Finland, Denmark, Singapore, Hong Kong, and the Province of Ontario in Canada, 80% or more of the schools had a ratio of less than nine students per computer. In contrast, a majority of schools in Chile, the Russian Federation, South Africa, and Thailand had between 20 and 40 students to a computer.

Schools in developing countries encounter many barriers to the use of ICT beyond access. In the evaluation of the World Links programme (Kozma, et al., 2004), schools in South American and African countries identified barriers that ranged from lack of access to computers in working order, to lack of software, technical support, administrative support, sufficient teacher training, internet access, and even lack of a reliable supply of electricity.

But even when resources are available, as in OECD countries, the use of ICT is not a central everyday feature in many classrooms. A survey of headmasters and teachers in 27 European countries found that nearly 100% of schools have access to computers and 96% have access to the Internet (Empirica, 2006). Nearly 100% of teachers in Europe have used computers and almost all have used the Internet. However, the most common use of computers by teachers was to prepare lessons; 89% of the teachers responding to the survey said that they had used the computer for this purpose over the 12 months prior to the survey. And while 74% have used a computer in class, 63% said it was used to support presentations. Of the teachers responding, 66% said that they had students use computers in class during the past year but of these 62% said they used it in less than 25% of their lessons.

In the Law, et al., study (2008), the typical response of 8th grade mathematics teachers about the use of a wide range of educational applications for ICT was somewhere between "never" and "sometimes" – whether in Singapore or South Africa. The three most common pedagogical practices in these classrooms were having students fill out worksheets, work at the same pace and sequence, and answer tests. These findings convey the limited extent to which the information technology paradigm has been incorporated into educational systems around the world. Education systems have yet to cross a threshold of significant ICT use and, as such, it is likely that ICT will have only a minimal impact on students and teachers. The low use of ICT in schools is in sharp contrast to businesses in the knowledge economy where computers are integrated into everyday practice and their use is central to business success.

Summary and Implications

While ICT have had a significant impact the global economy and on the way people around the world work, live, and play, they have yet to have a significant impact on education practice and on what and how people learn in schools. The marginal impact of ICT on student learning is reminiscent of the findings from early research on the economic impact of ICT. In the business sector, ICT did not have an impact on productivity until it was accompanied by a cluster of other changes that transformed the economy and brought companies into alignment with the information technology paradigm spawned by the new technologies. This shift has yet to happen in schools. The vast majority of educational systems, schools and classrooms around the world still participate in the mass production paradigm and technology is rarely used, even when it is readily available. What are the conditions under which ICT can make a difference? What policies and programs are needed to transform education? These are the questions addressed in the next chapter.

Chapter 2

A Framework for ICT Policies to Transform Education

Robert B. Kozma

The Potential of ICT to Support Education Change

Implications of the New Paradigm for Education

Even as the economy and much of the rest of society are being transformed in countries around the world, education is slow to change and looks very much like it did at the beginning of the 20th century. While people in the outside world work collaboratively and flexibly in distributed teams, using a variety of digital tools and resources to solve problems and devise new ideas and products, students in schools meet in structured classrooms at specified times; teachers cover the standard content by lecturing in front of a large class while students listen; students work individually and reproduce this knowledge on assessments; and their use of ICT is limited. This pattern is global. As mentioned in the previous chapter, the three most common classroom pedagogical practices in the Law, et al., study (2008) across schools in 23 countries were having students fill out worksheets, working at the same pace and sequence, and answering tests. ICT were rarely used.

The shift from a paradigm that is based on mass production and consumption of standardized goods and the hierarchical structuring of business, governmental, and social institutions to a paradigm based on the collaborative, customized creation, sharing and use of new knowledge by a large, diverse, and distributed population is creating tremendous pressure for change on all components of the education system. It has profound implications for what is taught, how it is learned, how teachers teach, how students are tested, and how schools are structured. And it has significant implications for changes in education policy–the visions that organize structures, programs, and practices in education systems.

In the mass production paradigm, only a small elite need to have the high-level skills required to manage the production system, while the large majority of workers and consumers need only a relatively low level of education to follow standard manufacturing procedures. However, when knowledge is the key productive factor and products and services must meet a variety of customized needs, a high level of education and a different set of skills are required of a much larger number of people who will be both sophisticated users of information and be engaged in the process of knowledge creation. Similarly, as a larger and more diverse group come to participate in governmental and civic processes and institutions, a higher level of knowledge and skill is required. The implications for the amount and kinds of use of technology are also profound. While the majority of people in the mass production paradigm use ICT merely to consume pre-packaged information, the broad base of population in the information technology paradigm must have the skills to productively engage in the use of ICT to create, share, and use new knowledge products and services.

Commentators have begun to describe how schools are likely to look under the information technology paradigm and they are very different from current schools (UNESCO, 2002; Bereiter, 2002; Hargreaves, 2003; Collins & Halverson, 2009; Schrum & Levin, 2009). The reports identify examples of these schools and classrooms, although they are surprisingly rare, even in developed countries. While disciplinary knowledge and the memorization of facts is important in the mass production model, disciplinary knowledge is augmented by the acquisition of other skills, such as collaboration, communication, and problem solving in the knowledge creation model, skills that are needed to create and apply knew knowledge. While the teacher is the central authority in the classroom and schools are hierarchically structured in the mass production model, learning is student-centered in the knowledge creation model. Individual seat work is stressed in the mass production model and technology is peripheral. In the knowledge creation model, collaborative projects and research investigations are commonplace and technology is embedded throughout teaching and learning practices.

Education Tuned for Mass Production	Education Tuned for Knowledge Creation
Small number of people acquire advanced skills and a large number acquire minimum skills	Large number of people acquire advanced skills
Standardization of processes and outcomes	Personalization of processes and a diversity of outcomes
Disciplinary knowledge is the curricular focus	Disciplinary knowledge is augmented by other skills, such as collaboration, communication, problem solving
Knowledge as established fact	Knowledge is to be created
Teacher as central authority and information disseminator	Students as intentional learners and knowledge creators
Individual seat work	Collaborative projects
Technology as supplement	Technology as central
Centralization of education and hierarchically structured schools	Decentralization of education and schools structured horizontally

The Capabilities of ICT and their Potential Impact on Education

With the introduction of each new technology – audio recordings, radio, film, television – bold claims were made about the significant impact they would have on the educational system. This is certainly the case with computers. In the past, each new technology came to be incorporated into the traditional forms of instruction but always on the margin and the educational system remained fundamentally unchanged (Tyack, and Cuban, 1995). This seems to be the pattern, so far, with the new information and communications technologies, as documented in the previous chapter. So why is there any reason to believe that these new technologies will ultimately make a significant – even profound – change in education?

For one, the new technologies are significantly more powerful than previous information technologies, as discussed in Chapter 1. Whereas radio, film, and television are all capable of distributing information in various forms, the new information and communication technologies allow teachers and students to produce, share, connect, and comment on their own knowledge and that of others.

However, a more important reason for being optimistic about the potential that new technologies hold for educational change is the way these new capabilities fit with an educational system that is tuned to knowledge creation and that is aligned with the emerging technological, economic, social paradigm. The distributive capabilities of radio, film, and television all fit the mass production paradigm for education. Each provided additional or supplementary informational resources to the teacher, who remained the primary source of information in the mass production paradigm. So there was no push for significant change in the system, and, since the system was finely tuned to support the mass production technological, economic, and social paradigm, it continued unchanged for decades, essentially unperturbed by these earlier technologies. The early applications of computers were also shaped to conform to this mass production paradigm. Tutorials and drill and practice software provided an additional information delivery resource for teachers operating in a mass production mode. Classes on ICT literacy provided students with skills in operating computers and basic business applications that prepared them to enter the increasingly automated mass production workforce. And management applications of computers allowed centralized school systems to monitor student attendance, progress, and performance and hold teachers accountable.

But as more sophisticated applications have been developed that use the productive capabilities of computers and networks' ability to share information, ICT have begun to have disruptive effects within the education system (Christensen, Horn, and Johnson, 2008). An even more significant push has come from the outside, as the new technological, economic and social paradigm demands a very different response from the education system, one more oriented to the information economy and knowledge society. The capabilities of new technologies can help policy-makers respond with needed changes in curriculum, pedagogy, assessment and social organization.

Within this new paradigm, ICT capabilities support a model of education in which knowledge creation and learning how to learn are both processes and goals. Within this paradigm, the multimedia capabilities of computers provide students with personalized instruction and interactive animations, games, and simulations that can make complex concepts and systems more understandable. The interactive, productive capabilities of ICT allow both teachers

and students to engage in collaborative projects and investigations and generate their own knowledge products. The networking capability of ICT allows both teachers and students to work with distant collaborators, participate in knowledge building communities, and access outside mentors, experts, scientists, and business people. In addition, knowledge resources and productive capabilities are available on an "anywhere, anytime" basis, inside and outside the school. These capabilities have significant implications for the transformation of educational structures and practices (Collins and Halverson, 2009) and tremendous implications for the role that education, so transformed, can play in a society and economy where everyone has the potential to produce, collaborate on, and consume knowledge products.

A Conceptual Framework: The Knowledge Ladder

Education Policies that Foster Development: The Knowledge Ladder

Positioned at the fork between *high road* and *low road* approaches to development, how can national policy-makers invest in their education system in a way that fosters economic and social development and moves their country toward the new information economy and knowledge society paradigm? How can education leaders connect their policies and programmes to the development of sustained economic growth, social progress, and widespread prosperity? How can ICT policy support this effort?

From an economic perspective, there are two sources of economic growth (Stigliz and Walsh, 2002): capital accumulation and productivity increases. Economic output can rise with an increase in input factors: more equipment is purchased and more workers enter the labour force–what economists call capital accumulation. This is what is now happening in China and other Asian countries and it has been an important mechanism by which hundreds of millions of people have moved out of poverty. Capital accumulation is the key to initial economic development. However, growth based on capital accumulation is subject to diminishing returns: additional increases in input result in smaller and smaller increases in output. Beyond capital accumulation, growth can occur with an increase in the economic output per person, that is, an increase in productivity. Increased productivity is the key to raising the standard of living and to sustained growth. It can result from capital deepening (the use of equipment and technology that is more productive than earlier versions), higher quality labour (a more knowledgeable workforce that is more productive, that can solve problems, and can add value to products and services), and from the creation, distribution, and use of new knowledge. This knowledge is the source of new products and services, of cultural enrichment, and of yet more new ideas.

From a social perspective, development begins with achieving universal primary education, promoting gender equality, and improving health, especially maternal health, reducing infant mortality, and combating malaria, HIV and AIDS, and other diseases. As the general human condition improves, development is built on increased social integration, participation in secondary education, and involvement in the formal economy and civil society. Increased participation by a more knowledgeable, skilled citizenry enables people to make more informed choices about their life, to make more valuable contributions to the culture and the economy, and to help solve the daunting problems faced by society. Human capacity continues to grow and individuals reach their full, creative potential through continuous, lifelong learning and personal development.

These economic and social factors offer four alternative, complementary approaches or models of how education can contribute to development. Each provides a different policy vision for the education system. Together, they represent a progressive trajectory for educational change and transformation. Education reform can contribute to development by:

- Providing the skills needed for improved health and welfare and to participate in the formal economy: the *basic education approach*.
- Increasing the knowledge level of the workforce and citizenry and their ability to use technology: the *knowledge acquisition approach*.
- Increasing the ability of the workforce and citizenry to use knowledge to participate in society and add value to economic output by applying school knowledge to solve complex, real-world problems: the *knowledge deepening approach*.
- Increasing the capability of the citizenry and workforce to continually learn, to create cultural artifacts, to innovate and produce new knowledge, and to benefit from this new knowledge: the *knowledge creation approach*.

Each approach has different implications for each of the components of the education system: educational policy, teacher professional development, classroom pedagogy, curriculum, assessment, and school organization and administration, ICT use, as summarized in Appendix 1. While these approaches are not empirically tested, they provide policy-makers with a conceptual framework – the *Knowledge Ladder* – by which they can plan a trajectory of coordinated, progressively higher forms of change that over time transform the education system in support of high-road economic and social development goals. The strength of the scheme is that it not only connects change to sustainable economic growth but it also addresses the other goals of the education endeavour: the preparation of students for active participation in civic discourse, the need to apply school knowledge to solve complex contemporary problems, the enrichment of the cultural environment with new ideas and artifacts, and the development of students to their full potential through lifelong learning. Following is a summary of each approach.

Basic Education

Governments of the least developed countries are severely constrained by the lack of resources and struggle to provide the most basic services. Yet, for them and their citizens, education is a way out of the poverty trap. The policy goals of this approach are to increase the number of people that enter the formal economy by providing them with basic literacy and numeracy skills. The social development goal is to provide life skills, increase civic participation, and improve health and welfare. Because national governments in this stage of development have little money for public spending, the decisions and priorities for this spending are that much more important. Universal primary education and increased participation of girls are very important policy goals for this development approach and emphasized by both the United Nations' Millennium Development Goals and the Education for All program. The elimination of primary school tuition, the expansion of school meals, increased adult literacy programs – especially for women – are investments that pay off in a number of ways that include more productive farming, reduced hunger and childhood diseases, increased participation in the economy and reduced poverty (Birdsall, Levine, and Ibrahim, 2005). These policy goals and the constrained resources of those countries that must focus on basic education place severe limitations on the various components of the education system. A particular challenge is preparing a teacher corps that is at least minimally competent in subject knowledge and teaching skill. Often, there are not enough teachers and teachers come to schools with few qualifications. This is especially true for rural schools where most of the population resides and where poverty is the highest. Because of the lack of funds and qualified teachers, student/teacher ratios can be very high, so lecturing is the dominant pedagogy, used as an efficient means of disseminating knowledge in schools. In the *Basic Education* model, the curriculum focuses on basic skills in literacy and numeracy, as do assessments. The system is often very hierarchical: minimally skilled teachers are given little autonomy and are closely supervised by curriculum inspectors using highly specified curriculum schedules. School facilities are minimal and if the physical structures of schools exist at all, students often need

BASIC EDUCATION

A primary classroom in a rural school in high-poverty country is filled with 80 students, many of them having come to school for the first time because the government recently eliminated primary school tuition. Students are squeezed into rows of benches and four of them share a textbook. The teacher feels overworked and rarely gives homework or seat work that would require a large number of answers to be corrected. Rather, the teacher lectures on mathematics concepts drawn from the standard curriculum for that day and asks the students questions, which they are expected to answer correctly and in unison.

to share desks and books. From a technology perspective, broadcast media can be a useful resource in this stage of development. Television and, particularly, radio can be a very inexpensive and efficient way to disseminate information to both teachers and students. If available at all, computers are usually limited in number. Their best use may be to improve teacher knowledge of their subject matter. If available, access to the Internet could be used for management and administrative support and to connect the school to the central authorities; however, it could also be used for access to online content, remote resources, and experts in support of teacher professional development. As primary enrolment increases and the basic educational foundation is laid, the next challenge for development is to increase secondary enrolment and improve the overall quality of the education system.

Knowledge acquisition

This is the approach most associated with the traditional, mass production model of education. The overall economic policy goal of this approach is to build an industrial base, participate in the global economy, and begin to lay the foundations for broader prosperity. This is accomplished by improving productivity with a high-quality workforce. Education contributes by preparing a workforce that is more knowledgeable and skilled and capable of taking up new technologies. The social goal is to provide opportunities for advancement and foster social integration and equity. Related educational policy goals include increasing secondary school enrolments, improving education quality, and increasing math and science skills, including technology literacy. In many ways, this approach is an extension of the *basic education approach*. Changes in the curriculum may include adding ICT as a subject in the curriculum or including time in the curricula of other subjects for the incorporation of ICT. The curriculum continues to be divided by traditional subject areas and emphasizes the recall of factual knowledge and basic problem-solving procedures. A major goal is to improve educational quality, as measured on traditional, standardized tests of students' ability to recall facts or solve simple, one-step problems. Changes in pedagogical practice may involve the use of various computer-based tutorials, tools, and e-content as part of whole class, group, or individual student activities but the use is often supplemental. Networked ICT may also allow learners to have access to remote, online resources or lessons that may not otherwise be available. Teacher practice may involve the use of technology for classroom activities and presentations, for management tasks, and to acquire additional subject matter knowledge for their own professional development. Little change in social structure is required of this approach other than, perhaps, the spatial placement and integration of technology resources in the school. Often computers are put in separate laboratories, since ICT is offered as a class and technology is not integrated into the curriculum. The challenge at this stage is to move students toward a deeper understanding of subjects that would allow them to apply their school knowledge in real-world situations.

KNOWLEDGE ACQUISITION

In a lower secondary biology class in lower-middle-income country, the teacher presents a lecture on the parts of a plant in the computer lab using a PowerPoint presentation. The lesson follows the standard science curriculum for that day. After the lecture, students cluster in groups of three around computer stations and interact with a prepared lesson on the parts of a plant. The instructor circulates around the class helping students operate the equipment and responding to their questions. After they go through the lesson, the instructor gives the students an oral examination in which students are asked to identify parts of the plant correctly and in unison.

Knowledge deepening

The policy goal of the *knowledge deepening approach* is to make school learning more relevant to the workplace and to social life. The intent is to increase the ability of the workforce to add value to economic output and to increase the ability of the citizenry to improve their standard of living and the condition of society by using their knowledge of school

subjects to understand and solve complex problems encountered in real-world situations of work and life. Rather than the superficial coverage of a large number of topics that is characteristic of mass production model, the curriculum in this approach focuses on the deep understanding of a smaller number of key concepts, principles, and procedures and on how these ideas are organized and interconnected within and across subject areas to form complex knowledge systems (Bransford, Brown, and Cocking, 2001). Teachers pose challenging questions that draw on core concepts and principles in the disciplines, as well as on student interests and motivations. They also structure collaborative classroom activities, projects, and investigations that engage students in the use of these key concepts and principles to solve extended, open-ended, real-world problems. Complex, real-world projects such as these often cut across boundaries of otherwise disparate disciplines, for example connecting science, mathematics, social studies, and the arts. Consequently, lessons may be conducted by teams of teachers working within or across courses and draw on their multiple talents. Because this type of learning is more complex, teachers need to possess both a deep understanding of their subject area as well as of the cognitive and social processes students employ and the problems they face when they engage in this type of learning. Teachers can use this pedagogical knowledge and their deep understanding of the subject to identify a student's specific learning problems and craft learning experience that help them master difficult-to-understand concepts. Technology can play an important role, as students use visualizations and simulations to explore, understand, and apply complex knowledge. Consequently, ICT becomes integrated into the curriculum and into daily classroom practice. Equipment cannot be relegated to the computer lab; it must be available in the subject classrooms for regular use. Networking can help teachers and students connect classroom activities and learning to the outside world. Extended assessments, consisting of several parts, parallel the complex tasks students will encounter in the real world and students use electronic tools and digital resources for their projects, much as they would in the real world. Because much of their work is in digital form, students accrue electronic portfolios of their work over time. Flexibility in school schedules and curriculum implementation can support these pedagogical efforts and technology in the home can keep students connected to their schools, teachers, fellow students, and digital resources outside of the school day. The challenge within this approach is to build on this deepening capacity to create ongoing knowledge communities and continuous, lifelong learners.

KNOWLEDGE DEEPENING APPROACH

Students in a primary school in an upper-middle- income country collaborated with other primary schools in nearby towns to create a digital history of the ethnically diverse region. Children worked in groups to collect audio and video interviews of their grandparents, take photographs of town monuments and important buildings, and videos of local stories, songs, and dances. Teachers used the project to focus on important events in world and national history and similarities and differences across cultures, as well as students' skills in collaboration, communication, and technology. The teachers worked with other teachers in their school and those from the other schools to create a website for the region in which each of the towns had its own home page. The website was launched during a special event, when student groups from the different towns gave presentations to the local citizens on each of their contributions.

Knowledge creation

The policy goal of the fourth approach – *knowledge creation* – is to develop a workforce and citizenry that are continually engaged in and benefit from knowledge creation, innovation, and learning. The implications of this approach for educational change are profound and transformational. If students are to participate in an economy and society in which the creation, sharing, and use of new knowledge and cultural artifacts are the basis for sustained development, their educational preparation must go beyond the learning of established knowledge. Knowledge creation does not conflict with knowledge deepening; rather, it builds on a base of deep understanding of school subjects. But the curriculum is extended to include a new set of transversal skills, on top of disciplinary knowledge. Knowledge creation skills include the ability to use a range of technological tools and digital resources; to search for, organize, and analyse information; to communicate effectively in a variety of forms; to collaborate with others of diverse skills and backgrounds; and to think critically, innovatively, and creatively. These are sometimes referred to as *21st century skills* (Partnership for the 21st Century, 2005; International Society for Technology in Education [ISTE], 2007; Kozma, 2009; Trilling and Fadel, 2009; European Commission, 2010). But paramount among the knowledge creation skills

KNOWLEDGE CREATION

Biology, chemistry, physics, and mathematics teachers at a secondary school in an upper-income country worked with professors at a nearby university on an project sponsored by an international science agency. This was one project among many at this school whose who culture was organized around knowledge creation. In this project, students collected and analysed local date on flora, fauna, climate , and air, and water quality data. Students worked in teams, each team worked with teachers and a university advisor to pose questions and hypotheses they wanted to explore. In addition to their own data, students also had access to local historical data as well as comparable data collected by students at other schools around the world. The teams posted their questions and hypotheses on the project's collaborative website which brokered connections with student teams at other schools working on similar questions. Students also had remote access to volunteer college students who could help them when they encountered problems with their analyses. Students posted early drafts of their reports online for comments by other students in their school and those in other schools. The final product was a local climate change event at which students presented their findings and an international website that published their video and written presentations.

are those that allow students to continue their learning throughout their lifetimes: the ability to set one's own learning goals, to assess current weaknesses and strengths, to set up a learning plan, to identify learning resources, and to monitor progress. Within the *knowledge creation* approach, teachers design a learning community and a set of activities and resources in which students are continuously engaged in the sustained, collaborative process of building on current knowledge and cultural artifacts to create and share new contributions (Scardamalia and Bereiter, 2006). This is a social process in which the contributions of others and one's own are modified, challenged, and extended. The value of each contribution is judged by the community of knowledge users, in addition to experts. Schools are transformed into learning organizations in which all actors are involved in the learning process (Senge, et al., 2000). Technology is pervasive. In the course of their explorations and discourse, teachers and students use a variety of electronic devices, digital resources, Web 2.0 and 3.0 social and knowledge environments, and ICT-based tools that support knowledge creation and the development of critical thinking skills; support continuous, reflective learning processes; and support interaction within knowledge communities that extend beyond the confines of time and place. Within this context, teachers are themselves master learners who model the learning process for their students. They are constantly engaged in educational experimentation and innovation in collaboration with an extended network of colleagues and experts to produce new knowledge about learning and teaching practice. In addition, head teachers work with their staff to continuously monitor their progress, review the school's vision and goals, and adjust to new circumstances.

Policy implications

The *Knowledge Ladder* is a set of complementary, alternative models or perspectives that together provides policy-makers with an education reform trajectory in support development. The framework is developmental in two senses. First, it is designed to accommodate a variety of developmental contexts. The *Basic Education* model may make sense for some countries but the *Knowledge Deepening* approach may make sense for others. Policy-makers may choose to implement one of these approaches or several for different development conditions within the country. It is also developmental in that each approach builds capacity that sets the stage for the subsequent stage. There is an internal coherence within the models that allows each of the components to draw on and contribute to the others. For example, the *Knowledge Deepening* model works because teachers have both subject matter knowledge and pedagogical knowledge, because the curriculum emphasizes depth over breadth, because the pedagogical approaches and organizational structures support extended, in-depth student explorations, because the ICT resources are readily available in the classroom, and because assessments measure the application of deep knowledge to solve complex problems of the sort students were engaged in during their studies. At the same time, each model generates the capacity that can lead to further development. Teachers who have both subject knowledge and pedagogical knowledge are in a better position to build knowledge communities among their colleagues. Technology in every classroom provides a basis for pervasive technology use.

However, the framework does not lend itself to a mix-and-match application. As desirable as it might be for a country to jump from the *Basic Education* model to the *Knowledge Creation* model, the *Knowledge Creation* model requires

a certain constellation of conditions for it to work. For example, it would be very difficult to implement the advanced pedagogical practices of the *Knowledge Creation* model by teachers who are minimally competent in their field or with curriculum or assessment approaches that emphasize rote learning. Conversely, it would be difficult to infuse schools with technology when teachers and students do not have the prior experience with technology that would support its massive uptake.

Having said that, policy-makers may find that their current system does not easily fall into one model or another. Unevenness may currently exist across components, relative to the models–that is, a significant number of teachers may be skilled in collaborative, project-based learning, even though the curriculum and assessment measure only individual performance of students on fact-based, standardized tests. This unevenness may provide opportunities to leverage these strengths to bring about change, a matter taken up in the next section.

Policy Development

The Role of Policy in Educational Change

Educational policy-makers are in a unique position to bring about change. This is illustrated in a study of 174 ICT-supported innovative classrooms in 28 countries (Kozma, 2003). In 127 cases, there was an explicit connection between the innovation and national policies that promoted the use of ICT (Jones, 2003). In 106 of the 174 cases, there was a connection with national education policy. In 89 of them, there was a connection to both national ICT policies and educational reform policies.

But while policy can facilitate change, it does not guarantee its implementation or impact, a fact well documented in many education instances (Tyack and Cuban, 1995). The international study cited above included only innovative classrooms; it did not cite the thousands of schools in which innovation did not take place, despite national ICT and education policies which supported those that did innovate. There are many reasons for the lack of policy impact. Sometimes national policies are merely symbolic acts meant to display concern or score points with political constituencies, special interest groups, or donors, without providing the programmes or resources needed to implement policy or affect change (Elmore, 2004). These symbolic policies are often accompanied by what Elmore calls "parallel play," in which school administrators and teachers respond to symbolic policy by making superficial changes that have no real impact on teaching and learning. This arrangement works to the extent that policies are vague enough as to not have clear mandates for the classroom and to the extent that outcomes, if stated at all, are not measured or measurable. In these cases, all parties in the parallel play are satisfied but no change occurs.

Sometimes, too, policies fail because teachers actively resist policy-based change that they see as imposed from the outside without their input or participation, or they may blend old with new practices by selecting parts of the reform that make their job more efficient or satisfying without making fundamental changes in schools (Tyack and Cuban, 1995).

Policies also sometimes fail to impact classrooms when they do not have explicit connections to instructional practice, when they do not provide teachers with an opportunity to learn the policies and their instructional implications, and when there is a lack of programmes and resources aligned with the intensions of the policies (Cohen and Hill, 2001).

But perhaps policies also fail because they do not address the changes that will make a difference in the education system. An analysis of policies in 30 European countries (Balanskat, 2007) found that 15 of the 30 included ICT as part of their general education policy and also had a specific ICT policy; 6 had an educational ICT policy but did not include ICT in their general education policy; and 4 had ICT in their education policy but did not have a specific ICT policy for education. Only four countries had neither an ICT policy or included ICT in their general education

policy. However, a further analysis of the content of the policies found that in most European countries, ICT-related policies focused on the technology – hardware, software, networking, digital content – rather than its relationship to pedagogy, curriculum, or assessment. ICT policy that only addresses these issues is not likely to have an impact on schools and most certainly will not transform education.

This chapter and the rest of the book is focused on transformational change in which ICT policy supports systemic education reform linked to economic and social development. Since the relationship between policy and change is important but not sufficient, the challenge for policy-makers who are committed to transformational education change is not just to have an educational ICT policy but to formulate policies that have an impact on school structures and classroom practices. To have a broad impact, these policies need to be systemic, aligned with national needs and priorities, and do this within the nation's developmental context.

Policy Development and Transformational Change

One way to think about policy is as *systemic change* that adds value to educational processes or outcomes is system-wide (Centre for Educational Research and Innovation [CERI], 2009a, 2009b). From a systemic perspective, policies can promote technology-based innovations, such as the introduction of digital learning resources or one-to-one computing, which aims to improve the operation of a system, its overall performance, or the perceived satisfaction of students, teachers or parents. The goal of the policy would be to implement these innovations throughout the system. However, the innovation can become system-wide and yet not change the system itself; that is, the innovation is adopted throughout the system, but the goals, practices, and structures of the system remain the same. This certainly can be a worthy goal and its implementation a significant accomplishment. However, the emphasis in this paper is on *transformational change* – that is, policies intended not only to change all the components of the education system but transform the system itself (UNESCO, 2002) so that education aligns with and supports an emerging social and economic paradigm shift.

CERI (2009a, 2009b) describes a process of systemic innovation as one that includes an initiation phase, an implementation phase, and a scaling-up phase, all of which are informed by monitoring and evaluation. Michael Fullan (2007) identifies a somewhat similar set of three phases in the educational change process: initiation, implementation, and institutionalization. These change models adequately capture innovation that is intended to become system-wide but they do not capture transformational reform in which the system itself is changed. Social psychologist Kurt Lewin (1947; 1958) describes a somewhat similar, three-step model of the change process: unfreezing, moving, refreezing. Lewin's terms convey the existence of mutually reinforcing conditions that characterize the current state, lock it in, and make change difficult to initiate. Over decades, each of the components of the education system become tightly aligned with each other and finely tuned to the current paradigm–they become "frozen." The key to change is the need to unlock or "unfreeze" these interlocking conditions. Consequently, Lewin's terms better characterize transformation in which the system itself changes.

ICT policies to "unfreeze" the system

With education that supports the mass production paradigm, teachers are trained to use a standard pedagogy, typically lecture and demonstration, to teach facts and simple procedures that are specified by the national curriculum. The national assessment uses standardized tests, typically multiple-choice, to measure the recall of facts and the use of simple procedures, as specified by the curriculum. Materials are developed and technologies used to make standard teaching more efficient and effective. Schools are organized in a way that makes the system run smoothly. Within this paradigm, attempted change in one component is often inhibited by the mutually reinforcing nature of connections between the components of the system. Teachers may explore interesting new pedagogical approaches with computers only to realize that these are not included in the national curriculum nor measured on the national assessments, so the explorations are abandoned and the computers may be put in the closet.

Consequently, significant change requires that policy-makers develop policies and programmes that un-freeze the current, mutually reinforcing conditions, implement new approaches, and then re-freeze these into a new set of mutually reinforcing conditions that will subsequently continue. An argument for why change is needed and a vision of what it will look like in the future can be used to launch a new policy. But the unfreezing phase must go beyond a vision and high rhetoric: new forces must be introduced that upset the equilibrium of the current system and create the opportunity for change and realignment. Unfreezing relies on the introduction of coordinated changes in two or more of the system's components. ICT can be a strategic lever for change but if it is introduced by itself, transformation will not happen – it will either be absorbed into the current model or left in the closet. Unless ICT is accompanied by other, mutually reinforcing changes it will be met with resistance and counter-pressure from other components. Thus, it is advisable to develop ICT policies and programmes that draw on two or three linked components. For example, in moving toward the *Knowledge Deepening* model, this might include the introduction of digital resources, simulations, and problem sets, along with new project-based pedagogical approaches integrated into a summer teacher professional development program. Or in moving toward the *Knowledge Creation* model, changes in curriculum that emphasize twenty-first century skills could be introduced along with computer-based assessments of these skills. In any case, the use of multiple, linked changes – although more difficult than change of a single component – is more likely to unfreeze the system and launch long-term transformational change.

The role of policy during the "moving" or implementation phase is crucial. While inspirational visions are often effective because they are general and vague enough in their details to garner widespread support, the implementation of significant change must be accompanied by detailed implications for schools and classrooms, administrators and teachers. New programmes should directly connect policy intentions to changes made in schools and classrooms (Cohen and Hill, 2001). The resources should be made available that are needed to carry out the specified changes, including significant opportunities for teachers to learn what the policies are and their implication for changes in the classroom. Again, levers can play an important role in implementation but programmes and resources should be used to tie together two or more components of the system around the strategic vision.

The institutionalization, or refreezing, of change can take a long time. With significant change of the sort discussed here, institutionalization comes as other components of the system shift into place so as to reinforce the initial set of changes and align with the new paradigm. This tuning of system components may require a series of follow-up policies, programmes and resources that connect the initially targeted components – for instance, ICT, pedagogy, and teacher training – with changes in other system components – such as curriculum and assessment. This implies a change trajectory that plots out a series of policy updates and improvements over time. Indeed, the prospect is that such a trajectory of may lead to a model of continuous change. Rather than institutionalizing or refreezing the new conditions, the education system engages in a process of continuous review and improvement, in line with the nation's social and economic development goals.

The role of monitoring and evaluation in educational change

Monitoring and evaluation (M&E) can play a crucial role in unfreezing the system and it should be an integral component of any planned ICT for education programme (Wagner, Day, James, Kozma, Miller, and Unwin, 2005). Findings from these studies can identify gaps between the stated goals of the programme and its progress and accomplishments. If done early enough in the programme, adjustments can be made in the implementation plan to increase the likelihood that the programme will ultimate succeed.

James and Miller (2005) suggest that monitoring and evaluation should be factored into planning before a project starts and they provide an overview of the processes, tasks and outcomes that are needed to implement a successful M&E plan. This includes appropriate, realistic and measurable indicators which should be used to monitor outputs and outcomes. They advise that major stakeholders should be identified and involved in making M&E decisions to avoid possible problems with "buy-in" and commitment later in the process.

Policy Components

Policies are normally thought of as the strategic statements that provide a broader context for change and articulate a vision that motivates people to change and coordinates otherwise disparate efforts within the system and across sectors (Kozma 2008, 2010). But policies can also be operational: these are the action plans, programmes, or projects that provide the mechanism and resources by which the vision is to be realized. This section describes the various strategic and operational components of ICT policy, with reference to the *Knowledge Ladder*. It also references the UNESCO ICT in Education Toolkit, which can be particularly helpful in formulating operational plans, programmes, and projects.

Articulating policy goals and a strategic vision

Educational policies, particularly in the early, "unfreezing" or initiation phase, can serve several important strategic functions. Policies can provide a rationale, a set of goals, and a vision of how the education system might look with the introduction of change, and how students, teachers, parents, and the general population might benefit from these changes in schools. An analysis of various national ICT policy statements (Kozma, 2010) identifies three alternative, somewhat related rationales that are used to support ICT-based change. These high-level statements can be thought of as "strategic policies." Strategic policies can promote the use of educational ICT to: support economic growth, promote social development, or advance pedagogical reform. Each of these is addressed by the *Knowledge Ladder*.

The most often used rationale for investment in educational ICT is the role it can play in preparing a future workforce and supporting economic development. The key to this policy approach is an articulation of specific ways that the educational deployment of ICT can support these broad economic goals, lest the connections between the two are nothing more than hollow platitudes. The *Knowledge Ladder* makes these connections explicit. For example, depending on the approach taken, education policies can connect the use of ICT to develop students' ICT skills which allow them to use new technologies in the workplace, or to develop students' capacity to use technology to solve complex real-world problems that can contribute to productivity, or to develop their twenty-first century and lifelong learning skills, which would support knowledge creation, innovation, and entrepreneurialism in an information economy.

Some countries have focused more on the potential social impact of ICT and governments have justified ICT investments with policies that promote their use to share knowledge, foster cultural creativity, increase democratic participation, make government services more widely available, enhance social cohesion and the integration of different cultural groups, or support the needs of individuals with different abilities. Within education, socially-oriented ICT policies can offer to connect classrooms across cultures, increase parental participation, provide student access to specialized educational services, and extend the delivery of education to remote populations. As with the economic rationale, the key is to articulate specific ways that educational ICT can support these broad social goals. In the *Knowledge Ladder*, the social focus is on progressive agency and participation in social and cultural institutions and processes.

Other policy statements are associated with the introduction of ICT along with pedagogical or curriculum reforms that emphasize high levels of understanding of key concepts within subject areas and the ability to apply these concepts to solve complex, real-world problems (Means and Olson, 1995; Means, et al., 2004; Bransford, Brown, and Cocking, 2000), as described in the *Knowledge Deepening* approach of the *Knowledge Ladder*. Other curriculum reforms emphasize what are sometimes called "twenty-first century skills," qualities that prepare students for the knowledge economy, such as creativity, information management, communication, collaboration, and the ability to direct one's own work and learning (Partnership for the 21st Century, 2005; International Society for Technology in Education [ISTE], 2007; Kozma, 2009; Trilling and Fadel, 2009; European Commission, 2010), as in the *Knowledge Creation* approach.

Most often, a nation will combine two or more of these rationales in a mutually reinforcing ways. The important thing is that policy-makers identify a rationale and provide a vision that will rally support, mobilize change, and advance national goals.

Professional development

Teacher professional development and initial teacher training are an important component of ICT in education policy. Often policies that address teacher training will do so in the context of providing teachers with the skills needed to operate the equipment. But ICT in education policy can address much larger issues related to professional development and do so in a broader context of educational change, as does the *Knowledge Ladder* and the UNESCO ICT *Standards for Teachers* (UNESCO, 2008). A big challenge to developing countries that are bringing more students into the education system is to increase the number of teachers. In many developing countries, ICT are being used to extend access to education for teachers, particularly those in rural areas. The UNESCO ICT *in Education Toolkit Toolbox* 3 provides helpful suggestions in this regard. Beyond helping to increase the number of teachers, ICT can be used to improve teacher quality, a crucial factor in the success of high-performing education systems (Barber and Mourshed, 2007). Consequently, ICT policies and programmes related to teacher training should be structured in a way that connects to specific classroom practices or engages teachers in a community of professional practice and ongoing development, policies that have proven to be effective in school reform (Cohen and Hill, 2001). In many countries, ICT-related teacher training policies spell out a specific set of skills that teachers are to acquire, as well as specify the duration of training (Kozma, 2010). In the early phases of ICT introduction, teachers need training in the operation of hardware, software, and, to some extent, networking. As ICT use by teachers becomes more common, professional development shifts to the pedagogical integration, the creation of content, and the development of shared knowledge and practice.

Pedagogical change

An especially important component of ICT in education policies, particularly for policies that promote education reform, is the articulation of ICT-related changes with innovative pedagogical practices. Early applications of ICT in schools included tutorial or drill-and-practice software that focused on the memorization of facts and the application of simple procedures, associated with traditional pedagogical models. But more advanced applications, such as simulations, games are associated with pedagogical changes that treat the students as active agents who are engaged in collaborative projects to solve complex, real-world problems, or sustained investigations, as in the *Knowledge Deepening* approach. Or, as in the *Knowledge Creation* approach, they include knowledge building environments that support student discourse and interactions that generate new ideas by building on and extending the ideas of others (Scardamalia and Bereiter, 2006). The pedagogical role of teachers is to structure and support these practices by providing resources and explicitly modelling cognitive and social processes and prompting students to take up these practices (Bransford, Brown and Cocking, 2000; Blumenfeld, Kempler and Krajcik, 2006; Krajcik and Blumenfeld, 2006).

Curricular development

In initial stages of ICT use in education, the focus has often been on the introduction of courses on ICT literacy in the curriculum. Students learn how to operate equipment and common productivity software. But as education systems become more experienced in the use of ICT and as it becomes more embedded in schools and classrooms, the curricular emphasis can shift to the integration of ICT throughout the curriculum to support the learning of school subjects, as in the *Knowledge Deepening* approach. The *Knowledge Creation* approach extends the curriculum beyond the subject domains to include the development of other skills facilitated by the use of computers. These can include information management skills, reasoning skills and complex problem solving skills, creativity, communication skills, collaboration, elf-management skills, and character development. Cross-discipline project work can be introduced into the classrooms to develop these skills and attitudes.

Assessment reform

Traditional assessments are focused on the memorization of facts and the application of simple procedures to set up, one-step problems. High-stakes assessments – those that determine the student's academic future – are given only at the end of the year or at key points during the student's career. Assessment reform emphasizes the need to assess a new set of twenty-first century skills not traditionally measured by standardized assessments (Partnership for the 21st Century, 2005; International Society for Technology in Education [ISTE], 2007; Kozma, 2009; Trilling and Fadel, 2009; European Commission, 2010). It also emphasizes the need for continuous assessment that is integrated into regular, ongoing instructional activity and involves new assessment methods that include performance tasks and portfolio assessments (Pellegrino, Chudowsky and Glaser, 2001; Mislevy, Steinberg, Almpond, Haertel, and Penuel, 2003). ICT can be a crucial enabler of these changes and assessment should be an important part of ICT policy. In this regard, simulations and multimedia cases can provide students with extended, open-ended, multi-part problems that embed key concepts and principles of a domain in real world situations. ICT can also support the creation of knowledge products, such as reports, presentations, and creative works to assess students' skills in analyzing and applying information, problem solving, collaborating, communicating, and using a range of technology tools. A major new international project is moving toward the use of ICT to measure 21st century skills.[15]

Restructuring the school

ICT can play an important role in restructuring the social and physical organization of the school. The traditional model of schooling, as reflected in the *Basic Education* and *Knowledge Acquisition* approaches, is divided into blocks of time, focused on a single subject in a bounded physical space, limited to a single teacher and a specific group of students. Technology can begin to break these boundaries and significantly expand the opportunities for learning. With the *Knowledge Deepening* approach, ICT can be used to support a significant restructuring of the school schedule that is required for extended, real-world, multi-disciplinary problems and it provides access to people and digital multimedia resources that allow student to explore key concepts and principles in depth. With the *Knowledge Creation* approach, ICT can make an even more profound impact on school organization, as pervasive technology and social networks are used to support "anytime, anywhere" knowledge production, collaboration, and knowledge sharing, in and out of school.

Technological infrastructure

Of course, the technology is itself a key part of ICT policy, although many policies err in focusing exclusively on this. ICT policies must address issues related to hardware, software and content development, networks, and technical support. With the *Knowledge Ladder*, education leaders can make these decisions in a broader context that connects the use of ICT with other important decisions related to pedagogy, curriculum, assessment, and teacher training.

Hardware. ICT policies most often include the provision of and budget allocation for computer hardware (Quale, 2003). This is typically a policy emphasis in the early stages of a country's use of ICT in education. Such plans often include the amounts and type of computer and multimedia hardware that will be purchased. UNESCO ICT *in Education Toolkit Toolbox* 3 can be particularly good in helping countries with this decision. Apart from computer hardware, broadcast media such as radio and television can play an important role in countries where the focus is primarily on increasing participation in basic education, as it has in Africa (Farrell and Isaacs, 2007) and other developing countries. Historically, radio has been an important resource because it is an inexpensive way to get information out to a large number of people both in the schools and in home. As with computers, the cost of radio and video production equipment is going down and the power is increasing and this can be harnessed for education and development (UNESCO, n.d.). Investment in computer hardware is often linked to ratios of computers to students or teachers, such as one computer to every ten students or one to every five students. The goal may also include supplying teachers with easy access to a computer. A more radical approach to equipment distribution is the One-Laptop-per-Child programme (OLPC) that capitalizes on the dramatic drop in the cost of hardware to develop computers specifically for the requirements of developing countries (Kramer, Dedrick, and Sharma, 2009).

15 http://www.atc21s.org/home/

More than 30 countries have begun to implement OLPC to some extent, including Ethiopia, Peru, Rwanda and Uruguay (Bassi, 2009). Evaluations have shown that one-to-one computing has been effective, at least in developed countries, when their use is aligned to policy goals, when it is accompanied by appropriate content, and when it is introduced within teacher professional development, and when it is introduced in the context of a broader change agenda (Zucker and Light, 2009). However, the approach has yet to demonstrate its effectiveness or impact in the context of less developed countries. The options offered by the *Knowledge Ladder* help policy-makers sort out these priorities. Countries focusing on *Basic Education* or *Knowledge Acquisition* would hardly benefit from low student-to-computer ratio, let alone an investment in one-to-one computing, to the extent that the pedagogical model and curriculum are focused on information dissemination. In this case, there are other, much cheaper media that can do this effectively. Still, school systems moving toward *Knowledge Deepening* and *Knowledge Creation* can benefit from a low student-to-computer ratio or even pervasive technology in the school and home, as it is used in connection with pedagogical, curriculum and assessment that emphasizes collaborative, project-based learning and knowledge building.

Software and content development. ICT in education policies often address the kinds of software that should be available to schools and teachers. The power of computers is expressed in the software applications that they can run. Tutorials and drill-and-practice software were early applications that took advantage of the rather limited capabilities of computers. These applications worked well with traditional pedagogical approaches. But as the power of computers increased to run simulations, multimedia applications, and sophisticated, collaborative tools and knowledge sharing environments, they supported different, more sophisticated approaches to pedagogy, curriculum, and assessment, of the sort represented by the *Knowledge Deepening* and *Knowledge Creation* approaches.

Software issues often include decisions about free and open-source software versus proprietary software (Dravis, 2003). The applications that are available through open-source have become increasingly sophisticated and reliable over the years and they now provide decision-makers with additional options to proprietary software. The advantages of this approach include lower costs and more control over the software. This is particularly true for network software. However, there is a significant amount of technical expertise that is required to take full advantage of the open-source alternative, particularly for application software. But in the end, this is not an either–or decision. Proprietary and open-source applications and resources and be used together in a mix. Policy-makers should look at their range of options from both practical and financial perspectives and decide what mix works best for them.

Many countries include the development of digital content as part of their ICT implementation policies. For example, the ICT programme in Chile supported the development of *La Plaza*, a socially oriented educational portal organized as a community square that includes a post office (email), information kiosk (digital content), and a cultural centre (virtual collaborative workplace). Some countries, because of the uniqueness of their curricula or special considerations of culture and language, find a need to emphasize the development of digital content as part of their operational policy. The ICT programme in Finland encourages the production of Finnish-language instructional materials on the Web, and this is now one of the business sectors that the government is nurturing as part of its economic development programme (Kankaanranta, 2009). The ICT policy in Brazil is supporting the development of Portuguese-language content appropriate for primary, secondary, and tertiary studies (Litto, 2009). In Hungary, a knowledge repository called Schoolnet Digital Knowledge Base was instituted to store digital texts, pictures, movies, sounds, simulations, test items, etc. (Karpati and Horvath, 2009). The "assets" in the Hungarian collection are tagged with meta-data to help teachers store, find, and edit digital learning resources. The assets can be interlined by teachers or students to form new compilations of digital learning materials.

Networks. Access to the Internet and local networking resources are also included in many ICT in education policies. These often address issues related to bandwidth, as well as the areas in the schools that will be networked. For wired networks, the choice comes down to the number of connections and location of computers. Wireless networks provide more flexibility in numbers and locations. In some school systems, with limited resources for equipment, wireless networks have been combined with carts of laptop computers that can be wheeled to classrooms for scheduled use. Bandwidth will depend on the number and amount of users, the kind of content to be used, and the origin of the content. A small number of computers used primarily by administrators and teachers for email or the

exchange of text documents would require low bandwidth in a few locations in the school. This would be more than adequate for the *Basic Education* approach and sufficient for most situations in the *Knowledge Acquisition* approach, particularly if pedagogical applications are limited to teacher presentations or most content is locally delivered via CDs or DVDs. If, however, the pedagogical approach requires the use of the World Wide Web for multimedia materials by many groups of students in multiple classrooms throughout the day, as with the *Knowledge Deepening* approach, high bandwidth connections will be required and wireless connections will need to be implemented across the school. Similarly, wireless networks would support the generation and sharing of students' digital content, per the *Knowledge Creation* approach. Budget decisions must include not only costs of the initial installation of networks but recurring costs of network services. In some countries, governments collaborate with service providers to offer discount rates to schools.

Technical support. Another important component of ICT in education policies and programmes is the provision of ongoing technical assistance. Teachers need this support not only in early phases of ICT use, when they need help operating the equipment, but also as hardware and networking technologies become more sophisticated and educational applications become more complex. As with teacher training, assistance is needed to support teachers' operation and connection of hardware and software, as well as help in integrating the use of ICT across the full range of curricular subjects.

Conclusion

To date, ICT have had a marginal impact on education, despite the significant investment that policy-makers have made in hardware, software, and networking. Research on the relationship between the educational use of ICT and student learning of traditional school subjects has shown a modest but statistically significant effect. However, research also makes it clear that ICT is currently not a central component of everyday classroom practice in schools across the world. While many teachers use ICT, they use it primarily to prepare lessons and when they use it in the classroom, it is to support their lecture presentations. Few teachers have their students use ICT regularly in their lessons. Consequently, ICT barely registers on the educational screen. Across the world, contemporary schools and classrooms look much as they did at the beginning of the twentieth century. Students in schools meet in structured classrooms at specified times; teachers cover the standard content by lecturing in front of a large class while students listen; students work individually to memorize facts and simple procedures and reproduce this knowledge on assessments. The use of new ICT, to date, has only reinforced this model.

In the meantime, massive economic and social changes have occurred around the world, many of them launched by new information technologies. A profound shift has occurred from a mass production paradigm in which manufactured products are the basis of the economy and large organizations are hierarchically structured to produce a high volume of standardized products, to a knowledge creation paradigm in which knowledge is the key productive factor; organizations are smaller, flatter, distributed, and networked; business and social practices are based on participation and collaboration; and information products and services are customized to user needs and interests–what is called the *information economy*. ICT is a key contributor to productivity gains in this new paradigm, but economic studies found these gains only when ICT investments were linked to a cluster of mutually reinforcing organizational changes, such as new strategies, new business processes and practices, and new organizational structures.

Outside of schools, ICT have had a significant social impact, too. Large numbers of people in developed countries use the internet regularly to conduct online purchases, access government services, make friends, use online chat and messaging, download music and movies, play games, exchange email, conduct banking transactions, and search for information. The capabilities of networked ICT allow people at distributed locations to communicate and collaborate with each other, while taking advantage of a rich body of multimedia content. As well, these capabilities have spawned a global network of social connections, communications, and information sharing, often referred to

as the *knowledge society*. These changes are reaching the most remote, rural villages in the least developed countries. Yet education remains, by and large, unchanged.

If research on ICT impact on the economy and on business structures and practices is any indication, the major impact of ICT on education is yet to come. But it will only be realized when ICT are accompanied by other organizational changes and classroom practices that work to align the education system with the emerging information technology paradigm.

This book looks at the ICT policy in the context of transformational change in education: reform in which all the components of the educational system, not just ICT, that are aligned with social and economic development goals. This approach envisions an education system in which students engage in the sustained, collaborative process of building on current knowledge and cultural artifacts to create and share new contributions. Students develop the ability to use a range of technology tools; to search for, organize, and analyse information; to communicate effectively in a variety of forms; to collaborate with others of diverse skills and backgrounds; to think critically, innovatively, and creatively; and to continue their learning throughout their lifetimes. Teachers collaborate with students and model the learning process. They are continuously engaged in educational experimentation and innovation in collaboration with an extended network of colleagues. Head teachers work with their staff to continuously monitor their progress, review the school's goals and vision, and adjust to new circumstances. And schools are transformed into learning organizations in which all actors are involved in the learning process. Within these schools, teachers and students use a variety of electronic devices, digital resources, and social and knowledge network environments to design ICT-based learning resources and tools that support the development of knowledge creation and critical thinking skills; support continuous, reflective learning processes; and support interaction with knowledge communities that extend beyond the confines of time and place.

For many policy-makers, it will be a major accomplishment to introduce ICT innovations that can, over time, be scaled up, system-wide. Such innovations can serve to improve quality or efficiency of the current educational system. However, this book focuses on a more ambitious goal. This chapter presents a conceptual tool – the *knowledge ladder* – and makes recommendations that policy-makers can use to craft policies and programmes that unfreeze the current system and align it with social and economic policies that move a nation toward an information economy and knowledge society. Within this context, ICT policies can be transformational. The chapters that follow examine ICT policy in five countries – Singapore, Uruguay, Jordan, Namibia, and Rwanda – to see how they are harnessing the power of ICT to advance their economic and social goals.

Appendix 1: The Knowledge Ladder: Education Reform, ICT, and Economic and Social Development

	Basic Education	Knowledge Acquisition	Knowledge Deepening	Knowledge Creation
Policies	Policy goals are to increase primary school participation, to increase the number of people that enter the formal economy, and to provide the skills that would improve health and welfare.	Policy goal is to prepare a workforce capable of taking up new technologies and contributing to economic productivity. Education policies focus on increasing quality and secondary level enrolments, providing students with ICT skills, and increasing student scores on standardized tests, primarily in reading and math.	The policy goal is to upgrade the productivity of the workforce so that they can add value to economic output. Education policies focus on improving the understanding and problem solving skills of students and connecting school learning to real world problems and contexts.	The policy goal is to increase innovation and knowledge creation to drive the knowledge economy. Education policies are focused on the research, development, the generation and sharing of new knowledge, and continuous learning. Schools, teachers, and students participate in these endeavors.
Professional Development	Supply the education system with a corps of teachers with at least minimum subject matter knowledge and teaching skill.	Teachers are expected to have a comprehensive knowledge of their field. Teacher training emphasizes the comprehensiveness and accuracy of teacher subject knowledge. Teachers may be tested on this as part of certification. Continuing professional development may not be required if mastery is achieved.	Teachers are expected to have a deep understanding of their field and principles of pedagogy. Professional development emphasizes both the deepening of teachers' subject knowledge as well as their understanding of student learning processes. This is done through a combination of continuing formal and informal experiences.	Teachers are model learners. As experienced professionals, they are primarily responsible for their own and each others' development, as colleagues and mentors. They collaborate with each other and with outside experts to build a professional community. They are engaged in creating and sharing their own body of professional knowledge and best practices.
Pedagogy	Class sizes with large student-to-teacher ratios, teaching relies on lecture.	Teaching is focused on information delivery. Lectures are common but information may be presented in a variety of forms. Alternatively, instruction can be individualized and self-paced.	Teaching is conducted in the context of complex, open-ended questions and problems and it is anchored in real world contexts. Classroom activities involve the application of key concepts and principles to analyze systems and solve problems across subjects. Internships and apprenticeships can be an important way to connect school learning to the real world.	Teaching consists of challenging students to build on their knowledge and explore new topics. Collaborative projects and investigations involve searching for information, collecting and analyzing data, generating knowledge products, and communicating with outside experts and audiences to share results.
Curriculum	Curriculum centres on basic literacy and numeracy skills.	The curriculum enumerates a large number of facts and concepts within school subjects and emphasizes their acquisition. ICT is included as a subject in the curriculum.	The curriculum identifies key, interrelated concepts and principles that organize the subject area. It emphasizes deep understanding of these within and across subjects and their application to solve complex real world problems. Curriculum implementation is responsive to local contexts.	The curriculum is flexible and responsive to student goals and local contexts. It emphasizes the development of collaboration, inquiry, information management, creativity, and critical thinking skills. Learning how to learn is essential.
Assessment	Tests of basic literacy and numeracy skills.	Assessments are composed of a large number of brief tasks that require the recall of facts and the application of principles to solve simple, one-part problems. Accuracy is emphasized. Students are tested frequently and receive regular feedback on progress.	Assessments are composed of a few extended, open-ended, multi-part problem-based projects that embed key concepts and principles and correspond to real world situations. These tasks are integrated into the learning experience.	Assessment tasks consist of investigations, reports, presentations, creative works, and other knowledge products. These products are evaluated through self, peer, and public review, as well as expert review. Assessments also emphasize student goal setting and self monitoring.
School Organization	Schools are hierarchically structured around the standardized delivery of content.	Schools are hierarchically structured with a high level of accountability and little autonomy or flexibility. Curriculum inspectors assure the curriculum is covered as prescribed. School and teacher performance is measured and rewarded by student test score gains.	Teachers have flexibility over implementing the curriculum and making it responsive to student interests, community needs, and contemporary issues. Structural flexibility allows teachers to adjust student groups or the class schedule to allow more time for projects, planning, and collaboration.	Schools are learning organizations and teachers are engaged in continuous innovation. Administrators, community members, teachers, and students create a shared vision and goals for their learning community. Within this vision, teachers have autonomy in implementing goals and accountability for results.
ICT Use	Minimum use of technology; some stand alone computing for administrative purposes. Potential of minimum networked technology to provide access to remote resources for administration and teacher professional development.	Technology is used primarily to deliver instruction and management. The ratio of students to computer may be low, if used by teachers for delivery, or high, if used by students for individualized instruction. Networking is used to support management and accountability.	Networks are used to support collaborative projects and connect students and teachers to outside contexts. Simulations and multimedia are used to support deep understanding of interrelated concepts, address misconceptions, explore systems, and solve problems.	Pervasive technology and social networks are used to support knowledge production, collaboration, and knowledge sharing by students and teachers. Networks are used to help teachers and students build knowledge communities.

Chapter 3

Case Study: Singapore

Philip Wong

Executive Summary

Singapore is a small island nation of about 700 square kilometres and a population of about 5 million people. Singapore gained its independence in 1965 and in 44 years, has attained a high economic progress. For a small country with limited resources, Singapore's economic achievement has been rated as one of the top ten countries out of 133 countries in the Global Competitiveness Report (GCR). The latest GCR ranked Singapore third, after Switzerland and the United States (World Economic Forum, 2009). In 2008, Singapore's Gross Domestic Product GDP was $257 billion (US $155 billion) and its unemployment rate was 2.2%.

To further enhance Singapore's global economic competitiveness and to keep pace with rapid technological advances, Singapore is constantly improving its ICT infrastructure. The government is investing in the Next Generation National Infocomm that will boost a nationwide ultra high-speed fibre access infrastructure to all homes and offices and a pervasive wireless network. This broadband fibre-optic network will support industries, education, and commercial companies to develop and utilize ICT-based services and products.

Since 1997, Singapore has launched three ICT in Education Master Plans, with each master plan spanning a five-year period. These master plans are in alignment with the country's push to a knowledge-based economy. In 1997, the former Prime Minister revealed the vision of "Thinking School, Learning Nation" (TSLN), (Goh, 1997). He explained the need to transform Singapore's education system into one that will prepare and build the workforce of the future. What ensued are many initiatives applied to the education system as the system makes constant adjustments to fine-tune its structure, approach, curriculum and various other aspects in a coordinated effort to better equip itself to be more responsive to the changing needs as the country grows. One of these initiatives was the launch of the first ICT in Education Master Plan (MP1).

The ICT in Education Master Plans are one strategy to maintain the country's economic competitiveness and advantage through the development of human capital, in schools and in the whole nation. It is noteworthy that although MP1 is political driven, the focus is on improving education through the use of ICT.

Another aim of the ICT Master Plans is to develop local Information Technology (IT) companies in creating new and innovative software, content and services. This is part of government's role in promoting and nurturing local IT companies. The Master Plans will not succeed if local companies are not involved and through the years, these companies have grown and have developed expertise in software development, business management, and marketing. Since English is the medium of instruction, all software developed for Singapore schools can be marketed internationally and thus, able to expand Singapore's growth market in IT.

The First ICT Master Plan for Education (MP1: 1997-2002)

There were four overarching goals in the first Master Plan:

- to enhance linkages between the school and the world around it;
- to generate innovative processes in education;
- to enhance creative thinking, lifelong learning and social responsibility; and
- to promote administrative and management excellence in the education system.

To help articulate these goals, the Ministry of Education identified four key dimensions that include: curriculum and assessment, acquiring and developing learning resources, building physical and technological infrastructure, and human resource development.

The MP1 drew to a close in July 2002 with a three-day conference called *iTopia*, which offered an opportunity for educators to exchange research findings and classroom practices related to the use of ICT in education, and showcased innovations and achievements of various schools and industries. The key achievements of MP1 are:

- students possessed basic skills to complete ICT-based projects or assignments;
- teachers possessed basic ICT competencies and were receptive to the use of ICT as a pedagogical tool;
- schools have basic infrastructure for ICT-based teaching and learning. The student/computer ratios were 6.6:1 for primary schools and 5:1 for secondary schools and junior colleges, respectively; and
- sporadic good practices on the use of ICT for teaching and learning in various schools have been identified.

ICT Master Plan 2 for Education (MP2: 2003-2008)

The second Master Plan (MP2) focused on pedagogical applications of ICT, in particular, engaging students in learning. MP2 encouraged the effective and pervasive use of ICT to enhance educational processes and structures. There were six desired outcomes for MP2:

- pupils use ICT effectively for active learning;
- connections between curriculum, instruction and assessment are enhanced using ICT;
- teachers use ICT effectively for professional and personal growth;
- schools have the capacity and capability in using ICT for school improvement;
- there is active research in ICT in education; and
- there is an infrastructure that supports widespread and effective use of ICT.

To operationalize the above principles, five major programmes were developed: ICT in Curriculum and Assessment, Professional Development, Schools' Capacity-Building; Research and Development; and Infrastructure and Support.

The MP2 likewise closed with a local conference and the following findings were reported:

- students possessed competencies in using basic ICT tools, including the Internet, email, word processing and presentation software;
- teachers also possessed these basic competencies and two-thirds of the teachers were comfortable in using existing resources to support classroom teaching;
- about 80% of the schools met the outcome expectations of MP2 and 15% of teachers performed better than expected outcomes; and
- schools possessed flexible network environments; all schools have sufficient funding to support student/computer ratios which were 6.5:1 for primary schools and 4:1 for secondary schools and junior colleges, respectively

ICT Master Plan 3 for Education (MP3: 2009-2014)

The third ICT Master Plan (MP3) was launched in August 2008; the four broad directions and goals of MP3 are to:

- strengthen the student's competencies for self-directed learning. The use of ICT could help to develop skills that are critical for survival in the knowledge age, including self-directed learning, collaborative skills, and critical evaluation of information;
- tailor learning experiences according to the way that each student learns best. Teachers need to develop the capacity to design learning activities with ICT that allow individual students to learn in the ways they learn best so as to develop their potential to the fullest;
- encourage students to go deeper and advance their learning. ICT tools are leveraged to engage students in authentic and meaningful learning activities for deep learning. For examples, to engage students in collaborative analysis of authentic multimedia sources for humanities topics so as to gain deeper understanding and appreciation of different perspectives; and
- be able to learn anywhere. To make use of wireless and mobile technologies to extend learning beyond the physical confine of classroom and structured in-school curriculum time.

Lessons Learned

There are some lessons learned from the first two Master Plans and these will help the implementation of the third Master Plan.

- teachers' readiness and the capacity to effectively integrate ICT into the curriculum remained a key challenge, particularly the understanding and application of pedagogical principles in designing ICT-based lessons;
- better ICT integration into curriculum is needed rather than using ICT as an add-on tool;
- to encourage innovation, more varied modes and methods of assessment could be incorporated, including process-oriented assessment and assessment of twenty-first century skills;
- the availability and accessibility of digital resources remained an important component to support the Master Plans;
- school leaders must possess the capacity to provide direction and create conditions for the pedagogical use of ICT in their schools; self-evaluation tools and guides were provided to schools to facilitate their implementation of the Master Plans;
- schools enjoyed sufficient funding and flexibility in developing their infrastructure and engaging technical support; and
- bridging the gap between research and practice remained a challenge; in particular, there is a gap in transferring researching findings into practice and more effort is required to motivate and coordinate meaningful research activities among the researchers, practitioners and industry partners.

Conclusion

While Singapore has implemented two Master Plans of five years each, there are still a number of major hurdles to overcome and, hopefully, some of these challenges can be addressed in the third Master Plan. For example, the scalability of good projects and good practices is still an issue which the authorities have to examine. Teachers' professional capacity to conduct good ICT-integrated lessons, the lack of computing resources in classrooms, the tension of preparing students for high-stake examinations, and the lack of collaborative projects within local and international partners are some challenges that MP3 will need to address.

Abreviations and Acronyms

CPPD	Curriculum Planning and Development Division
ETD	Educational Technology Division
GCE A Level	Singapore-Cambridge General Certificate Advanced-level Examination
GCE O level	Singapore-Cambridge General Certificate Ordinary-level Examination
IDA	Infocomm Development Authority
iN2015	Intelligent Nation 2015
IP	Integrated Program
LMS	Learning Management system
ITE	Institute of Technical Education
LSL	Learning Science Laboratory
MDA	Media Development Authority
MOE	Ministry of Education
MP1	First ICT Master Plan for Education
MP2	Second ICT Master Plan for Education
MP3	Third ICT Master Plan for Education
NE	National Education program
NIE	National Institute of Education
PSLE	Primary School Leaving Examination
TSLN	Thinking Schools, Learning Nation
WDA	Workforce Development Authority

The Context

Singapore, located at the south of Malaysia and north of Indonesia, is a small island nation with a land area of about 712 square kilometres or 275 square miles (Singapore Department of Statistics, 2009a). It has a population of about 4.99 million as of December 2009, of which 3.73 million are Singapore citizens. It is a multi-ethnic society; of the citizens, about 74.2% are Chinese, 13.4% are Malays, 9.2% are Indians, and 3.2% are other ethnicities (Singapore Department of Statistics, 2009b).

Singapore became an independent nation in 1965 and in 44 years, has attained a high level of economic development. Singapore, through the hard work of its people, has moved from a third-world economy to a first-world economy within that period (Furlund, 2008). For a small country with limited resources, Singapore's economic achievement is enviable. It has been among the top ten countries in the Global Competitiveness Report, and the latest GCR ranked Singapore third, after Switzerland and the United States (World Economic Forum, 2009). In 2008, Singapore's GDP was $257 Billion (US $155 Billion) and its unemployment rate was 2.2% (Singapore Economic Development Board, 2009). Singapore relies extensively on entrepot trade, by purchasing raw goods that it does not have and refining and exporting the processed products. Exports in electronics (e.g., wafer) and chemicals (e.g., oil refining) have formed the main source of economic revenue. Leveraging its strategic geographical location, the Port of Singapore is current the busiest in the world. Singapore Airlines and Singapore's Changi Airport have constantly being voted as top airline and airport, respectively, by many international traveller magazines.

ICT Infrastructure

Championed by the Infocomm Development Authority (IDA), Singapore has implemented 6 national ICT Master Plans since the 1980s. Under the National Infocomm Infrastructure (NII) initiative, under the ICT 2000 Master Plan, a high-speed nationwide broadband network known as Singapore One was established. Singapore One has catalysed the development of broadband industry and its ubiquitous applications in schools and businesses. The latest statistics on telecom services (Infocomm Development Authority, 2009a) reveals a household broadband penetration of over 117%, a mobile penetration of 130%, while Internet penetration amongst households is at 76% of the population.

To further enhance Singapore's global economic competitiveness and to keep pace with rapid technological advances, the Intelligent Nation 2015 (iN2015) Master Plan was launched in 2006. Its vision is to develop Singapore into an intelligent nation and a global city that is powered by Infocomm. The Government is investing in the Next Generation National Infocomm Infrastructure (Next Gen NII) that will boost a nationwide ultra high-speed fibre access infrastructure to all homes and offices and a pervasive wireless network (Infocomm Development Authority, 2009b). The Next Gen NII will support industries' strategic transition to the next phase of Singapore's economic development, for example, the digital media and the biomedical sciences industry. Concomitantly, a National Grid project will be launched to capitalize on the power of grid computing for services that require data intensive computing. It will benefit industry sectors such as finance and banking, interactive and digital media, manufacturing, and healthcare and life sciences. To complement the development of National Grid, IDA will speed up the development of Grid Service Providers that offer grid-enabled supporting services. It is also expected that the grid computing industry will further boost the broadband services.

The latest ICT Development Index in 2009 (International Telecommunication Union, 2009) ranked Singapore fifteenth of 154 countries in the world. This index combines the previous ICT Opportunity Index and Digital Opportunity Index to include 11 factors related to ICT access, use and skills, and literacy levels, and examines the cost of ICT services in the country. Singapore is ranked tenth for the subindex ICT use that includes three indicators, Internet user penetration, fixed broadband penetration, and mobile broadband penetration.

Education

As a small nation devoid of natural resources, Singapore has strategically invested in *human capital* for the country's economic development and overall well-being. Nineteen ninety-seven was a watershed year when the former Prime Minister revealed the vision of 'Thinking School, Learning Nation' (Goh, 1997). He explained the need to transform Singapore's education system into one that would prepare and build the workforce of the future. What ensued were many initiatives applied to the education system as the system makes constant adjustments to fine-tune its structure, approach, curriculum and various other aspects in a coordinated effort to be more responsive to the changing needs as the country grows. For example, Singapore reviewed the Junior College/Upper Secondary curriculum to explore a more holistic approach to preparing students intellectually for a range of university programmes (MOE, 2002). This resulted in the introduction of integrated programs, which allow selected students to focus more on learning rather than preparation for examination (Shanmugaratnam, 2003). This initiative paved the way towards a more diverse and flexible education system in Singapore.

Table 1 shows the breakdown of the number of schools, enrolment figures and the number of teachers in each type of school.

Table 1: Education Statistics

Types of schools	Primary Schools (Grades 1-6)	Secondary Schools (Grades 7-10)	Mixed Schools (Grades 1-10)	Junior Colleges (Grades 11-12)	Total
Number of schools	174	154	14	14	356
Enrolment	272,097	201,531	30,981	24,323	528,932
Number of teachers	12,723	11,062	2,112	1,997	27,894

Source: Education Statistics Digest, 2009

K-12 education

The overarching goals of Singapore's education system are to (1) develop each individual child's sense of responsibility themselves, their family, and their friends, and (2) to develop each child's sense of citizenship so they feel responsible to their community and country. There is an emphasis on the holistic development of children, which includes aiding in their moral, intellectual, physical, social, and aesthetic development. The medium of instruction for all schools in Singapore is the English language and the learning of a mother-tongue language is based on the ethnicity of the student. This is part of the bilingualism policy of the education system. (Mother tongues offered are Chinese, Malay and Tamil for the different ethnic groups of Chinese, Malays and Indians.)

Education in Singapore starts with pre-school education. Pre-school education is provided by both community-based organizations and commercial kindergartens and catering to students of ages from 3 to 6 years. The curriculum of each kindergarten will vary but most will include learning activities that develop language and literacy skills, basic number concepts, simple science concepts, social skills, creative problem-solving skills, appreciation of music, outdoor play, and mother-tongue language.

Primary Education

Primary education spans six years, with the typical age of the children ranging from 6 to 12 years old. The primary education system is broadly divided into the foundation stage (Primary 1 to 4) and the Orientation stage (Primary 5 and 6). The core subjects covered during the six years are English, Mother Tongue, Mathematics and Science. All these are studied from Primary 1 except Science, which is only introduced from Primary 3. Besides these subjects, other areas of studies are included to have a balanced curriculum. Students at the end of their six-year primary education will sit for the national level, Primary School Leaving Examination (PSLE). The majority of the students

will be examined in the four core subjects. In 2009, the MOE conducted a review of the primary education and recommended to include co-curricular activities to all primary students.

Secondary Education

Over the years, the education system has become more diverse and flexible as it strives to cater to the individual needs of the students. Based largely on students' performance at the PSLE, each student will have options as to which secondary course he or she can choose to attend. These include a Special/ Express course, a Normal Academic course and Normal technical course, or a six-year Integrated Programme.

In the Special/Express course, students will be sitting for GCE 'O'-level (Singapore-Cambridge General Certificate Ordinary-level Examination) after four years, while in the Normal (Academic) course, students will sit for the GCE 'N'-level examinations. Students who perform well in their 'N'-level examinations, will proceed to sit for the GCE 'O'-level examinations the following year. This offers opportunities for some students to learn at a pace suitable to their abilities. In the Normal (Technical) course, students will also be taking their 'N' level examinations at the end of four years. It differentiates from the Normal (Academic) curriculum in offering more practical and technical electives for the students. Students can transfer laterally from one course to another based on abilities and aptitudes.

Of the PSLE cohort, about 8.9% on average get into the Special Course, 53.5% Express Course, 25% Normal (Academic) Course and 12.6% Normal (Technical) Course.

The pathways for education through 1–12 can appear complex at first glance. A schematic representation of the key pathways is shown in Figure 1 below.

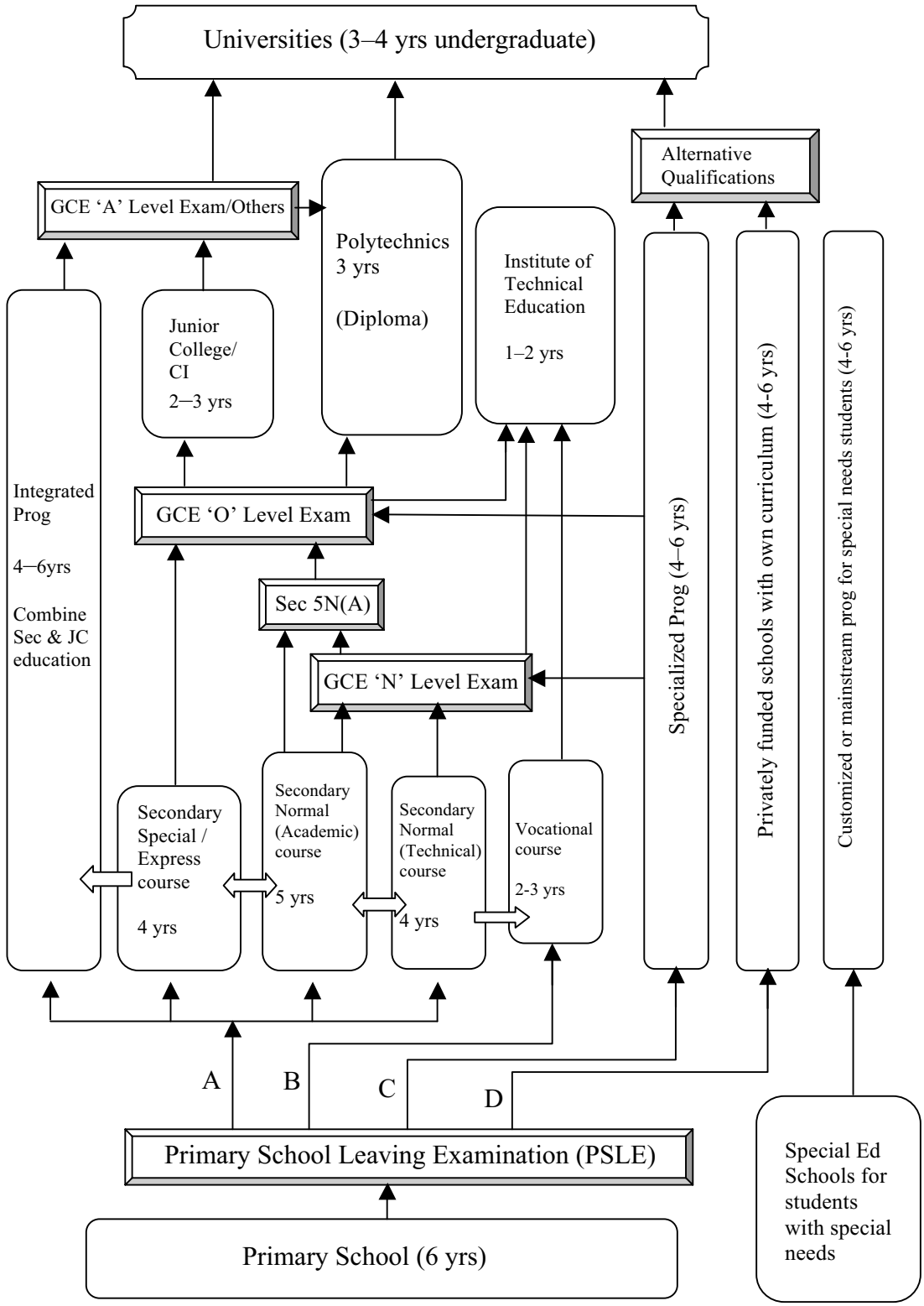
Integrated Programme

Singapore has evolved from a largely 6-4-2 system (six years in primary, four years in secondary and two years in junior colleges) to include schools with a six-year integrated programmes (IP) that allow selected students to go through a continuous curriculum leading to the Cambridge GCE 'A'-level examinations with the option of skipping the Cambridge GCE 'O'-level examinations. These programmes are offered to academically inclined students so that they can focus on learning a broader range of skills and knowledge rather than spend time preparing for two examinations (O and A levels) over three years. By removing the pressure of the 'O'-level examinations, students should be able to take greater pleasure in the learning. Note that these IP programmes essentially provide a more broad-based education such that the students can enjoy a more holistic development.

Post-secondary Education

It is worth mentioning that post-secondary education is very much part of a comprehensive education system in Singapore. After completing Secondary 4 (Grade 10 equivalent), students have many choices to further their education. Those who obtained good scores from their GCE O level have an option to continue with Pre-University Education for two more years (equivalent to Grades 11 and 12 in other countries). At the end of their two-year education in a junior college, they will sit for the GCE 'A' level and then apply for admission to universities. Another option is to continue their education in polytechnics. Students who wish to pursue practice-oriented and applied training and have the necessary GCE 'O' level qualifications can apply for admission to one of the five polytechnics. Polytechnics offer a number of professional diploma courses such as nursing, engineering, legal studies, early childhood education, business, media communication, and technology-related courses such as animation, game design, multimedia programming and many others. The courses in polytechnics are normally for a period of three years and on completion, the students can apply for admission to universities. For others with GCE 'O' or 'N' level certificates, they can further their education through the Institute of Technical Education (ITE). ITE offers 1-2 year technical and vocational courses and students who do well are able to proceed to polytechnic for diploma courses.

Figure 1: Overview of the Singapore Education System



Source: Ministry of Education (2008)

Notes:

A Schools offering integrated programmes, independent schools, autonomous schools and mainstream schools with niches of excellence have autonomy to admit some of their students directly without PSLE.
B Vocational schools have more practice-based curriculum.
C Specialized independent schools are for students with special talents such as sports.
D Privately funded schools offer more options.
E It is possible for students to cross into specialized independent schools and privately funded schools.

Workforce Continuing Education

Beyond the formal K-12 education, there is a concerted effort to continually develop the knowledge and skills of the workforce, to build a culture of lifelong learning and to encourage a mindset of innovation and enterprise (Teo, 1998). This is to encourage the workforce to remain flexible, relevant and competitive.

The Singapore Workforce Development Agency (WDA, http://www.wda.gov.sg/), a statutory board under the Ministry of Manpower, was set up in 2003. WDA aims to enhance the competitiveness and employability of a workforce that can meet the changing needs of Singapore's economy. Collaborating with industry, unions, and training organizations like the Institute for Adult Learning, WDA helps to define industry standards on workforce skills qualifications, and assists industries in several ways, including development of manpower plans, identification of skills gaps, and development and implementation of continuing education.

Achievement

The country has a high literacy rate of 96% with 89.6% with secondary or higher education (Singapore Economic Development Board, 2009). Education is compulsory for all Singapore citizens. The dropout rate has been decreasing from 5.3% in 1997 to 3.6% in 2002 and 1.6% in 2008.

The Trends in International Mathematics and Science Study (TIMSS) conducted in 2003 ranked Singapore first in both mathematics and science in a 49-country study of Grade 4 (Primary 4) and Grade 8 (Secondary 2) students. In a similar study conducted in 2007, Singapore was ranked first in science and the top three in mathematics (Gonzales et al. 2008) for both grade levels.

Singapore participated in the international student achievement in reading for Grade 4 students conducted in 2006 by Progress in International Reading Literacy Study (PIRLS, (http://timss.bc.edu/index.html). Forty countries took part in this study and Singapore was one of the three top-performing countries. The results also showed that Singapore and the Russian Federation *had the greatest percentages of high-achieving students, with nearly one fifth of students* (19%) *reaching the Advanced International Benchmark* (*e.g., could provide and support interpretations, integrate information across texts, and understand literary and organizational features*)" (Mullis et al., 2007, page 3.)

Challenges

Singapore, like many other countries, is facing the challenge to prepare students with the right skills and attributes for the twenty-first century workforce. In July 2009, a group of Education Ministers from seven top-performing school systems met in an International Education Round table in Singapore. One main topic of discussion focuses on ways to improve the education systems in order to equip students with the relevant skills, knowledge and attributes that are required in the twenty-first century. In their discussion, they identified a number of challenges education systems face. One of the most challenging issues highlighted during the meeting was the need to prepare students to work in a knowledge-based economy and the need to provide high-quality education to all rather than just the elite. Basic education is not sufficient to equip tomorrow's workforce, as future jobs require workers with post-secondary education. They also mentioned that students of the future would require a strong knowledge base and, in addition, many other skill sets such as cross-cultural communication, creativity, good ICT literacy and interpersonal skills. These attributes will allow them to work globally interacting and solving problems with international colleagues. The challenge for education systems is to find a balance between content competency and other twenty-first century skills (MOE, 2009). Similarly, Singapore's education system is also facing a challenge to strike a balance between content acquisition and the development of twenty-first century skills. In the past, Singapore's education system has emphasized the acquisition of content knowledge and has placed less emphasis on the development of other attributes, such as communication skills, problem solving skills, creativity, and collaborative skills. In the past few years, the MOE has taken steps to remedy this and has introduced a number of initiatives to develop these skills at the school level. For example, project work has been introduced to students in both primary and secondary schools and is now a compulsory subject at the GCE 'A' level. Currently, the MOE is preparing its future curriculum for implementation by 2015, which has strong emphasis in developing twenty-first century skills among students.

To prepare students for the future economy in Singapore, it is necessary to reduce wastage in the education system. Singapore has no natural resources and depends only on its people to create and sustain its economy. As such the Government is concerned with the percentage of school dropouts. Although the drop-out rate in 2008 was low at about 1.6% of a school cohort of about half a million students, it will have an impact on the country's knowledge-based economy. When students drop out from the school system, they will not have completed ten years of education and will thus miss the chance for post-secondary education that will equip them with skills for the future workforce. The concern to reduce the dropout rate has sparked off a number of initiatives introduced by MOE. There are programmes to identify at-risk students and to implement various invention strategies such as education and career guidance, counselling, participation in co-curricular activities, social support for families, introduction of practical-oriented elective subjects and many other school-based educational support programmes. To further reduce the attrition of at-risk students, the Ministry provides an additional full-time counsellor and operations manager to schools that have a higher proportion of at-risk students (Zulkifli, 2008).

Another challenge to the Singapore education system is to provide equal opportunities for all students so that students' education will not be hampered because of the lack of funds or facilities. Due to the downturn of economy in 2009, the unemployment rate has increased and many families are faced with financial difficulties. Many families have reduced income and may find difficulties in coping with expenses. To reduce expenditure some families may resort to taking their children off school and into the labour market. The Government has put in place a number of strategies to provide financial assistance to families with school-going children. They are a number of government schemes to assist companies, employment, individuals during this period of financial crisis. Schools have also available a scheme of financial assistance and bursary scheme. Families with two school-going children and a gross income not exceeding $1,500 (US $1,100) per month and those with three or more school-going children and a gross income not exceeding $1,800 (US $1,280), are eligible for financial assistance. School and other fees are waived for eligible students, free textbooks and school uniforms are provided and some are eligible for bursaries (MOE Website, http://www.moe.gov.sg/initiatives/financial-assistance/). In addition, there is a community-run programme, School-Pocket Money Fund, which provides pocket money for school children to purchase food in the school canteen and for personal use.

While the Ministry of Education is promoting the use of technology for learning, there is a concern that some households can not afford to buy computers and to subscribe to Internet services for their children. All schools provide e-learning content and learning activities through their learning management system and it is expected that students be able to access them through the Internet. Schools often conduct various online collaboration activities and project work and students are required to do research using the Internet. Under these circumstances, students who do not have appropriate computer environments at home will be disadvantaged. Together with the IDA, the Government has developed a scheme to provide computers and Internet access to households who cannot afford to purchase computers. The scheme, called the Neu PC programme, started in 1999 with the first ICT in Education Master Plan. The scheme provided qualified households with a computer, the necessary licensed software and Internet access. They had to pay a small amount as co-payment and since then, 27,000 households have benefitted from the program. In 2006, the scheme was enhanced with new qualifying conditions and reduced co-payment. The Neu PC Plus programme provides the following schemes: a PC Bundle scheme, an INSPIRE fund, and a Broadband-only scheme. The INSPIRE fund is supported by the industries and IDA and provides additional funds to help those needy students to own a free computer by allowing them to contribute in kind through community service. Since 2006, an additional 7,000 households have benefitted from the Neu PC Plus programme and it is expected that 38,000 needy households will benefit by 2015 (Infocomm Development Authority, 2009c).

While there is an emphasis on the use of technology for teaching and learning and also for personal lifestyle, there is a concern for the need for students to be aware of the potential hazard of participating in online activities. Students' cyber wellness is a concern for all and it has been included as part of the third ICT in Education Master Plan. Recently, a study was done by the National Institute of Education (NIE), on the gaming habits of students. In a three-year study involving 3,000 primary and secondary school students, the researchers found that youths are spending about 27 hours per week playing computer video games such as Maple Story® and World of Warcraft® – Yes. Commercial products. The acting Minister for Information, Communications, and the Arts, Liu Tuck Yew

expressed concerns that the figure was so high (Chua, 2009). The figure is high when compared to American youths who spend about 13 hours per week on computer games. The authorities are concerned about this excessive gaming among students and the effects of gaming on their psychological development.

Policy Features

Singapore introduces three successive ICT Master Plans for education since 1997. This phased approach provides schools with concrete foci in each Master Plan and encourages the schools to make incremental progress building on the foundations laid by the preceding Master Plans.

Before the conceptualization of the first ICT Master Plan in 1997, there were many ICT-based projects. However, these projects were not nationally driven and started on an ad hoc basis. These projects were mostly exploratory and schools joined on a voluntary basis. One example is the AITP – Accelerated ICT Practice for primary schools. A number of primary schools group together with the support from the Ministry of Education (MOE) to introduce the use of computers in teaching and learning. Similarly, projects were started by a number of secondary schools, and junior colleges (university matriculation colleges) to help students to acquire ICT skills and use technology for teaching and learning (Wong, 1999). The National Computer Board, a government body for promoting the use of technology for education, business and administration was also involved in a number of projects for the schools. They supported the schools by working with various IT companies to provide the technology and skills training. There were many pockets of innovation but there was no synergy among the projects, no systematic scaling-up of projects and no plans for its sustainability. The Ministry of Education felt that there was a need to mount a national programme to help school operationalize the use of technology and to get all schools involved rather than just a pocketful of schools.

In 1997, the Prime Minister, Mr Goh Chok Tong announced a vision for Singapore's education system – Thinking Schools, Learning Nation – this is an important philosophy for the country's educational system and until today, we are referring to this phrase in our educational reforms. It is important and should not be removed.. The vision describes a country with its citizens committed to be lifelong learners and schools to serve as the cradle for promoting this vision through their thinking students. Schools' programmes and initiatives shifted to help students acquire and develop good thinking skills. One of the initiatives to help support the TSLN vision is the introduction of the first ICT Master Plan for Education. The underlying philosophy of the Master Plan is that "education should continually anticipate the future needs of society, and work towards fulfilling those needs." The skills required for the future will centre on thinking skills, learning skills and communication skills' (MOE, 2002a).

The First ICT Master Plan for Education (MP1: 1997-2002)

Goals

There were four overarching goals in the first Master Plan (Teo, 1997):

- enhance linkages between the school and the world around it;
- generate innovative processes in education;
- enhance creative thinking, lifelong learning and social responsibility; and
- promote administrative and management excellence in the education system.

Implementation Strategies

To help achieve these goals, four key dimensions were identified:

Curriculum and assessment

ICT tools were leveraged to help students shift from an acquisition mode of learning to one that engages higher order thinking, such as application, synthesis and evaluation. For example, Internet, email and video-conferencing tools were used for Singaporean students to collaborate with students in Southeast Asian Ministers of Education Organization (SEAMEO) countries. A target was set for schools to integrate ICT into 30% of the curriculum time.

Content and learning resources

Software and web-based resources were developed to meet the increasing demand of ICT-enriched teaching and learning environments. An Internet Education Resources (IER) portal was developed by the MOE to provide schools with information on relevant Websites for teaching and learning. The MOE also set up a central software clearinghouse to provide recommendation on software appropriate for local curriculum. Several digital learning resources were developed by the MOE, sometimes in partnership with the software industry.

Physical and technological infrastructure

The goal was to provide teachers and students with adequate access to hardware and the Internet. A network was developed to connect all the schools to the MOE and to Internet services. For teachers, the target for teacher–computer ratio was set at 2:1 and a computer purchasing scheme was provided to subsidize teachers for the purchase of personal computers. For students, a 2:1 student–computer ratio was targeted, starting with 6.6:1 student–computer ratio for primary schools and 5:1 for secondary schools and Junior Colleges. In addition, schools are provided with guidelines and budget to purchase necessary ICT equipment like projects, digital cameras and printers and to upgrade the school's physical infrastructure with additional LAN points and power points.

Human resource development

The target was to equip all teachers in Singapore with the necessary ICT skills and pedagogical knowledge on the appropriate use of ICT in teaching and learning. ICT trainers were engaged to provide all teachers training on basic computer operation and office productivity software.

The Educational Technology Division (ETD) in the MOE provided training on the pedagogical use of technology for teaching and learning. To reach out to more than 25,000 teachers, ETD implemented the training in three phases. In addition, a cascading approach was adopted by seconding trained teachers with relevant ICT expertise to ETD as trainers. Using this approach, in three years, all the teachers went through at least 30 hours of core training.

Budget

The Government committed a budget of S$2 (US $1.2) billion from 1997 to 2002 for the implementation of the first ICT Master Plan (Teo, 1997). This amount included funds for computers, full networking of the schools, physical renovations, software and courseware, and teacher training. In addition, a $600 (US $375) million was provided to replace hardware, develop new software for teaching and learning and for teacher professional development. This amount was committed for the five-year ICT Master Plan but the actual expenditure was much less as equipment costs decreased and there were savings from various cost-saving exercises such as purchasing in bulk, open tenders, and obtaining cheaper costs through competitive bidding. There are no official published figures but gleaning from various sources, the actual cost for the first ICT Master Plan for education would be much less than budgeted.

ICT Master Plan 2 for Education (MP2: 2003-2008)

The first Master Plan equipped all schools with the necessary equipment and infrastructure, and provided training to all teachers. Building on this foundation, the second Master Plan focused on pedagogical applications of ICT, in particular, engaging students in learning.

Goals

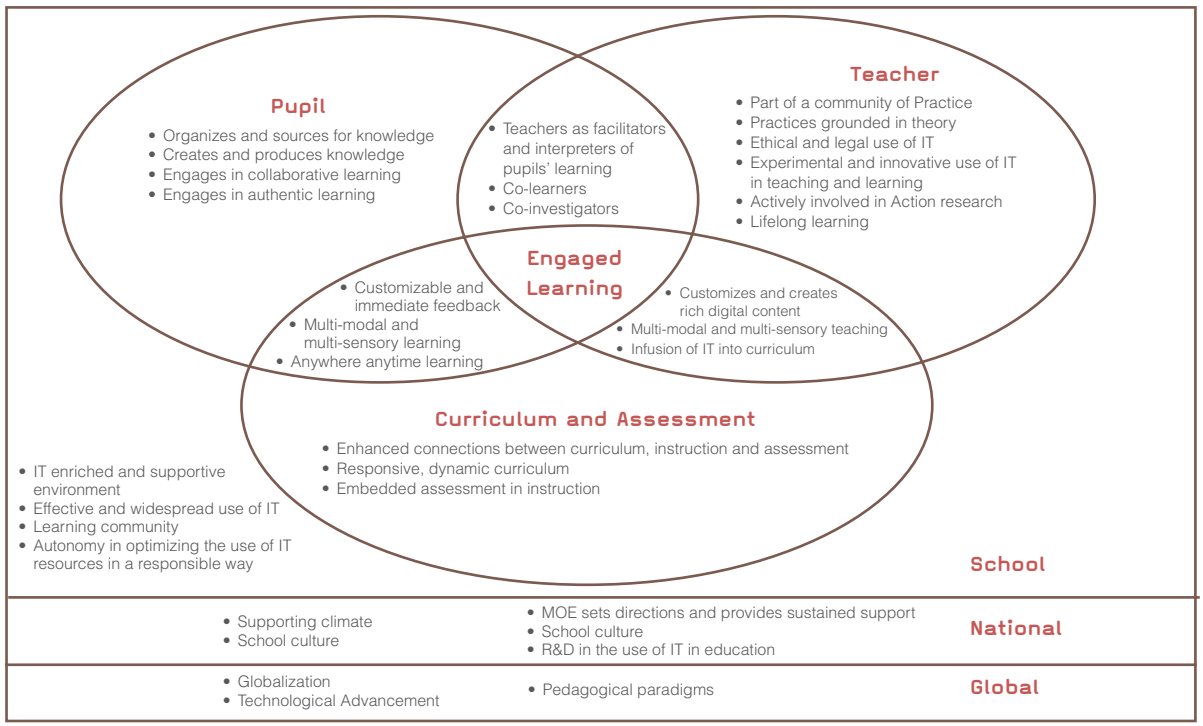
MP2 encourages the effective and pervasive use of ICT to enhance educational processes and structures. The six desired outcomes for MP2 are:

- pupils use ICT effectively for active learning;
- connections between curriculum, instruction and assessment are enhanced using ICT;
- teachers use ICT effectively for professional and personal growth;
- schools have the capacity and capability in using ICT for school improvement;
- there is active research in ICT in education; and
- there is an infrastructure that supports widespread and effective use of ICT

Conceptual Framework

MP2 aims to balance the pedagogical practices that are predominantly teacher-centric to include more student-centric pedagogy practices. It adopted a systematic and holistic approach that addresses various interrelated factors that could bring engaged learning in classrooms to fruition: changes in curriculum and assessment, teachers' capacity-building, pupils' learning, school infrastructure and culture, research and development activities that support the use of ICT in education.

Figure 2: MP2 Conceptual Map



Source: Koh & Lee, 2009, page 60

Implementation Strategies

Through an analysis of the existing reality in schools and the desired outcomes, several broad principles were articulated to guide the implementation of MP2 (Table 2).

Table 2: Desired Targeted States for MP2

Existing state	Targeted state
ICT was used to support existing curriculum	There is seamless integration of ICT into curriculum, starting at the planning stage of curriculum design
Predominant use of static content in print form	Predominant use of a repository of dynamic digital content
One-size-fits-all approach	Customization and ability-driven approach
Teachers demonstrate basic skills and competencies in the use of ICT for teaching	Teachers demonstrate a range of competencies in the use of ICT for teaching
Phased approach in the implementation of technology in schools	Schools have greater ownership and accountability in technology implementation
Standard technology provisions for all	Flexible technology provisions for all
Predominantly practicing teacher-centred pedagogies	Predominantly practicing pupil-centred pedagogies

To operationalize the above principles, five programmes were developed.

1. ICT in Curriculum and Assessment

This programme was similar to and reinforced one of the goals set in MP1, that is, to shift learning from information receiving to information process and knowledge creation. To achieve this, it emphasized seamless integration of ICT into curriculum and leveraging ICT for formative assessment and summative assessment.

This programme included MOE-initiated projects. For example, the use of graphic calculators was specified in the mathematics curriculum and data loggers were used for students' science practical assessment. Instead of distributing contents through CD-ROMs, the MOE focuses on development of rich digital media content in the forms of learning objects that could be accessed through online portal. MOE also set up a portal called edu.MALL that hosted these learning objects and other related resources.

Complementing MOE initiated projects, schools were encouraged to develop and share their resources. An online platform called iSHARE (inter-cluster Sharing of Resources) was developed to facilitate sharing of resources among schools.

2. Teacher Professional Development

While MP1 provided largely standard basic training programs, professional development in MP2 emphasized customization. Schools were given autonomy to decide on the types of professional development programmes required for their teachers. Professional development guides were provided to help teachers and heads of departments to identify their learning needs.

In addition, rather than relying mainly on trainers, greater emphasis was given to professional sharing among teachers. Teachers were funded and encouraged to attend and present in local and international conferences, seminars and workshops. There were also attempts to set up communities of practice among the teachers.

To recognize teachers for their contributions, the MOE worked with industry to provide several awards to encourage innovative use of ICT. One such award was the MOE-Microsoft Professional Development Award.

3. Schools' Capacity-Building

While MP1 was primarily driven by the MOE ("top-down" approach), MP2 encouraged schools' autonomy and ownership ("bottom-up" initiatives). To this end, several strategies were implemented.

First, schools were given autonomy to manage ICT funds to purchase equipment and develop infrastructure to support customized ICT programmes in the schools. Instead of governing and managing standardized provision, ICT consultancy services were provided by the MOE. The main responsibility of consultancy teams was to support

the schools' initiatives by providing professional advice such as technical requirements of projects or assisting schools with experimentation on emerging technologies.

In addition, to building schools' capacity in evaluating their ICT programs, a self-assessment rubric was developed and shared with schools. The rubric, Benchmarking Your ICT Practices for Excellence in Schools, or BY(i)TES, has been used by all schools as part of their schools' annual self-evaluation exercise.

4. Research and Development

To promote active experimentation on the use of ICT for engaged learning, a research and development (R&D) unit was set up in the Educational Technology Division in the MOE. This unit focused on applied research works that could inform pedagogical practices in schools. Complementing the R&D unit, the Learning Sciences Laboratory (LSL), located in the National Institute of Education, was set up in 2005. Partial funding for the set-up of the lab was drawn from the research budget of MP2. LSL's mission is "to foster deep student learning with technology-enabled pedagogical practices for cultivating twenty-first century knowledge and skills through learning sciences research in Singapore schools" (http://www.lsl.nie.edu.sg/about.htm). Researchers in LSL worked with schools to explore innovative practices with the use of technology and to investigate how these practices can be made sustainable and scalable. There were five signature research models in LSL: New Literacies, Science as Systems, Mathematics & Problem-Solving, Knowledge Building Community, and Emerging Research & Pedagogies.

5. Infrastructure and Support

While MP1 provided the schools with basic ICT infrastructure and equipment mainly through centralized control by the MOE, under MP2, schools had greater autonomy to enhance their ICT infrastructure to meet their varied modes of lesson delivery. Three key strategies were adopted by the schools:

- to enhance Internet access;
- to enhance ICT-enriched environments, both in schools and at home; and
- to provide greater technical support.

In MP1, all school networks were connected to the MOE's network, including Internet access. In MP2, while the schools maintained the connection to the MOE's network for official works and data communication, a separate network was provided with higher bandwidth to allow schools better access to multimedia content and to experiment with newer technologies. The schools' individual bandwidth ranged from 3 Mbps to 5 Mbps which is complemented by a shared bandwidth of 200 Mbps among all the schools.

To provide an ICT-enriched learning environment for all students, sufficient funding was provided for schools to achieve a student/computer ratio of 6.5:1 for primary schools and 4:1 for secondary schools and Junior Colleges. In addition, students from low-income families continue to benefit from the NEU PC scheme, a collaborative project under the Infocomm Development Authority and the IT industry, to purchase a new desktop and three-year unlimited broadband access for under S$300 (US $200).

The schools continued to enjoy the basic ICT support provided by the MOE, including a central helpdesk, an on-site technical assistant, and network and asset management support. The schools were given the option to purchase additional support service, including hiring an ICT Executive.

Budget

MP2 was announced at iTopia in 2002, and further articulated in 2003. The overall MP2 budget for 2003-2009, was $600 (US $400) million, breaking down to $300 (US $200) per student or roughly $450,000 (US $300,000) per school. The initial amount budgeted for the Financial Year (FY – 1st April to 31st March) 2003 and 2004 was $120 (US $80) million. This covered various expenditure areas, such as the replacement of ICT equipment, deployment of new ICT infrastructure, courseware development, training, and selected pilot projects on ICT in curriculum and assessment. This amount was small compared to the first ICT Master Plan because most of the infrastructure had already been

put in place and equipment cost was reduced by more than half. No official announcement was made on the actual expenditure on MP2.

ICT Master Plan 3 for Education (MP3: 2009-2014)

The third ICT Master Plan was launched by the Minister of Education, Dr. Ng Eng Hen, during the opening address for the inaugural International Conference on Teaching and Learning with Technology in August 2008.

Goals

As a continuation of the vision's first two Master Plans, MP3 aims to harness ICT to transform the learning environment for the students. The minister's speech outlined four broad directions and goals of MP3:

- Strengthen students' competencies for self-directed learning. The use of ICT could help to develop skills that are critical for survival in the knowledge age, including self-directed learning, collaborative skills, and critical evaluation of information.
- Tailor learning experiences according to the way that each student learns best. Teachers need to develop the capacity to design learning activities with ICT that allow individual students to learn in the ways they learn best so as to develop their potential to the fullest.
- Encourage students to go deeper and advance their learning. ICT tools are leveraged to engage students in authentic and meaningful learning activities for deep learning (for examples, to engage students in collaborative analysis of authentic multimedia sources for humanities topics so as to gain deeper understanding and appreciation of different perspectives).
- Learn anywhere. To make use of wireless and mobile technologies to extend learning beyond the physical confine of classroom and structured in-school curriculum time.

Operationally, to achieve a systemic and holistic engagement of the key stakeholders in schools, more concrete goals were set for students, teachers and school leaders (Teo, 2010). These include:

- students develop competencies for self-directed and collaborative learning through the effective use of ICT, and become discerning and responsible ICT users;
- teachers gain the capacity to plan and deliver ICT-enriched learning experiences for students to become self-directed and collaborative learners, as well as nurture students to become discerning and responsible ICT users;
- school leaders provide direction and create conditions to harness ICT for learning and teaching;
- ICT infrastructure enables and supports learning anytime, anywhere.

Implementation Strategies

Four broad strategies were articulated for MP3:

1. ICT in curriculum

As a continuation of MP2, rather than using ICT as an add-on for traditional mode of teaching, MP3 aims for better integration of ICT in curriculum and teaching. ICT integration planning starts from the of curriculum and assessment design stage, so that teachers consider pedagogical applications of ICT into lesson designs even before classroom teaching. fDue attention is given to developing students' awareness in cyber-wellness issues.

2. Building the capacity of teachers

A comprehensive professional development road map will be developed for teachers and school leaders. In addition, specialist teachers will be identified and deployed to provide leadership in pedagogical applications of ICT.

3. Improve the sharing of best practices and successful innovations

To encourage sharing of best practices and dissemination of research findings. This involves setting up a network comprising educational labs, situated in Lead ICT schools and FutureSchools, as well as research labs in higher education like the National Institute of Education.

4. Enhance and upgrade infrastructure

Moving in tandem with the trend of increasing bandwidth, increasing computing power, and decreasing costs, school and home computing environments will be further enhanced to enable anytime, anywhere learning.

The Policy Rationale

The political will to make the ICT Master Plans for education a success in Singapore is very strong. The three ICT Master Plans for education were all launched by the Minister of Education in 1997, 2002 and 2008 respectively. It is worth noting that this political driving force is coupled with an emphasis on building capacity of the people through education, so as to maintain the economic competitiveness of the country in an innovation-driven economic era.

The launch of the inaugural ICT Master Plan for Education was preceded by a speech from the former Prime Minister, Goh Chok Tong should not cut – to highlight that ICT is supported at the highest political level "Singapore vision … for the future is encapsulated in four words: THINKING SCHOOLS, LEARNING NATION" (Ministry of Education, 1997)) – correct reference. In this speech, which was made in the opening address of the 7th International Conference on Thinking in 1997, the former Prime Minister explained the situational challenges to Singapore: the country is facing an intensely global future with diminishing barriers and ever-changing competition field, Knowledge and innovation will be critical for a country to maintain its competitive edge, and the people must recognize change is constant and be able to adapt to change. Thus, the future wealth of the country is dependent on the capacity of its people for learning. The vision of Thinking Schools was elaborated in the speech: one that focuses on developing students' passion for learning and the capacity to think critically. The strategies include curriculum review and introduction of innovative methods like the use of ICT in teaching and learning. The vision of Learning Nation focuses on developing lifelong learning as a national culture, extending learning beyond schools to all life stages, especially among the workforces.

The underlying message in the speech is that it is imperative for Singapore to maintain its economic competitiveness through education. To understand this rationale, we need to review the constraints faced by the country. Singapore has a land area of about 700 km^2 and a population of less than 5 million, including non-residents. As a small country devoid of natural resources, human capital becomes the key asset for its economic competitiveness. Singapore's government has long recognized that the knowledge-related economy demands knowledge workers who are self-directed learners and can adapt to change quickly. Investing in human capital has reaped its profits. In the Economic Restructuring Committee report (Economic Restructure Committee, ERC, 2003) from the Ministry of Trade and Industry, the committee recommended that Singapore has to remake and upgrade in order to make "… Singapore a leading global city, a hub of talent, enterprise, and innovation" (ERC, 2003, page 5). Singapore is moving towards a knowledge-based economy, has to be entrepreneurial and open to new ideas, be creative and innovative, and developing new products through research and development. In terms of manufacturing, Singapore has to move up the value chain supported by strong research and development. Singapore has to be a leader in Asia to offer first-class services in finance and banking, tele-communication, ICT, education, healthcare, tourism, and others.

The relationship between ICT and a knowledge economy is evident from many technical reports. For example, a study has shown that ICT capital goods have contributed significantly to the economic growth of the G7 (Schreyer, 2000). Similarly, another study found that among the OECD countries, the growth of GDP is attributed to the investment in ICT between 1990 and 1995, and 1995 to 2003 (Ahmad, Schreyer, and Wölfl, 2004). An OECD report (2007) – have changed dateexplained the catalytic role of ICT in economic development and activities, which creates

values not from the ICT goods, but also application|s related to technology. For example, the introduction of broadband technologies in a country requires investment in the infrastructure, which stimulates related industries like development of applications that tap into broadband, and consequently brings about improvement in the service industry, including customer benefits (OECD, 2007). Thus, ICT creates a whole new ecology in raising the demand on ICT specialists and ICT-using occupations, which make up a high percentage of total employment in most advanced economies (OECD, 2009) (e.g., 20.2% in the United States and 28.0% in the United Kingdom). The introduction of technologies also permeates to all sectors in a society and creates profound impact on education.

Thus, the first ICT Master Plan was driven by the vision of Thinking Schools, Learning Nation Vision, one that is underpinned with maintaining the country's economic competitiveness and advantage through the development of human capital, in schools and in the whole nation. The first ICT Master Plan reinforced this message by stating its philosophy: "education should continually anticipate the future needs of society and work towards fulfilling these needs" (Singapore Ministry of Education, 1997). - It is worth noting that although MP1 is politically driven, the focus is on improving education through the use of ICT. This is clearly reflected in the four goals of MP1 presented in the earlier section. It implied a belief in the potential benefits of using ICT for education in improving curriculum and pedagogy, administrative efficiency, lifelong learning and social responsibility.

MP2 was launched by Mr. Tharman Shanmugaratnam, who later became the Minister of Education, in his keynote speech for a local conference called iTopia. In his speech, it is clear that the philosophy to prepare the people for the future needs of the society remained unchanged. MP2, however, has a much stronger emphasis on the use of ICT to enhance teaching and learning. This is reflected in the focus on engaged learning, as discussed earlier. There is also a greater emphasis on systemic approach by engaging not just the students, but also the teachers, the schools and the wider community in the Master Plan.

MP3 was similarly launched by the Minister of Education, Mr. Ng Eng Hen, in 2008 in a local conference called iCTLT. The Minister reviewed the learning experiences in the first two Master Plans and again stressed that MP3 is a continuum of the vision of the first two Master Plans. There is, however, an even stronger emphasis on the innovative use of ICT for teaching and learning, particularly in developing twenty-first century skills in students.

The Policy Development Process

The ICT in education Master Plans are blueprints and frameworks for the directions on the use of technology in education. Each Master Plan provides a guide for a period of five years, although during that period, new technologies may be introduced. However, the plans are not dependent on technologies alone but also overall strategic pedagogical thrusts for teachers and educators in the use of technology for teaching and learning. As mentioned in the previous sections, the ICT Master Plans are based on strong pedagogical principles for the use of technology for administration, assessment, teaching and students learning. The strategies in the Master Plans are all related to education, and thus, they have to be crafted by educationists with inputs and advice from various experts in the ICT field. The following section describes some of the processes applied in developing the Master Plans. These processes are not sequential and many of these processes are conducted concurrently.

Setting Up a Master Plan Steering Committee

The ICT Master Plan is an educational plan and thus it must have the support of all the officials in the MOE. This Master Plan has to be aligned with other learning initiatives of the Ministry. For example, the Master Plan is aligned with other working groups within MOE, such as the committee that is overseeing the professional development programmes for principals and teachers, the curriculum committee that is designing a new curriculum, the assessment committee which is exploring alternative and authentic – an acceptable educational term in education assessment – means based on real-world challenges that require students to apply their knowledge and skills.

Please don't remove this word.assessment modes, and other working committees. An MOE official will head the Master Plan steering committee whose function is to set the general direction in crafting the Master Plan.

Setting Up Sub-Committees

From the steering committee, various sub-committees are formed. These sub-committees are tasked to work at different sections of the Master Plan. The number of sub-committees will depend on the thrust of the Master Plan and normally, each sub-committee is chaired by a senior officer, who could be from the MOE or a principal from the school. The sub-committee will have MOE officials from the educational technology division, curriculum planning division, schools division. School principals, teachers, schools' ICT department heads, faculty staff from NIE and researchers from LSL are also be co-opted into the sub-committees. The number of members in the sub-committee will be at the discretion of the chair of the sub-committee. The sub-committees are supported by officers from MOE who act as secretariat and they work as a team to look at the sections under their purview. They will submit a draft report to the other sub-committees for review and alignment of reports.

Learning from the Past Master Plans

The MOE also conducts feedback studies on the implementation of each of the Master Plans. Principals, teachers, students and ICT vendors provide feedback on issues pertaining to the implementation of the Master Plan. Besides looking at the teaching and learning components of the Master Plans, the MOE will also obtain feedback of the administrative aspects of the implementation of the Master Plan. For example, they will examine issues related to disbursement of funds, schools' use of funds, types of hardware purchased, types of ICT services purchased and other administrative details. They will also track the kinds of problems that schools may face during the implementation and include these issues as inputs into the crafting of the Master Plans.

Singapore has developed three Master Plans and has learned many lessons from the past. At the end of each Master Plan, an international team conducts an evaluation study on the effectiveness of the Master Plan. In their reports, the evaluators will highlight achievements and areas for improvement. They will also provide some recommendations on how to move forward in the next plan. These reports are valuable as they provide information for the sub-committees that are preparing for the next Master Plan. The sub-committee will study the evaluation reports and may propose some suggestions to be incorporated into the next Master Plan.

Review of Literature

Before starting to develop the Master Plan, some officials from the ETD and academics from the university conduct a literature review on the use of technology in teaching and learning. This is important as there are many research studies being carried out all over the world. They scan research reports, best-practice reports, reports describing trends in the use of technology for teaching and learning, position papers, and conference papers, and then synthesize these reports into easy-to-read documents to support the work of various sub-committees. It is important to learn from others to avoid costly mistakes and also to consider adopting some innovative strategies.

Scanning the Landscapes

Many countries have their own ICT Master Plans and have implemented ICT in education projects. For example, the United Kingdom and Queensland (Australia) both have a comprehensive ICT plan for their schools and it is interesting to learn from them. A country's ICT plan cannot be replicated by another country because of the differences in education systems and their social and cultural contexts, but there are many similarities and common issues which schools all over the world may be facing. Thus, it is a good practice to learn and share with the global community.

Since the Master Plan has components for technology and the plans span the next five years, it is vital that the sub-committees be aware of new technology developments. Some of these new developments can have an impact on

students' learning. For example, five years ago, when the second Master Plan was developed, there was not much development in educational games. By 2009, Internet gaming was so prevalent that a Master Plan for the next five years could not ignore this trend. Similarly, five years ago, there was hardly any use of social networking software such as Twitter or Facebook; smart phones were not readily available; wireless technology was not prevalent; and mobile computing was limited. By 2009, these technologies were pervasive in Singapore's ICT environment. All these technologies have an impact on the delivery of lessons and content. Thus, there is a need to be aware of technology trends as some of these technologies are useful for teaching and learning and can be incorporated into the Master Plan.

Study Trips

Study trips are incorporated as part of the envisioning process in planning. Members of various sub-committees will go on study trips to selected counties to visit schools, universities, research centres, departments of education, industries and IT companies. The purpose of these trips is to learn from others, understand how systems work, study how some processes can help teachers and schools, look at new technologies, explore potential industry partnerships and see examples of how some schools execute their country's Master Plan. These educational visits provide extra information and knowledge that can be fed back to other sub-committees. At the end of these trips, there is an exchange and sharing of lessons learned. The various sub-committees will then discern and may suggest some learning points to be incorporated into the Master Plan.

Industry Collaboration and Feedback

IT companies in Singapore play an important part in the implementation of the Master Plan. For example, in the second Master Plan, various IT companies developed e-learning content for teachers and students to use. They have developed content materials for simulation, animated visuals, different types of learning objects, instructional video clips, self-paced learning materials, online activities, and even learning management systems. They have developed learning and administration portals for schools, as well as communication systems and other systems to help the schools implement their ICT plans. These companies may provide skills training for the teachers and students, and work with teachers to develop tools and content for the schools. As such, the IT companies play a vital role in supporting the schools and they are considered to be a key partner by the schools. Their experience at the school operational level can provide valuable feedback on the implementation of the Master Plan. Thus, the sub-committee will engage them in a dialogue to tap on their experiences and get inputs from them for consideration for the next Master Plan.

Consultation with Other Ministries

Since this is a national plan for education, it is important that the document take into consideration other ministries' plans. This will ensure that the ICT Master Plans are in alignment with the country's broad thrust and direction in developing the economy. In Singapore, the IDA developed the iN2015 strategic plan for technology infrastructure and the use of technology for all the whole country. In their in2015 plan, there is a section on ICT in education and since this document was developed before the third ICT Master Plan, it was used as a reference point. In addition, a senior official from the IDA participates as a member in the sub-committees and provides input from the technological viewpoint. Media Development Authority has a strategic plan on media in learning and this is also be taken into consideration when crafting the ICT Master Plan.

Budget Proposals

Once a draft ICT Master Plan has been drawn up, a sub-committee will look at the cost of the various projects and determine the kinds of funding required. Although the actual costs of implementing future projects are hard to determine, it is necessary to provide an estimate of the costs. The officers from the Finance division in the MOE and officers from the technology group in the ICT Master Plan office will help. An estimated cost for the following

items are usually included: manpower, equipment, maintenance, software and content development, training costs, research, and special project costs.

Communication of the Master Plan

Before submitting the whole plan to the MOE senior management for approval, the MOE will organize a feedback session on the draft plans. School principals, school ICT department heads and relevant personnel from other organizations are invited to attend a day's session on the draft plan. During the sessions, participants will be divided into groups and they will look at the proposed parts of the draft plan. They will give feedback, provide suggestions and raise issues on the feasibility of the plans. This is a useful exercise as it shows that the process is consultative, and that principals have a stake in the future execution and implementation of the plan. The draft plan is then refined based on feedback from the participants and it will then be submitted to the senior management for approval.

Senior Management Approval

At this stage, the draft ICT Master Plan is completed and submitted to the senior management of the MOE for approval. They are briefed on the Master Plan and the committees will work on the feedback and comments from senior management. If everything is fine, then the plan is submitted to the Ministry of Education for review. The Ministry will then announce this plan in one of the ICT conferences organized by ETD where all principals and heads of ICT departments are present.

In summary, this whole planning process takes up to 1-2 years before the launch of the Master Plan and it is a time-consuming planning process. The series of activities are necessary so that the plans are feasible, strategic and able to address future concerns in improving teaching and learning with technology.

Governance of the Reform Process

The policy rationales underscore the political will of the Singapore government in developing its citizens' capacity to be adaptive and innovative lifelong learners. The MOE is the key driver for the ICT Master Plan, with a strategic framework that leverages intraministry collaboration, interministry collaboration, partnership with institutes of higher education and partnership with ICT industries and other organizations (Koh and Lee, 2009).

Ministry of Education

Within the MOE, the Educational Technology Division was established at the launch of MP1 to spearhead the implementation of the Master Plan. It provided professional development for teachers and assisted the teachers in designing ICT-based lessons, identified and recommended appropriate software or technologies to schools and provided guidance in planning and setting up physical infrastructure in schools. In MP2, an R&D section was set up in ETD and it started to provide more customized consultancy services to schools.

The implementation of the ICT Master Plans requires holistic and concerted effort of people of different expertise and a range of resources. Within the MOE, the ETD works with various divisions such as the Curriculum Planning and Development Division (CPDD), the Information Technology Branch and the Training and Development Division. Each of these divisions plays a key role in shaping and implementing the policy. For example, one of the key roles of CPDD is to review the syllabuses of various subjects in the schools. Better integration of ICT into schools' curriculum should start at this level.

In addition, a Master Plan Project Office (MPO) was set up in 1997 for the administration, coordination and monitoring of the Master Plans.

Interministerial Collaboration

The IDA champions the development of a vibrant and competitive ICT industry in Singapore to enhance the country's economic competitiveness. It has been responsible for formulating and implementing six national ICT Master Plans since the 1980s. The IDA is spearheading the iN2015 by transforming the key economic sectors, government and society through more sophisticated and innovative use of infocomm – for example, by establishing a high-speed network infrastructure and facilitating the development of an ICT-savvy workforce. There is obvious impact of the works by IDA on ICT Master Plan in education and collaboration with the MOE is a necessary strategy. As reported on IDA's Website, under its education program, a flagship project called Edvantage is implemented to "provide a learner-centric, collaborative learning environment that extends beyond the classrooms, thereby enabling a diverse and vibrant schools landscape in the use of infocomm."

Institutes of Higher Education

One of the key partners of the MOE is the National Institute of Education, which provides initial teacher training, professional development, graduate education and research. The Learning Sciences and Technologies academic group, for example, offers a core course to all pre-service teachers on the pedagogical applications of technologies for teaching and learning. In addition, a research arm called the Learning Sciences Laboratory (LSL) was set up in 2005, partially funded from the research budget of MP2. LSL aims to "to foster deep student learning with technology-enabled pedagogical practices for cultivating twenty-first century knowledge and skills through learning sciences research in Singapore schools" (http://www.lsl.nie.edu.sg/about.htm). LSL has identified five signature models of twenty-first century learning: New Literacies, Science as Systems, Mathematics & Problem Solving, Knowledge Building Community, and Emerging Research & Pedagogies. Under these models, LSL has since conducted numerous research projects by working closely with practitioners in the schools. In addition, LSL also conducts system wide studies. For example, studies that examine teachers' beliefs, leadership and technology use in Singapore schools, pre-service teachers' beliefs regarding teaching and learning, distributed leadership in school ICT reform, and the evaluation of the ICT Master Plans.

Besides the NIE, the MOE also collaborates with other institutes of higher education, including Nanyang Technological University (NTU), National University of Singapore (NUS) and various polytechnics. For example, student interns from polytechnics are often employed to develop games, flash animation objects, and learning resources for ETD.

ICT Industries and Other Organizations

From the description of various projects by Koh and Lee (2009), it is evident that the MOE actively seeks partnership with ICT industries and other organizations when appropriate. Rather than producing all digital contents in-house, the MOE has collaborated with the ICT industry to produce digital learning resources, for example, with Times Media Pte Ltd. to produce the Active Primary Mathematics CD-ROM series. Various schemes were developed to provide financial and resource support for MOE-industry collaboration, including MOE-Local Industry Upgrading Program, Digital Media Repository, and School Industry Partnership.

To expand students' learning experience, the MOE has also collaborated with other organizations. Under the Learn@ Series in MP1, the MOE has collaborated with the Singapore Zoo, the Singapore River Trail, the Discover Centre, museums, national parks and libraries to create authentic learning experiences out of classrooms. Students have, for instance, captured digital photos and videos, edited them with multimedia authoring tools and developed Web pages to report their learning experiences.

Various strategies were deployed for collaboration between MOE, the key driver of the Master Plans for education, and other parties, with varying degree of formality. There are formal schemes, complete with financial and resources support, set up between MOE and other parties. For example, the MOE-Local Industry Upgrading Programme is a tri-partite framework between MOE, the Economic Development Board and the industry. Riding on a strong relationship between the MOE, the NIE and schools, informal approaches were also adopted. For example, Tan and

Koh (2006) described a case where LSL researchers, ETD officers, and school teachers were brought together for a school-based project. The distributed expertise of various parties were leveraged to bring the research intervention to fruition, it also helped in enhancing the usability of research findings and knowledge transfer among the collaborators.

Policy Alignment and Consistency

Singapore ICT Master Plans are linked and aligned to major education policies and initiatives drawn up by the MOE. As mentioned before, the ICT Master Plans are directly linked to the Thinking Schools, Learning Nation paradigm and how the various components in the Master Plans are preparing students to develop their skills and competencies for the future workforce. In addition, the MOE has leveraged on the ICT Master Plans for other initiatives launched by them. Here are some examples.

ICT in National Education

In 1997, the Government started a National Education (NE) programme for all school-going children. The NE programme's purpose is "to develop national cohesion, the instinct for survival and confidence in the future" (MOE, 2007). The programme achieves this objective through formal and informal learning. Core values of Singapore society, understanding of different cultures, racial harmony, understanding of oneself, are some areas they will explore. Students will also develop an understanding of "the Singapore story"–of how Singapore succeeded in becoming a nation, its constraints, and challenges. NE is taught using a variety of teaching approaches such as interactive lessons, activities, excursions, field trips, competitions, community work and lately through ICT, which are used extensively to deliver the NE instruction. For example, students participated in NE competitions by creating videos and animations using the equipment from the schools' media labs. Students create Websites to report their NE experiences, activities, and events. They communicate with their peers and friends from other schools using social networking sites. Recently, virtual online games were introduced to help students learn about NE. MOE sponsored a research and development project with LSL on the use of games for NE. In their project, *Students' Learning of Singapore National Education through game playing*, LSL researchers looked at the processes "related to students' problem solving, situated understandings, social practices, identity formation, and the development of shared community values through game play" (LSL Website: http://lsl.nie.edu.sg/m30.htm). Recently, the MOE commissioned a local games developer company to develop an NE computer game and have received positive feedback from students and teachers.

Use of ICT in Curriculum

As the following quoted examples show, and in line with the ICT Master Plans, the MOE has infused technology into its curriculum. All primary and secondary subjects have statements about the use of ICT in their syllabus, requiring that students manipulate ICT to help them to research, understand content, solve problems, and create artifacts related to the content. For example, in history, students are encouraged to use the Internet to go further in researching topics and to prepare presentations based on what they have found.

"ICT-based lessons could be incorporated so as to harness the ICT skills of the N(T) students. Students will have the opportunity to work collaboratively and create products to demonstrate what they have learnt." Social studies syllabus, Lower Secondary, Normal (Technical), 2005.

"Information and Technology (IT): When used as a tool to support appropriate teaching strategies, IT can enhance the teaching and learning process and lead to engaged learning. For example, teachers can tap on the Internet for alternative resources which can be used to support inquiry-based learning activities. Appropriate IT devices such as data loggers and other hand-held devices can be used to enhance data collection and speed up data analysis.

Abstract concepts in science can also be made more comprehensible with the use of simulations, scenarios and animations." – Science Syllabus, Lower Secondary, 2007.

Aligning ICT Master Plans to Singapore's Infocomm Plans

One of the aims of the ICT Master Plans is to develop local IT companies that will create new and innovative software, content and services. This is part of the IDA's role in promoting and nurturing local IT companies. IDA will sometimes co-sponsor the development of various software or tools and this financial assistance to companies will help the IT companies, as most of them are small companies with limited resources. The Master Plans will not succeed if local companies are not involved and through the years, these companies have grown and have developed expertise in software development, managing their business and marketing. The IDA with the help of other government agencies, help the companies to go global with their products and services. Since English is the medium of instruction, all software developed for Singapore schools can be marketed internationally and thus, are able to expand Singapore's growth market in IT. Many of these software are used in countries like Australia, China, Hong Kong, Indonesia, Malaysia, Thailand, the United States, and others. The following sections are some examples of how ICT Master Plans have helped the local companies develop their products.

- Presently, all schools have a learning management system (LMS) and practically all of them are using locally developed LMS. Local companies have improved their LMS development and have incorporated a number of unique features in their LMS through feedback and consultations with the schools and teachers. These companies have exported their LMS to other countries and a number of schools have used them.
- Two major companies have developed multimedia content for Singapore schools. These two companies, Learning Edvantage (http://www.lead.com.sg/LEAD/login/lms_login.aspx) and AsknLearn (http://www.asknlearn.com/) have developed content in science, mathematics, and English for Singapore schools and have also marketed these materials internationally. A number of schools in the Middle East and Asia have purchased the content from these companies. Based on the success of these companies, other software development companies have ventured forth to the US and have been selling their software to American schools. One example is Eyepower Games Pte. Ltd., which has developed a news-making software, called *NewsMaker*. This software helps students role-play in creating news broadcasts and, in the process, learn skills in writing, reading and presenting. This software won the 16th Annual Teachers' Choice Award for classroom and Tech and Excellence award, 2009 (http://www.aboutnewsmaker.com/).
- Some IT companies have engaged schools as experts and work with the teachers in developing their products. Heulab (www.heulab.com) works with one of the top secondary schools and the teachers are co-developers of the products. Their award-winning software, *Fun with Construction*, was jointly co-developed with the secondary school teachers. *Fun with construction* has been sold in many countries including Australia and the US. After the success of this project, the company collaborated again with the school teachers to develop a management system named *Heucampus*. This secondary school has adopted a one-to-one computer scheme and they needed a communication and management system in a one-to-one computer environment resulting in the company developing the software, *Heucampus*. It is a system application software whereby students communicate with their peers and their teachers through instant messaging. Students can form groups, share documents with each other, share screens with their peers and their teachers and work collaboratively in a virtual environment – online environment?.In addition, there are additional features such as peer assessment, attendance marking, audio and video conferencing. This has been adopted by a number of institutions including one of the polytechnics.
- FutureSchools, an initiative under MP2, is a collaboration between the IDA, the IT industries, the MOE and schools in exploring the use of technology for learning, management and administration. One of the aims of the FutureSchool project was to engage IT companies to develop learning and administrative tools for the schools. The IDA co-sponsors this project with co-funding for the companies. Each FutureSchool is led by a consortium of IT companies who will be in charge of systems integration, development of learning environments, acquisition of hardware, creating of learning tools, management of learning and other IT facilitated tasks. These companies learn from their engagement to these schools and intend to bring their expertise overseas to offer their services. Some companies have developed a number of futuristic learning applications. One of

these is the company, Playware Studios Asia Pte. Ltd. They have developed a 4Di system which is a 3-D virtual environment embedded with interactive learning activities using a handheld device. A prototype of the system can be viewed on YouTube (http://www.youtube.com/watch?v=SI0PLToFI4o). This 4Di environment was tested with students from Canberra Primary school, one of the FutureSchools. During a test run of the programme, (available on YouTube at http://www.youtube.com/watch?v=6Dvk7qiVPzE), students from the schools were interacting with virtual historical objects. It is anticipated that Canberra Primary School will be the first in the world to have such a virtual learning environment for its students.

Aligning ICT Master Plans with Media Plans

Besides aligning the ICT Master Plans with the IDA's strategic thrust, the ICT Master Plans are also aligned with another government agency. The Media Development Authority (MDA) is an organization within the Ministry of Information, Communication and the Arts and it has created its own strategic thrusts to make Singapore a vibrant and creative media centre.

The MDA has proposed a new initiative, Media-in-Learning, to promote the use of media for learning, education and training. Recently, it was announced that the MDA budgeted S$6 (US $4.3) million dollars development funding to co-sponsor games companies to develop serious games for learning and education. The aim of this initiative is to build up game developers capabilities to build games in learning so that in future, their products can be commercialized for off-the-shelf-sale. They have identified the following categories in the education domain:

- games to enhance twenty-first century skills;
- location-based games for learning;
- multiplayer simulations; and
- summative assessment games (based on core curriculum).

This initiative is directly aligned with MP3 and, to a certain extent, helps to support the Master Plan. The MOE and the MDA both believe that serious games can help in the learning process and have started to pull resources together to innovate in this area.

Some schools, as part of MP3, have started to employ one-to-one computing for their students and the MOE is looking at online content to support such learning. Recently, the MDA issued a call for proposals from companies for online content integration, application and service development under their project, Futurebooks. Futurebooks is a strategic initiative to get companies to work together to develop services, content, and applications for the e-book platform. Textbook publishers, newspaper publishes, and technology companies are working together with other application development companies to create such a system. When these systems are ready, they will provide additional digital resources and materials for Singapore students, and these systems can be then sold in the global market.

Monitoring and Evaluation

Two main sources of information can be used to gauge the achievement of the first two ICT Master Plans for Education in Singapore: summative evaluation by the MOE and results from international comparison studies.

Summative Evaluation by the MOE

The public sources of summative evaluation came from the speeches made by the ministers in the launch of the Master Plans and a book edited by Koh and Lee (2009). Koh was the former Director of the Educational Technology Division in MOE and Lee has been an assistant director in the division.

Findings for MP1

MP1 drew to a close in July 2002 with a three-day conference called iTopia, which offered an opportunity for educators to exchange research findings and classroom practices related to the use of ICT in education, and showcased innovations and achievements of various schools and industries. Specific research findings mentioned in the Minister's speech are summarized in Table 3.

Table 3: Summary of Impacts of ICT Master Plan for Education

Impact on:	Findings
Pupils	• 90% found ICT had made lessons more interesting • 82% felt that use of ICT had increased their knowledge • 77% felt that use of ICT had improved learning • 77% felt that use of ICT had encouraged them to learn beyond the curriculum • Primary school pupils responded more positively than secondary or junior college pupils • More than 64% of teachers found ICT has allowed for greater pupil interactions • ICT products created for IT-based competitions were more creative • Pupils performed well in international ICT-based activities
Teachers	• Every teacher received 30–50 hrs per year of training in use of IT in teaching • 84% interested in further training in use of ICT to enhance teaching process • 65% find preparing ICT-based lessons worthwhile • 77% want to explore more ways of integrating ICT into teaching

Source: Tharman, 2002

The key achievements of MP1 are further summarized by Koh and Lee (2009):

- Students possessed basic skills to complete ICT-based projects or assignments.
- Teachers possessed basic ICT competencies and were receptive to the use of ICT as a pedagogical tool.
- Schools have basic infrastructure for ICT-based teaching and learning. The student– computer ratios were 6.6:1 for primary schools and 5:1 for secondary schools and Junior Colleges, respectively.
- Sporadic good practices on the use of ICT for teaching and learning in various schools have been identified.

Koh and Lee further identified some key learning points for the ministry. First, the teachers have different professional development needs on the use of ICT for teaching and they need to be persuaded with real-life practices that worked. There is also a need to promote a sharing culture among the teachers. Second, in terms of infrastructure, the centralized and standard approach worked well to help all schools achieve a baseline level of ICT readiness. Third, valuable lessons have been learned about R&D activities. In essence, there was a need to adopt a more systematic approach towards R&D and more time should be given for the researchers and teachers to meaningful research activities. Better coordination was needed for multi-party collaboration on experimentation with ICT.

The key learning points of MP1 provided valuable information for the conceptualization of MP2. For example, MP2 placed greater emphasis on pedagogical applications of ICT for teaching and learning. Also, explicit goals and targets on R&D activities were set. Research units like the Learning Sciences Lab were also set up.

Findings for MP2

Like MP1, MP2 closed with a local conference called iCTLT. At the conference, the Minister's speech (Ng, 2008) highlighted two key learning points from the first two Master Plans. First, teachers need to be competent in pedagogical principles to design ICT-based lessons and being ICT-savvy is not sufficient. He acknowledged that there is a gap between familiarity with ICT and translating it into effective teaching practices. Second, there is a need to balance a centralized approach and schools' autonomy. While it is important for schools to remain the key drivers for ICT implementation in classrooms, some degree of centralized control is needed to maintain quality in executing the Master Plans across schools.

Koh and Lee further elaborated on the key learning points. First, teachers' readiness and their capacity to effectively integrate ICT into the curriculum remained a key challenge, particularly the understanding and application of pedagogical principles in designing ICT-based lessons. Also, to foster a sharing culture, there is a need to study factors promoting a more effective community of practice among teachers. More time and space need to be provided for teachers to design and implement ICT-based lessons, and to share, discuss and reflect on their implementation with their colleagues.

Second, better ICT integration into curriculum is needed rather than using ICT as an add-on tool.

Third, to encourage innovation, more varied modes and methods of assessment should be incorporated, including process-oriented assessment and assessment of twenty-first century skills.

Fourth, the availability and accessibility of digital resources remained an important component to support the Master Plans; schools and industries could play more important roles in developing these resources and a one-stop portal could increase the accessibility of these resources.

Fifth, school leaders must possess the capacity to provide direction and create conditions for the pedagogical use of ICT in their schools; self-evaluation tools and guides were provided to schools to facilitate their implementation of the Master Plans.

Sixth, schools enjoyed sufficient funding and flexibility in developing their infrastructure and engaging technical support.

Lastly, schools need more support in experimenting with ICT and more opportunities to share their experiences. Bridging the gap between research and practice remained a challenge, and it was specifically noted that there is a gap in transferring research findings into practice and more effort is needed to motivate and coordinate meaningful research activities among the researchers, practitioners and industry partners.

Some key achievements of MP2 as reported by Koh and Lee (2009) are:

- Students possessed competencies in basic ICT tools, including the use of the Internet, email, word processing and presentation software.
- Teachers, likewise, possessed these basic competencies and two-thirds of the teachers were comfortable in using existing resources to support classroom teaching.
- About 80% of the schools met the outcome expectations of MP2 and 15% of teachers performed better than expected outcomes.
- Schools possessed flexible network environments. All schools have sufficient funding to support student–computer ratios were 6.5:1 for primary schools and 4:1 for secondary schools and junior colleges respectively.

While the MP2 findings reflect a high ICT-based environment for teaching and learning, there are some underlying challenges that teachers in Singapore face when using technology for instruction.

Challenges as Reflected through MP2

The strong emphasis on a high-stakes examination system tends to limit the innovative use of technology for instruction. The statewide examinations at the end of primary school (Year 6), the GCE 'O' level examination at the end of secondary schooling (Year 10), and the GCE 'A' level examinations (Year 12) are high-stakes examinations, which, to some extent, determine the education pathway of students and their career prospects. Teachers tend to fall back on traditional methods of teaching of content with an emphasis on solving problems based on the examination requirements. As such, it was common classroom practice for graduating classes to be engaged in drill-and-practice exercises. This limits the use of technology for collaborative work, project work and inquiry work.

While Singapore has a high standard of technology infrastructure in the schools, students' access to computers could be further expanded. In most classrooms, there are no computers for student use even though all classrooms are equipped with one computer and a data projector that are mainly used by teachers. In most schools, to conduct a computer-mediated lesson, students need to move to a computer laboratory. As such, various inquiry approaches to learning such as searching the Internet for information, running simulations or modelling tools to explore relationships could not be conducted in common classrooms. This was also reported in a study by Choy, Wong, and Gao (2008) when they examined pre-service teachers' patterns of technology usage for teaching during their school attachment for teaching practice. The teachers were mainly using presentation software for their lessons and hardly attempted to use technology for collaborative learning.

The teachers' pedagogical skills and understanding of ICT integration into curriculum could be further developed. They need to develop a good understanding of principles and concepts of the use of technology to enhance the teaching and learning processes. There are cases when technology was used to replace a paper version of tasks in which students used the computers to fill in answers to teacher-supplied worksheets. More professional development workshops on the use of technology to support student-centred learning could be conducted to help teachers acquire pedagogical skills and understanding.

While there are many cases of good and innovative uses of technology for teaching and learning, there is a problem of scaling up the practices to other schools. For example, the winners of the local Microsoft Innovative Teachers' competition (http://apac.partnersinlearningnetwork.com) showed exemplary use of technology for inquiry-based learning, student-centred learning approaches and collaborative learning. The use of mobile learning for investigative learning is another example. Some schools are using mobile learning approaches to investigate relationships between organisms in the ecosystem. However, these practices are not widespread and many of these and other innovative approaches are confined to some schools only. While there are sufficient avenues for professional sharing through interactive workshops, conferences, and district-wide sharing sessions, the scaling up of innovative practices to more schools can be further enhanced. Besides these innovative approaches, many research and development projects are undertaken with one or two schools as experimental schools. However, good practices and lessons learned from these projects are not scaled up to other schools and therefore cannot benefit more school students.

While Singapore is currently implementing its third Masterplan after completing two Master Plans of five years each, there are still a number of major hurdles to overcome. The scalability of good projects and good practices is still an issue which the authorities have to address. Teachers' professional capacity to conduct good ICT-integrated lessons, the lack of computing resources in classrooms, the tension of preparing students for high-stakes examinations, and the lack of collaborative projects within local and international partners are some challenges that MP3 will need to address.

International Studies

Singapore participated in international studies on the use of ICT in education, including the Second Information Technology in Education Study (SITES) Module 1 in 1998, Module 2 from 2000 to 2001, OECD Studies from 2000 to 2001, and SITES 2006. SITES 2006 focused on examining teaching and learning practices in schools in 22 education systems and how these practices are supported by ICT. It is based on surveys of school principals and Grade 8 mathematics and science teachers for their self reports and perceptions. To reflect the recent state of achievement, highlights from the recent SITES 2006 study (Law, Pelgrum, and Plomp, 2008) are presented, focusing on results of Singaporean participants relative to the other 21 educational systems.

School Conditions

Singapore secondary schools compared favourably with their international counterparts in terms of ICT infrastructure and support: it ranks among the five education systems with 80% or more of its secondary schools having a student/

computer ratio of less than 10:1; Singapore schools have the highest rate of owning a Learning Management System (95%) and were best equipped with computer projectors (100% of schools with more than five projectors). Similarly, the findings were favourable in terms of ICT support to schools. Singapore secondary schools reported a high level of maintenance support (highest), technical support (fifth highest) and pedagogical support (third highest). All secondary schools provided teachers with laptops or other mobile learning devices.

In terms of pedagogical vision and orientation, compared to SITES Module 1 in 1998, there is a substantial increase in percentage of school leaders who indicated the presence of lifelong learning pedagogical practices in schools (for example, +16% for information handling, +24% for cooperative and project-based learning). While the school leaders agreed with the pedagogical vision of using ICT for lifelong learning (e.g., independent learning, solving real-life problems) and connectedness (connected global community), they still held on to the vision of using ICT for traditional pedagogies.The ICT leadership also compared favorably with the other 21 education systems in such actions as reallocating workload for collaborative planning (85%, second highest), reallocating workload for technical support (71%, fifth highest) organizing demo-workshops (98%, highest) and reviewing pedagogical approaches of teachers (97%, highest).

Use of ICT for Mathematics and Science

The Grade 8 Singaporean teachers of mathematics and science reported high levels of confidence in the technical use of ICT (among the top two), although their confidence in pedagogical use was lower (among the top five). Science teachers reported the highest use of ICT (over 80%) and mathematics teachers reported the second highest use of ICT (over 70%). The pedagogical practice orientations of the teachers, however, did not fare well compared with other educational systems. For example, lifelong learning and pedagogical practices to develop an online community were rated at the lower end (lowest 7 systems). The teachers perceive the use of ICT to have low impact on themselves and on their students – for example, in students' achievement and outcomes. They perceived higher impact of ICT on empowering the teachers and improving ICT skills of teachers and students.

In summary, it is evident that there are at least two main sources of information for evaluating and monitoring the ICT policy for education in Singapore. It is apparent that survey studies sponsored by the MOE were used and summative findings and recommendations were usually announced at the closure of each Master Plan, leading to the following Master Plan. At the same time, participation in international studies allows Singapore to compare its achievement against other educational systems.

Conclusion

Singapore has made a conscious choice to leverage ICT to enhance and enrich the learning experience of students in its education system. As the technologies advance, their use in education has become increasingly more pervasive and effective. The continual success in the use of ICT for teaching and learning will necessarily depend on a committed government that has the tenacity to see through the implementation of various ICT Master Plans in Education as well as the foresight to chart out future needs in this area. To this end, it is important for Singapore to actively collaborate with various partners, be they from industry or academic institutions, as a necessary part of the equation for success. The areas where such collaborations can take place include:

- Research into the development of pedagogies taking into account emerging technologies;
- International cross-cultural studies of ICT effectiveness in teaching and learning;
- Partnership in jointly developing technologies for teaching and learning;
- Collaboration on projects amongst students from various schools (locally and internationally); and
- Joint conferences and workshops for sharing experiences in the use of ICT in teaching and learning.

ICT has brought about unprecedented possibilities in the way students learn. They have also extended the horizon for such learning to take place. As Singapore continues towards it goal to maximize the potential of each child, the possibilities for regional and international efforts in this direction are plentiful.

Singapore is investing in the future by committing a lot of resources to education even when the economy is down. The country's education budget has increased from 3% of GDP in 2008 to 4% of GDP in 2009. The Minister of Education, Dr. Ng Eng Han, disclosed this in the annual budget announcements on February 10, 2009 (Ng, 2009). The education budget will be increased by 5.5% to $S8.7 (US $6.2) billion in 2009 despite the slowdown in the country's economy. By committing resources to education, Singapore is investing in the future workforce. Similarly, by investing in the use of ICT in education, Singapore is preparing the workers of the future with the relevant twenty-first century skills and a workforce that is very competent in the use of ICT. Being ICT-competent is an important twenty-first century skill as Singapore has moved from a low-value manufacturing economy to a knowledge-based economy.

ICT in education has further developed an industry of ICT in education. One of the key thrusts of the government is to develop the IT industry and to be a major player in this area. Singapore has done well in the use of ICT to support online transactions for government services in Singapore and many IT companies has ventured to other countries to provide these type of ICT services. ICT in education is a new business and Singapore has started this industry well with many well-known products. Its e-learning content is used worldwide and the use of English as the medium of instruction helps. E-learning content can be used internationally and other countries have used Singapore textbooks and, as well, the e-learning content that complements the textbooks. In addition to developing content, many IT companies have gained experience in IT systems integration for education and these IT companies have ventured to other countries to offer their services. For example, Singapore Technologies Electronics Limited (ST Electronics) announced in June 2008 that they have set up joint ventures with a local company in Kazakhstan. The joint-venture company will focus on the projects involving the use of technology for education. They will supply, integrate and install ICT equipment, operating system and educational content (http://www.stee.stengg.com/newsrm/2008/06-01.html).

Projects under the ICT Master Plans have developed a number of interesting and innovative projects. Because of the FutureSchools project under MP2, some IT companies are developing innovative IT environments and using cutting-edge technology for teaching and learning. For example, there is a great emphasis on the use of serious gaming for learning and a number of research and development projects are underway to create these games. If successful, these games will help to improve learning, not only in Singapore but also internationally. Another interesting example is the development of virtual and immersive environments wherein students can be actively involved in manipulating the avatars, making decisions and solving complex problems through collaboration. Again, if this experiment works, there is a great potential to extend this system to other learning scenarios.

Finally, the ICT Master Plans and the overall Government's ICT directions and policies have produced a climate of innovation in schools, industries and organizations which is both leading and thus strengthening the country's knowledge-based economy.

Chapter 4

Case Study: Namibia

Shafika Isaacs

Abbreviations and Acronyms

EMIS	Education Management Information System
ETSIP	Education and Training Sector Improvement Plan
GRN	Government of Republic of Namibia
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
ICTs	Information and Communication Technologies
ITU	International Telecommunications Union
LFA	Logical Framework Approach
LTSFF	Long Term Strategy and Financing Framework
MDG	Millennium Development Goals
NETSS	National Education Technology Service and Support
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa

Executive Summary

Namibia is a relatively young country, having gained independence from South African Apartheid rule in 1990. At independence, the Government of the Republic of Namibia (GRN) inherited a system of deep-seated social, economic and cultural segregation and an education system beset with crises. As part of its strategy towards the fundamental transformation of the education system, the GRN embarked on a programme of human development that focuses on education equity, access to education, quality education for all, democracy and lifelong learning. Included in this strategy is the integration of ICT in its national curriculum, teacher development plans, transforming the pedagogical practice of learning and teaching and in the management and administration of the national education system.

Since gaining independence in 1990, Namibia has made significant social and economic progress: it is among the top ten countries worldwide in terms of share of GDP spent on education, and second to South Africa in Africa, in per capita expenditures on health. By virtue of its historical ties to the South African economy and its geographic location, Namibia's ICT infrastructure is well developed, especially when compared to other African countries outside of South Africa. However, it has among the world's worst HIV/AIDS epidemics and among the most unequal income and asset distribution in the world.

Namibia's education policy is enshrined in its Education and Training Sector Improvement Plan (ETSIP ,which is a comprehensive programme that combines educational, economic and management imperatives, with social redress and the attainment of equity as a priority. It articulates a role for education as facilitating the transition to a knowledge-based economy and combines this with a pro-poor bias. It also integrates the struggle against HIV/AIDS in education with the attainment of equity and envisages a role for technologies within this. This is the backdrop against which the GRN developed an ICT in Education policy.

ICT in Education Policy

Namibia ranks among the first to have developed an ICT in Education policy in Africa. Its policy process evolved since the late 1990s when the Ministry of Basic Education developed a National Policy for ICT in Education through its National Institute for Educational Development (NIED). This Policy was revised in 2000 and by 2005 it was formally adopted. The purpose of this Policy is to guide all Namibian education stakeholders in their preparation to meet the challenges that the twenty-first century and a globalizing world economy places on Namibian society. The Policy envisages that it will guide the attainment of ICT literate Namibian citizens, capable of participating in the

new economies that emerge from ICT and related developments; it will guide the ability to leverage ICT to facilitate learning by teachers and learnerg , improve the administrative and management efficiency of the education system and broaden access to quality educational services for all.

The Policy's value proposition for investing in ICT integration in education includes the recognition that ICT have a role to play in education both directly as a subject and indirectly as tools to assist in educational delivery and management. It proposes that, when used appropriately, ICT can bring many benefits to the classroom and the education process and can provide new opportunities for teaching professionals delivering education. The Policy also provides a maturity model which articulates development levels of ICT access in education institutions and it outlines a list of services to be offered.

The design and articulation of the Policy is very practical, informed by evolving experience of various education stakeholders since the 1990s.

The GRN also developed an implementation framework based on the ICT in Education Policy. This implementation framework is spelt out in the Tech/Na! Implementation Plan which adopts a "holistic, demand-driven and end-to-end solution" approach and offers a framework for public private partnership. A review of Tech/Na! in 2008-2009 conducted by the Global eSchools and Communities Initiative (GeSCI) reveals that progress has been made with the implementation process to date such as the establishment of the eLearning Centre and the NETSS Centre but implementation was also challenged by the absence of a Project Management Office (PMO) and infrequent meetings of the Steering Committee on ICT in Education. It calls for the establishment of the PMO to ensure the effective co-ordination of implementation.

Namibia has in many ways played a pioneering role in Africa, not only in terms of innovative grassroots projects targeted at children and communities but also with reference to inclusive national policy development. One of its defining features is the active involvement of a range of organizations from the NGO, private and public sectors through strategic multi-stakeholder partnerships and the healthy debate that accompany these engagements. If coupled with a more conscious stakeholder learning environment through the integration of Monitoring and Evaluation in its programme implementation, Namibia will continue to be a leader in ICT integration in education in Africa.

The Context

Background

Namibia is a fairly young country, having gained independence in 1990 after almost a century of German and South African rule. At independence, the newly formed Government of the Republic (GRN) of Namibia inherited an education system deeply entrenched in racism, segregation and social exclusion. The Bantu education system was based on inequitable funding, resource allocation and access to education and was ideologically premised on a view that indigenous Namibians were not qualified or capable of making decisions to shape their own destiny. This culture of racism, inequality and social, economic, and academic segregation was maintained through the fragmentation of the national system into 11 separate education authorities based upon

Source: CIA World Factbook, 2010

ethnicity. The system left a legacy where teachers had only eight to ten years of education, student/teacher ratios were up to 60:1, and where drop-out and failure rates of up to 82% prevailed (Dunn, 2003). The GRN endeavored to transform this system by establishing an education system based upon the principles of access, equity, quality, and democracy. The GRN recognized at an early stage the value that information and communication technologies (ICT) could add to their ambitions to transform the education system. In this sense, Namibia has historically played a pioneering role in ICT in Education in Africa. The country ranks among the first to have developed an ICT in Education policy and have also consistently led the way in Africa, with transforming its schooling system through the integration of ICT.

Socio-economic Profile

Namibia is the second least densely populated country in the world after Mongolia. It has a population of 2.1 million and a population density of 2.6 persons per square kilometre. The majority of the Namibian population is black African, mostly of the Ovambo ethnicity, who are concentrated in the north of the country. Other ethnic groups include the Herero and Himba who speak a similar language. Table 1 below provides demographic indicators for Namibia.

Table 1: Demographic Indicators Namibia, 2009

Indicator	Performance
Population	2.1 million (2009)
Population Density	2.6 persons per square km (2009)
Population Growth Rate	0.95% pa (2009)
Age Structure	0–4 years: 35.9%; 15–64: 60.2%
Median Population Age	21 years (2009)
Life Expectancy	51.24 years (2009)
Infant Mortality	67.18 deaths for every 1000 live births (2009)
% Urban Population	37% (2008)
HIV/Aids Adult Prevalence Rate	15.3% (2007)

Source: CIA, World Factbook, Namibia, 2010

From Table 1, it is evident that Namibia has more than one-third of its population under the age of 14 years, making it a young population. It also shows that just over one-third of its population lives in urban areas, making it predominantly rural population as well.

Since gaining independence in 1990, Namibia has made significant social and economic progress: it boasts among the highest investors in education and health by the GRN; it has one of the most liberal and free press and has among the highest "business competitiveness" rankings and the lowest levels of corruption (USAID, 2009). Namibia is among the top ten countries worldwide in terms of share of Gross Domestic Product spent on education, and second in Africa to South Africa in per capita expenditures on health. The Government has improved access to safe water and sanitation; it has laid the foundation for gender parity, and launched programmes to protect the country's environment and natural resources. Namibia is also one of the few countries in Sub-Saharan Africa that maintain a social safety net for the elderly, disabled, orphaned and vulnerable children, and war veterans. Furthermore, Namibia has a Social Security Act that provides for maternity leave, sick leave, and medical benefits (World Bank, 2009).

However, Namibia has among the world's worst HIV/AIDS epidemics and among the most unequal income and asset distribution in the world. Whilst the country has a per person Gross Domestic Product average of USD2,166 a person, one-third of Namibians survive on less than a dollar a day. Its Gini coefficient, which measures income inequality and poverty, scores 0.6. Namibia has had a reported decrease in HIV prevalence to 17.8% (down from

22% in 2002) and an estimated 15.3% adult HIV prevalence. However, HIV/AIDS remains a serious threat to the country's development. The Ministry of Education's Policy on HIVAIDS in Education revealed that the pandemic has already affected the life expectancy negatively and that it is impacting both the education system and human development in Namibia (Ministry of Basic Education Sport and Culture and Ministry of Higher Education, Training and Employment Creation, 2003). Adding to the HIV/AIDS challenge, Namibia has one of the highest tuberculosis prevalence rates in the world (765 per 100,000 in 2006, with several regions reporting rates of over 1000 per 100,000). (USAID, 2009 and World Bank, 2009). Table 2 below provides basic socio-economic indicators for Namibia.

Table 2: Socio-economic Indicators Namibia, 2007

Human Development Index (HDI)[1]	0.686 (2007), ranking 128th out of 182 countries;
Human Poverty Index (HPI)[2]	17.1%, ranking 70th out of 135 countries
Per Capita Gross National Income in US Dollars	$1,728)

1. The HDI measures the average progress of a country in human development.
2. The Human Poverty Index (HPI-1) focuses on the proportion of people below certain threshold levels in each of the dimensions of the human development index - living a long and healthy life, having access to education, and a decent standard of living. By looking beyond income deprivation, the HPI-1 represents a multi-dimensional alternative to the USD1.25 a day (PPP USD) poverty measure. The HPI-1 measures severe deprivation in health by the proportion of people who are not expected to survive to age 40. Education is measured by the adult illiteracy rate. And a decent standard of living is measured by the unweighted average of people not using an improved water source and the proportion of children under age 5 who are underweight for their age.

Namibia is classified as a lower-middle-income country by the World Bank. It has a small open economy closely linked to South Africa. The economy is heavily dependent on the extraction and processing of minerals for export. Mining accounts for 8% of GDP, but provides more than 50% of foreign exchange earnings. Rich alluvial diamond deposits make Namibia a primary source for gem-quality diamonds. The country is the fourth largest exporter of nonfuel minerals in Africa, the world's fifth largest producer of uranium, and the producer of large quantities of lead, zinc, tin, silver, and tungsten. The mining sector employs only about 3% of the population while about 50% of the population depends on subsistence agriculture for its livelihood. Namibia normally imports about 50% of its cereal requirements; in drought years food shortages are a major problem in rural areas. Much of the land is farmed, mainly for cattle and other livestock; approximately 40% of the land is commercially farmed and a similar area is communal farmland. The commercial farmers are currently actively diversifying away from food crops and into cash crops such as cotton and also, experimentally, tobacco. Tourism and, in particular, fishing, are the two other significant industries (CIA, 2009).

The World Economic Forum's *Global Competitiveness Report* (GCR) 2009 ranks Namibia 74th out of 133 countries in terms of its *Global Competitiveness Index*. It reports that Namibia's comparative strengths are the quality of the institutional environment, property rights, independent judiciary and strong public trust in politicians. The GCR reports however that Namibia's health ranks low on its health sub-pillar, with high infant mortality and low life expectancy and on the educational side, enrolment rates remain low, and the assessment of the quality of the educational system remains poor. It also suggests that the country could do more to harness new technologies to improve its productivity levels, with low penetration rates of new technologies such as mobile phones and the Internet. The GCR also confirms that the quality of Namibia's infrastructure including its ICT infrastructure is considered to be in excellent condition (World Economic Forum, 2009).

ICT Infrastructure

Namibia's ICT infrastructure ranks amongst the best in Africa, according to a study done by ICT consultants, Palladium Strategy Consultants (IT News Africa, 2009). However, technological activities are mostly urban-based and tends to follow the traditional diffusion pattern of the national road network, except in broadcasting whereby radio and TV programmes are well covered countrywide.

Namibia ranks 112th out of 154 countries on the ICT Development Index scoring an index of 1.92 in 2007 compared to 108th in 2002 with an index of 1.58 (ITU, 2007). This suggests that relative to 2002 compared to other countries, Namibia has dropped in rank over the five-year period between 2002 and 2007 (ITU, 2009).

Table 3 provides indicators of the state of Namibia's ICT infrastructure and shows relatively high levels of mobile phone penetration.

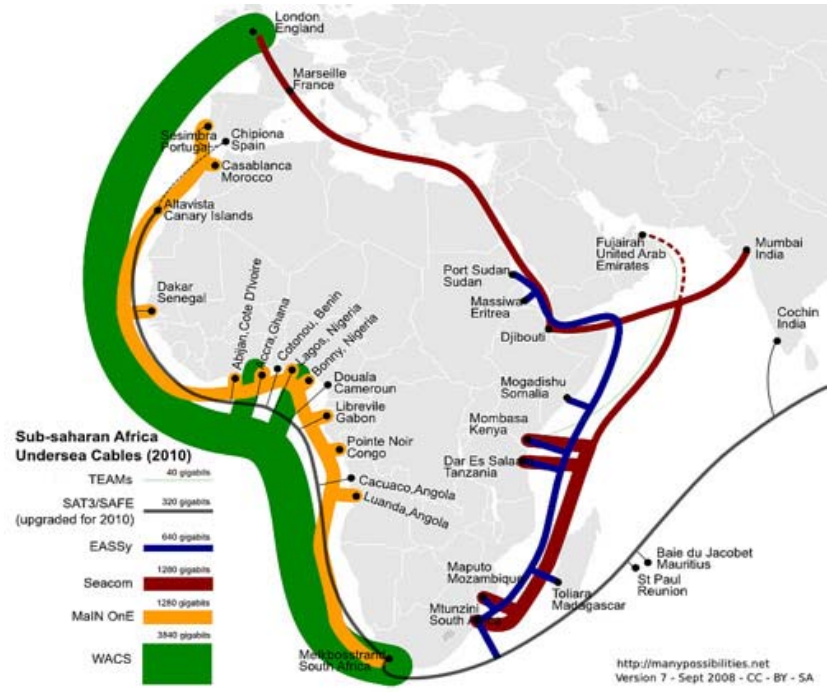
Table 3: ICT Infrastructure Indicators Namibia

Number of telephone lines	140,000 (2008)
Number of mobile telephones	1.052 million (2008)
Number of Internet Hosts	17,840 (2009)
Number of Internet Users	113,500 (2008)

Namibia also has a combined fixed-line and mobile-cellular tele-density of about 55 per 100 persons. It was one of the last countries in Africa to introduce competition in the mobile communications sector when a second network finally launched in 2007. Telecom Namibia still holds a monopoly on fixed-line services, but as a member of the World Trade Organization, the GRN plans to open the telecom sector to full competition.

Despite being reasonably competitive with seven ISPs, the development of Namibia's Internet and broadband sector has been held back by high prices for international bandwidth, caused by the lack of a direct connection to international submarine fibre-optic cables. The GRN is making plans for direct connection in their attempt to lower bandwidth costs. Presently Namibia has a fibre-optic cable to South Africa, a microwave radio relay link to Botswana, direct links to other neighbouring countries; and is connected to the South African Far East (SAFE) submarine cable through South Africa (CIA, 2009). The SAFE submarine cable is a subsystem of the SAT3/WASC/SAFE Consortium, which is an international fibre that goes from Portugal to South Africa and out across the Indian Ocean to Asia. The SAFE cable is situated in the Indian Ocean whereas the SAT3/WASC runs in the Atlantic Ocean. The combined length of the SAT3/WASC/SAFE system segments measures 28,800km. It has 36 members (including Namibia Telecom) who collectively put up USD600 million to build and operate it for the life of the cable over the next 25 years (fibreforafrica.net, 2009). A diagram of this is shown below.

Figure 1: The SAT3/WASC/SAFE Cable



Source: www.fiberforafrica.net (accessed December 21, 2009)

In 2009, the GRN also made efforts to establish a strategic plan for their ICT policy and regulatory framework. Here reference is made to specific projects including the Pan-African Satellite E-Network sponsored by the Indian Government to provide connectivity amongst African countries with Indian institutions of higher learning and health. The strategic plan also includes projects that establish direct access to the SAT3/WACS (which stands for West African Cable System) cable. Namibia and Botswana are cooperating in this submarine cable project that will ensure a landing point at Swakopmund in Namibia. A further connectivity route through the East African Submarine System (EASSy) cable on the east coast of Africa is also in the pipeline. (Hon. Minister Joel Kaapanda, February 2010). It is hoped that these communication networks will lower bandwidth costs in the medium to longer term.

Higher education institutions act as a major ICT hub for servers, computers, e-learning media system and Internet access through narrowband and broadband technologies offered by Telecom Namibia, MTC, and other service providers. For example, the Polytechnic of Namibia has over 2,200 PCs and Laptops located in more than 35 labs as well as in the library and offices, 259 laptops are to be used by students and staff and 120 servers. (IST-Africa, 2009).

Thus, by virtue of its historical ties to the South African economy and its geographic location relative to South Africa, Namibia's ICT infrastructure is well developed especially when compared to other African countries outside of South Africa. It is hoped that the impending fuller liberalization of Namibian communications market and the coming to fruition of direct access to submarine cable, will bode well for higher levels of access to connectivity and lower bandwidth costs in the medium to longer term.

Education

Since gaining independence from South Africa in 1990, Namibia's education system has undergone extraordinary transformation from servicing a privileged few to one involving all learners in integrated classrooms. The GRN supports the 1990 Jomtien Declaration on Education for All and has enshrined compulsory education up to Grade 10, or age 16, into its Constitution (Clegg and Van Graan, 2002).

Namibia's school education system begins with primary education that lasts for seven years. Junior secondary education lasts for three years and senior secondary education lasts for two years, leading to the Namibian Senior Secondary Certificate, or NSSC (Higher and General levels). This certificate is based on the International General Certificate of Secondary Education (IGCSE) which gives access to higher education. Vocational training centres (VTCs) of which there are seven, offer technical subjects at the junior secondary level. Higher education is mainly provided by the University of Namibia, the Polytechnic of Namibia, four colleges of education, three colleges of agriculture and one police training college (USAID, 2009). Table 4 provides an overview of the structure of Namibia's education system.

Table 4: Structure of Education System, Namibia

Level	Grade or Stage	Type	Number of Years	Offered By
Pre-Primary	Under 6 Years Old	General		Pre-primary Schools
Primary	Lower Primary (1-4)	General	4	Primary Schools
	Upper Primary (5-7)	General	3	Primary Schools
Secondary	Junior Secondary (8-10)	Junior Secondary School Certificate	3	Junior Secondary Schools or Vocational Training centres
	Senior Secondary (11-12)	National Senior Secondary Certificate	2	Senior Secondary Schools
Tertiary	University Undergraduate	Degree	4	University of Namibia
	Polytechnic	Higher National Diploma		Polytechnic of Namibia
	College	Higher National Diploma	3	Colleges of Education (4), College of Agriculture (3) and Police Training College (1)

Source: USAID, 2009

Table 4 shows that Namibia's education system includes a pre-primary education phase which is managed by the Ministry of Women Affairs and Child Welfare with the Ministry of Education bearing responsibility for the curriculum (Ministry of Basic Education, Sport and Culture, 2004).

During lower primary years, the medium of instruction is based on 12 different home languages. For the rest of the school and tertiary education, English is the medium of instruction.

Vocational training is provided by 6 vocational centres in basic technical skills and Adult Basic Education particularly the completion of Grades 10-12 is assisted by the Namibian College of Open Learning (NAMCOL)

A policy of continuous assessment based on a set of competencies that learners are expected to acquire, provides the basis for the promotion of learners from one grade to another. The Ministry of Education introduced a national exam in Grade 7 on Mathematics, English and Science to help monitor learner acquisition. Table 5 provides an indication of education performance in Namibia.

Table 5: Education Indicators Namibia, 2007[16]

Indicator	Performance
Gross Enrolment Ratio – primary (2007)	109%
Net Enrolment Ratio – primary (2007)	87%
No of primary school children out of school (2006)	89,000
Gross Enrolment Ratio – secondary (2007)	59%
Gender Parity Index for Gross Enrolment Ratio (2007)	0.99
Number enrolled in primary school (2007)	362,828
Adult Literacy Rate (% aged 15 and above)	88% (HDR, 2009)

Source: UNESCO Institute of Statistics, 2009

Namibia's education system made significant achievements over the past three years despite many challenges. These achievements include an increase in the number of learners in secondary schools, the training of Pre-Primary teachers, the use of information and communication technology in the professional development of teachers and the increase of face-to-face education at the Namibian College of Open Learning (NAMCOL), (Jacobs, 2009).

However, HIV/AIDS continue to impose structural challenges to education access, quality and the management of the system. As the leading cause of death in Namibia, the social effects on the education system have been debilitating. A study commission by the GRN revealed that as many as 17% of children under the age of 18 are orphaned by at least one parent (Ministry of Health and Social Services, 2009). This leads to orphans and children caring for terminally ill parents coupled with depletion of family resources, which makes it difficult for children to enrol and remain in schools. Namibia's teachers are at high risk of HIV and AIDS infection. Projections suggest that one in seven teachers are |HIV Positive.

An influx of refugees into Namibia has also led to increase in refugee children, which further challenges the Government in the provisioning of quality education.

According to the GRN's Education Training Sector Improvement Plan, despite the improvements in the education system to date, it is still not addressing the creation of a knowledge-based economy adequately. Small numbers of Namibians are achieving senior secondary education, and too few complete vocational or tertiary educations. A system of information and knowledge management and of technological innovation remains lacking, despite a rich endowment of minerals and other natural resources. HIV/AIDS is threatening the few gains made. Redressing the

16 UNESCO Institute of Statistics, 2009 http://www.schoolsandhealth.org/Lists/School%20Health%20Database/DispForm.aspx?ID=86 (20 November 2009

extremely high levels of inequality inherited from South African apartheid rule is proving to be more challenging (GRN, 2009).

These challenges have prevailed despite attempts at redress in Namibia's education policy frameworks which reflects the complexity of education transformation and the extent to which the policy frameworks act as guidelines for addressing complex challenges.

Namibian Education Policy

The GRN outlines in its Education Act 2001 that the main objective of its education programme is to provide a national education service that is accessible, equitable, qualitative and democratic. The GRN's specific educational priorities are outlined in more detail in its Education Training Sector Improvement Plan, which is a 15-year (2006-2020) improvement plan for education developed with the support of the World Bank. ETSIP's main purpose is to enhance the education sector's contribution to reach the country's national development goals and facilitate Namibia's transition to a knowledge-based economy.

ETSIP's objectives are to improve the provision and quality of education across the spectrum from early childhood development to secondary education, vocational education and training, lifelong learning, adult basic education and tertiary education. It also aims to improve the efficiency of education management including HIV/AIDS management as well as information and knowledge management. In doing so, it proposes the establishment of appropriate institutions to enable the realization of these objectives including institutional capacity development. It also aims to increase ICT access to enhance learning and administration.

Consistent with the Millennium Development Goals and National Development Plans, ETSIP recognizes that education is of cross-cutting relevance for almost all sectors – for HIV control, poverty reduction, democracy, multi-culturalism and good governance. ETSIP also makes clear an understanding that improving economic growth depends on improved productivity, which must be generated through better use of knowledge and technology. It is also designed to reverse the challenging trends observed by a World Bank investigation of Namibia's education system which suggest that the system is not able to produce its desired results because of poor quality, inefficiency, inequity, inadequate management, and the impact of HIV and AIDS.

The Programme is phased into three five-year cycles with the first cycle extending from July 2006 to November 2010. The first phase is focused on strengthening the quality, effectiveness and efficiency of the general education and training system. The emphasis is on a pro-poor expansion of the country's skill base through expansion of opportunities for high quality senior secondary education, high-quality market responsive vocational education and training and the expansion of pre-entry programmes for tertiary education and training.

ETSIP also operationalizes quality improvement based on its clearly stated goals, which include clear definitions of requisite skills for learners, strengthening educators' ability to facilitate such skill acquisition, improving learner assessment and system evaluation and strengthening managers' and teachers' accountability for system effectiveness.

ETSIP is evidently a comprehensive programme that combines educational, economic and management imperatives, with social redress and the attainment of equity as a priority. It articulates a role for education as facilitating the transition to a knowledge-based economy and combines this with a pro-poor bias. It also integrates the struggle against HIV/AIDS in education with the attainment of equity in education and envisages a role for technologies within this. Such an education policy tries to accommodate the contradictions within a highly complex and dynamic change process that characterises social transformation in Namibia.

The above confirms that Namibia's socio-economic development has made significant progress since the independence in 1990. This is evident not only from its consistent economic growth over the past decade, but

also from being on track to achieving key Millennium Development Goals including universal primary education. However Namibia faces significant socio-economic challenges that threaten its education system and general human development in the country. From a policy perspective, education is considered catalytic in addressing both the social imbalances and the country's transformation towards a a knowledge based economy.

Policy Features

Overview

Namibia's ICT in Education policy process has evolved since the late 1990s when the Ministry of Basic Education developed a national policy for ICT in Education in Namibia through its National Institute for Educational Development (NIED). This policy was revised in 2000 and by 2005 an ICT in Education policy was adopted.

Policy Objectives

The purpose of this Policy is to guide all Namibian education stakeholders in their preparation to meet the challenges of the twnety-first century and that of the globalizing world economy. The Policy envisages that it will guide the attainment of ICT literate Namibian citizens, capable of participating in the new economies that emerge from ICT and related developments; it will guide the ability to leverage ICT to facilitate learning by teachers and learning, improve the administrative and management efficiency of the education system and broaden access to quality educational services for all.

The Policy also makes explicit its educational goals. It is concerned with providing clear objectives and basic competencies in ICT knowledge for learners, students, and teachers. With reference to the provision of equity and quality in education, it proposes that curricula make explicit what is expected of learners, students, and teachers with reference to ICT in Education. This includes guidance to teachers on how to present the relevant assessment criteria to learners and students. The Policy also proposes that these curricula include cross-curricular "opportunities" to provide Ministry guidance to educational institutions, which have ICT access. These educational goals place emphasis on the pedagogical use of ICT as an integrated tool in the teaching-learning process at all levels in the educational system. It also suggests that competence in the use of ICT by teachers, students and community members be developed through a long period of guided practice and investigation.

Policy Content

With reference to the content of the Policy, it provides a clear vision, mission and statement of purpose. Its vision is to support the GRN's Vision 2030's call for constructive global partnerships founded on common interest, obligation, commitment, and equality premised on good governance democracy, and human rights. Its mission is to to articulate the relevance, responsibility, and effectiveness of integrating ICT in education with a view to meeting the challenges of the twenty-first century.

It also includes a clear definition of ICT which covers all the technologies used for the handling and communication of information and their use specifically in education.

The Policy states the value proposition for investing in ICT integration in Namibia's education system clearly. This value proposition includes the recognition that ICT have a role to play in education both directly as a subject and indirectly as tools to assist in educational delivery and management.

It proposes that when used appropriately, ICT can bring many benefits to the classroom and the education process and can provide new opportunities for teaching professionals delivering education. The Policy suggests that these benefits include: more student-centred teaching; greater opportunity for students at risk; greater exposure to vocational and workforce skills; greater opportunity for communication and collaboration; foster greater enthusiasm for learning amongst student; provide teachers with new sources of information and knowledge and provide learners with additional resources to assist resource-based learning.

The Policy also gives due recognition to the complexity of integrating ICT in education and how the rapid rate of technological change creates greater complexity. It also acknowledges that differing views and perspectives on these matters exists. For this reason, the Policy proposes to be open-ended to encourage its longevity instead of becoming obsolete before it is adopted.

The Policy also recognises that investment in ICT integration in education can also assist with developing local educational ICT businesses and solution providers that could develop local solutions and create local employment. It also encourages the use of ICT facilities outside of school hours to allow for services to the community but places the onus on the local school management take responsibility for these activities.

It further proposes that detailed implementation plans, curricula, teachers' guides, deployment criteria and technical standards be developed as an addition to this Policy. It provides a maturity model that articulates development levels of ICT access in education institutions. Table 6 provides a snapshot of these level and some of their matching criteria.

Table 6: Development Levels of ICT Access and Use

Development Level	Attributes
Level 1	A small computer room with 2 to 12 computers used for teaching ICT skills Staff have the skills to retrieve information, prepare documents, use school management software, and develop their skills 1 or 2 staff will have a minimum basic ICT literacy qualification Students will spend about one hour a month using a computer
Level 2	All level 1 attributes apply All teaching and administrative staff should have reasonable access to a computer (at least 1: 5 staff and 1:10 students) and are able to use the Internet, e-mail and word processor The site is connected to the Internet Learning materials are downloaded and occasionally created by teaching staff Significant email and web communication and administration with the rest of the parent Ministry Students will spend about 1 hour every 2 weeks on the computer At least 2 of the site staff will have an ICT qualification The site will have a classroom equipped with a computer and projector system and/or the ability to display audio-visual materials to students
Level 3	Use of ICT underpins significant proportions of the work All students have reasonable access to a computer (1:10 students), and all staff have access to a computer (better than 1:3 staff) The site has an Internet connection suitable for the number of users All students are able to use a computer, communicate by e-mail, find information using web-based systems, create output using a word processor e.g. assignments Learning materials are downloaded, created, and uploaded by teaching staff Over a third of the communication and administration with the rest of the parent Ministry is done via e-mail and web services Some computer based training materials are used to support teaching 30% of staff will have some ICT qualification. Students will spend about two hours a week using a computer The site will have one or more classrooms equipped with a computer and projector system and/or the ability to display audio-visual materials to students

Development Level	Attributes
Level 4	Use of ICT underpins much of the work All students have reasonable access to a computer(better than 1:5 students), and all staff have access to a computer (1:1member of staff) he site has a reasonable (fixed) Internet connection in relation to the number of students/learners and staff All students/learners are able to use a computer, communicate by e-mail, find information using web-based systems, create output using a word processor, spreadsheet and presentation software e.g. assignments Learning materials are downloaded and created on computers by teaching staff Over a half of the communication and administration with the rest of the parent Ministry is done via e-mail and web services Computer based training materials are used to support teaching Modelling software is available to allow student to experiment and investigate, along with Computer Based training software to assist in supporting the teachers Over half the staff will have an ICT qualification Students/learners will spend over 1 hour a day using a computer The site will have significant number of classrooms equipped with a computer and projector system and/or the ability to display audio-visual materials to students
Level 5	This is normally reserved for an educational facility with an ICT focus All students and staff have good access to a computer Most staff will have an ICT qualification A significant number (more than 50%) of staff will have an advanced ICT qualification ICT subjects such as programmeming, database design and usage, system configuration etc. will be taught A good Internet link will be in place Computer based training will be commonly used to support teaching using a blended earning approach Most communication and administration will use ICT Most of the work done by students/learners will be done using computers Students/learners will be obtaining employment in the ICT and related industries Students/learners will spend at least 4 hours a day using a computer The site will have significant number of classrooms equipped with a computer and projector system and/or the ability to display audio-visual materials to students

Evidently the maturity model is premised on the levels of access and nature of using ICT in education settings ranging from what is considered basic to more advanced levels of integration. It also links the maturity of the development level to the proximity of learners to the labour market. For example, learners in pre-service teaching establishments are about to enter the workforce and will be passing on their skills to others which makes them a higher priority than learners in primary schools that have many years ahead with further opportunities to develop their ICT skills.

The Policy also stipulates desired development levels. For example it states that:

- all Pre-service teacher-training facilities should be at least level 4;
- all schools with secondary grades should be at least level 2;
- all tertiary education establishments (University, Polytechnic, etc.) should be at least level 3 (4 for certain faculties).

In this respect, the Policy sets priorities which include Colleges of Education and related in-service programmes; schools with secondary grades; teacher education programmes at tertiary institutions; vocational training; primary schools, libraries and community centres, adult education centres, and special needs education.

The Policy states that within this overall structure, a model will be developed, evaluated, maintained and used that will guide the Ministries of Education and their partners in selecting priority sites for ICT investment. It also outlines a list of services to be offered. These services can be divided into technology-related services which include networking, email, web access, security and maintenance and support. They also include services related to curriculum change which include digital content creation and digital library services. Another set of services relate to capacity development which include training and support.

Pedagogical and Curricular Change

The Policy is explicit about curriculum reform with regard to the integration of ICT in Education. It suggests that curricula should promote skills of accessing, managing, and processing information; collaborative working skills;

problem solving; and learning to learn concepts. It proposes that the curriculum must be explicit in providing guidance to all teachers. It also proposes that an ICT curriculum be developed as and suitable guidance for the use of ICT in all other areas of the curriculum be established.

The Policy identifies three aspects to the role of ICT in the curriculum:

- Curriculum for ICT skills and knowledge, which is referred to as ICT Literacy Skills. It proposes that all learners have basic ICT Literacy before they complete secondary education.
- ICT as a Subject: This refers to the explicit study of ICT and includes Computer Studies and Information Technology geared towards more advanced technical skill development.
- Curriculum for the use of ICT within subjects other than ICT which is referred to as cross-curricula ICT. This refers to the generalized use of ICT in all curriculum activities and that individual subject curriculum will also be adjusted to reflect the role of ICT in teaching the subject.

The Policy also proposes that curriculum change should be considered for pre-service training of teachers. Furthermore, it identifies content development as crucial and content software as integral to the teaching/learning process and must be developed. Here, the Policy poses the option of either acquiring content when suitable and cost effective; adapting content that is acquired or creating content when suitable and cost-effective. It also specifies the creation of local Namibian content wherever the need is perceived in subjects such as history, social studies, geography, language and literature.

It also proposes to promote reliable information on a range of platforms including audio and video and relevant websites; an evaluation mechanism to assess the quality of content; identifying sections of websites that can be aligned to the curriculum and the identification of priority areas for content development as well as suitable agencies who can support local content creation is proposed.

A Digital Library is also proposed in order to provide educational materials to support the curriculum, the administration, and the training of the education community. The digital library is envisaged as a channel for education consumers to retrieve the knowledge needed and that content within the library will only come from 'trusted' and/or approved sources.

This suggests that the Policy focuses more on the integration of ICT in curriculum development and delivery and less on the pedagogy of curriculum delivery. The Policy also expresses an openness to acquire and use content that are produced elsewhere. Here, the emphasis appears to be on the suitability of content. It is assumed that this suitability refers to the extent to which the digital education content is aligned to the curriculum. The notion of "suitable content" is not spelt out in the Policy.

Teacher Development

The Policy refers to "staff training," which encompasses the development of teachers, lecturers, principals, administrative staff and other stakeholders who would require varying levels of training to integrate the use of ICT in their practice. It calls for pre-service and in-service training targeted mainly at teachers who are required to have confidence in using ICT including communication via email, understanding the value of integrating ICT in learning and teaching. Similarly, what is referred to as "pre-service lecturers," principals, advisors and inspectors and administrators are required to develop their confidence in the use of ICT and preferably work towards an ICT qualification. The use of ICT in conceptualized as an ability to search for, retrieve, prepare, and present materials using a computer; communication via email and an understanding of management and administrative ICT systems. Included too is a suggestion that the value of ICT within various work contexts of these stakeholders need to be understood.

In addition, the Policy proposes training courses for ICT trainers, considered to be a group with higher levels of competence who are tasked with training education stakeholders in the use of ICT, evaluating their performance and monitoring their development.

What is apparent in the formulation of the Policy is that at the time when it was adopted, the development of teachers in particular was understood to assume the form of "training." Training was conceived and practiced as a short-term, often one-off learning opportunity focused more on learning about the technologies and less on how to use them in the practice of teaching, learning and administration. Few if any references were made at the time to the institutionalization of teachers' professional development with the use of ICT. Professional development, as opposed to "training", is considered to be a continuous, modular process based on the authentic contexts of teachers and the development of individual learning pathways for teachers.

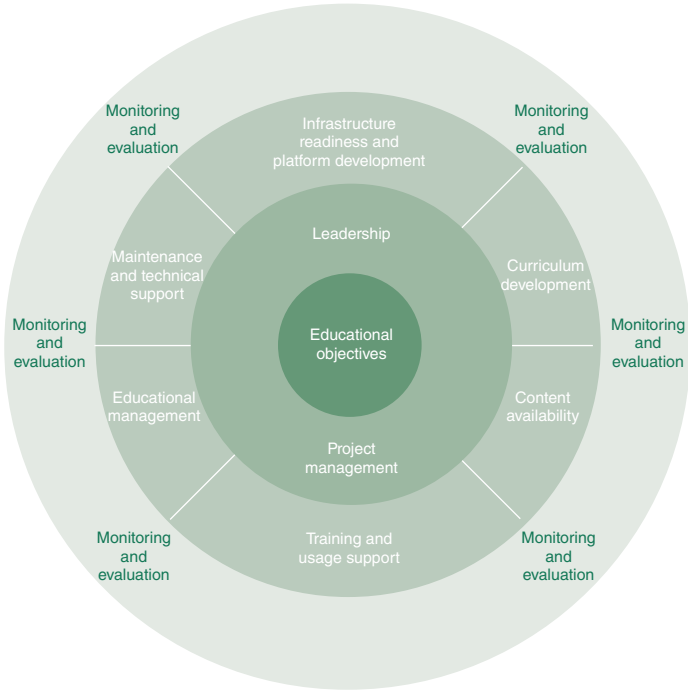
The design and articulation of Namibia's ICT in Education Policy is clearly very practical, informed by evolving experience of various education stakeholders since the 1990s. This is evident from its attempt at a holistic approach to the integration of technologies in learning and teaching practice and linking this to the development of a clearly articulated maturity model together with desired levels as targets to be achieved. The Policy also reflects the collective understanding of Namibia's policy-makers and stakeholders of the meaning and implications for the integration of the education system with technologies in the period up to 2005 when the Policy was adopted.

Policy Implementation Framework

The GRN also developed an implementation framework based on the ICT in Education Policy. This implementation framework is spelt out in the Tech/Na! Implementation Plan (hereafter, Implementation Plan) which adopts a "holistic, demand-driven and end-to-end solution" approach .

TECH/NA!'s main goals are to equip educational institutions with the technologies and all associated educational and technical services and support; to educate stakeholders in ICT literacy and ICT integration and to empower communities to bridge the digital divide and meeting the goals of Vision 2030. The Plan includes ten key elements, shown in Figure 2.

Figure 2: Holistic Approach to Policy Implementation



The Implementation Plan places the educational objectives as the driver of the implementation process. The Plan envisages that these objectives would be guided by the leadership of the Ministry of Education, and will be supported by a Project Management Officethat oversees the day-to-day management of the initiative. In addition a Steering Committee comprising representatives of stakeholders would support the Project Management Office with strategic direction and coordination.

The framework highlights key issues for successful implementation. It suggests that physical infrastructure needs to be in place in the form of power, buildings, and telecommunications. An appropriate curriculum needs to be in place for basic ICT literacy skills, for the integration of ICT across subject areas, and for ICT as a subject in itself. It advises that content needs to be available to support the delivery of the curriculum. It highlights that training programmes need to be implemented; that the educational management at school, district, and national level need to be aligned and all hardware, software, and personnel need to be appropriately supported through centralized and on-site support. And all of this must be monitored and evaluated regularly in order to make suitable adjustments. The Steering Committee established working groups based on each of these focal areas.

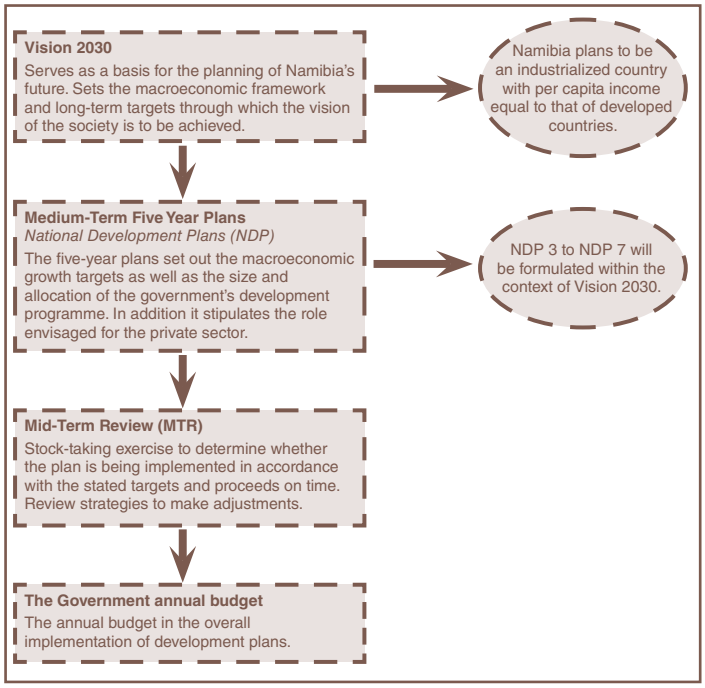
- Each of the 10 components shown in Figure 3 is described in detail in the Ministry of Education's Implementation Plan Guide for ICT in Education.
- The framework tries to reflect a comprehensive solution for the implementation of ICT across the education sector. It also envisages 2 phases of implementation with Phase 1 between 2006–2009 and Phase 2 commencing in 2009. During Phase 1, the Framework targeted the holistic deployment of ICT in pre-service and in-service teacher education institutions; schools with secondary grades; and vocational training centres and community skills development centres. It also targeted implementation in regional and community libraries during Phase 1.
- During Phase 2, all national, regional, and community libraries and community and adult education, and primary schools were targeted for completion.
- A crucial component of Namibia's ICT in Education implementation framework was the establishment of the National Education Technology Service and Support (NETSS) Centre. This Centre's main purpose is to serve as a one stop ICT shop for the deployment and support of ICT in all educational institutions and take oversight responsibility for sourcing, refurbishing, installing and supporting ICT in these institutions. It was to serve as a distribution hub for ICT hardware and software and provide maintenance and technical support to institutions via local support. A centralized NETSS Support Team is envisaged.

The way that the Tech/Na! is articulated suggests that the implementation process has tried to be inclusive by involving a wide range of partners and stakeholders in the governing structure. It also tried to be holistic and comprehensive by ensuring that it accommodates educational, technological and administrative functions in the implementation process. The institutional framework with the proposed establishment of a Project Management Office also suggests that the intention was to ensure a well-coordinated and managed implementation process. These dimensions are often dependent on the level of resources at the disposal of the implementation process, of which financial resources are central.

Financing

Tech/Na! does not provide a financial resourcing model to support the implementation process. However, because it stems from the ICT in Education Policy that has been guided by Vision 2030, such a resourcing model would consider the planning and finance framework related to Vision 2030. This National Planning Framework related to Vision 2030 is shown in Figure 3.

Figure 3: National Planning Framework



Source: Vision 2030

Thus Vision 2030 guides the Medium-term Expenditure Framework which in turn guides the Mid-term Review which in turn guides the GRN's annual budget. Budgetary allocations towards an ICT in Education endeavour will be linked to an education budget at this level. Historically, Namibia has allocated a significant proportion of its budget to education and thus, within this, the plans outlined in Tech/ Na! will be considered.

With reference to funding arrangements, ETSIP is designed as a sector-wide programme and falls within the normal planning, reporting and financial arrangements of government, including the National Development Plan and the Medium-term Plan. ETSIP is being implemented through the ThirdNational Development Plan (2006-2011) and through Annual Work Plans which commenced in 2006-2007. The GRN generally prefers to receive budget support, including targeted budget support. A Facility has also been created by agreement with the European Union and Swedish International Development Agency (SIDA) for institutional strengthening and capacity development. The Education Act 2001 provides for an Education Fund under the control of the Ministry of Education for disadvantaged learners.

The additional costs associated with the implementation of the first phase of ETSIP amount to an estimated US $3 million over five years, which is to be jointly financed by the Namibian Government and a consortium of international development partners. Collaboration with the Namibian private sector and civil society is also an important aspect of ETSIP.

An important tool for conceptualizing the financial resources required, is the adoption of a total cost of ownership model. The ICT Policy for Education proposes a total cost of ownership model for consideration when calculating the cost implications for the investment in ICT in education in Namibia. Total cost of ownership is a tool used in financial planning when working on the cost estimates of an intended intervention. It refers to the consideration of the full range of costs, both explicit and hidden, direct and indirect, over time in order to give an indication of the resources that will be required when planning an ICT in Education intervention. Namibian education stakeholders have been innovative about the development of TCO models. Here the pioneering work done by SchoolNet Namibia and GeSCI in clarifying the costs that need to be considered in a TCO model have been influential in the Namibian ICT in Education policy process.

The Policy Rationale

The policy rationale is based on the Government's premise that investment in ICT integration in education has the potential to enable the achievement of Namibia's education and developmental goals. The ICT Policy for Education states that ICT enable the delivery of equitable, quality education, thereby providing an opportunity to improve the lives of Namibians. The Policy suggests that it is imperative that Namibian children, parents, and teachers be exposed to ICT to improve the quality of education and technical proficiency of the country's human resources which could lead to increased productivity and accelerated development.

The Policy also advocates the integration of ICT in Namibia's education system from the perspective of developing twenty-first century skills required by a knowledge-based economy. The Policy is replete with references to skills, skill development and competency development in this respect with particular emphasis on the relevance of skill development to the needs of the labour market. The Policy suggests that education systems play a crucial role in preparing learners for the "real world" and the labour market. The integration of ICT is considered important for developing competencies in the use of ICT for a labour market where knowledge-based and knowledge-intensive skills will be in demand.

Included in the policy rationale is an awarenessh of the need to prepare Namibian citizens to adapt to the demands of the global economy and participate in electronic commerce. ICT enable communication and opportunity to understand other peoples and cultures which allows Namibia to defend its renewed legacy of peace and tolerance.

The related draft IT Policy for Namibia provides a more explicit economic rationale. It recognizes the important role of ICT for economic growth and that in Namibia in particular, ICT contributes to five important economic roles:

- economic growth;
- industrial development;
- poverty eradication;
- equal opportunity;
- regional coordination.

This Policy therefore identifies the growth of the ICT sector in Namibia as a national imperative.

Thus, in a nutshell the policy rationale is informed by the view that integrating ICT in education will deliver quality education, will enable greater access to education, will catalyse transformation in the labour market and the economy because it will produce learners with ICT skills. Investment in ICT is also linked to an economic growth, improved communication and the development of peace and tolerance.

The Policy Development Process

Steps in Policy Development

The development of the ICT Policy for Education in Namibia dates back to 1995 when the Ministry of Basic Education, through the National Institute for Educational Development (NIED), developed a national policy for ICT in Education in Namibia (NIED, 1995). NIED is a directorate in the Ministry of Education tasked with ensuring the continuous improvement in Namibia's education system in accordance with the latest developments in education and the needs of the people of Namibia.

The Policy was revised in 2000. The revised policy justifies the investment in ICT in educational institutions and enlists the policy options, software, training, hardware, and qualitative estimates of costs, for each rationale, which

are further broken down into aims, objectives, and strategies for both the short-term (three-year) and the long-term (five-year).

By 2004, a host of projects and programmes on ICT in Education had emerged within Namibia. This collective experience was drawn upon when in 2004, a mixed working group based in the two Ministries of Education, was formed to update and expand the Policy further, reflecting on these developments and drawing on the existing knowledge base in pedagogy, research, technology, and partnerships.The formation of the ICT and Education Steering Committee drawing on Ministry of Education officials, project managers and NGO leaders, emerged from this process.

Under the leadership of the Steering Committee, through an inclusive process of consultation, involving extensive discussion and debate among a wide range of stakeholders and partners, the revised ICT Policy for Education was developed. This policy development process also evolved into a strategy for sector-wide educational change through the integration of ICT for teacher training, classroom learning, and educational management. As this process took shape, a framework for engagement for all partners emerged as well as a comprehensive framework for implementation which considers a wide-range of experiences, stakeholders, and perspectives. The implementation framework referred to as TECH/Na! was developed by the Steering Committee in collaboration with the Global eSchools and Communities Initiative in early 2005. GeSCI is an international not for profit organization set up in 2003 by the UN ICT Task Force to provide demand-driven assistance to developing countries seeking to harness the potential of ICT to improve their education systems.

Table 7 provides an overview of the various stakeholders involved in the ICT in Education initiative in Namibia.

Table 7: Namibian ICT for Education Stakeholders

Stakeholder Category	Stakeholder	Role
Co-ordinating Organizations	Ministry of Education ETSIP ICT in Education Steering Committee	Co-ordination and oversight on all ICT in Education programmes and policies
Central Government	Office of the Prime Minister	Overall direction in line with national goals and priorities
Government Ministries	Ministry of Gender Equality and Child Welfare Ministry of Mines and Energy Ministry of Information and Broadcasting Ministry of Youth, National Service, Sport and Culture	Support with delivery and implementation of ICT in Education programmes nationally
Ministry of Education	Directorate of Adult Basic Education Directorate of Education Programme Implementation Directorate of Higher Learning Directorate of General Services Directorate of Science and Technology Education Management and Information Services Unit	Support with delivery and implementation of ICT in Education programmes
International Private Sector	Accenture Development Partnerships Microsoft Corporation Learnthings Africa Cambridge University Press	Support and partnership with Ministry of Education and GRN in delivery of ICT in Education
Local Private Sector	Telecom Namibia	Work with Government and its partners in delivery of ICT in Education programmes and projects
Donor and Development Agencies	USAID SIDA UNESCO Embassy of Finland	Partnership with Government in delivery of broad education goals and with specific projects related to ICT in education
Foundations	Rossing Foundation	Partnership with Government in delivery of broad education goals and with specific projects related to ICT in education

Stakeholder Category	Stakeholder	Role
Civil Society and NGOs	CECS Namibia ICDL Foundation ICT Alliance NOLNet NETSS Centre eLearning Centre Peace Corps Namibia SchoolNet Namibia	Technical support to Government on matters relating to ICT in Education
Education Institution Communities	Education Institution Management PTAs Teachers/Lecturers Learners Student/Youth Organizations Trade Unions	Apply and manage the integration of ICT in the educational institutions

Source: www.tech.na/partners.htm (accessed December 28, 2009)

Table 7 shows that there is a wide range of stakeholders involved in Namibia's ICT in Education policy development process. This is a defining feature of the Namibian ICT in Education landscape. Many stakeholders have been active in a range of ICT in Education projects in Namibia historically and have contributed actively to the country's policy development process through open and transparent debate and participation.

Governance of the Reform Process

Institutional Framework

At the time when the ICT Policy for Education was developed, Namibia had 2 Ministries of Education. There is now one integrated Ministry of Education in Namibia. The Policy is now managed by an Executive Committee which includes both Ministries of Education to whom it reports. The role of the Executive Committee is to:

- administer the Policy;
- approve or reject recommendations made by the Steering Committee;
- publish performance measures for appropriate distribution, delivery, maintenance and integration of ICT in education; and
- report annually on the Policy.

In addition, a broad, inclusive Steering Committee was established to co-ordinate implementation of the policy. The Steering Committee is made up 70 individuals representing a cross section of stakeholders including all the Directorates in the Ministry of Education.

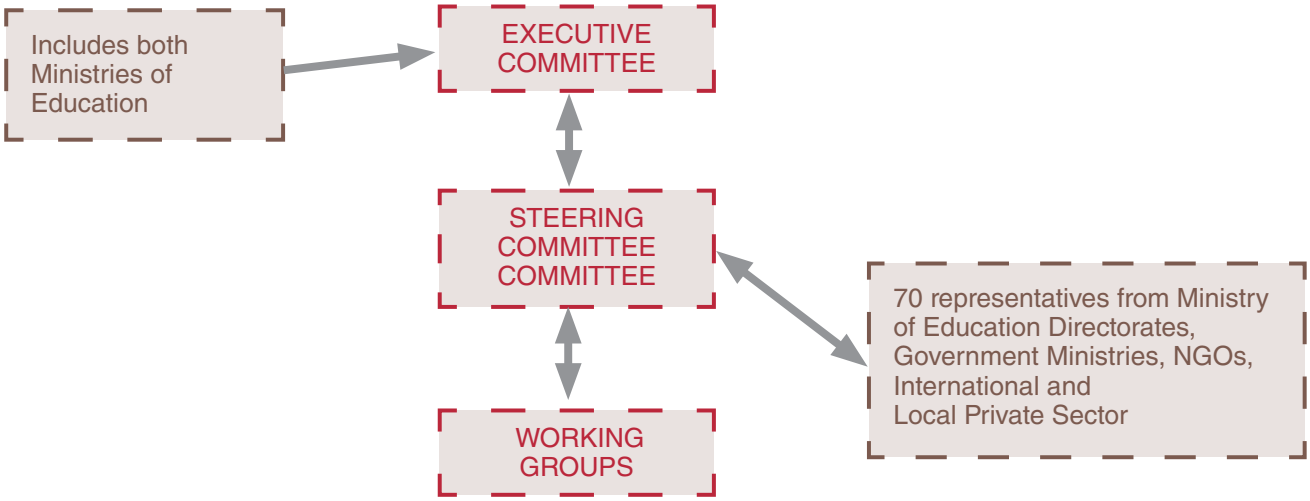
The role of the Steering Committee (under guidance from the Executive) is to:

- establish an efficient framework for co-operation between line ministries, stakeholders, partners, educational institutions, to ensure the successful implementation of ICT for Education for Namibia;
- co-ordinate national ICT activities; and
- make recommendations to the Executive Committee about mutually agreed standards of:
  - acceptance,
  - cost and quality of operations,
  - services,
  - support and maintenance,
  - teacher and staff training,

- institutional development,
- capacity-building,
- research, and
- public awareness within the ICT Policy Framework.

It was proposed that a Project Management Office be set up to assist the Steering Committee and its Working Groups, which are organised around each component of the framework for implementation. To date, the Project Management Office has not yet been set up. More and more, the Working Groups are becoming the decision making bodies of the Steering Committee, with each working group making recommendations for their areas of expertise and the Steering Committee reviewing these recommendations for endorsement. Figure 4 illustrates the governance structure explained above.

Figure 4: Governance Structure for ICT in Education in Namibia



The ICT Policy for Education includes in its appendix, a detailed terms of reference for the Steering Committee including a list of organizations and groups and their representatives who serve on the Steering Committee (Ilukena, 2006). Figure 5 confirms that the policy implementation process has tried to be inclusive through the representation of key stakeholders on the structures governing the process.

Instruments to Regulate Public-Private Partnerships

The ICT Policy for Education recommends the proactive use of partnerships to speed up implementation of the policy, to develop the Namibian ICT economy, and to reduce the burden on taxpayers. TECH/Na! is one instrument set up to support the regulation of public private partnerships. TECH/Na! outlines a "framework for engagement" for all partners to influence the ways in which ICT are introduced and utilised for the education sector. TECH/Na! is essentially a framework for the inclusion of both strategic and implementation partners. The ICT and Education Steering Committee fulfil an oversight function in this respect. One of the key dimensions in regulating partnerships and multiple stakeholders is the management of educational change, the many "competing visions" and the messy nature of the ICT in education sector in Namibia. Representatives of the Ministry of Education consider this to be an "asset" because the framework for partnership engagement provides the unifying dynamic for the sector. (Ilukena, 2006)

Partnerships Currently in Existence

The Namibian Ministry of Education has already established a host of partnerships with donor, development agencies and private sector. Table 8 lists some of the key partnerships that are in existence during 2009-2010 and the respective projects that have been underway.

Table 8: Current Partners in ICT for Education Namibia

Name of Partner	Projects
USAID	To expand quality education for both students and teachers in the lower primary grades; and, To put in place the systems and structures necessary to deliver quality education services and strengthen the capacity of the MoE to manage educational management
Accenture Development Partnerships	Subsidised technical expertise
Inwent	eLearning Centre
Microsoft	Partners in Learning
Global eSchools and Communities Initiative	Technical Support and Advice
Community Education Computer Society	ICT literacy and ICT training for communities

At the time of writing, organizations such as SchoolNet Namibia who have played a path-breaking role in the ICT in Education sector in Namibia over the past ten years, had closed down, which shows the fluidity of the environment under which partners and stakeholders are working in this sector.

Policy Alignment and Consistency

There is significant consistency and alignment between the GRN's Vision 2030, the country's policy and strategy for education improvement and the ICT Policy for Education. There is also consistency and strong alignment with the international policy context with reference to sustainable socio-economic development. The GRN's vision statement and subsidiary policies related to education endorses the Millennium Development Goals and Education For All goals.

Vision 2030

The GRN's long term vision for the country's socio-economic development is enshrined in its Vision 2030: Policy Framework for Long Term National Development document which was adopted in 2004. It is a national plan to "improve the quality of life of the people of Namibia to the level of their counterparts in the developed world by 2030" (GRN, 2005:2). Vision 2030 serves as a broad guiding vision that unifies the five-year rolling plans (referred to as National Development Plans), providing direction to government ministries, private sector, NGOs and local authorities.

Vision 2030 aspires towards Namibia becoming a prosperous and industrialized nation, developed by the country's human resources, and enjoying peace, harmony and political stability. The Vision proposes to transform Namibia into a healthy and food-secure nation, in which all preventable, infectious, and parasitic diseases are under control, and where people enjoy a high standard of living, high-quality life, and have access to quality education, health, and other vital services. All of these aspirations translate into a long life expectancy and sustainable population growth. In support of the objectives of 2030, capacity-building is being pursued by both the private and public sectors and proposes to be enabled by political stability and freedom, a sound legal system, economic resources and opportunities, and social norms that are conducive to sustained development.

The major objectives of the Vision are to:

- transform Namibia into an industrialized country of equal opportunities, which is globally competitive, realising its maximum growth potential in a sustainable manner, with improved quality of life for all Namibians;
- achieve stability, full regional integration and democratized international relations: the transformation from an aid-recipient country to that of a provider of development assistance;
- ensure that Namibia is a fair, gender-responsive, caring and committed nation, in which all citizens are able to realize their full potential, in a safe and decent living environment;
- create and consolidate a legitimate, effective and democratic political system, and an equitable, tolerant and free society that is characterised by sustainable and equitable development and effective institutions, which guarantee peace and political stability;
- develop diversified, competent and highly productive human resources and institutions, fully utilising human potential, and achieving efficient and effective delivery of customer-focused services which are competitive not only nationally, but also regionally and internationally.

Vision 2030 sets the macroeconomic framework and long-term targets through which the vision of the society is to be achieved. Furthermore, it serves as the basis for the planning of Namibia's future. It also serves to guide all planning mechanisms, which consist of the national development plans, medium-term reviews, and the national budget.

With particular reference to education, Vision 2030 reiterates an education policy driven by four goals: access, equity, quality and democracy. Free primary and compulsory basic education, lasting ten years was introduced, based on these four goals. The vision for education is for a strong general education base in science and technology, flexible delivery of a flexible curriculum combined with new teaching methodologies. It also envisages a renewed focus on science and mathematics at basic and secondary education levels and on science and technology at tertiary level including pre-service training of teachers; basic education outcomes include reading, writing, numeracy and general competencies; a national quality assurance system at all levels with a large number of accredited and learning centres will exist all over the country; facilities for Vocational Training that are adequate and equitably distributed throughout the country and that higher education of good quality is accessible to all qualified Namibians and produce highly qualified people in all professions.

With specific reference to ICT the Vision provides a list of goals to be achieved by 2030. These include a fully implemented national ICT policy; a University of Applied Science and Technology with adequate support established; Internet access available to and used by all Namibians and that significant local production of ICT equipment has been achieved.

The Vision also sets clear milestones for human resource development, some of which include: expanding access to secondary schooling for the target age group by 2006; providing all schools with drinking water and electricity where the necessary infrastructure will be supplied by 2006; equipping all schools with furniture by 2006; ensuring that by 2015, at least a 1:35 teacher pupil ratio in primary schools and 1:30 for secondary schools have been achieved; achieving 50% improvement in levels of adult literacy by 2015 especially for women; and providing equitable access to basic and continuing education for adults.

These visionary goals are consistently referenced in subsidiary policies related to education, ICT and ICT in Education. A discussion on the policy objectives and content has already been covered. Policy alignment and consistency is evident here as well as in the IT Policy for Namibia.

IT Policy for Namibia

This Policy outlines education commitments as part of its objective to transform the IT sector in Namibia, including telecommunications, broadcasting and postal services. With reference to education the Policy proposes that the

Government stimulate the development of the ICT skills through the establishment of ICT Centres of Excellence at centres of further learning. It also proposes that the IT training as part of the educational curricula, starting from primary school level as well as establish institutions of ICT learning in smaller towns (Namibian Ministry of Information and Palladium Consulting, 2008).

Figure 5 summarizes succinctly, the key policy objectives of each subsidiary education and ICT in education policy flowing from Vision 2030.

Figure 5: Aligning Policy Objectives

The above suggests that the policy objectives for the integration of ICT in Namibia's education system have strong educational underpinnings linked to a broader objective for socio-economic development.

Vision 2030 provides a comprehensive framework to transform the Namibian political and economic landscape in areas such as land reform, housing, the environment, health, education and building an economy that provides equal opportunities for all. It sets out the key development challenges for Government such as human resource development, job creation, the provision of infrastructure, changes in the ownership patterns of the economy and the reduction in income inequality and poverty in the Namibian society.

Policy alignment seems to revolve around the importance of investing in ICT to support Namibian inclusion in the global economy; the importance of investing in ICT skill development so as to foster knowledge society attributes in the Namibian labour market; the importance of developing healthy and educated citizens in Namibia; the value the ICT in socio-economic development and modernizing Namibian economy and society and the contribution of ICT integration to promoting education access, quality and relevance.

Monitoring and Evaluation

As indicated above, the ICT Policy for Education and *the* TECH/Na! make explicit reference to the inclusion of comprehensive monitoring and evaluation (M&E) in the national ICT for education initiative in Namibia. TECH/Na!, in particular, articulates how monitoring and evaluation encompasses the entire implementation plan as shown in Figure 5 above. Neither TECH/Na! nor the Policy itself spells out the M&E approach and methodology to be adopted however.

M&E Activities to Date

To date, there has been limited monitoring and evaluation of projects and programmes on ICT in Education in Namibia. In 2000, SIDA conducted an independent evaluation of SchoolNet Namibia and its projects and programmes. This evaluation revealed a host of valuable lessons not only for SchoolNet Namibia but for large scale ICT in Education projects in Namibia and the rest of Africa. Some of the key lessons that emerged from this evaluation include:

- Sustainability in schools is closely linked to affordability of ICT. Affordability has to consider total cost of ownership which include the wider costs of ownership both in the present as well as future costs.
- ICT can be made more affordable and accessible to school through the use of volunteers, refurbished computers, open source operating systems and providing discounted or free connectivity.
- Fostering optimal use of technologies in ways that enable learning, can be challenging and requires commitment from the school and the involvement of specialised partners in e-learning or content development
- Role players and stakeholders need to communicate clearly and effectively in order to work towards common goals and priorities.
- Since many schools do not have in-house ICT expertise, the technical support becomes very challenging. Some technical support functions can be delivered through partnerships with specialized agencies
- ICT can contribute to the quality of education in schools. Through schools they can also contribute to informal and life-long learning and the empowerment of youth and communities.
- Whilst quantitative data can be collected on regular basis, it is more challenging to gather data on the qualitative use of ICT for learning and teaching (INASP, 2004).

This evaluation was conducted ten years ago. SchoolNet Namibia wasdissolved in 2009. In 2007, InfoDev supported a workshop with the Ministry of Education to develop a monitoring and evaluation framework for the Tech/Na! implementation plan.

In 2008, an independent evaluation of Global eSchools and Communities' activities in Namibia was conducted and in 2009, GeSCI conducted a review of Tech/Na! to which the Ministry of Education contributed substantially.

The main highlights from this review build on the findings of the evaluation of GeSCI's activities in Namibia and include the following:

- That Namibia has made significant strides with reference to ICT in Education which include:
  - the successful creation of a common agenda for the development of ICT in education;
  - an integrated approach and a comprehensive Implementation Plan;
  - the alignment to the national development agenda;
  - the establishment of broad-based multi-stakeholder partnerships;
  - the development of comprehensive ICT standards for all deployments; and in addition;
  - Namibia is seen to be leading in terms of e-readiness with regard to its progress in ICT.

- That innovative approaches in dealing with ICT issues have been introduced. Here the example of innovative partnership between Telecom Namibia and the MoE to provide affordable connectivity to educational institutions through XNet was raised.
- That there is policy alignment and integration with the Tech/Na! Implementation Plan being a sub-programme of the ETSIP and being aligned to the national Vision 2030 and its National Development Plans.
- That technical standards and specifications for infrastructure have been developed (though are still incomplete) and approved and the results of the ICT Mapping Surveys are available and utilized in planning.
- That deployment criteria for the allocation, distribution and installation of computers and related equipment, were developed.
- That with reference to teacher preparation for ICT a foundation level curriculum for literacy and curriculum for the integration of ICT for educators (ICTED) were developed.

- That a number of successful capacity-building courses were executed by the Namibian e-Learning Centre (NeLC).
- That localized ICT syllabuses for secondary school learners were developed and approved.
- And that impactful partnerships (e.g. with ICDL) for ICT literacy development have been achieved.

However, the review also found that the structures for implementation were not properly implemented which constrained the implementation of the plan. These include that the ICT in Education Steering Committee did not meet regularly which resulted in inadequate consultation with stakeholders and that the TECH/Na! Project Management Office was not yet established. Similarly, whilst the eLearning Centre was well established there were concerns that the Namibian e-learning capacity that was developed was not utilised for the development of local e-learning content.

It also found the NETSS Centre was established and did some deployments but did not operate as a "one-stop shop" for support and repairs as was envisaged. It has been functioning as if for small-scale deployment. Since it received large numbers of equipment which had to be inventoried, tested, installed with approved content and software, dispatched to institutions and installed, the centre struggled to deploy and install them owing to a lack of adequate staffing (Swarts et al., 2009).

The review also recognizes ways in which policy implementation could be improved. It recommends that the structures such as the Project Management Office for Tech/Na! be made operational and that it functions effectively if the ambitions of the national implementation plan is to be realized. It also proposes the strengthening of the NETSS Centre and defining more clearly the roles and function of the IT division of the NETSS Centre given its prominence in the implementation of Tech/Na!

It further recommends that the human resource capacity for ICT integration be developed at all levels and that regular and clear communication between all stakeholders be developed in order to enable the working groups from the ICT in Education Steering Committee to be involved in negotiating partnerships

It also recommended that the M&E component needs to be urgently integrated within all the processes and programme management of the *Tech*/Na! plan for continuous feedback and timely adjustments (Swarts et al., 2009).

The review of the Tech/Na! Implementation Plan is comprehensive and has served as a basis for stakeholder learning. Some progress was witnessed since the review was published, such as increased regularity of meetings of the Steering Committee and the incorporation of the NETSS Centre into the Ministry of Education and its ability to reduce the backlog that had accumulated over time.

Conclusion

The policy process in Namibia has evidently been a dynamic living process involving a wide range of very active stakeholders in the public, private and NGO sectors. The policy evolved steadily from the 1990s until when it was adopted in 2005. It was followed by an implementation plan which was also evaluated independently after a few years; this is testimony to the dynamic, visionary leadership and commitment of Namibia's education stakeholders. The way the Policy and Implementation Plan are articulated reflects the collective imagination on how ICT can enable the transformation of the country's education system, how it can be acquired and deployed, how stakeholders would learn, and how the technologies could be used in learning, teaching and the management of education institutions. This articulation demonstrates the pertinent issues and debates that prevailed during the late 1990s and the first few years of the new millennium. This is evident from the maturity model presented in the Policy, the way curriculum change and teacher development is conceptualized in the Policy, which are perhaps the most insightful expression of how thinking emerged at the time of what was meant by the integration of ICT in education, how this could be measured and how this could morph towards higher levels of integration and use.

The disruptive nature of layering technologies into a resource-poor, social and cultural system fraught with tensions and contradictions and the need for change management could not be as clearly understood as it is now, after almost a decade of experience with integrating ICT in education. This demonstrates how the process of policy development and implementation on ICT in Education is largely an emergent, exploratory process that consistently confronts highly complex challenges as it endeavours to move towards a collective vision of education transformation.

Being an early adopter in Africa, the major stakeholders in the ICT in Education policy development and implementation in Namibia experienced many unanticipated challenges, which also enabled significant stakeholder learning about what can and cannot work within a Namibian context.

One of the most salient features of the Namibian ICT in Education landscape is that the country has historically had a vibrant civil society, a strong leadership team within Government and a range of proactive local and international private sector companies and development agencies involved in educational transformation through the use of ICT. It appears that Namibia has now reached a crucial stage in its evolution towards realizing its national vision. Sustaining its high calibre of collective leadership appears to be more challenging now. The Review of Tech/Na! conducted by GeSCI provides worthwhile recommendations to address some of these challenges. The implementation of these recommendations coupled with a healthy approach to stakeholder learning through consistent integration of M&E in future policy implementation plans will bode well for Namibia's continuing in its pioneering and leadership role for the rest of the African continent.

Chapter 5

Case Study: Jordan

Tayseer Alnoaimi

Executive Summary

Jordan is recognized both in the Middle East and internationally as a leader in developing its ICT infrastructure and promoting ICT as a tool to improve human capital, foster economic development and reduce poverty. His Majesty, King Abdullah II, is a strong advocate in the promotion of ICT as key to Jordan's role as an IT hub in the region. In 2002, the King issued the "Vision for the Future of Education in Jordan," which provided strong support to the role of ICT. In 2006, this commitment was updated by the King's issuance of the Jordan National Agenda. This directive has helped government efforts to promulgate a policy and investment environment that promotes and nurtures strong public and private sector partnerships.

Jordan's ICT sector has a fully liberalized market, which has had a positive impact on economic stability. This is due, in part, to the proactive policies of the Jordanian Telecommunications Regulatory Commission (TRC), formed in 1995. It has a strong record of enabling intergovernmental collaboration as well as supporting private sector investment and partnership in policy and programme development. In mid-2007, the TRC and key government agencies, with the IT Industry Association acting as lead, published the *National* ICT *Strategy of Jordan* 2007-2011. This document provides a sound guide from both the private sector and public sector perspectives, on how Jordan should manage its ICT development program.

The Ministry of Education (MoE) has been pro-active in its direct association with each of these ICT developments and in adopting the directives as part of its sector reform program. Jordan has invested heavily in its education system and in its human resources with a strong emphasis on enabling a more ICT-friendly and technology-aware population. The Kingdom's education system is ranked as one of the best in the region in terms of access, equity, efficiency and quality. The use of Internet, the acquisition of computers, the use of service providers, and overall technology use, have increased substantially.

The Ministry has taken a systematic approach to its ICT policy development process. In 2003, the Ministry produced a list of key policy shifts for ongoing education development, each with a strong emphasis on ICT application. These resulted in policy debates and the *National Education Strategy* (2004), and an overall policy framework for 2007-2011, recently updated for 2009–2013. In 2004, the MoE issued its Curriculum and Learning Assessment Framework which guided the rewriting of curriculum in all subjects for all grades between 2004 and 2008. This Framework also provided the basis for the development, with the Jordan Education Initiative (JEI), of a broad programme of e-learning content which is now in full application and ongoing development.

The MoE has worked intensively with the National Centre for Human Resources Development (NCHRD) to monitor all activities in its reform programme – the *Education Reform for the Knowledge Economy* (ERfKE). This reform programme is characterised by a strong emphasis on ICT and this will be expanded during the next phase scheduled for 2009-2015. This key agency has played an important role in researching ICT applications in the basic and secondary education sub-sectors and its recommendations are integrated into the next phase of reform. A continuing link with the JEI, the private sector, donor agencies, and other government bodies will continue to be integral to ongoing policy development and ICT implementation and in the MoE education development program. Included in this is its newly established Education and Training Institute designed to ensure that teachers are fully literate in ICT and their use in teaching and learning.

Abbreviations and Acronyms

CIDA	Canadian International Development Agency
DCU	Development Coordination Unit
DTQS	Directorate of Training, Qualifications, and Supervision
ERfKE	Education Reform for Knowledge Economy
EU	European Union
FDI	Foreign Direct Investment

GCC	Gulf Cooperation Council
GITR	Global Information Technology Report
GNI	Gross National Income
GNP	Gross National Product
GOJ	Government of Jordan
ICDL	International Computer Driving Licence
ICT	Information Technology and Telecommunication
INTAJ	Information Technology Association of Jordan
IP	Internet Protocol
IT	Information Technology
JD	Jordanian Dinar
JEI	Jordan Education Initiative
KG	Kindergarten
MENA	Middle East and North Africa
MoE	Ministry of Education
MOICT	Ministry of Information and Communications Technology
MOL	Ministry of Labour
NBN	National Broadband Network
NCHRD	National Centre for Human Resources Development
NRI	Network Readiness Index
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
PSPS	Policy and Strategic Planning Secretariat
TIMSS	Trends in Mathematics and Science Study
TRC	Telecommunications Regulatory Commission
TSLRIC	Total Service Long Run Incremental Costs
UIS	UNESCO Institute of Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development

The Context

Socio-economic Profile

Demography

The Hashemite Kingdom of Jordan's population growth is comparatively high with an annual increase of 2.5% and a population of 6.1 million (2008). Jordan has one of the youngest populations among lower-middle income countries with 38% of the population under the age of 14. More than 70% are under the age of 30 and life expectancy at birth has significantly increased to 72 years over the past 15-year period. Population growth in 2007 was 3.2% and 2.7% in 2006 due mainly to an influx of Iraqis who now represent approximately 800,000 of the total population.

The National Agenda states, "Jordan is one of the smallest and poorest economies in the Middle East with 14% of Jordanians living below the poverty line."17 Poverty rates declined from 21% to 14% between 1997 and 2003 and recent estimates by the National Statistics Bureau indicate that poverty levels are now at 11%, which suggests

17 National Agenda, Section on "The Jordanian Challenge," p. 5.

continued progress. Infant mortality is at 21 per 1,000 live births and child malnutrition is 4% of children 5 years old or under.

Human resource development has been a key aspect of Government policy with a focus on a reduction in poverty and unemployment and expansion of access and quality of preschool, basic, secondary and tertiary education. There is extensive collaboration among the various government ministries to reach each of the Millennium Development Goals (MDGs) and expedite the target achievements. Integral to government policy are strategies to increase social and economic planning on a regional basis (Governorate) including steps to increase local responsibility and accountability within the context of decentralisation. Also integral is to incorporate technology to ensure a citizenry that is competent to allow Jordan to compete internationally.

Economy

Jordan is a small, middle-income country that has faced severe repercussions due to regional political and security issues. The Kingdom faces economic development challenges due to its restricted natural resource base, water scarcity, limited oil resources, and a small domestic market. Despite this scenario, the Jordanian population has one of the highest per-capita disposable incomes compared to other emerging countries in the sub-region. Economic growth has been relatively steady, due in part to pro-active initiatives by the Ministry of Finance and other key agencies. Jordan's status as a foreign investment destination has improved substantially in moving its status from fourteenth to first among the Middle East Arab countries on the AT Kearney Global Index for Foreign Destinations.

According to the World Economic Forum's Global Competiveness Report, Jordan is ranked 50th out of 133 countries in its 2009 Global Competitiveness Index, compared with 48/133 and 49/131 in the previous two years. Gross Domestic Product (GDP) amounted to US $20 billion in 2008 and GDP per capita stood at US $3,421.4, which represents a significant increase from 2006 at US $1,700.[18] The Gross National Income (GNI), based on the World Bank Atlas method, shows for 2007 a per capita rate of US $2,850 and a GNI per capita (PPP, international $) of US $5,160.[19]

Between 2004 and 2007 the Kingdom averaged an annual 7.7% economic growth rate. In 2008, the rate decreased to 5.5% and further reductions are expected given the global economic recession. Future growth will continue to depend on exports and construction along with continuing changes in structural reforms and debt consolidation. Government net debt decreased from 88.5% of GDP in 2004 to 72.5% in 2006. In the same period external debt reduced from 7.9% of GDP to 5.9%. More recent economic challenges are likely to have exacerbated these statistics.

Employment

Government policy is focused on creating more jobs for Jordanians and increasing their productivity to enable further diversification and economic growth. Given a 40% labour penetration rate, Jordan ranks as one of the lowest in the region (67% males and 14% female). Annually, more than 60,000 citizens want access to the labour market, thereby creating substantive challenges for the country. In 2007, approximately 19,000 individuals were employed in the ICT sector. Annual job growth is approximately 1,500 persons per year whereas there are approximately 5,000 IT-related higher education graduates. There are various schemes underway to build higher education and private sector linkages and partnerships to enable these graduates to be better prepared to enter the industry and better equipped to function in a business environment.

Unemployment and underemployment are high, particularly among the young given that over one-third are below 24 years of age. Actual unemployment has varied between 12% to 14% over the past ten years with the highest levels recently recorded. Government accounts for 30% of a total labour force of 1.4 million while micro-enterprises with less than four persons employed represent approximately two-thirds of private sector business. Approximately 25%

18 World Economic Forum, Global Competitiveness Report 2009–2010, page 184.
19 Jordan at a Glance, World Bank Development Economics, Development Data Group, 2008.

of the labour force is comprised of migrant or foreign workers. This situation fosters political and social pressure on efforts to increase Jordanian productivity, diversification and economic growth.

ICT infrastructure

Starting in 2005, Jordan has been guided in its ICT development by a National Strategy. The Strategy's goals are

- Internet penetration to reach 50% from 2007 rate of 11%;
- ICT sector revenues to reach US $ 3 billion from 1.5 billion; and
- ICT sector employment to reach 35,000 jobs (19,000 in 2008).

Included in the Strategy is the identification of the sub-sectors that are best suited for growth within the private sector and it defines actions that the Government should take to facilitate growth in the ICT sector. The realization of these goals could be improved through greater communication and coordination among state institutions particularly with regards to e-government services. The country's fixed line infrastructure is very reliable and the mobile and independent service provider markets are highly advanced.

The World Economic Forum's research on network readiness, indicating the extent of preparedness for the use of ICT, ranks Jordan forty-fourth among 134 countries based on its Network Readiness Index (NRI).[20] This is an improvement for Jordan and can be attributed to the Government's commitment to a consistent focus in its national agenda on education excellence, innovation and increased ICT access.

Jordan's ICT sector has a fully liberalized market, which has had a positive impact on economic stability (see Tables 1a and 1b). 2006 data shows Jordan with an ICT use rate of 1.08 based on the Madar Research's Arab ICT Use Index.[21] This makes Jordan the sixth highest among the 13 countries, with Bahrain, Kuwait, Qatar Saudi Arabia and United Arab Emirates (UAE),. Fixed and mobile telephone networks and penetration has increased annually, given that the Jordanian Telecommunications Regulatory Commission (TRC) has been granting licenses for fixed broadband wireless access. Jordan has a fixed line penetration rate of 11.79% (2006) with a reduction in 2007 to 10.2%, primarily due to the rapid increase in mobile subscriptions. The latter is due in part to Jordan's allowance of high competition in the mobile market. In 2007, there were a total of 4,772,000 telephone subscribers with 4,343,000 mobile users. Jordan ranks third in the region for mobile-to-fixed line ratios with 6.14 mobiles to each fixed line (2006 data). Between 2000 and 2007, the number of mobile subscriptions per 100 population increased from 8.1% to 83.4% (2003 was 24.2%).[22]

The Government plans to foster increased competition (see Table 1a) to the fixed-line backbone with a plan to move to a virtual competition model which is used in some parts of the European Union (EU). This is dependent on an IP-pricing model based on total service long run incremental costs (TSLRIC). There is clear evidence of increased competition in transforming Internet services similar to recent changes in the mobile services. This has been expedited with Jordan being the first market outside of the U.S. to offer Motorola's 4G wireless service (March 2009). This is in addition to already having four WiMax operators enter the market between 2008 and 2009.

20 World Economic Forum, Global Information Technology Report 2008–2009 (GITR), Jordan Times, 27 March, 2009.
21 Aggregated data for 2007 show an increased rate from 1.08 to 1.25, remaining in sixth position (GITR).
22 Comparative data from 2000 to 2007 is from World Bank ICT Report, Jordan Statistics, 2008.

Table 1a: Key Players in the Mobile Market

Operators	2007 Market Share
Zain	33.7%
Orange	38.5%
Express Telecom	1.2%
Umniah	26.5%

Table 1b: Internet Service Providers

Sama	Link
Zain	MEC
Orange	NEXT
Betelco-Jordan	TE Data
Cyberia and IONet	Wanadoo (Orange)

The use of the Internet has increased dramatically, as in all regional economies. 2006 data shows a seventh place standing (out of 13) in Internet penetration at 13.84% but an eleventh place ranking in the growth rate of use at a 6% annual increase. Between 2000 and 2007 per 100 population Internet use changed from 2.7% to 19.7% with 228 subscribers per 1,000 individuals and 1,163,000 Internet users.

Fixed broadband subscribers as a percentage of total Internet subscribers changed between 2000 and 2007 from 0.6% to 38.2% and at the same time Internet bandwidth per second per person increased from 18 to 164. 2009 data on Internet use shows a reliance on international service providers where 79.1% of respondents indicated they use Yahoo and 69.5% use Hotmail along with 61.6% using MSN Messenger and 54.6% using Yahoo Messenger.[23]

In the case of personal computer dissemination Jordan ranked seventh with a penetration rate of 10.1% and tenth in annual growth rates at 5.45%, followed by Iraq, Lebanon and Palestine. Comparing 2000 with 2007, the number of personal computers per 100 population increased from 3.1% to 6.7%. In 2007, there were an estimated 678,000 personal computers. This penetration rate is below the strategic objectives mainly due to affordability given its GDP per capita situation compared with other regional economies.

ICT are an increasingly vital mainstay of the economy. The TRC has overseen a reduction of 70% in Internet Protocol costs for service providers since 2007 and a further reduction of 15% is scheduled to be completed by the end of 2009. Costs are expected to continue to reduce with the second high-capacity cable linking Aqaba with the Red Sea which will improve access to and the U.S. and the EU.

Current Government plans are to create a fibre-optic high-capacity link between all of the nation's schools and education establishments. Through the National Broadband Network there has been substantial increase in human capital development due to the high speed fibre connectivity with public universities and public schools. Knowledge stations have been established nationwide and training has been provided to more than 70,000 between 2001 and 2008. Table 2 summarizes the major strengths, weaknesses, opportunities and threats associated mainly with ICT sector.

23 Arab Advisors Group, Online Survey, Press Release, August 11, 2009.

Table 2: Summary of Strengths, Weaknesses, Opportunities and Threats Associated with the ICT Sector

Strengths	Weaknesses
Connectivity and Infrastructure • Reliable fixed infrastructure • Second fixed operator license and National Broadband Network as alternative infrastructures • Competitive mobile and ISP markets • Dedicated government	Connectivity and Infrastructure • Monopoly telecom provider in fixed access • Low GDP per capita impedes further progress in penetration of all ICT equipment and services • Empowerment of the regulatory body
Human Capital • Strong leadership and vision • Clear national strategy • Multiple initiatives on various topics • Young and highly qualified population • Strong English skills of the population • Sufficient school enrolment and funding for education • High number of ICT graduates • Good cultural fit of the human resource • No censorship of the Internet	Human Capital • Mismatch between number of jobs and graduates • Mismatch between industry needs and higher education curricula • Limited planning and project management skills • Slow and unreliable connection in schools • Issues in quality of education • Insufficiency of motivational elements for citizens:
Macroeconomic and Business Environment • Growing and globally competitive economy • Competitive tax rates due to investment laws • Low corruption rates	Macroeconomic and Business Environment • High unemployment rate • Low credit rating • Inadequate quality of legal system • Much bureaucratic red tape • High costs of starting a new business • High number of procedures in government to business transactions • Relatively low diffusion of ICT into businesses • Lack of cyber crime and privacy laws, digital certification, PKI and e-payment infrastructure
Government • Strong vision and objectives parallel to the most developed e-Government strategies in the world • Citizen centric e-Government mission • Advancement in the development of shared services such as the Secured Government Network • High Internet connection rates in public institutions	Government • Lack of project management and implementation skills • Lack of citizen centricity in actual implementation • Underdeveloped e-Services • Relatively low organizational capacity of the e-Government unit and low readiness of some government departments • Lack of an action plan and allocated budget for e-Government deployment • Lack of collaboration between government departments and unaligned business processes • Lack of motivation and ICT utilization in government employees • Limited operational leadership from individual ministries in terms of following up the actions • Limited formal feedback structures for the development of national strategy
IT Industry and Innovation Capacity • Rapid growth in the IT industry and its share in ICT • Young, well-educated and IT capable population • Availability of engineers and IT trained resources • Sectoral institutionalization • Government prioritization of R&D and established institutions to lead government R&D • Comprehensive action plan to develop ICT sector • Emphasis on exports and FDI • High contribution of ICT to GDP	IT Industry and Innovation Capacity • Insufficient R&D and innovative skills to create IP products • Small business sector and underdeveloped economic environment to develop large scale and/or sectoral expertise for the IT sector • Limited growth in exports

Opportunities	Threats
Connectivity and Infrastructure: • Modern and comprehensive framework of regulations to establish competition in the use of infrastructure • Full privatization of Jordan Telecom • Utilization of National Broadband Network as an alternative and high capacity infrastructure • Global low price PC production initiatives and direct follow-up in Jordan	Connectivity and Infrastructure • Possible delays in enabling competition on the use of infrastructure resulting in high costs for service providers which will constitute a barrier in front of further penetration
Human Capital • Availability of funds for education • Concentration of trainings on youth • Teacher trainings • Integration of ICT into existing programmes and curricula • Leveraging broadband infrastructure to provide access to knowledge resources to increase competitiveness	Human Capital • Financially advantageous neighbouring countries leading to brain drain • Insufficient coordination between government entities regarding implementation of initiatives • Insufficient coordination between universities and the Industry

Opportunities	Threats
Macroeconomic and Business Environment • Increasing attention to Jordan and FDI growth • Initiatives aiming to increase access to finance • Excess liquidity in the Middle East	Macroeconomic and Business Environment • fluctuating oil prices • Instable regional environment
Government • Leadership from His Majesty • High motivation in IT department Heads	Government • Limited funds • Resistance to change from government employees • Having e-Government unit in a vertical organization and lack of a body for enabling collaboration among ministries • Low utilization of open source software • Limited participation from private sector and NGOs in preparation of e-Government strategy • Shortage of qualified resources
IT Industry and Innovation Capacity • Opportunity for Jordanian IT Diaspora in export markets • IT investments in e-Government and e-learning to enlarge Arabic content and online services • Fast growing regional IT demand	IT Industry and Innovation Capacity • Competitive regional clustering and tax advantages • Regional political instability and prevention of foreign IT companies from long-term investments

Education System – Current Status

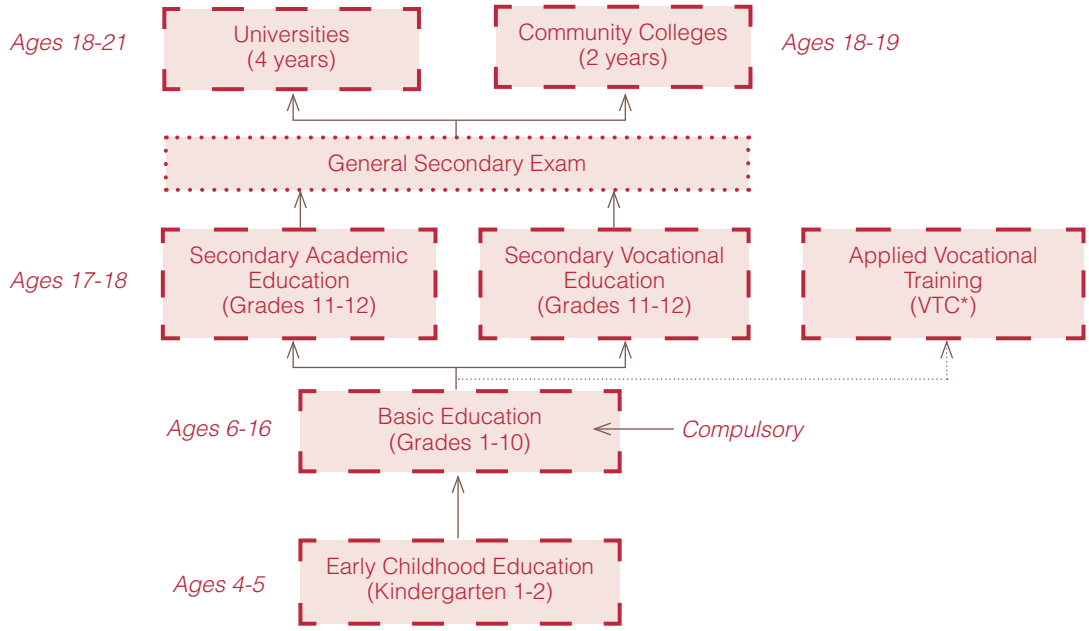
As Jordan strives to take its place as a modern country on the world map, education has been at the top of the agenda and takes on even more significance. A country with few natural resources, Jordan looks increasingly to its human resources as the key element for its success in the markets of the region, and the prosperity, health, and security of its people. The country envisions a population of responsible, self-confident, and innovative learners, engaged in reflective and creative thought on important topics and issues.

Jordan faces significant challenges to pursue its programme of economic and social development in a rapidly evolving region and world. Lacking natural resources, Jordan looks to the development of a high quality labour force as a priority to build a competitive advantage in the global knowledge economy and has the ambition of becoming an ICT hub in the region.

Yet this kind of ambition goes well beyond the achievements made to date as regards education. Jordan has one of the highest enrolment rates of the MENA region, relatively low illiteracy rates and has already achieved universal primary education and also achieved gender parity in all levels of education including tertiary education. However, to achieve its ambitious objectives, Jordan through successive education reform programs, is planning to converge to OECD standards in terms of basic skills (critical thinking, problem solving, decision making, numeracy, communication skills, managing information, learning continuously, entrepreneurship, adaptability, teamwork, innovation and creativity).

In terms of structure, the education system in Jordan at the general education level is comprised of three stages: pre-school (for two years and not compulsory), basic (for ten years, free and compulsory) and secondary (two years, free but not compulsory). Figure 1 below shows the structure of the education system in Jordan.

Figure 1: Education Structure in Jordan



Jordan has invested heavily in its education system and in its human resources with a strong emphasis on enabling a more ICT-friendly and technology-aware population. For decades, Jordan has been a major supplier of skilled, educated, and trained workers to the countries in the region. A recent World Bank report[24] ranked the Kingdom's education system as one of the best in the region in terms of access, equity, efficiency and quality (see Table 3).

Jordan has made remarkable progress in education access over the past 15 years with respect to enrolment rates, basic completion rates, and gender parity. Results on international tests have been positive and encouraging with respect to Jordan's education standing in the region and international comparisons.

Table 3: Main Indicators of Jordan's Education System – 2008

Indicators	Value
Gross enrolment ratio in basic stage	99%
Gross enrolment ratio in secondary stage	77%
Gross enrolment rate in KGs (1 and 2)	37%
Gross enrolment rate in KGs (2)	51.8%
Illiteracy rate	6.7%
Survival rate up to 5th grade	99.2%
Survival rate at the end of the elementary stage (grade 6)	99.4%
Dropout rates in basic education stage (national stage)	0.65%
Percentage of students in rented schools	10.9%
Percentage of students in double-shift schools	11.3%
Percentage of current education expenditures GDP	4.4%
Percentage of MoE budget out of public budget	12%

Jordan has a high level of gender parity in access to basic services. It has achieved 90% parity in literacy, full parity in primary and secondary enrolment, and increased life expectancy for both sexes. The Kingdom has the third lowest illiteracy rate in the Arab world (8.9%). 2007 data indicates that adult literacy rates for males as a percentage of ages 15 and older, was 95% and for females was 87%. Between 1994 and 2006, the primary gross enrolment

24 The Road Not Traveled, Education Reform in the Middle East and North Africa, World Bank, 2008

ratio increased from 71% to 98.2% and net enrolment in basic education increased from 89% in 2000 to 96.5% in 2005/06. According to World Bank data, 2007 gross enrolment rates as a percentage of age group for males was 96% and 98% for females. Transition rates to secondary education have risen dramatically from 63% to 97% between 2000 and 2006. The public sector is the primary deliverer of education with less than 20% of enrolment in private schools although the number of private schools have increased steadily in basic and secondary education. In early childhood the ratio of private to public has decreased with private schools providing 90% of schooling compared with 93% in 2003.

Jordan currently provides a higher proportion of its public budget for education than most countries. Data from UNESCO show that public expenditure on education as a percentage of GNP is about 4.9%.[25] This is about 20.6% of public expenditure, with about two-thirds (13%) of that amount allocated to elementary and secondary education. Jordan also allocates about 4.8% of primary expenditure for teaching materials – which gives Jordan the relatively high rank of 9th out of 30 countries in a recent UNESCO Institute for Statistics survey.

Commencing in 2003, the Government started a broad-ranging reform programme for basic and secondary education as well as interventions to support higher education. In the case of kindergarten to grade 12, the reform was referred to as E*ducation Reform for the Knowledge Economy* (ERfKE I) involving eight donors including the World Bank.[26] This programme was in mid-2010 when a second phase (ERfKE II) will commence. ERfKE I has been judged as highly successful in achieving its main outputs: (i) formulating a strategic development plan for the sector; (ii) re-defining the learning outcomes for grades 1 to 12; (iii) developing new curriculum, teacher guides, learning resource materials and learning assessment tools for all subjects; (iv) delivering intensive teacher training; (v) equipping schools with ICT infrastructure and related e-learning resource materials; (vi) building new schools; and (vii) initiating quantitative and qualitative development of the early childhood development sector. Within ERfKE I, there have been extensive commitments to ICT in education.

The Government has committed in the next phase of its education reform program, to focus on the quality of education and to ensure that the returns from a quality education are improved. ERfKE II will involve five components: (i) establishment of school-based development system; (ii) policy, planning, M&E and organizational development; (iii) teaching and learning resources; (iv) special focus on early childhood development, vocational training, and special education; and (v) quality physical learning environments. There will be a continued priority to ICT in education.

In 2003, the Jordan Education Initiative (JEI) was formed as a public-private partnership as a product of collaboration between the Government and private enterprise, facilitated by the World Economic Forum. In 2008, a separate corporation in its own right was established, under the sponsorship of Her Majesty Queen Rania. The JEI's focus included guidance for 100 public schools in the areas of in-classroom technology, e-curriculum development and training (referred to as Discovery Schools where all JEI products were piloted prior to the Kingdom-wide launch by the Ministry of Education). Additional areas of focus included lifelong learning and ICT industry development. The JEI assumed the lead role in enabling the MoE in the development of e-curriculum through its private-public partnership model. The e-curriculum for Grades 1–12 commenced in 2003 and was completed for nine different subject areas in 2008 with the earliest content, for mathematics, formally being launched in 2004. Recently, the JEI was awarded a UNESCO prize as an agency that has demonstrated considerable success for ICT in education best initiatives.

The link between the MoE and the JEI has been a key element in enabling dialogue on policy as well as enabling significant products and services for ICT in education. Other strong partnerships for the MoE include its liaison with the Ministry of Labour (MoL) to ensure that changes in the education system are closely linked with the Government's priority of labour market transformation. Actual enrolment in vocational education institutions was 12% in 2005 and has remained relatively constant. For this reason, and the increased need for qualified graduates, ERfKE II has a strong focus on vocational education linked directly with similar efforts in the MoL.

25 http//www.nationmaster.com/graph/edu_on_tea_mat_education_spending_on_teachinh_material.
26 Donors include Islamic Development Bank, Arab Fund, CIDA, USAID, JICA, DFID, and the EU.

Policy Features

Policy Objectives

In September 2002, His Majesty, King Abdullah II, issued the *"Vision Form for the Future of Education in Jordan."* It set the scene for education development and placed a strong emphasis on the integration of information technology at all levels in order to increase the country's human resource capital and to promote its role as an IT hub of the Middle East:

> *"The Hashemite Kingdom of Jordan has the quality competitive human resource development systems that provide all people with lifelong learning experiences relevant to their current and future needs in order to respond to and stimulate economic development through educated population and a skilled work force."*[27]

This Vision provided the foundation for the Ministry of Education to set four policy directions for the formulation of its longer-term strategic plan as well as ERfKE 1 priorities. These policy directions were: (i) structuring the education system to ensure lifelong learning; (ii) ensuring responsiveness of the educational system to the economy; (iii) accessing and utilizing information and communications technologies to support effective learning and system management; and, (iv) ensuring quality learning experiences and environments. A key emphasis in each of these themes is to enable Jordan's citizens to have the knowledge and skills, and a lifelong learning capability, to make the economy competitive in the global marketplace and to maintain and extend the security and stability of Jordanian society. Based on the Vision document, the Ministry re-articulated its own strategy documents (2003) and created new vision, mission and goals statements which provided the key guide to its policy formulation process:

Vision

The Hashemite Kingdom of Jordan has quality competitive human resource systems that provide all people with lifelong learning experiences relevant to their current and future needs in order to respond to and stimulate sustained economic development through an educated population and a skilled workforce.

Mission

Create and administer an educational system based on "excellence," energized by its human resources, dedicated to high standards, social values, and a healthy spirit of competition, which contribute to the nation's wealth in a global "knowledge economy."

Goals

Learners are unique and the education system must assist each individual to achieve their potential, recognizing that each person commences their formal education from different vantage points; each has different abilities, learns in different ways and at different rates; and, includes some who are disadvantaged and require special support services.

This participatory forum gathered the consensus of all stakeholders, from governmental institutions, civil society and the private sector. From this vision, a policy framework (*"Statement of Sector Policy of the Government of Jordan,"* 2003) was established and four areas were identified for human resource development in Jordan:

- structuring the educational system to ensure lifelong learning;
- ensuring the responsiveness of the educational system to the needs of the labour market and the economy;
- accessing and using ICT to support effective learning and system management; and
- ensuring quality learning experiences and environments.

27 National Education Strategy, 2006, p.11

Within this policy framework, the GoJ has prepared a comprehensive investment programme for a first major reform programme for: the *Education Reform for Knowledge Economy* (ERfKE).

The ERfKE includes four themes:

- The re-orientation of education policy, objectives and strategies through governance and administrative reform. This includes redefining the future integrated educational vision and strategy, updating the future educational administration and decision-making mechanisms, building an integrated educational decision support system, activating educational research for monitoring, evaluation, policy development, and effective management, and coordinating investment in the field of educational development;
- The transformation of educational programmes and practices for the knowledge economy. This axis includes developing curricula and learning measurement methods, developing lifelong professional development and training programmes, thereby reflecting the evolving needs of the labour market, and providing sources for supporting effective learning;
- The provision of quality learning environments, particularly for more vulnerable groups. This axis includes replacing unsafe crowded school buildings, upgrading schools to support and improve learning and providing suitable school buildings to cope with population increase; and
- The promotion of readiness for learning through the generalization of Early Childhood Education. This axis includes building institutional capacity, professional development of kindergarten teachers, expanding pre-primary education in deprived areas and raising awareness on enrolment in pre-primary education.

In 2004 the Ministry of Education issued its draft *National Education Strategy* that was formalized in 2006 based on extensive input from internal and external dialogue. Also, in 2004, the MoE commenced its policy review process based on the directives from the Government's Cabinet Retreat Policy Recommendations. Work on policy formulation and strategic planning within the MoE continued but in 2006, the Government's "*Jordan National Agenda*" took precedence and provided further guidance on both the process and content of reform initiatives in all human resource sectors in the Kingdom. The MoE's planning for ERfKE II has benefited from the policy and planning imperatives provided by the *Agenda*, the MoE *National Strategy for Education* (2006) and *the Policy Framework for Education* and the MoE *Strategic Plan*, 2009–2013 (2008). The Ministry established a core guideline for the development of policy:

> *"Curriculum, assessment and resources are to reflect national and cultural goals translated into knowledge, skills, and attitudes that learners must acquire at the school level in order to achieve their maximum potential. Educators, and the communities they serve, must demonstrate understanding that in today's competitive world, no society can afford the high social and economic costs of an unprepared or under-educated population. All stakeholders need to understand that in an increasingly global technological economy, it is not enough to be solely academically strong in subsequent pursuit of post secondary education, employment or participation in civil society.*[28]

Table 4: Critical Knowledge Economy Skills [29]

Academic Skills	Personal Management Skills
Communication skills • Understanding and speaking the languages in which business is conducted • Effective writing and comprehension of charts, graphs, and other technical forms of displaying information Thinking skills • Thinking critically and logically to evaluate situations, solve problems, and make decisions.	Positive attitudes and behaviours • Self-esteem, honesty, initiative Responsibility • Setting goals and priorities • Planning and managing time • Accountability for actions taken Adaptability • Identifying creative ideas for doing things differently • Maintaining a positive attitude toward change Teamwork • Using a team approach to problem solving • Understanding and contributing to an employer's goals • Planning and making decisions with Others

28 Curricula and Assessment Framework, 2004, p.4 Ministry of Education.
29 National Education Strategy, 2006, p.6.

The Ministry of Education has developed a new, more comprehensive N*ational* E*ducation* S*trategy*, which goes beyond ERfKE. The new S*trategy* builds on and fine-tunes educational initiatives that are already taking place. The purpose of the strategy is to give overall direction to the operations of the Ministry of Education for the next five to ten years while implementing annual reform activities and to communicate to the general public how the stated goals will be achieved. The S*trategy* fits within the context of the philosophy, objectives and policies stated in Jordan's Education Act of 1994 and is the culmination of a period of intense debate on the importance of human resource development to the future of Jordan and a growing consensus on the nature of a nationally integrated social and economic reform programme, a key component of which is education.

The E*ducation* S*trategy* broadens the scope of ERfKE by formulating strategies for aspects of the educational system that did not receive sufficient attention under ERfKE. Hence, the chapter on the Learner lays emphasis on universal access, opportunity and equity, regardless of gender, ethnicity or economic status; while that on Curriculum and Assessment places stress on the employability of school-leavers and points out the importance of revising the education system in order to fit the current and projected needs of the labour market.

An analysis of the sector policy allows some major elements to be pinpointed as critical to the success of the reform programme:

Long-term commitment

In the recently released National Reform Agenda for the coming ten years, education remains one of eight top priorities for the country.

High level of ownership

The ownership of educational activity and reform has been demonstrated through participation and national reporting.

Sufficient capacity

The GOJ has developed sufficient capacity from the continuous efforts in education reform in the past 15 years and is ready to address the major challenges associated with a long-term qualitative reform. (The building of policy frameworks in such key areas as curriculum, assessment, and training is the right pathway for achieving deep and sustainable change in these areas).

Transparency on educational results

Jordan participates in major international assessments of student learning and the use of ICT in education and has demonstrated a willingness to develop a culture of planning based upon analysis of various components of system performance.

Private-public ICT joint venture

The growth of the Jordan Education Initiative as a test-bed for public-private partnerships to support development and implementation of e-learning materials, is a significant development. In addition, there are a number of technological developments and economic development imperatives that require systemic changes within the educational system such as the introduction of a high-speed broadband learning network.

Different monitoring and evaluation reports conducted by the Ministry as well as by external agencies including donors such as the World Bank, clearly showed that these policy features were critical to the successful educational reform programme in Jordan. Results achieved so far through the successive education reform programmes in Jordan were evident, whether in improving the quality of education as measured by improvements on international assessments or in improving access to education, gender parity, and quality school environments.

Policy Content

In 2003, the MoE produced a list of key policy shifts that were required for ongoing education development. These policy shifts have been captured in the design and content of the government's intended educational reform program. These shifts include:

- increasingly engaging various stakeholders in determining the direction, design and delivery of education in Jordan as opposed to an approach that effectively limits public and private sector participation in education direction-setting and policy level decision-making;
- moving to an outcomes-based curriculum from an input-focused model of education;
- adopting a learner-centred approach to curriculum and teaching from a teacher and textbook-centred approach;
- implementing a core curriculum – the learning outcomes of which can be met through different approaches with many different learning resources – and a supplemental curriculum to meet the various learning needs of different individuals rather than a "one-size fits all" approach;
- incorporating a lifelong learning approach to the provision of education rather than the closed terminal approach that has traditionally guided educational programs;
- implementing the role of teacher as the facilitator or guide for learning from a role of teacher as provider of information;
- recognizing the professional nature of teachers through an effective ranking and rewards system as compared to a civil service view of human resource development;
- investing in quality continuous professional development of education staff (teachers and leaders) rather than accepting pre-service training as sufficient to meet the needs of learners;
- ensuring equity in the provision of early childhood education by establishing Kindergartens in economically disadvantaged areas through government-financed facilities and services rather than relying solely on the private sector to provide early childhood education;
- utilizing technology as an integral part of the education and learning process and as a tool to support/enhance learning, thereby enabling the effective and rapid acquisition of knowledge and skills for the new knowledge economy requirements;
- enhancing the capacity of an independent educational monitoring and evaluation agency (National Centre for Human Resources Development) to provide a neutral coordinated approach to national educational research and policy analysis and development from a situation that provided limited feedback and advice to the educational system;
- focusing increasingly on cost-efficiency measures within the educational system to acquire resources for quality enhancement activities rather than depending on annual increments to the education budget as the sole source of funds for educational improvements. These cost efficiency measures include:
  - increasing the student-teacher ratio from 22:1 to 25:1;
  - decreasing the number of educational administrators resulting from re-organization through attrition or retraining for assignments in schools and directorates;
  - increasing the cost-effectiveness of decision-making through the wide-spread use of an integrated educational decision-support system, including school mapping, and by devolving decision-making to directorates and schools;
  - increasing administrative cost-effectiveness by increasing the use of computers and technology;
  - reforming the education law to enable the consolidation of smaller schools (i.e. the requirement for a school for ten students) into schools of an appropriate size to effect economies of scale enabling quality-enhanced learning environments; and
  - utilizing the high-speed broadband learning network to provide increased access to learners at lower costs, reducing maintenance and administrative costs of technology in education and extending the life cycle of technology through re-use of older computers as thin-client terminals in schools.

They provided the guidance for the implementation framework discussed between 2004 and 2006 and resulted in the initial policy framework for 2007-2011 and the more recent documentation for 2009-2013. The policy shifts related to information technology that helped in the design of ERfKE I and longer-term policy statements are as follows:

- increasingly engaging various stakeholders in determining the direction, design and delivery of education in Jordan as opposed to an approach that effectively limits public and private sector participation in education direction-setting and policy level decision-making;
- utilizing technology as an integral part of the education and learning process and as a tool to support/enhance learning, thereby enabling the effective and rapid acquisition of knowledge and skills for the new knowledge economy requirements;
- increasing administrative cost-effectiveness through increasing the use of computers and technology;
- utilizing the high-speed broadband learning network to provide increased access to learners at lower costs, reducing maintenance and administrative costs of technology in education and extending the life-cycle of technology through re-use of older computers as thin-client terminals in schools.

In 2006, the Ministry established the Policy and Strategic Planning Secretariat (PSPS) comprised of personnel from within MoE, supported by international consultants sponsored under the ERfKE program. The Secretariat reported directly to senior MoE officials and was responsible for determining, based on internal and external consultations, the core policy categories for detailed policy articulation, including:

- Student Access, Equity and Mobility;
- Student Achievement;
- Internal Efficiency, Effectiveness and Quality;
- Relevance, Responsiveness and External Efficiency;
- Public Awareness, Recognition and Respect;
- Decentralization and Devolution of Authority; and
- System Sustainability.

Based on these categories the Ministry engaged in internal and external discussions and formulated policy at three levels – (i) the intended direction of what is to be achieved – strategic level; (ii) how is the strategic policy to be achieved and who will do the work – operational level; (iii) identify the implementation steps and the organizational and individual work unit tasks – implementation level. Based on these guidelines, policy was formulated for the above seven categories.

Prior to the formulation of these overriding policies, two areas of policy were documented in detail in order to guide ERfKE I implementation and also subsequent policy deliberations. These were the Curriculum and Learning Assessment Framework (2004) and the Information and Communication Technology Policy (2004). In addition, the Ministry completed several detailed studies related to information and communications technology and these provided considerable guidance in its ICT policy formulation and policy review process.[30] Also integral to the policy dialogue was the promulgation of National Teacher Professional Standards (2006) which emphasised the importance of ICT in teaching careers, the teaching-learning processes, and the integration of ICT in curriculum content .

Implementation Framework

Overview

The National Education Strategy guided the entire process of policy formulation, planning priorities, and the establishment of target indicators. The strategy approach includes the three levels of policy referred to above (strategic, operational and implementation). It articulates each policy area by cross-referencing all statements to: (a) the Education Law; (b) the National Education Strategy (2006); and (c) existing MoE policies. The process of annual progress assessment is based on monitoring against four core management functions: (i) Programme planning, design and development; (ii) Budget planning and financial management; (iii) Human

30 Draft ICT in Education Policy, September 2004; Computerization Strategy for MoE Schools and Data Centre, March 2005.

resources planning and management; and, (iv) Physical infrastructure planning and management. These are assessed along with four management processes: (i) Executive decision-making, leadership and accountability; (ii) Strategic policy development and knowledge management; (iii) Operational policy, roles and responsibilities; and (iv) erformance monitoring, evaluation and communicating results.

ICT Operational and Implementation Policy

Policy Formulation

The Ministry recognized the importance of coordinating all policy development as part of the implementation of ERfKE, particularly in view of the large number of donors involved. It established a Development Coordination Unit (DCU) with considerable executive responsibilities to ensure coordination and collaboration for efficient and effective application of the planned interventions. The DCU assumed this lead role and relied on internal Ministry task teams as the responsible agents for different policy agendas. An example of one of the task teams would be the policy resulting in the Curriculum and Learning Assessment Framework (2004) that guided the rewriting of curriculum in all subjects for all grades between 2004 and 2008.

The Ministry recognized the need for a more formal structure to coordinate policy formulation and review and, in 2006, established the Policy and Strategic Planning Secretariat (PSPS). This Secretariat was formed based on assembling a large working group comprised of representatives from all key directorates. This group, in collaboration with the DCU, assumed responsibility for coordinating all policy development. They required each policy process to involve dialogue sessions with broad representation from the central ministry as well as field directorates. In some cases, there was extensive other government agency and community involvement – e.g. ICT, special education, early childhood education, vocational education. Given the work completed by this Secretariat, the Ministry of Education was able to issue its 2009-2012 *Policy Framework and Strategic Plan*.

During 2005 to late 2006, the DCU sponsored task teams that worked on three areas of ICT policy, each receiving the Policy and Strategic Planning Secretariat (PSPS) endorsement in early 2007. These were "Information and Communications in Education," "E-Content," and "Appropriate Use of ICT." These policies were made with consideration of the results of various research and special studies conducted by various agencies on schools that were under the JEI Discovery School programme (100 schools) and also in all other public schools directly through MoE (3,200 in 2009). In addition to various policy documents adopted by the MoE, different manuals were also developed to facilitate integration of ICT in education. These include: e-content development manuals, acquisition of learning resources manual, teachers and principals manuals.

Plans to Implement Policy

In 2002, Jordan's Government adopted the "Connecting Canadians" approach, a Canadian programme aimed at making Canada the most connected nation in the world, and launched the "Connecting Jordanians" program. Similar to Canada's School Net program, a broadly based private and public sector partnership to plug schools and libraries into the Internet, the Jordanian Ministry of ICT initiated the NBN project aimed at connecting all 3,200 public schools through a fibre-based network. In addition, eight public universities were included and were given higher priority, thus implemented first. The school part was segmented into eight stages, spanning several years. By end of 2009 around 300 schools were connected. This project is to be concluded by 2011, allowing over 80,000 school computers to get connected to the Ministry of Education Data Centre and the Internet.

Besides providing the educational sector with a state-of-the-art ICT infrastructure, the NBN project is planned to serve other sectors such as the health sector (hospitals and clinics) and the commercial sector (Tel Cos and ISPs).

The Ministry of ICT has also implemented a closed and secured network, the Secured Governmental Network (SGN) specially designed for the e-Government project. Ministries and governmental departments were connected to this

Intranet to facilitate data interchange, allow safe access to the internet and provide pubic e-Services. A gateway to the cell network was also established to integrate the e-Services over the Internet and the GSM mobile network.

In 2003, the Ministry of Education adopted EduWave (a locally developed learning portal) as a comprehensive Learning Management System which provides the necessary components to facilitate and manage the integration of ICT in education such as e-content authoring, learning objects handling, content delivery, student learning/ progress tracking, in addition to providing collaborative learning tools for students, teachers, principals and parents.

The ERfKE I project included a significant role for ICT as a means for improvement of student learning and as a catalyst for pedagogical and curriculum reform. In order to expedite and coordinate this key initiative the Ministry established a team comprised of representatives from all Directorates to formulate an "Integrated Implementation Plan." This plan was updated monthly and forecasted implementation activities, recorded activities completed, and incorporated research results. The plan reviewed and addressed the current and ongoing investment in hardware, software, e-content, networks, training, and technical support. It provided cohesion and coordination for the myriad of interventions underway.

The Integrated Plan team worked closely with the Policy Secretariat (PSPS) in formulating quarterly and annual plans. The "plan" and the process was heralded by the World Bank review missions for ERfKE I as a highly successful mechanism to implement policy and provide feedback for ongoing policy review. The approach will be replicated in ERfKE II.

Programmes Related to Hardware and Networking Infrastructure

The MoE ICT Directorate maintains records of all schools in the Kingdom, including numbers of students, classes, labs, computers, printers and other relevant data. Annually, the Directorate produces a report on the students to computer ratios in all government schools in the Kingdom. They use the ERfKE policy goal as a guide. The data shows the number and percentage of schools which have student to computer ratios from below 10:1 to more than 40:1. Following is the report results for 2006 for elementary and secondary schools (Tables 5-7).[31]

31 Classroom and Computer Lab Deployment Strategy in Government Schools Grades 1–12, January 2007, Directorate of ICT and Directorate of Curriculum and Textbook report.

Table 5: Elementary School Students to Computer Ratio

	Number of Schools	Percentage of Total Schools
Below 10:1	272	13%
Between 10:1 and 20:1	346	17%
Between 20:1 and 30:1	249	12%
Between 30:1 and 40:1	255	13%
Above 40:1	897	44%
Total	2019	100%

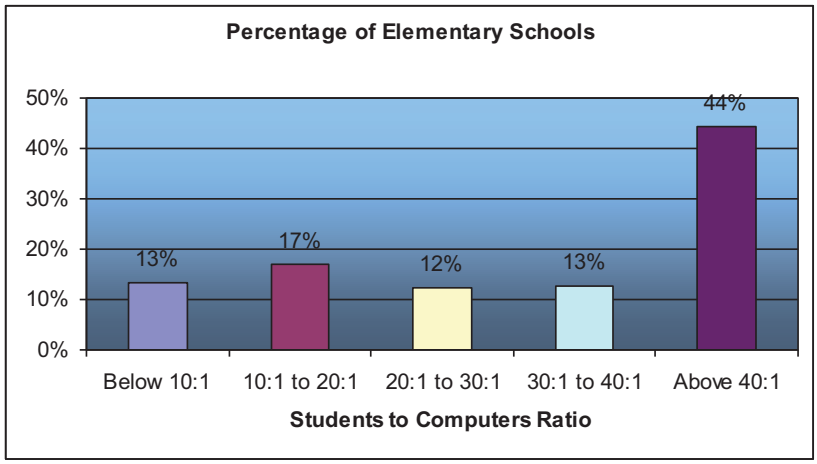


Table 6: Secondary School Students to Computer Ratio

	Number of Schools	Percentage of Total Schools
Below 10:1	93	9%
Between 10:1 and 20:1	371	36%
Between 20:1 and 30:1	340	33%
Between 30:1 and 40:1	139	13%
Above 40:1	94	9%
Total	1037	100%

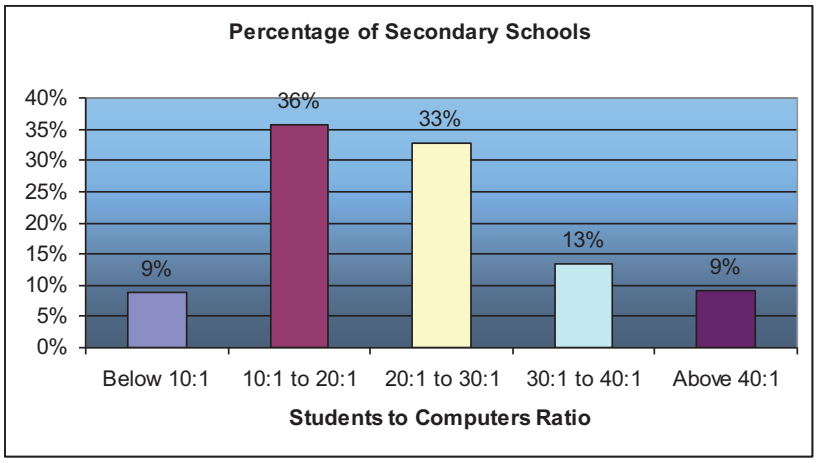
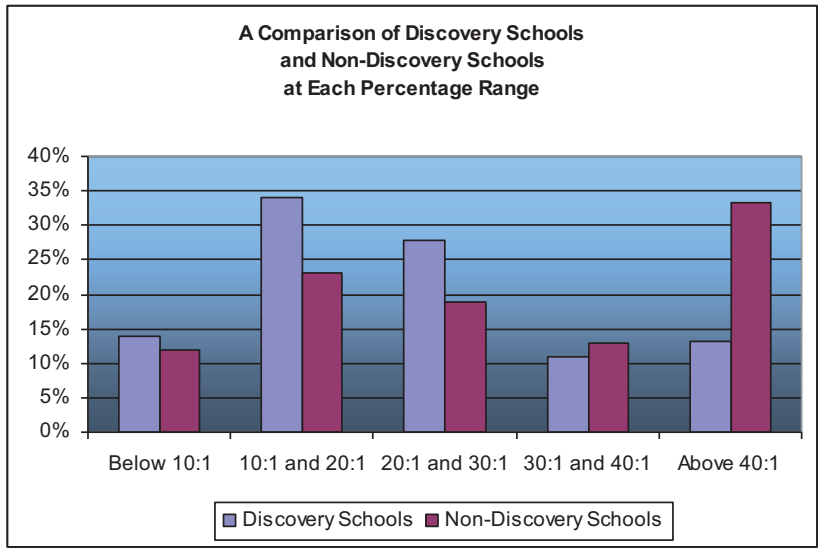


Table 7: A Comparison of the Computer Ratio in Discovery Schools and Non-Discovery Schools

	Discovery Schools		Non-Discovery Schools	
	Schools	Percentage	Schools	Percentage
Below 10:1	18	14%	347	12%
Between 10:1 and 20:1	44	34%	673	27%
Between 20:1 and 30:1	36	28%	553	19%
Between 30:1 and 40:1	14	11%	380	13%
Above 40:1	17	13%	974	33%
Total	129	100%	2927	100%



The remainder of ERfKE I and ERfKE II include continued support for schools to acquire computers and computer labs. This is scheduled based on school access to data lines and the strategy of improving the student to computer ratio in each school as well as providing other ICT-related equipment. The ICT Directorate also has a programme to provide schools with technical support, either directly from the Ministry or through private providers. This Directorate works closely with the Ministry of Information and Communications Technology (MoICT).

Table 8 is a summary of the 2009 status of hardware and connectivity among the 3,300 public schools.

Table 8: Summary of ICT Hardware/Connectivity in Government Schools – 2009

Item	Number	% of Total Schools
Schools with PC Labs	2, 791	85%
Schools Connected **	2,716	82%
Personal Computers	75,000	
PC Laboratories	4,068	
Datashows	2,476	
Scanners	1,837	41%
Servers	1,340	

** 2250 ADSL; 174 ISDN; and 392 NBN

Programmes Relating to Digital Content

The MoE reached agreement with the JEI as well as a number of independent Jordanian software providers to prepare e-content for a range of subjects under the facilitation of the JEI. This work commenced in 2004 and ran in parallel to the MoE's rewriting of its curriculum. Individual subject initiatives included liaison between the software writers and representatives from the MoE's Curriculum and Textbooks Directorate. During a three-year period e-content was prepared and released for Science, Maths, Civics, ICT, Arabic, English, MIS, and also for the core subjects of ICT and Geography (GIS). Studies were conducted to assess the degree to which the e-content provided by these initiatives matched the curriculum prepared by the Ministry as well as studies to determine the extent to which actual classroom instruction used the e-content (see Section VII). By 2008, all of the e-content prepared through these private-public sector partnership initiatives were available to all schools (after pilot testing by the MoE). In addition to content provided through the JEI public-private partnership programme the MoE's Digitization Department in the Managing Directorate of Curriculum and Textbooks also produced extensive instructional ICT support materials and resources to assist teachers.

Programmes Relating to ICT in Teacher Training

The MoE required all personnel, particularly principals and teachers, to be ICT-literate. Therefore, in 2003, all individuals were required to complete the Microsoft ICDL©® program. Between 2003 and 2009, over 90,000 teachers, principals and other ministry employees completed this programme as part of the MoE's effort to ensure basic ICT skills were available to respond to the integration of e-content in curriculum and the use of ICT in management. Also, during this period, donor agencies and special programmes provided by recognized agencies were active in Jordan providing training for teachers. This included the work of the JEI, World Links, USAID and CIDA projects, as well as private sector companies contracted by the MoE's Directorate of Training, Qualifications and Supervision (DTQS).

A wide range of programmes were also provided for teachers, principals, and supervisors. These programmes were designed to empower teachers, principals and supervisors with required skills to integrate ICT in instruction. These programmes include Intel Teach to the Future, Worldlinks and Schools-Online. Specialised courses were also offered by the Ministry's ICT Directorate in networking, server maintenance, and other hardware oriented training. It is worth mentioning here that all ICT in education training programmes were officially recognized by the MoE as part of Teacher Ranking System. Successful completion of these programmes allows teachers to move from one rank to another with financial allowances on their monthly salaries. This has helped the Ministry in attracting almost all teachers to enrol in these programs. The following summarizes the major ICT–related training programmes currently delivered by the MoE.

Table 9: ICT Literacy and ICT Integration Programmes for Teacher Professional Development in Jordan

Programme	Start-up Date	Number of Teachers Enrolled	Delivery Methods	No. of hours Involved	MoE Accreditation	Comments
ICT Literacy						
ICDL/ Cambridge UJCDL	2000	90,000 enrolled with 60,000 certified; Completed all practicing teachers by mid-2009	F2F in training centres/schools	112	Yes	ICDL requires 7 modules; UJCDL has 9 with Outlook and Front Page added; pre-requisite to all accredited ICT Integration programmes and promotion from Assistant to Teacher rank with 10% salary increase
ICT Integration in Teaching/Learning						
World Links	2003	1500 thus far; anticipated to extend up to 9,500 teachers by 2009	F2F by Master trainers; online coordin-ation	160	Yes	4 modules required; includes some overlap with ICDL; EduWave covered; final MoE examination required ; evaluation of programme to be completed in June 2006
Intel	2003	38,000 enrolled up to 2009	F2F by Master Trainers	160	Yes	3 phases involved (40 hours introductory pedagogy, 40 hours EduWave, 80 hours ICT integration); final MoE examination required; evaluation of programme to be completed in April 2006
Schools on Line	2004	Only small number of teachers enrolled but programme content continues	F2F by SoL trainers; online coordin-ation with collabo-rative projects & communities of practice	170	No	SoL is working with 12 under-resourced schools and one teacher from each. 10 computer- Internet Learning Centres have been created. Training is conducted over two phases: Phase I was done over 12 days in 2004. Phase II is projected for the fall of 2006
iEarn	2001	Not known	Fully on-line TPD courses; each course has two online facilitators	Accreditation only in USA	No	Each iEARN course is 9 weeks. Eight online courses are available in English twice a year in various subjects. Main focus is to train teachers on developing project-based student learning though modeling the process themselves
British Council	2004	100 teachers plus 80 principals	F2F workshop, weekly meetings at BC Knowledge Centres, online community of practice (using BlackBoard)	160	Not as Yet	Focus of each 20-week course in Math, English and Science is to use existing ICT in-school resources including EduWave and Intel; Pilot programme run until 2007. First run-through is currently being evaluated
CADER ErfKE Support Project (ESP)	2005	430 to end of 2008	F2F workshop, weekly group visits in schools, final evaluation	160	Not as Yet	Project uses 20 Master Trainers trained in Jordon and Holland. ESP is funded by USAID and operates in 5 schools selected on basis of solid ICT infrastructure to test various technology models
CADER Higher Education Diploma for ICT and Education	2005	347 (updated figures not available)	Weekly 4-hour campus lecture, 4-hour on-site lecture and in-school visits by Master Trainers over 3 semesters or 48 weeks	704 hours (27 credits)	Yes	The Diploma is made up of 6 courses, 2 taken each semester. 3 Jordanian universities are involved (north, central and south). Instructors consist of Master Trainers with supervision by professors from Yarmouk and In-Holland universities. This is the first post-graduate diploma of its kind in Jordan (and Arab region)

Source: Coldevin, Gary. Teacher Training in ICT, BearingPoint Consultancy Report, 2006 (updated 2009)

National Conditions Constraining Implementation and Scaling of Programmes

As evidenced in Tables 2 to 6, there is considerable scope for increasing the number of computer labs and computers in each school. Enrolment forecasts indicate that during the next five years, over 100,000 more students will enter the system in addition to kindergarten students. Each of these students deserves access to e-content and the use of computers. The issue is one of scale plus the number of computers that are now old compared with current versions. Also at issue is for many schools outside of the urban areas is reliable access to bandwidth and the network. Reaching the stated target as stated in the MoE ICT *Policy Document* (one PC for eight students) is a major challenge to the MoE given the financial constraints.

Despite extensive access to training, there remain many classrooms that have teachers who tend to teach in traditional ways rather than using technology and applying student-centred techniques in the instructional process. The MoE launched (2009) its own teacher training institute for new teachers in an effort to ensure that teachers enter the profession with a good grounding in more effective pedagogical techniques. In addition, more extensive in-service training is planned.

The UNESCO 2002 report *Information and Communication Technology in Education* describes a four-stage model showing a continuum of approaches to ICT development in schools. The model describes school jurisdictions moving through the stages:

Emerging → Applying → Infusing → Transforming

Using this model, and based on 2008 conditions, many of the schools in Jordan are likely at the "applying" stage – a stage where most of the computers in schools are in computer labs, teachers dominate the learning environment and ICT are beginning to be used in various subjects, not only for teaching about ICT.

Jordan is poised to move into the "infusing" stage; however, it is clear that some schools are well into the transforming stage (e.g. some Discovery Schools). At this stage, ICT are integrated or embedded across the curriculum. Schools are beginning to use a range of computer-based technologies in laboratories and classrooms and increasingly, more teachers are beginning to explore how ICT can change their personal productivity and teaching approaches. Despite many major achievements in ICT in education in Jordan many challenges remain if the full potential of ICT in education are to be reached.

It is fair to say that Jordanian schools are well underway to implementing ICTs: the infrastructure is quickly becoming available;-content for the major subjects is also available; ICT training programmes are available to all staff; the majority of schools are connected and many educational actors are innovation oriented. However there are indications that continuous and maybe intensified attention is needed for the potential obstacles that were identified in various ICT assessment reports: student/computer ratios, connectivity, resource management, curricula flexibility, staff development and development of a common vision in schools and the trajectory to the future.

Financing

Similar to other Gulf Co-operating Council (GCC) countries, Jordan has been pro-active in the search for foreign direct investment (FDI) in the sector. In 2007, FDI in the IT sector amounted to 12,336,455 million Jordanian Dinars and ICT sector revenues were JD1,657.20 million. Annual investment in the overall telecom sector JD163,802,817 million. ICT expenditure as a percentage of GDP was 9.3% in 2007. Revenues from the ICT sector account for approximately 14.3% (1% from education sector and 10% from ICT sector itself) of the Kingdom's GDP which represents a contribution that has grown at a markedly faster rate than the rest of the economy. By 2010, it is forecasted that ICT sector

revenues could surpass USDone billion. This overall scenario of relatively rapid growth has been enabled by the consistent prioritization of ICT in the Government's economic development strategy.[32]

Government support to the ICT sector is considered positive but further adjustments are considered necessary by many observers. IT as an industry is taxed at a 12% rate which is well below the 25% rate applied to telecoms but not consistent with the World Trade Organization's 100% tax exemption proposals on service exports. Plans to remove the 16% sales tax on PCs has not materialised – considered one of the reasons more than 50% of Jordanians can't afford direct access to the technology. The Government's plans (January 2008) to enable a "computer to every citizen" and to subsidize laptops for students have not been successful primarily due to the overall economic downturn. In terms of financing ICT in education programmes (Hardware, software, e-content, connectivity, training, maintenance, etc) over the last six years, more than USD150 million were spent. This amount was made available through GOJ and International Donor Agencies (Around USD100 million from the Government and US $25 million from donor agencies for the JEI). Scaling up these programmes however is a major challenge.s

Given its current high level of education expenditure (4.9% of GDP) it is unlikely at least in the short term that Jordan will be able to finance from its own resources the requirements for scaling up the e-learning ICT requirements for all schools. Such financing will have to be accomplished in planned stages over a number of years and will depend critically on the availability of external funding and partnerships.

The costs to date for the development phases of the JEI activities provide only a partial guide for the costs in the next phases.[33] Total investment in the development phase was about USD25 million, including in-kind contributions, of which about $19 million USD was provided by Jordanian and international partners and USD6 million from the MoE resources. The McKinsey Group's review of the partnership commitments for the first three years (as of the end of 2004, 20 months into the project) estimated the contributions were 73% financial, 14% goods/equipment, and 13% human resources.

According to the McKinsey report, USD18 million of the total USD25 millionwas spent on e-learning activities, including curriculum content development (USD9.5 million), in-classroom technology (USD8.2 million), and teacher training (USD0.3million). Global private sector partner contributions were 83% of total support for the JEI, 50% of the total financing (USD11 million). Donor funding was 32% of the total (USD7 million), Jordanian government investment was 11% of the total (USD2.5 million), and Jordanian private sector investment was 7% of the total (USD1.3 million, mainly FastLink for e-science). The Jordanian government contributions for the JEI appear underestimated, given the contribution of personnel and existing infrastructure in the schools and nationally, particularly for the EduWave portal and the National Broadband Network.

The Policy Rationale

The MoE's policy for ICT reflects the Government's commitment to integrating technology in government, education, the private sector and for its citizenry at large. His Majesty, King Abdullah II's commitments to this objective are well documented in the 2002 Vision, the 2006 National Agenda as well as in presentations to the World Economic Forum and to Parliament. The establishment of JEI under Her Majesty Queen Rania is a clear statement of the Royal Court's intent to ensure the Kingdom of Jordan continues its lead role in the Middle East as a technology hub and source of excellence in ICT. Similarly, Government short- and long-term plans, including the Ministry's National Education Strategy (2006) continue to support all aspects of technology in education. Close collaboration between the Ministries of Planning, Information and Communications, Education, Labour and Higher Education as well as local and international donor agencies occurs to ensure a systematic and coordinated approach to enabling access and competence in all aspects of ICT.

32 Commencing in 1999, Government started the REACH initiative (regulatory framework, estate and infrastructure, advancement programsme, capital and human resource development), which set ambitious targets but helped to create a commitment to ICT in subsequent planning and overall government and private sector liaison (int@j).

33 USAID (2009), Cost Assessment of Technology Support for E-Learning in Jordan. Part of a series of JEI assessment activities.

These government initiatives are strongly supported by the private sector. The IT Industry Association has worked with government and non-governmental organizations to plan for effective and efficient use of ICT to improve business, reduce poverty, improve public services, and to encourage improvements in all government-oriented sectors. The IT Industry Association published in mid-2007 its National ICT Strategy of Jordan 2007-2011 based on extensive dialogue among all sectors including close liaison with the Ministry of Education.

Present progress indicates that the majority of the objectives outlined in the Strategy will be achieved before the end of 2012, therefore, only slightly beyond the original targets. The Strategy calls for giving an important role to the private sector, so that it participates with government in enabling the achievement of the goals and in identifying the targets and actions for 2010-2014.

Leadership in ICT policy development, therefore, is distributed with TRC and MOICT acting as a policy regulator in close collaboration with private sector. Jordan provides a good example of a high degree of collaboration between all stakeholders and evidence of mechanisms that provide for ongoing dialogue and enhancements to policy directions. Clearly, as evidenced by the increasing share of GDP, ICT oriented business has benefitted from the national strategy to improve the quality of its human resources and to provide for the required networking and broadband access.

The Policy Development Process

What have been the various steps of the policy development?

The MoE Policy and Strategic Planning Secretariat has the lead executive role in policy formulation and review. In 2006–2007, the Secretariat reviewed all policy statements from all key MoE agencies and documents. Considerable data was secured from the minutes of the Board of Education where final decisions on official authorization of education developments occur. This data and data from each Directorates policy guidelines were categorized and priority policy areas were identified. Task teams were established to address areas where there were duplicate policy statements and areas where there was a clear need for further dialogue. The product of this process was the 2007 *Policy Framework* which provided further detail by including a strategic plan for the period 2009-2012. This latter document fulfilled the Ministry directive to produce a more integrated approach between the policy and the planning processes.

Parallel to these efforts is the MoE programme to integrate the budget planning activities with targets specified in the policy and planning framework. The MoE, responding to directives from the Ministry of Finance, introduced in 2006 a results-based budgeting process. This was conducted on a parallel basis with the traditional budgeting practices for the 2007 fiscal year and then gradually implemented during that year and also for 2008. This linking of the budget with the policy process had a cross-fertilization effect in that as Directorates were required to link their budget forecasts and expenditure plans with more precise targets, the value and contribution of more precise policy became more evident. Similarly, the process identified the need for greater clarity in policy and planning statements. This iterative procedure is now reasonably engrained in established MoE practices.

What modalities/mechanisms have been put in place?

The MoE Directorates and Field Directorates are required to prepare their planning documents approximately four months prior to finalization of the budget request. This process now incorporates the requirement to review existing policy and planning targets and to include in the budget request documentation of precise targets (results-based) and reference to the relevant policies. All budget requests are related to the Integrated Plan coordinated by

the Development Coordination Unit. This process links the operational and implementation process under the core development programme (ERfKE) with the overall MoE financial management process.

The Ministry sponsors a donor coordination group that is chaired in different years by representatives from the different donor groups. In essence, therefore, the MoE acts in a Secretariat role. This coordination group is a key vehicle for the MoE to share its plans and requests for donor priority inputs as well as gaining advice on areas requiring further attention by MoE, including policy directives.

Donors are also members in the Ministry's Central Planning Committee along with extensive participation from MoE Directorates. Therefore there is ample opportunity for interactions to occur that foster dialogue on current and future implementation. On a more operational level, donor representatives meet directly with Directorate managers through the monthly DCU coordinated meetings, chaired by the Secretaries General.

What instruments have been used?

As indicated above, the MoE uses results-based budgeting formats where critical targets are identified. In addition, the MoE has the various internal meetings coordinated by the DCU as well as facilitating the role of the Policy and Strategic Planning Secretariat.

Another mechanism to guide policy development is a Resource Planning Guide for ICT which has been piloted in several field directorates. It is a set of guidelines that result in a database that can be reviewed by the officials in each field directorate as well as the central Managing Directorates of ICT, and Training. This tool provides for greater collaboration between the regional offices and the central ministry in determining priorities as for annual planning as well as investment options.

Governance of the Reform Process

What institutional framework exists to oversee and guide the policy?

There are a range of processes that guide policy review, revision and development. One main process is conducted through the DCU and the PSPS whereby all implementation activities under the ERfKE Integrated Plan are monitored on the basis of policy guidelines. Each MoE directorate provides monthly updates to the Integrated Plan Committee on their respective activities and areas that require more formal documentation in policy guides.

The DCU also works with the National Centre for Human Resources Development to monitor all ERfKE activities. This key government agency has played an important role in overall ERfKE I monitoring and evaluation. Their reports to the DCU and to the World Bank provide guidance on areas requiring policy review. In addition, the DCU requires each donor agency to complete monthly updates on their respective implementation and each agency has its own monitoring procedures. These often include more intensive studies. The combination of these avenues provides the Ministry with constant feedback through its committee structure to highlight all aspects of policy.

The MoE Board of Education, which includes other agency participation, is the ultimate review agency within MoE. Its actions are governed by the Education Law. Its overall command role in education development provides it with the mandate for ongoing policy review. In the longer term, its review provides the vehicle for interaction with Government for potential revisions to the education law. In the shorter term, the Board provides the vehicle

for the presentation of all aspects of policy. Its endorsement of the MoE's National Strategy (2006), the ERfKE II programme plan, and the MoE annual implementation plans provide for ongoing policy assessment.

Within Parliament, the Government has its education review committees, each with a mandate to assist the MoE in its development process. The Minister of Education is responsible for presentations and representations to the parliamentary committees. This interaction also provides for the opportunity for the public assessment of the needed changes in education. One other key agency is the Royal Commission for Education (2007). This group is comprised of well recognized leaders in public affairs. This Commission includes monthly reviews of education development at the basic and secondary levels as well as higher education. One key aspect of their mandate is to ensure the education system is continuing to be developed according to best international practices.

What procedures and structures have been put in place to ensure interministerial cooperation?

Interministerial cooperation is extensive and commenced in earnest with the establishment of the Telecommunications Regulatory Commission (TRC) in 1995. This Commission has taken a lead role in the development of the industry as well as maintaining a close working relationship with the Ministry of Education. The Minister of Information and Communications Technology chairs the e-Government Committee with representatives of all line ministries. This committee plays the key role in regulating and supervising the Government's strategy and process of delivering e-Government services. The MoE is working with MoICT to track students transferring to secondary school, their progress, registration and achievement on the national final year Tawjihi examinations, and their transfer to university and subsequent registration. Another critical link between MoE and other government entities is the 2003 establishment and operation of the National Information Technology Centre, which has assumed a key role in the liaison of all ICT matters amongst all government entities.

What instruments are established to promote and regulate public-private partnerships?

The Ministry established a working relationship with a private company to use EduWave®. It is an instructional design, authoring and publishing environment designed for use as a country-wide electronic learning management system providing publishers, instructors, students and administrators with a flexible and powerful authoring and learning tool that further enhances the learning experience by harnessing the power of the Internet. The result is a fully integrated, easy-to-use, web-based distributed e-learning solution working as a gateway to connect the educational community with the knowledge, resources, information, and tools that are relevant to their academic needs.

The MoE also used its accreditation process to endorse third-party ICT training based on its review of the content from a particular agency or company and then awarding an accreditation for use with teachers and principals. This approach has been used with a wide range of suppliers with the core group being the link with the International Computer Driver License, British Council, USAID, CADER, World Links and Intel.

The MoE has nurtured its link with the Information Technology Association of Jordan (Intaj). As referenced, this organization has played a key role in developing a strategy for ICT and has a close working relationship with the MoE and with universities to systematically improve the quality of human resources that will enable the teaching-learning process at all levels and to participate directly in the industry.

Perhaps the most recognized partnership is that between the MoE and the Jordan Education Initiative . Senior ministry officials sit on the governing board of JEI and others participate in the design and enabling of the

delivery of ICT-related services, particularly relating to the teaching-learning process. As already referenced (section C(ii)d), JEI assumed a key role in the development of learning objects for nine core subject areas. In addition, there has been and currently exists extensive liaison in the ongoing professional development of teachers and school principals. The JEI's support for the 100 Discovery Schools as a means to introduce its programmes, and to modify content and implementation strategies based on this experience, is a key aspect of enabling the Ministry to roll out the respective service or innovation to all schools. Various structures to facilitate and regulate public-private partnerships, including incentives, were established. Jordan has been recognized internationally through the JEI as a model for public-private partnerships in implementing large-scale education reform programmes at large and ICT in education in particular.

What partnerships are in existence?

Much has been said already about partnerships, particularly those between JEI and donor agencies. Following is a review of several other but important alliances between the Ministry and other organizations.

In 2002, His Majesty King Abdullah II launched the IT Community Training Centres through the King Abdullah II Fund for Development. This initiative has been successful in enabling Jordanians to master basic computer literacy skills. As such, a priority has been directed to establish these centres in remote and underprivileged areas.

In 2007, Intaj in collaboration with MOICT and with the education ministries launched a programme of a Laptop for every Jordanian university student. Although, this initiative has been challenged by the economic downturn, it represents a concerted effort to increase student access to technology and continues to aim for its ultimate goal.

In 2008, Her Majesty Queen Rania launched the MADRASATI Initiative to provide an opportunity for the private sector to contribute to the improvement of the physical conditions in schools, as well as piloting various innovative programmes including ICT in education. This programme has been highly accredited as a very important service to the establishment of preventive maintenance programmes and the actual renovation of a large number of schools, in conjunction with to school-focused improvement programmes like physical fitness, safe school environment, health education programs, and various ICT in education programmes. The programme has gained substantial momentum in 2009 and now plays a vital role in the Ministry physical works improvement programme and school-focused improvement programmes.

Other partnerships of reference are the link with the private sector company ITG and its support in the use of EduWave®. In 2003, the Ministry signed its first formal agreement with ITG for the use of this learning platform. Subsequently, there have been other agreements, each aimed at enabling all schools and all students to benefit from its use. This interaction has also been supported with an agreement between MoE and Itisalat (Orange) to enable increased connectivity for schools and also reducing the costs of student use.

Policy Alignment and Consistency

How does the ICT in education policy relate to/is part of the overall education sector policy?

ICT are a core element of the National Education Strategy (2006). It is an integral part of both the ERfKE I design and implementation and also the ERfKE II design, which is scheduled to commence in mid-2010. It is the only policy area that has undergone two revisions during the first reform phase (2003-2009). Sector development planning in ERfKE II will move to more regional planning thereby the unique circumstances faced

in each region as it relates to access and use of ICT will become more evident and therefore more integral to short and long term planning and investment.

The MoE placed a high priority on two areas of policy at the commencement of its sector reform program. These were curriculum and assessment and also ICT, both of which were promulgated in 2004. Curriculum revision was perhaps the highest priority in ERfKE I. This entailed a major redesign of the Grades 1 to 12 and early childhood curriculum, moving it to an outcomes-based system with general outcomes and specific outcomes for every subject and grade level. From the very beginning the ERfKE reform has been designed with ICT as an integral part, an enabler of change and reform and a basic outcome for students' knowledge economy skills.

Existing MoE ICT policy places a heavy emphasis on the importance of providing teachers with Teacher Guides that provide good examples of ICT use. A constant theme in the MoE's human resources policy and its guidelines for both new teacher and existing teacher professional studies is the importance of ICT in education. Central MoE human resources upgrading policy for curriculum developers, authors and subject coordinators have a strong emphasis on ICT competence.

What linkages are put in place with the broader ICT policy?

The MoE has several ICT-oriented committees. One is essentially an internal grouping of key officials involved in ICT. The other provides for dialogue between MoE officials, selected ICT consultants who act as advisors to the MoE, donor representatives, JEI representatives, private sector industrial representatives as well as other government agencies (e.g. Ministry of Information and Communications Technology). This group, during 2006-2008 played a key role in reviewing the initial MoE ICT policy (2004) and the three policy areas for ICT developed in 2006 and endorsed in 2007. This interchange of ideas and views on ICT policy in education extends to other dialogue relative to overall national ICT policy development. Included in this group are representatives from the ICT Industry and some of the exchanges are captured in their National Strategy, published in 2007.

Monitoring and Evaluation

How is policy evaluation conceived?

A key principle of Jordan's vision and mission for National Education is:

> *"A quality education system enables universal access to educational opportunity, equality in the delivery of services, and to the benefits of modern information and communication technology."*[34]

This principle has guided the MoE programme of policy evaluation. From the onset, evaluation was an integral part in the reform programme and perceived to be of utmost importance to provide feedback and to guide policy. Within the JEI framework, for instance, monitoring and evaluation activities are part of annual work plans and conducted regularly whether internally or externally. Regular site surveys, pre-piloting, piloting formative evaluation and summative evaluation activities are conducted regularly. For the entire education reform program, an autonomous evaluation centre was commissioned by the Government to conduct evaluation activities focusing mainly on impact assessment of reform initiatives including the JEI. Evaluation is also reflected in almost all donor agencies programs.

34 National Education Strategy, 2006, p.12

Within the MoE itself, each Managing Directorate and each Field Directorate are to prepare annual plans. These plans are based on a standard format that includes specification of planned targets and reference to relevant policy guidelines. Where activities within specific plans are identified and there is no directly relevant policy statement, planners must articulate the need for official guidance. All plans are reviewed by the Policy and Strategic Planning Secretariat in conjunction with the Managing Directorates of Planning and also Finance. This iterative and collaborative process highlights areas requiring policy review and areas requiring new policy. This process is supported by the DCU monthly reviews of ERfKE implementation as well as its reviews of monitoring reports by donors, NCHRD, JEI, or other agencies.

Policy evaluation, therefore, is an integral part of ongoing MoE operations. It was also a key component in ERfKE I's management development work and continues to have a high priority in the proposed ERfKE II design. For ICT in education, evaluation has been greatly emphasized and deemed necessary by different policy groups for obvious reasons related to the basic questions: Does ICT in education improve its quality? How is ICT in education changing the way teachers are teaching and students are learning? Are there any new emerging paradigms in teaching and learning as a result of all these initiatives of ICT in education? Do the returns in terms of students' achievement justify high costs of investment in ICT in education? How can we afford enough multimedia-capable,Internet-connected computers so that a classroom computer is always available for all students? How can we afford enough computers and telecommunications to sustain new models of teaching and learning? How can many educators who are disinterested or phobic about computers and communications be induced to adopt new technology-based models of teaching and learning? How do we prove to the public that new technology-based models of teaching and learning are better than current instructional approaches? How can educational technology increase equity rather than widen current gaps between "those that have" and "the have-nots"? If we use technology well, what should we expect as "typical" student performance?

Basically, when it comes to ICT in education, the strategic concerns for the Ministry are: scalability of ICT initiatives at large and the JEI in particular to all schools, affordability of costs, sustainability of the initiatives, integration of ICT in all aspects of operations within the education system, institutionalization of initiatives within the system when additional funds are not made available, commitment of all partners to continue working within a coherent and effective frameworks, and commitment to change among teachers

What ICT evaluation studies have been conducted?

There have been extensive studies undertaken by the MoE, NCHRD, individual donors, the JEI, the British Council, and the private sector (national and international). These studies span the full realm of ICT-related elements, including network infrastructure, bandwidth, hardware and software distribution and use, other digital support equipment, management and teacher competence and application of ICT, etc.

Individual Governorates within the Kingdom are also active in evaluating the extent to which their regions have parity with other areas and are providing an increasingly strong voice in overall Government planning.

As part of the ERfKE programme management and ongoing design, the DCU has commissioned a range of studies, including specific studies conducted by NCHRD and by individual programme design consultants. The Managing Directorate of Curriculum and Textbooks, through its Digitization Directorate developed a set of evaluation criteria and instruments to be applied to the e-content products. This internal MoE team developed and field tested the criteria and tools and now apply a system to fulfil their monitoring and evaluation function. A list of the evaluation studies consulted is provided in *Appendix* G. Following are some of the key findings.

What were the findings?

The various evaluation studies produced a wide range of findings, observations and recommendations. Following are the key findings that provide a valuable guide for policies related to investments in ICT in education and ongoing evaluation on ICT in education, particularly in Jordan:

- In Jordan like most other countries embarked upon major education reform programmes with ICT as a central component, an issue of concern is the lack of clear precise vision of the role of ICT in the classroom. Although the MoE is proactively developing the reform strategy that incorporates JEI as one approach to explore ways to prepare students for the knowledge economy, the vision and legitimacy of the integration of ICT in the education system is not clearly articulated.
- Although there are signs in some schools and among some teachers that a new paradigm is emerging in the ways students are learning and teachers are teaching, the traditional teacher-centred approach is still predominant in most schools. Furthermore, although students in Discovery Schools (JEI) outperformed students in Non-Discovery schools on international assessments (both TIMSS and PISA), further analysis with students socio-economic status taken as a covariate, however, showed that socio-economic was a more significant predictor of students scores than attendance in a Discovery Schools. Attending a Discovery School was a much smaller, but still a significant predictor of their scores. In general, being in a Discovery school may account for only 1% to 2% of the performance difference.
- Despite substantial success at creating and providing e-learning resources to schools, the common uses of these new resources do not yet align with the vision of use desired: teacher-centred practices still predominate among most of the teachers interviewed and observed.
- The current in-service training programmes are primarily guided by ICT literacy skills with less focus on the application of ICT in the teaching-learning process by using examples of creative uses of ICT in the classroom as found in the teacher guides and textbooks instructionally appropriate ICTs and use them in the context of effective instructional strategies.
- The Jordan Education Initiative and MoE approach to e-content development really benefitted from the field testing process (pre-pilot, pilot and roll-out phases) which were conducted in 100 Discovery Schools in the greater Amman area. This approach provided direct input from teachers to software developers and also from MoE curriculum specialists on the extent to which items in the e-content precisely matched the actual curriculum and areas where content was not supported. Therefore, prior to actual roll-out, the e-content materials were improved and also guidance was provided on what kind of training was required for teachers as part of the MoE human resources development program.
- The MoE should explore the idea of integrating the scope and sequence of ICT topics for grades 7 to 10 in other subjects. Greater impact may be achieved if the periods of hands-on computer time that are currently reserved for teaching about ICT in isolation were given to mathematics, science, Arabic, EFL, geography, and other subjects, so that ICT skills are developed in the context of these subjects.
- Reducing the ratio of students to working computers in computer laboratories is critical to increase student access to e-content.
- The delivery of e-content to schools via EduWave will continue to be vulnerable to problems with network reliability and performance. There appear to be no technical reasons why e-content could not be cached at the school level.

Conclusion

ICT policy development and ICT use in Jordan has made credible progress. The drive for such policy and enabling broad utilization has come from the highest levels given His Majesty King Abdullah II's strong support as well as that of key government ministries. There are clear examples of interministerial collaboration to create the right investment and development climate for ICT. On a parallel basis, the private sector has been, and continues to be, highly pro-active in its support for ICT as a key aspect of overall development in the Kingdom.

In the case of education, the Ministry has been an advocate both in terms of policy, the reform agendas and actual investments in the soon to be completed ERfKE I and the upcoming ERfKE II programs. It is this integration of effort at all levels that has enabled the progress achieved. Given these different avenues of ICT pursuit, it is fair to say that there has been a blending of technology and pedagogy as the drivers for change. If is difficult to say which has had more impact particularly given the commitment from the Ministry of Education. The financial demands to enable widespread use of ICT in the education system are well known. Clearly, Jordan has made a strong commitment in this regard with 4.9% of GNP and 13% of public expenditure being devoted to education with a recognized allocation devoted to ICT.

Overall, there are reasonable alignments between all parties including the lead roles taken by MOITC and the Telecommunications Regulatory Commission. But, the pace of change required also suggests that there is a need for greater collaboration and clearer government direction. Even in the MoE, there remains enough evidence of lethargy in adopting new technology that there is a need for public dialogue to inform the process and ensure that transparency about the rate of progress in ICT application is being achieved. MoE has strategic concerns that remain a challenge in both the short and long term. These are related in part to available investment but also include the changes required in managing human resources. Key issues relate to the scalability of ICT initiatives to all schools, affordability of costs, sustainability of the initiatives, integration and institutionalization of ICT in all aspects of the education system, and institutionalization of initiatives within the system when additional funds are not made available.

Jordan's progress in creating infrastructure is to be recognized as does the MoE role. However, there is a need to expand the exploration of ways to prepare students for the knowledge economy. Despite valiant attempts, the vision for the integration of ICT in education can benefit from greater articulation, documentation and integration into actual work plans. There has been extensive investment in ICT at all levels; however, there remain many schools, teachers and students who do not use much ICT in the teaching-learning process. Similarly, there are many citizens who do not have either the capability or the opportunity. This overall scenario is an all too familiar situation in many countries, therefore, although an issue, Jordan can be viewed as addressing the changes required in a reputable manner. Key government initiatives to enable the changes required include the move to reduce internet protocol costs, to reduce taxes on the ICT industry, to help individuals to procure hardware and software, to expand broadband access to all education institutions, and to distribute the leadership for ICT development to all levels.

Jordan is a good example of a nation giving early recognition to the importance of ICT and the alignment of government agencies to support its development. There is clear evidence of government action in the mid- to late 1990s, which has subsequently been followed up in both planning and investment practices. The ability to attract international recognition through the World Economic Forum (2003) and to form public-private partnerships has been crucial. The establishment and support for the Jordan Education Initiative has made a solid contribution to Jordan's being recognized as a leader in integrating ICT in the classroom. In many respects, the pro-active role that the JEI has played has had some impact on the MoE initiative to revise its curriculum for all grade levels. This was achieved with a definite commitment to the integration of e-content and e-learning practices. The extent of this integration has been dependent on the ability to scale up or roll out the products developed and the practices encouraged.

The public-private partnership in creating a national strategy for ICT has played an important role in building confidence and alliances among all parties. It is recognized that many of the targets to be achieved may have been overly optimistic given world events but the fact that a planning document exists has helped to focus energies and investment. It has helped to solidify a sustainable commitment to collaborate and through joint efforts make the changes required. Jordan should continue to be recognized as a nation that has embraced ICT and one that will make every effort within its capabilities and capacity to ensure it keeps pace and indeed leads development in the region.

Given its current high level of education expenditure, it is unlikely at least in the short term that Jordan will be able to finance from its own resources the the scaling up of the e-learning ICT requirements for all schools. Such

financing will have to be accomplished in planned stages over a number of years and will depend critically on the availability of external funding and partnerships.

The instructional effectiveness and learning gains under various ICT in education initiatives as well as judgments on programme effectiveness are still unanswered questions. The learning gains to date appear to be modest and are difficult to attribute solely to the ICT and e-learning approach. However, it is too early to draw a conclusion because the transformational processes are still underway.

The results of various ICT assessments in Jordan have showed that in the past few years the access to ICTs in Jordanian schools has improved considerably. There are indications, however, that Jordanian schools tend to emphasize, in this stage of the introduction of ICT, learning about computers. This typically occurs in the initial period of introducing computers, an experience shared by many countries, but which is usually then followed by a stage of intensified integration in school subjects.

The results show that, in Jordan's schools, emerging pedagogical practices are beginning to be realized. In this regard, the ambitions of Jordan's schools are quite high, which points to a sound spirit of innovation. It was also observed that great differences exist from one school to another: some schools seem to be much more innovation-oriented than other schools. A very crucial condition for changing pedagogical practices and integrating ICTs is that teachers and support staff need to be adequately trained in order to feel comfortable to apply ICTs in their daily instructional activities. Next to infrastructure, curricular flexibility and staff development, management and organizational factors play a crucial role in this process.

In summary, it appears that Jordanian schools are well underway to implementing ICT. The infrastructure is quickly becoming available and many educational actors are innovation oriented. However there are indications that continuous intensified attention may be needed to overcome existing issues related to student/computer ratios, connectivity, quality of e-learning materials, staff development programmes and development of a common vision on ICT in schools.

Chapter 6

Case Study: Uruguay

J. Enrique Hinostroza
Ignacio Jara
Mario Brun

Executive Summary

Uruguay, with its 3.5 million inhabitants, has an economy characterized by an export oriented agricultural sector, a well-trained work force, and high levels of social spending. For this reason, Uruguay is considered an "upper middle-income" country, and scores slightly above average for the main economic indicators in this category of countries. The country's ICT indicators make Uruguay one of the best ranked in Latin American and the Caribbean. This position is probably the result of several ICT-related policies implemented since the 1990s, especially those launched since 2005. The latter led to the creation of government structures responsible for the digital development of the country (such as the Agency for e-Government and the Information and Knowledge Society (AGESIC) and the National Agency for Research and Innovation (ANII)).

Over the last few years, the main initiative has been Plan Ceibal (Conectividad Educativa de Informática Básica para el Aprendizaje en Línea [Educational Connectivity of Basic Informatics for Online Learning]), which aims to provide every primary student with a laptop. This Plan was launched by President Tabaré Vásquez at the end of 2006 and has placed Uruguay as the first country in the world to embark on the large-scale rollout of the OLPC programme.

Plan Ceibal is both a social and an educational policy that has the purpose of contributing to social equity. Its specific aims are to:

- Provide all children and teachers of public primary schools, universal and free access to portable computers in order to reduce the digital gap in the country;
- Promote social justice by establishing the conditions for equal access to information and communication possibilities for all people in the country;
- Facilitate the construction of new learning environments and the generation of an adequate context for Uruguay's children to be able to respond to the demands of the information and knowledge-based society;
- Stimulate active participation by making available to students and teachers new tools that can widen their learning, increase their knowledge and develop their awareness of lifelong learning.

The policy is driven by the Presidency of the Republic. It is headed by a commission that incorporates several government institutions and agencies, including the Ministry of Education and Culture and the National Agency for Public Education (ANEP), which is in charge of the administration of the educational system, and it is being implemented by Uruguay's Technological Laboratory (LATU).[35] Additionally, large numbers of organizations from the private sector as well as civil society actively participate in its implementation. Ceibal's action lines include the provision and support of ICT infrastructure, teacher training programmes, the development of educational content and the provision of pedagogical support, among others.

Ceibal is being implemented in four stages, including a pilot stage that began in early 2007. It also includes three expansion waves starting in the interior of the country in late 2007 and ending in 2009, covering all public primary schools in the capital city, Montevideo. So, with an investment of approximately US $140 million, by the end of 2009, more than 380,000 laptops were delivered, 2,000 schools and 250 public places offered free access to Internet and more than 18,000 teachers were trained. Currently, *Ceibal* is starting a new phase, which includes the consolidation of the implementation in primary education and the incorporation of secondary education.

Ceibal has had wide social and political support probably because it embodies Uruguayan society's shared aspiration for social justice in the twenty-first century. Recent results of the monitoring and evaluation initiatives confirm the general adherence to this initiative in society. They also show promising indications of an initial impact on the digital divide and cultural change in the behaviour of the children who are using these tools at home with their families.

35 In March 2010 the government set up a new institution named CITS (Centro para la Inclusión Tecnológica y Social), which will be in charge of Ceibal.

Abbreviations and Acronyms

AGESIC	Agencia para el Gobierno de Gestión Electrónica y Sociedad de la Información y el Conocimiento [*Agency for e-Government and the Information and Knowledge Society*]
ANEP	Agencia Nacional de Educación Pública [*National Agency for Public Education*]
ANII	Agencia Nacional de Investigación e Innovación [*National Agency for Research and Innovation*]
ANTEL	Administración Nacional de Telecomunicaciones [*National Telecommunications Administration*]
Ceibal	Conectividad Educativa de Informática Básica para el Aprendizaje en Línea [*Educational Connectivity of Basic Informatics for Online Learning*]
CEIP (or CEP)	Consejo de Educación Inicial y Primaria [*Council for Initial and Primary Education*]
CEMB	Consejo de Educación Media Básica [*Council of Basic Secondary Education*]
CEMS	Consejo de Educación Media Superior [*Council of Upper Secondary Education*]
CES	Consejo de Educación Secundaria [*Council of Secondary Education*]
CETP	Consejo de Educación Técnica y Profesional [*Council for Technical and Professional Education*]
CITS	Centro para la Inclusión Tecnológica y Social [*Center for Technological and Social Inclusion*]
CODICEN	Consejo Directivo Central [*Central Directive Council*]
DFPD	Dirección de Formación y Perfeccionamiento Docente [*Teacher Training and Professional Development Department*]
ICT	Information and Communication Technologies
IDB	Inter-American Development Bank
IKS	Information and Knowledge Society
LAC	Latin America and the Caribbean
LATU	Laboratorio Tecnológico del Uruguay [*Uruguay's Technological Laboratory*]
MEC	Ministry of Education and Culture
OLPC	One Laptop per Child
PEAID	Programa de Equidad para el Acceso a la Información Digital [*Access to Digital Information Equity Program*]
SME	Small and Medium-sized Enterprises
TDP	Technological Development Program
UDA	Uruguay's Digital Agenda
UDELAR	Universidad de la República [University of the Republic]

The Context

General Background

The Oriental Republic of Uruguay is a South American country, located between Argentina and Brazil; with a total area of 176,215 km^2. It is a constitutional republic, its capital is Montevideo and it is administratively divided into 19 departments.

Figure 1: Map of Uruguay

Uruguay is still well known for its high literacy rate, large urban middle class, advanced education and social security systems and relatively even income distribution, despite the deterioration of some social conditions over the last decades of the twentieth century.

Socio-economic Profile

Uruguay's total population is 3.5 million. Its inhabitants are highly concentrated in urban areas (98%) and the majority are white European descendents (88%), with a minor presence of other ethnical groups such as mestizo (8%) and black (4%). The predominant religion is Christianity (66%), and the national official language is Spanish. Table 1 provides an overview of the country's demographics.

Table 1: Main National Demographic Indicators

Population	3,494,382 (July 2009, est.)	1
Population density	19.8 inhabitants per km^2	1
Median of population ages	33.4 years (2009 est.)	1
Growth rate	0.3% (2008)	3
Life expectancy total population	76 years (2008)	4
Infant mortality (*per 1,000 live birth*)	11.3 (2008)	2
Urban population	92% of total population (2008)	1

Sources: 1 - CIA (2009) ; 2 – World Bank (2008) ; 3 – World Bank (2009a) ; 4 – World Bank (2009b)

Uruguay's economy is characterized by an export-oriented agricultural sector, a well-trained work force, and high levels of social spending. Since 2004, through prudent macroeconomic management and aided by favourable conditions abroad, its economy has been growing at an average of 8% annually (CIA, 2009). This economic growth and the social policies implemented by the government have supported a reduction in poverty (from 33% in 2002 to 21.7% in July 2008) and unemployment (from 20% in 2002 to 7.6% in 2008) (World Bank, 2009b). Table 2 shows the main indicators for 2008.

Table 2: Main Economic Indicators 2008

Budget revenues	$8.16 billion	1
Budget expenditures	$8.55 billion	1
External debt	$10.73 billion	1
Inflation rate (consumer prices)	7.9%	1
Exports	$7.08 billion	2
Imports	$8.80 billion	2
GDP (Purchasing Power Parity, or PPP)	$32.19 billion	3
GDP per capita (PPP)	$9,750	1
GDP (Real Growth Rate)	8.9%	1
GNI (AM-Atlas Method)	$27.54 billion	3
GNI per capita (AM)	$8,260	3
GNI (PPP)	$41.81 billion	3
GNI per capita (PPP)	$12,540	3

Sources: 1 – CIA (2009); 2 – World Bank (2008); 3 – World Bank (2009a)

Uruguay is categorized as an "upper middle-income" country with the main economic indicators being slightly above the average in this category of countries (World Bank, 2009d).

Uruguay's socio-economic performance in 2007 and its Human Development Index (0.865) and the Gini Index (0.462), put the country into a prominent situation when compared with other Latin American countries, in terms of human development and economic equity (World Bank, 2009a; UNDP, 2009).

ICT Infrastructure

In 2008, Uruguay had 959,300 main telephone lines in use (the highest density in Latin America: 0.29 fixed lines per person), as well as 3.51 million mobile phones (109%, the third in Latin American and the Caribbean countries according to Bibolini and Baker, 2009). The overall fixed line and mobile cellular teledensity is 1.3 telephones per person.

Regarding the structure of the ICT sector, there is a separate telecommunications regulator, and the status of the main fixed-line telephone operator is that it is publicly owned. Competition among Uruguay's mobile market providers is quite intense: all three operators (state-owned ANCEL, Telefonica's Movistar and America Movil CTI Movil) have already launched 3G services (Miniwatts Marketing Group, 2009).

On the other hand, 47.8% of the households have a computer, and 28% have Internet access at home[36] (INE, 2009).

Regarding the overall Internet penetration, there are 1.34 million users (almost 40% of population), and 498,232 Internet hosts (CIA, 2009).

As shown in Table 3, Uruguay is well positioned among Latin American and Caribbean (LAC) countries, not just regarding its economy but especially its ICT sector: it shows comparatively high rates of ICT penetration as well as a growing market through international trade based on the exports of ICT-related services.

Table 3: ICT Sector Main Indicators

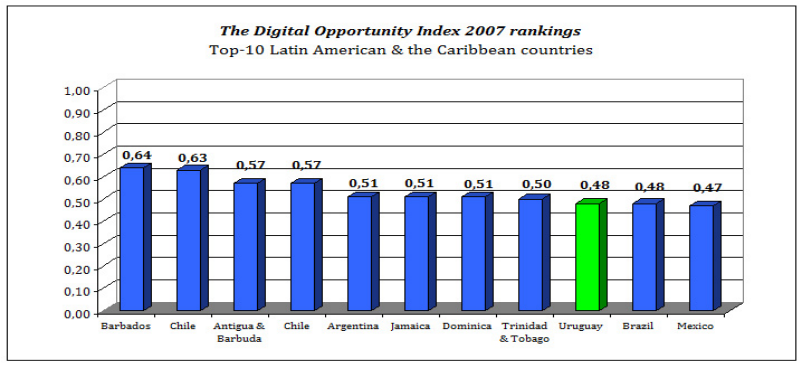
Indicator	Uruguay	Latin America and the Caribbean region
Access		
Telephone lines (per 100 people)	29.0	18.1
Personal computers (per 100 people)	13.6	11.3
Households with a TV set (%)	92	84
Quality		
Population covered by mobile cellular network (%)	100	91
International Internet bandwidth (bits/second/person)	903	1,126
Affordability		
Price basket for residential fixed line (US $/month)	10.7	9.5
Price basket for mobile service (US $/month)	16.1	10.4
Price basket for Internet service (US $/month)	23.4	25.7
Trade		
ICT goods exports (% of total goods exports)	0.1	11.4
ICT goods imports (% of total goods imports)	6.5	15.9
ICT service exports (% of total service exports)	8.8	4.7
Applications		
ICT expenditure (% of GDP)	6.0	4.9
E-government Web measure index	0.51	0.44
Secure Internet servers (per 1 million people)	42.6	18.2

Source: World Bank (2009c)

36 Percentages include the improvements generated by Ceibal.

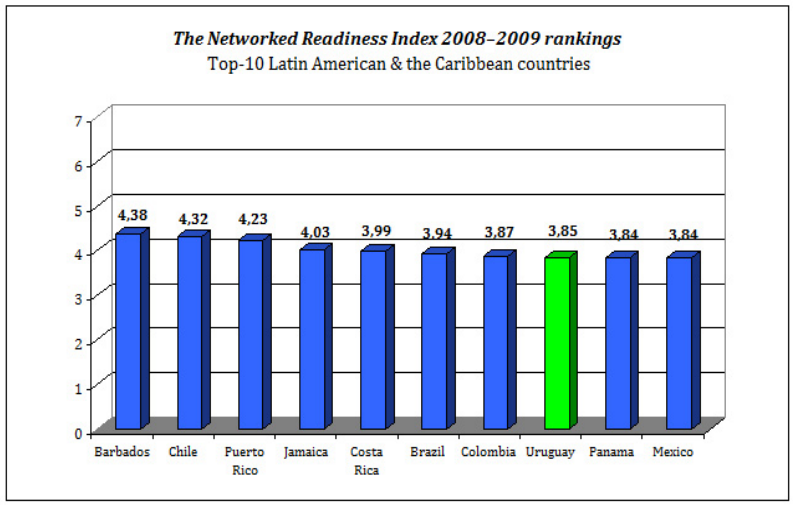
In relation to the wider international context, in 2007 Uruguay ranked 63 among 181 countries in the Digital Opportunity Index (DOI),[37] scoring 0.48 compared to the world average of 0.4, and ranked ninth among LAC countries (Figure 2). Also, in the last edition of the Networked Readiness Index (NRI)[38] Report (2008–2009), Uruguay ranked 65th among 134 countries (scoring 3.85, while the highest was Denmark, scoring 5.85). Ten countries from the LAC region featured in the top half of the international ranking, and Uruguay scored eighth among them (Figure 3). Finally, in the 2008 edition of the ICT Development Index (IDI)[39] Uruguay ranked 49th among 154 countries, occupying the third place among LAC countries (ITU, 2009).

Figure 2: DOI for top-ten LAC countries(2007)



Source: ITU, 2007

Figure 3: NRI for top-ten LAC countries 2008-2009



Source: WEF, 2009

37 DOI is an e-index based on internationally-agreed ICT indicators, and provides a valuable resource for benchmarking the most important indicators about the Information Society, becoming a powerful policy tool for exploring the global and regional trends (and allowing to compare ICT performance within and across countries). The DOI is a composite index (measured in a 0–1 scale) comprising 11 indicators, grouped in 3 clusters: opportunity, infrastructure and utilization (ITU, 2007).

38 NRI is an index that constitutes a methodological tool to assess countries' preparedness to leverage ICT advances for increased competitiveness and development. It is also a composite index, measured in a 1–7 scale, grouped in three sub-indexes (comprising 9 pillars and 68 variables): environment, readiness and usage.

39 IDI captures the level of advancement of information and communication technologies (ICT) in 154 countries worldwide, and compares progress made between 2002 and 2007. Its main objective is to provide policy makers with a useful tool to benchmark and assess their information society developments and to monitor progress that has been made globally to close the digital divide (ITU, 2009).

As it can be appreciated, the general performance of Uruguay in relation to ICT is good in both contexts: the LAC region and the world.

This relative good performance regarding ICT could be attributed to a large extent to the current ICT-related policies that the country is implementing. In fact, during the 1990s Uruguay implemented several initiatives regarding ICT and the Information and Knowledge Society (IKS), aimed to reduce the access divide, however, their success was relative and uneven. In 2000, the National Committee for the Information Society was created, under functional dependence of the Presidency of the Republic to promote a widespread national strategy to develop the Information Society. This work started with a significant level of support, but the initial impulse faded out and ended in 2003. Since then, and until 2005, there were only some small-scale and not articulated actions, without any relevant impact on national life (AGESIC, 2007).

One exception among the former initiatives was the Technological Development Programme (TDP), that started in 2001 and aimed to strengthen Uruguay's capacity for research, technological development, innovation, and business competitiveness. The programme was financed through a US $30 million loan from the Inter-American Development Bank (IDB) with an additional US $20 million as local contribution. The term of this loan was for five years and the executing agency was the Ministry of Education and Culture (MEC) of Uruguay. The general purpose of this programme was to mobilize the country's innovative capacity in order to boost the competitiveness of small- and medium-sized enterprises (SMEs) that produce goods and services, as well as to improve the conditions for science and technology development.

In 2005, the national development strategies were reformulated and a new institutional framework was created to address the issues and challenges regarding the Information and Knowledge Society. Among others, the more relevant new agencies were:

- *Agencia para el Gobierno de Gestión Electrónica y Sociedad de la Información y el Conocimiento* (AGESIC) [*Agency for e-Government and the Information and Knowledge Society*]. It was created in 2006 with the mission to drive the development of the Information and Knowledge Society, promoting the best use of ICT among citizens, institutions and government. Its objective is to "ensure the improvement of the services for the citizens using the possibilities provided by ICT" (AGESIC, 2009).
- *Agencia Nacional de Investigación e Innovación* (ANII) [*National Agency for Research and Innovation*]. This is a state agency which mission is about the implementation of the state's political and strategic guidelines related to research and innovation, promoting, articulating and strengthening the capacities of the National Innovation System (ANII, 2009).

Since then, some of the more significant projects and initiatives carried out in relation to the national ICT infrastructure are the following:

- The *Libro Verde de la SIC en Uruguay* [*Green Book of the Information and Knowledge Society in Uruguay*] is an explorative and descriptive work that includes an overall analysis and diagnosis about the Information and Knowledge Society, according to data collected between late 2006 and early 2007. Its main purpose was to provide an overview of the concepts encompassing the Information Society, as well as to describe the country's overall situation regarding ICT in the regional and international contexts (AGESIC, 2007).
- The *Technological Development Programme II*. It is the second IDB-financed project for technology development in Uruguay, aimed at further encouraging technological innovation. This US $34 million loan was approved in 2008 for a 25-year term; and its executing agency is the ANII. The programme promotes projects for the business sector, for science and technology services and other projects of public interest. It also strengthens human resources capacity in science, technology and innovation, and aims at improving the system's capacity for monitoring and evaluation. Its main challenge is to promote private sector participation and link academic work with the needs of the national industry. A particularly innovative characteristic of the programme is that it also considers funds to encourage the use of ICT solutions to social inclusion, enabling national authorities to fund innovative projects aimed at tackling pressing problems in areas such as poverty reduction, public

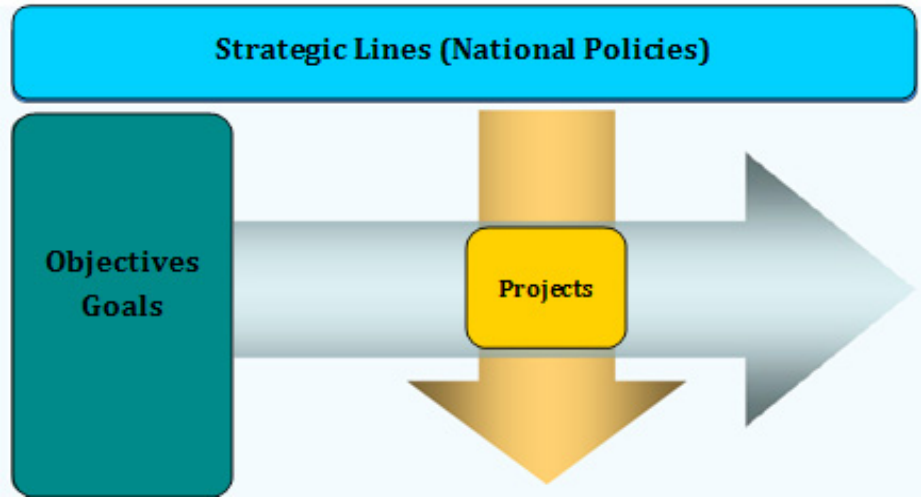
health, and environmental protection, among others. Its components are: (1) the promotion of innovation in private enterprises; (2) strengthening technological services; (3) strengthening professional skills in prioritized areas; (4) support to innovation projects with high public interest; and (5) strengthening of the ANII's ability to monitor and assess projects (IDB, 2008).

- Finally, *Uruguay's Digital Agenda* (UDA) 2008-2010, developed by AGESIC, is the country's programme for addressing ICT issues at a national level, including the development and enhancement of ICT infrastructure, goals related to social equality in the use of ICT as well as the generation of educational contents. It promotes transparency, democratic strengthening, digital inclusion and e-government -among other aspects- in order to improve the population's quality of life (AGESIC, 2008).

  The UDA includes seven strategic action lines:
  - equity and social inclusion;
  - democratic strengthening;
  - state reform;
  - infrastructure development;
  - knowledge-based economic development;
  - culture, education and knowledge production; and
  - regional insertion and integration.

  In particular, the infrastructure development line's main objective is to develop and enhance the technological infrastructure at a national level, as well as to achieve the technical skills required to its sustainability. Each one of these lines had several objectives and goals (to be achieved in 2008-2010, including a set of projects to implement the action lines (Figure 4).[40]

Figure 4: Overall Structure of Uruguay's Digital Agenda



Source: Adapted from Rios, 2008

Some of the main goals included in the UDA are (AGESIC, 2008):

- Complete implementation of *Plan Ceibal* across the whole country, providing access and connectivity to all urban and rural educational institutions;
- Install 15 Centres for Access to the Society of Information (CASI) and 15 Centres for Social Internet (CSI) every year, until 2009, in order to increase access points to the Information Society;
- Implement the strategic plan of the software industry, to triple exports between 2008 and 2010;
- Install an e-government platform in at least 50 government institutions by 2010;

40 Information about the level of achievement was not available at the date of this publication.

- Implement the national inter-administrative network (RED-UY) in every government institution by late 2009;
- Install and provide equipment to 35 MEC Centres every year, until 2010; and
- Provide connectivity to all Higher Education and Research Centres in the country.

In summary, based on these initiatives, Uruguay is rapidly progressing in the integration of ICT in the society and government, already showing good ICT indicators when compared to other countries in the LAC region.

Educational System

System's Structure and Educational Levels

The school system has a long tradition in Uruguay since its early birth during the late nineteenth century when the country started to provide universal, free, secular and compulsory primary education. Currently, the Uruguayan Public Education System is managed by three independent institutions with clearly differentiated areas of competence: the Ministry of Education and Culture, the National Administration of Public Education (ANEP, or Agencia Nacional de Educación Pública) and the University of the Republic (UDELAR, or Universidad de la República).

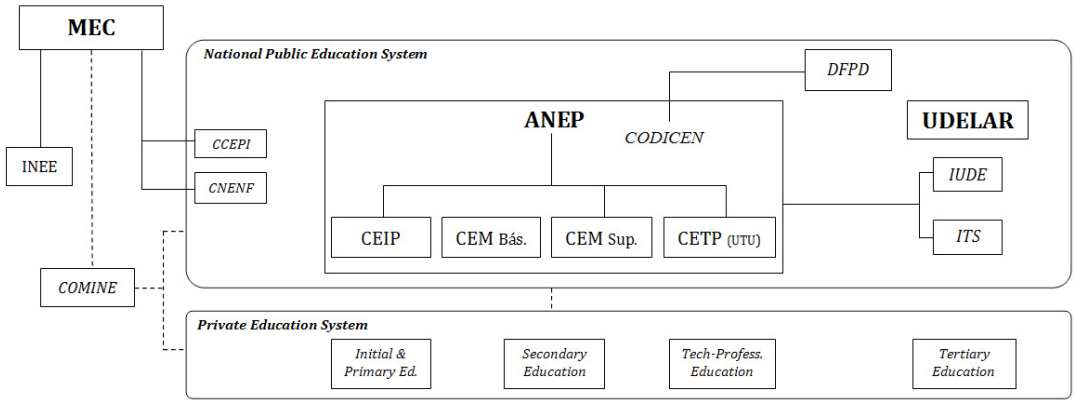
The MEC is responsible for coordinating education at a national level, promoting cultural development in the country and maintaining the artistic, historical and cultural heritage of the country, as well as the innovation, science and technology and the promotion and strengthening of the maintenance of the human rights. Additionally, it is responsible for developing the state's multimedia communication system and for driving the population's access to digitalized information. It is also responsible for the formulation and coordination of policies regarding judicial defence of the state's interests, and to ensure the availability of the required information to apply justice (MEC, 2009). In Uruguay, the MEC is not responsible for public education, which is the responsibility of ANEP.

ANEP, created in 1985, has technical and administrative autonomy from the executive body, but not financial autonomy. Its main purposes are to establish the country's education policy, handling the planning, the operational management and the administration of Uruguay's public educational system including preschool, primary and secondary levels, as well as the technical education, the tertiary teacher training and the supervision of all private schools in the country. Its superior body is the Central Directive Council (CODICEN, or Consejo Directivo Central). ANEP has the support of several autonomous decentralized councils, responsible for administering each sub-system associated to the educational levels; they are:

- Council for Initial and Primary Education (CEIP, or Consejo de Educación Inicial y Primaria): responsible for preschool education (children aged 4 and 5), and primary education (six years of compulsory schooling).
- Council for Secondary Education: is responsible for compulsory basic secondary education, covering the first to third years, and upper secondary education, covering the first, second and third years of the secondary school certificate course. In 2008, the new National Education Law, separated this council into two different councils: the Council of Basic Secondary Education (CEMB, or Consejo de Educación Media Básica) responsible for the compulsory basic stage; and the Council of Upper Secondary Education (CEMS, or Consejo de Educación Media Superior) in charge of the upper cycle).
- Council for Technical and Professional Education (CETP, or Consejo de Educación Técnica y Profesional): also responsible for compulsory basic secondary education, as well as for secondary technological education, basic vocational education and advanced vocational education, which prepare young people to continue with higher studies, as well as to enter the workforce.

Figure 5 shows a diagram containing the main institutions of the Uruguayan Education System, as well as the relationships between them.

Figure 5: Structure of Uruguayan Education System



Sources: Poder Legislativo, 2008; UNESCO-IBE, 2006; Verocai and Marroig, 2003

Nomenclature

MEC (Ministry of Education and Culture)
ANEP (National Administration of Public Education)
UDELAR (University of the Republic)
CODICEN (Central Directive Council):
CEIP (Council for Initial and Primary Education)
CEM Bás. (Council for Basic Secondary Education)
CEM Sup. (Council for Upper Secondary Education)
CETP/UTU (Council for Technical and Professional Education)
INEE (National Institute for Educational Assessment)
COMINE (National Commission of Education)
CCEPI (Commission for the Coordination of the First Childhood Education)
CNENF (National Commission for Non Formal Education)
DFPD (Teacher Training and Professional Development Department)
IUDE (University Education Institute)
ITS (Higher Tertiary Institute)

Education in Uruguay is structured across four levels: initial, primary, secondary and tertiary (university or not). Education is compulsory from age 5 to 14, comprising the last preschool year, the primary and the basic secondary levels. Secondary studies are composed of two stages or sub-levels: a basic level, with a common three-year plan; and an upper level consisting of a three-year baccalaureate or technical professional courses (ranging from two to seven years). The bachelor offers three basic orientations: biologic, scientific and humanist, each one of them diversifies in two options during the last year (before higher education studies). There is only one public and official university (University of the Republic), and access to public higher education is free and unrestricted. Table 4 shows the education levels, institutional responsibility, the number of years and its character.

Table 4: Education levels in Uruguay's Educational System

Level	*Institutional responsibility*		*Grade or stage*	*Years (and character)*
Preschool	CEP (ANEP)		Preschool	*
Primary			Primary	1 2 3 4 5 6
Secondary	CES/CETP (ANEP)		Basic Stage	1 2 3
	CES (ANEP)		Diversified Bachelor	1 2 3
	CETP (ANEP)		Technological Bachelor	1 2 3
			Basic Professional Training	
			Technician in Secondary Level	
			Higher Professional Training	
Tertiary	Not univers.	CETP (ANEP)	Technician in Secondary and Upper Levels	
		DFPD (ANEP)	Teacher Training	
	Univers.	UDELAR	Higher Education careers	

References: Compulsory; Not compulsory; * Early Childhood *(3 years old)*

Source: ANEP (2009)

Regarding administration of the schools, the majority of schools in Uruguay are public (80.9%) which means they are administered by the state, and a small percentage are private schools (19.1%) that receive a subsidy through the exoneration of taxes.

Main Indicators of the Educational System

Table 5 shows the main figures of the educational system in Uruguay.

Table 5: Educational System Figures (2008)

Indicator	Public	Private	Total
Schools			
Preschool	185	78	263b
Primary	2,144	404	2548
Secondarya	492	184	676
Teachers			
Preschool	2,952	1,064	4,016
Primary	17,462	6,557	24,019
Secondarya	–	–	28,398c
Students			
Preschool	82,649	27,005	109,654
Primary	300,320	54,532	354,852
Secondarya	240,702	39,623	280,325

Source: MEC, 2009

[a] Figures include basic and upper cycles, as well as technical education
[b] Only includes institutions supervised by the ANEP
[c] The official source has no made distinction regarding public/private education

With regards to enrolment rates, Uruguay is in a relatively better situation than other LAC countries (Table 6).

Table 6: Net Enrolment Rates in Uruguay and Latin American (2006)[41]

Educational level	Uruguay	Latin America average
Preschool	80%	58%
Primary	97%	94%
Secondary	68%	67%
Tertiary	64%	42%

Source: UNESCO, 2007

In a similar vein, the literacy rate in Uruguay is 98%, the highest in Latin America and the Caribbean, where the average rate is about 91% (CIA, 2009; World Bank, 2009c). School life expectancy (primary to tertiary education) in 2006 was 15 years (CIA, 2009) and the overall gross primary, secondary and tertiary enrolment in 2007 was 89%, whilst the LAC countries' rate was about 81% (World Bank, 2000c; URSEC, 2009).

The education expenditure in 2006 was 2.9% of GDP, corresponding to 11.6% of total public expenditure (meanwhile, LAC figures were, respectively, 4.4% and 14.6%). Table 7 shows the distribution by educational level. Regarding educational institutions, while Table 8 shows the percentages corresponding to public schools in relation to the total, from preschool to secondary level.

Table 7: Expenditure Distribution by Educational Level (2006)

Educational level	Participation (%) of expenditures
Preschool	9%
Primary	33%
Secondary	38%
Tertiary	20%

Source: UNESCO, 2007

Table 8: Percentage of Public Schools by Educational Level (2007)

Educational level	Public (%)
Preschool	69%
Primary	84%
Secondary	67%

Source: MEC, 2007

Considering a set of basic indicators associated with school infrastructure, and making a comparison with the average of LAC countries participating in the international SERCE study (LLECE, 2008), results show that Uruguay's education system is in a relatively good situation (Table 9).

41 This data will be verified and updated for the next version.

Table 9: Indicators Related to School Infrastructure

Indicator	Uruguay	LAC average
Schools with potable water	98%	79%
Schools with enough sanitary installations	82%	69%
Schools with library	75%	53%
Schools with computer lab	42%	37%

Source: LLECE, 2008 (p.186)

Main Policies and Initiatives

Despite the solid bases of the Uruguayan school system, it still has many difficulties to overcome. For instance, secondary enrolment is much lower in the upper cycle (40%) than in the basic cycle (70%); and educational outcomes are much more uneven than expected by society.

The more relevant challenges of the Uruguayan educational system in the short- and medium-term, are described by ANEP as:

- the consolidation of the democratic and participative institutional environment;
- the implementation of processes to facilitate the coordination between the new agencies and entities created by the new General Law of Education;
- the sustainability of universalizing the compulsory primary education;
- the improvement of quality, equity and pertinence of primary education;
- the universalization of secondary education;
- the reorganization of technical professional education;
- the design of a new institutional framework for teacher training at university level; and
- the enhancement of teachers' professional development (ANEP, 2009).

At primary education level, the main policies and initiatives during the last years aimed to:

- universalize the enrolment's coverage (including preschool education, for children 4 to 5 years of age);
- increase the amount of full-day schools (within the specific programme *Programa de Escuelas de Tiempo Completo*);
- develop innovative pedagogical strategies;
- design a new curriculum;
- implement the educational components of *Plan Ceibal*;
- universalize Physical Education (approved by law in 2007);
- implement the *Community Teachers* Programme (*Programa de Maestros Comunitarios*, started in 2005 to improve the links between schools and communities, within the framework of vulnerable social environments); and
- help schools in a critical socio-cultural context (Cardozo, 2008; Azar and al., 2008; ANEP, 2009).

The more significant policies at secondary education level were those related to:

- designing and implementing a new integrated national curriculum (Plan *Reformulación* 2006);
- developing special educational programmes to improve the access, permanence and graduation from secondary studies, by reducing school failure, repetition, and dropout rates;
- increasing the staff at school labs and libraries;
- investing in school infrastructure and equipment;
- implementing the *Community Classrooms* Programme (*Programa de Aulas Comunitarias*);
- extending the offer related to the upper secondary stage, according to the labor market demands;
- implementing the *Solidary Summer* programme (to make children participate in recreational and educational activities during the summer); and

- starting a project focused on universalizing the basic secondary level to improve the outcomes in the 74 high schools with the worst student performances over the last ten years.

Regarding teacher training, the main policies were associated with the development of a new national system to train teachers, with a new curriculum; and the strengthening of building infrastructure as well as the amount and quality of equipment.

Aligned with this, the ANEP has been working on several projects with external funding:

- Primary Education Quality Improvement Programme (*Mejoramiento de la Calidad de la Educación Primaria*, MECAEP): this World Bank financed project ($29.9 million for "Third Basic Education Improvement Project" additional funds, since 2009) aims to improve the quality, equity, and efficiency of the public primary education system by: (i) expanding the full-time school (FTS) model and introducing an alternative model for improving the quality of schools in low-income vulnerable sectors; (ii) improving teacher training and introducing teaching aids; and (iii) strengthening educational assessment and monitoring capabilities.
- Quality Improvement of Secondary Education and Teacher Training Programme (*Mejoramiento de la Calidad de la Educación Media y Formación Docente*, MEMFOD): Although attendance in Uruguay's primary education system compares favourably with that of developed countries, their indicators fall off sharply at secondary level. In order to correct this deficit, the IADB approved in 2001 a $75 million loan (operation N° 1361/OC-UR) to assist the consolidation of the universal coverage for the first stage of secondary education, and at the same time transform the second cycle (via institutional and curricular reforms, such as new programmes and the increase of lecturing hours), focussing these efforts to the needs of the twenty-first century's citizens (IDB, 2001) by offering more options related to labour market. The programme also aimed to strengthen the teacher training system, to improve curricula and pedagogical quality, as well as education management, by modernizing the administrative processes. Its associated resources were assigned to investments in infrastructure, equipment, educational materials (multi-resource learning centres, including multimedia facilities, reference books and magazines) and the expansion of the basic secondary education coverage to the whole country (including rural areas).

Regarding the national evaluation system, the ANEP assigned the responsibility for the assessment of pupils within the education system to its Learning Assessment Department: A formative and holistic approach that prioritizes the use of outcomes to improve constantly the teachers' pedagogical work was selected. So far, the main lines addressed were: (i) assessment of pupils' learning when ending each schooling level; (ii) support to the Language Test required to enter to Teacher Training careers; and (iii) spreading of assessment outcomes achieved in international test (namely, PISA[42] and SERCE[43]). Moreover, since 1995, Uruguay has been systematically applying standardized learning outcome tests to the different educational levels.

Among the new policies recently formulated that impact on the education system, one demands the highest attention: the *Plan Ceibal*, which was included in the *Plan de Inclusión y Acceso a la Sociedad de la Información y el Conocimiento* (Plan of Inclusion and Access to the Information and Knowledge Society), a core component of the national *Digital Agenda* (Gabinete Ministerial de la Innovación, 2007). Given the relevance of this plan in relation to the national ICT in Education Policy, its features, components and implications will be presented in the following sections.

42 Programme for International Student Assessment (OECD, 2006)
43 Second Regional Comparative and Explicative Study (LLECE, 2008)

Policy Features

Overview of ICT in Education Policies in Uruguay

Currently, Uruguay is implementing an ambitious policy for the widespread provision of ICT in society and the educational system, the P*lan Ceibal*. At the end of 2006, Uruguay's president launched P*lan Ceibal* with the aim of providing each student and teacher of primary education with a portable computer (Vázquez, 2006). The implementation of the plan started in 2007 as a pilot in one school and it was expanded to the rest of the country in 2008, ending in 2009 when the capital, Montevideo, was covered. Quantitatively, reaching this goal means that all students and teachers in public schools already have their own portable computer (362,000 students and 18,000 teachers); that they can access free wireless Internet installed in more than 2,000 schools and hundreds of public spaces in cities and towns; that all primary teachers were trained and that they have access to an educational portal with resources and communities to support and enrich teaching and learning. After accomplishing these goals, the Government is now aiming at providing portable computers to secondary education students and teachers (*Ceibal*, 2009a).

In this way, Uruguay has become the first country in the world to adopt the proposal of the OLPC Foundation, headed by Nicholas Negroponte[44]: this organization developed a low cost computer especially designed for children called the XO and uses a Linux-based operating system and software designed for kids. The XO was meant to enable the nationwide provision of ICT in developing countries.

Beyond the technological novelty, the OLPC proposal considers that laptops should be owned by students in the first levels of primary education so that each child can use his/her personal laptop at school as well as at home, that Internet should also be provided through ubiquitous connectivity, and that this should be done at a massive scale aimed at reaching "digital saturation" in a given community, without excluding any child.

The educational proposals of OLPC are based on the constructivist theories of learning pioneered by Seymour Papert, who argued that computers provide the children a highly flexible learning platform that enables them to create, explore collaborate and express themselves and therefore to learn (OLPC, 2009). Of all the countries that expressed initial interest in participating in this initiative (including India, Brazil, and Argentina who later on desisted), Uruguay is the only one that has accomplished the goal of providing a laptop to all children in public primary schools.

Ceibal is inspired by the OLPC and adopted the XO laptop, but its design and implementation was adapted to the Uruguayan context, resulting in a slightly different project compared to the original proposal. The main differences are outlined below.

Firstly, *Ceibal* is aimed to promote the massive use of ICT in society and schools. The vision of *Ceibal* is that through the provision of laptops to children, these computers become part of the daily life of the family, thereby widening the social impact of the initiative (*Ceibal*, 2009a). Therefore, in addition to the provision of laptops, *Ceibal* is also expanding wireless Internet access in public spaces, training and supporting parents to operate the computers and use them as sources for information.

Secondly, as opposed to the philosophy of the OLPC, *Ceibal* has an educational vision that insists on the central role of the teacher in the learning process, considering ICT as a means for constructing children's meaningful learning opportunities. Therefore a significant part of *Ceibal*'s efforts are dedicated to training and supporting teachers, and helping them to integrate ICT in their teaching.

44 See www.laptop.org

Finally, *Ceibal* is a complex initiative, that considers the different dimensions needed to implement such a policy, including: complementing the original educational software built in the machine with the provision of digital educational content through an Internet portal; the implementation of a variety of teacher training strategies aimed at strengthening the curricular integration of ICT, structuring a technical support system that provides the logistics, software development and technical support services at national scale; articulating a support network of volunteers, social organizations and public and private universities; monitoring and evaluating the implementation of the project and developing a public TV channel to support the initiative.

Ceibal was driven by the highest political authority: the presidency of the republic, and it was coordinated by a Political Commission that included the institutions managing the public educational system, agencies in charge of the digital development, research and innovation institutions, the states' telecommunication company and the institution in charge of its implementation (LATU, *Laboratorio Tecnológico del Uruguay* or Uruguay's Technological Laboratory). As mentioned previously, in 2010, a new institution was established to be in charge of *Ceibal*.

The *Plan* required strong political and executive support since it was one of the main goals of the socialist government of President Tabaré Vázquez and it needed to be completed in his presidential period, before the end of 2009.

It should be noted that this policy generated wide social and political support, which probably arose from the fact that the idea shaped a national wish to leapfrog into the future. Such calls respond deeply to Uruguayan national values, such as building a society with opportunities for all and recovering the role of the public educational system as a state's privileged instrument to provide equal opportunities to all citizens (Vázquez, 2006). In Uruguay, the promise of "technology for all" seems to be a national challenge that blends identity and shared aspirations and that has a great chance of being successful because of the institutional, technical and political capacities that the nation was able to align towards its realization.

Thanks to this policy, Uruguay is reducing the digital gap at an unprecedented speed; and it is reaching the widespread availability of ICT in the educational system overcoming the limitations of the previously implemented initiatives. In fact, since the mid 90s, Uruguay developed different strategies aimed at incorporating ICT in the educational system, but none of them accomplished the reach of *Ceibal*. Some examples of these initiatives are:

- INFED 2000: Implemented during the mid 1990s, aimed at the installation of computer labs in primary and secondary schools, training ICT teachers to coordinate the use of the labs with other teachers so that students can use curriculum content and acquire basic ICT skills.
- PLAN 96: Started in 1996, it was part of the secondary education reform and included the provision of computer labs in which specially trained teachers taught ICT skills courses to students of the 1st and 2nd grades of the basic secondary level.
- ICT *Bachelor*: In 1997 they started to implement a mathematics and informatics processing bachelor's degree that included the use of computer labs and simulation software.
- *Educational connectivity program*: This programme started in 2001 aimed at promoting Internet connection and expanding the educational use of ICT in primary, secondary and technical vocational schools (Jara, 2001).

Additionally, the ANEP has continually invested in this area, especially in multimedia labs and libraries, connectivity and maintenances, educational resources and educational portal, teacher training, etc. (ANEP, 2009). As a result of these efforts, in 2006, 57% of the primary schools in Uruguay had at least one computer used in teaching and learning, although only 20% had a computer lab and 6% had more than ten computers (ANEP, 2007). In secondary education, as PISA 2006 results showed, 40% of the students reported to use computers frequently in their schools, with an average of 64 students per computer (ANEP, 2008b). Regarding teachers, a relevant percentage of them (circa 70%) declared to have acceptable or good ICT skills (ANEP, 2008a).

Summarizing, although Uruguay started to implement ICT in education policies since the early 90s, it is only recently when it was able to articulate a policy with a scope and continuity that allows to reach all students and, through them, to all the schools and homes in the country. In only one move Uruguay not only updated its ICT in

education policy, but placed itself as one of the international leading countries in this area, materializing the one-to-one computing scenario, which probably the rest of the countries will approach much more gradually. Therefore, this report focuses mainly on describing the current ICT in education policy, namely the *Plan Ceibal*.

Policy Objectives

The main objectives of *Ceibal* are to (UNESCO, 2008):

- Provide all children and teachers of public primary schools universal and free access to portable computers in order to reduce the digital gap in the country;
- Promote social justice by establishing the conditions for equal access to information and communication possibilities for all the people in the country;
- Facilitate the construction of new learning environments and the generation of an adequate context for Uruguay's children to be able to answer to the demands of the information and knowledge-based society; and
- Stimulate active participation by making new tools available to students and teachers in order to widen their learning, increase their knowledge and develop their awareness of lifelong learning.

During the launch of *Ceibal* in December 2006, the President Tabaré Vázquez defined these aims by saying, "… provide a computer for each child and teacher, with the long-term purpose of promoting social justice ensuring equal access to information and communication tools of all the people" (translated by the authors from Vázquez, 2006). In concordance with this general statement, Vázquez declared that, "the strategic principles embedded in this project are equity, equal opportunities for all the children and youngsters, democratization of knowledge, as well as the availability of resources to learn, and learning not only what is taught in schools, but also to learn by him/her self to use modern technology" (translated by the authors from Vázquez, 2006).

From an educational point of view, there is a specific perspective regarding the purpose of *Ceibal*. According to the Educational Commission of *Ceibal* (2007), technologies arrive at schools with the overarching aim of supporting the quality and equity of education. Particularly, the Commission states that this will be accomplished since ICT can:

- Promote significant learning in children through the integration of ICT and provide educational possibilities through individual and group-based work in the classroom;
- Promote a culture and abilities to work and learn collaboratively and facilitate the creation of knowledge-sharing networks; and
- Acquire digital competencies, especially those related to searching, selecting, validating and using information, with the purpose of making sense and assigning value to the information.

Additionally, the Commission establishes that, although there is a clear need to integrate ICT in education, teachers continue to be central in the teaching and learning process; moreover, teachers themselves are entitled to decide when, how and why to use ICT, since they are the ones that have the adequate pedagogical knowledge and understanding of the concrete circumstances that they face in order to make these decisions.

It should be noted that although *Ceibal* was initially targeted for primary students only, since the end of 2008, this original aim was expanded in order to include secondary students also (*Ceibal*, 2009a).

Content

Regarding teachers' professional development, Uruguay's ICT in Education policy promotes curricular integration of ICT. In order to achieve this goal (and even though in his original project, Negroponte said that it is not necessary to train teachers to use laptops) teacher training is key in ensuring better appropriation of these technologies. However, for many educational actors at a national level, the new policies appeared rather suddenly, forcing them

to think about their implications simultaneously with its implementation. This is not the traditional way to train teachers: actually, technology is today both an instrument to facilitate teachers' learning about different subjects and knowledge areas, as well as a content itself, that in this case they needed to use immediately in their pedagogical practices, since they already were in their classrooms. Policies are fostering the inclusion of new content in the teacher training agenda, on the basis of the particular demands emerging from *Ceibal*.

The pedagogical and curricular aspects of *Ceibal* seem to foster an ICT integration process that promotes pupils' learning in a collaborative way and encourages students' expression and creativity, trying to take advantage of the potential offered by computers, and changing the traditional model of education, which includes passive learning focused on the transmission of knowledge, although the teacher would not be the main source of information (Kaplún, 2009). The main aspects of the integration of ICT in the curriculum are the following:

- In primary education, the integration of ICT as content into the formal curriculum is currently not compulsory. However, different activities are frequently performed for learning how to use the XO laptops and/or activities such as webquests, multi-disciplinary and/or collaborative projects, etc.;
- Regarding secondary education, Former P*lan* 96 was an initiative started in 1996 as part of the reform process, that included computer labs where teachers, previously trained in the use of ICT, delivered lessons of technology to first stage secondary students, in order to teach them basic ICT skills.
- According to the last curricular changes (2006), the current amount of time assigned to ICT courses in secondary education is about four hours a week (or two in the case of technical education) during the first two years (in basic secondary cycle). Thus, technology is not only a subject but also a transversal resource that could be used in other disciplines. This approach tries to improve learning outcomes about ICT at a younger age, in order to reduce the high levels of school failure, repetition, and dropout rates showed during the last years.
- With reference to teacher training, there is a new subject-based curriculum that includes specific workshops about ICT for future teachers (UNESCO-IBE, 2006). In 2009, in the initial teacher training centres (CERP), student teachers started to use and learn about the same laptops (XO model) that their future pupils already had.

Regarding digital contents, aiming at selecting innovative ideas for digital content to be used by *Ceibal*, since 2009, LATU and ANEP have been calling for ideas and proposals through open contests, mostly oriented to ANEP's teachers, from primary, secondary and technical education, as well as to enterprises and institutions, in some calls. Another recent initiative calls for the presentation of curricular proposals to use the XO as an educational resource, that will be published in the *Ceibal* educational portal. This call is oriented to primary teachers, promoting the development of pedagogical activities using XO and involving content related to the following disciplines: Language, Mathematics, Arts, Social Sciences, Natural Sciences and Physical Education.

In relation to assessment, although ICT is not used to assess pupils' learning outcomes, in September 2009, a first experiment was performed in order to assess second grade pupils' learning in Math, Language and Natural Sciences (in all primary schools of the country): the test was performed online using the laptops, and children received immediate feedback on their performance.

Finally, regarding institutionalization, *Ceibal's* main challenge is to develop a sustainable structure involving the institutions that are currently implementing the project. In this regard, in 2010 the government created the Centre for Technological and Social Inclusion (Centro para la Inclusión Tecnológica y Social - CITS), which was renamed to Ceibal Centre to Support of the Education of Children and Youngsters Education (Centro Ceibal para el Apoyo a la Educación de la Niñez y la Adolescencia) in early 2011. This Centre, in addition to managing Ceibal, is responsible for the coordination and development of plans and programmes to support policies for children and youngsters, as well as to contribute to exercise the right to education and social inclusion facilitating the access to knowledge, and the development of educational programmes for the target population.

Implementation Framework

What plans/strategies and operational arrangements are put in place to implement the policy (Ceibal)?

Ceibal is incorporated in a broader ICT equity programme, the "*Access to Digital Information Equity Program*" [Programa de Equidad para el Acceso a la Información Digital-PEAID]. Its main expected outcomes are:

- One laptop for every child and teacher of all public schools;
- Wireless connectivity in public schools;
- ICT training for teachers and ICT support for families; and
- The generation of digital educational resources

Ceibal's design considers giving a laptop to every child and every teacher, as well as offering the whole teaching community the necessary ongoing education, materials, guidelines, and support to achieve the proposed objectives. But, of paramount importance is that this framework explicitly includes the insightful aim of going far beyond: the main goal is not just to provide schools with equipment and accessibility to it, but to guarantee its innovative use, integrated to the everyday events of the classroom.

The implementation strategy of *Ceibal* is characterized by:

- Strong leadership at political (Presidency of the Republic) and technical (LATU) levels;
- A decision-making system based on consensus and participation, through the Political Commission; and
- Operational conduction that prioritized the technological component (connectivity, computers, services).

The remaining challenge is to deepen teachers' training and awareness of the potential benefits of ICT as well as to support families in taking advantage of ICT, in order to achieve increasing support in the execution of the plan, by schools and communities. In 2009, the IDB assisted *Ceibal* via technical assistance about the formulation of strategies related to teacher training and impact evaluation (IDB, 2009).

Plans/strategies related to hardware and networking infrastructure

Political will is crucial for a successfully integration of ICT as well as to ensure the country's ability to progress towards its national development goals. So far, the Educational Connectivity Programme began as an initiative coming directly from the President of the Republic in a joint effort with ANEP and ANTEL (Administración Nacional de Telecomunicaciones - Uruguay's government-owned telecommunications company)[45], and was designed for providing Internet access to all public primary, secondary, technical and tertiary schools and also for training teachers in the use of ICT and digital resources that could be incorporated into their subject curriculum. This programme has garnered international attention regarding the replicability, effectiveness and optimal use of available resources in addressing the difficulties affecting national educational systems (Gutterman et al., 2009).

Plan Ceibal has been considered a policy with deep potential to impact on Uruguayan society. With reference to its execution, a strategic plan was required, including as key points (Cardozo, 2008):

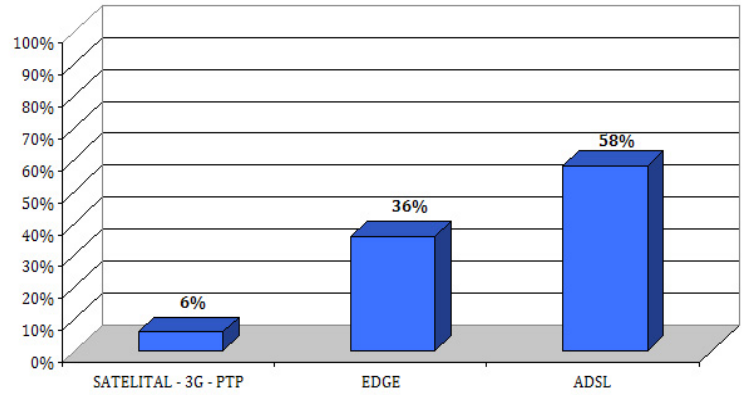
- Geo-referencing of each selected zone;
- Design the outer and inner networks in each school;
- Technical structure required to achieve the goal of providing access under a 300 m. distance; and
- Installation of servers and content filters in each school

45 ANTEL main purpose is to provide all telecommunication services. The company has the monopoly of the fixed telephone services and data transmission, including Internet. It also offers cellular communication services, but in this area the market is shared (ANTEL, 2009).

During the initial implementation, the LATU had a technical area that provided connectivity; network design and support; systems development; and security mechanisms at school and laptop levels; as well as a follow-up service (using a remote server). It also had a logistics area in charge of organizing the provision of laptops to each child and teacher in public schools, and keeping these computers running properly over time. This area also supervised the warehouse process for the upgrading and allocating the machines, and planned the distribution and transportation of the laptops to deliver them to their users (Gómez Monroy, 2008).

In this sense, connectivity is fundamental in 1:1 models like this. The selected model of laptop (XO) could connect to the Internet via wireless access-points. The LATU installed a server per school and provided the required infrastructure to give connectivity for up to 40 computers, at the same time. The availability of free Wi-Fi connection in more than a hundred public squares across the country enhanced the connectivity range. Conversely, the mix of different technologies (namely, GPS, ADSL, satellite, etc.) made connectivity in small rural schools with barely 6–8 pupils, a real challenge. Figure 6 shows the percentages of primary schools, according to the connection type. In order to ensure the sustainability of the plan, an agreement between ANTEL and LATU was established, securing Internet access in the long term.

Figure 6: Percentages of Primary Schools with Different Connection Types



Source: LATU, 2009

Regarding the quality of the connectivity service, all schools in *Plan Ceibal* have a broadband connection, with an average of about 1.92 Mb/s. The schools of secondary and technical education have, so far, facilities to access to the Internet free of charge and with no data flow limits.

Until 2009, ANTEL connected to *Plan Ceibal* approximately 2,068 and 293 primary and secondary educational institutions respectively, this is, 95% of public schools (Ceibal, 2010). In turn, until 2009 LATU delivered almost 370,000 laptops – pupils and teachers – loaded with educational software, and deployed more than 3,000 hotspots, or Wi-Fi zones (LATU, 2009). Nowadays, computers per student ratios show the degree of *Ceibal*'s success: 0.99 in primary schools; 42.95 in secondary and 24 in technical high-schools.

Policy-makers in Latin America have frequently focused on a techno-centric approach to improve access to ICT without much reflection about the uses of the technology; they also sustained an approach focused on covering basic needs before providing access to ICT. In spite of this perspective, Uruguay has taken a different route seeking to achieve social inclusion through ICT policy, becoming the first country to commit to a large-scale nationwide deployment of the OLPC initiative.

Plans/strategies related to ICT support, technological support, pedagogical support

Ceibal includes the provision of free technical support, for monitoring and repairing servers and connections, as well as the deployment, attention to users and – eventually – laptop maintenance. The agency in charge of this service is LATU.

In case of a technical problem, users can call a dedicated free phone line (via a personalized helpdesk with operators that assist with questions and concerns from teachers, pupils and parents). In Montevideo and other major cities, if a problem cannot be solved remotely, a technician visits the school to solve it. In addition, currently *Ceibal* is decentralizing this service as part of the "*Rayuela*" project.

There is another interesting programme, called "*Ceibal Móvil*," consisting of a Minibus with equipment, hardware/software technicians and even ICT/technology teachers that travel across the county visiting schools, providing support and helping teachers. This works on the basis of planned visits previously arranged (generally by concentrating the demands according to geographical criteria). Finally, there is also available an online Frequently Asked Question service.

Overall, users seem to have a positive perception about the quality and response time of the support service (LATU, 2009). The rate of laptops with technical problems is about 0.25 and this figure increases up to 0.45 when only the laptops for primary education are considered. The next challenge is to complete a national network of technical support providers.

As part of its second stage, is expected to create a National Pedagogical Coordination of *Ceibal* (within the Primary Education Council) in charge of providing pedagogical support for users. On the other hand, CODICEN created the *Plan Ceibal Implementation Commission* (integrated by representatives of all state educational bodies) with the main role of coordinating and conducting its pedagogical dimensions.

It seems that an issue as important as the pedagogical support appeared later than (or at least, was slightly delayed from) the plan's classroom implementation, probably providing a reasonable argument for those who criticized the lack of this key support (running the risk that ICT resources could become only a toy, instead of a tool for education and social inclusion).

Plans/strategies related to digital content

The strategy to provide digital content is based mainly on the development of educational portals. In effect, there are four main educational web portals in Uruguay:

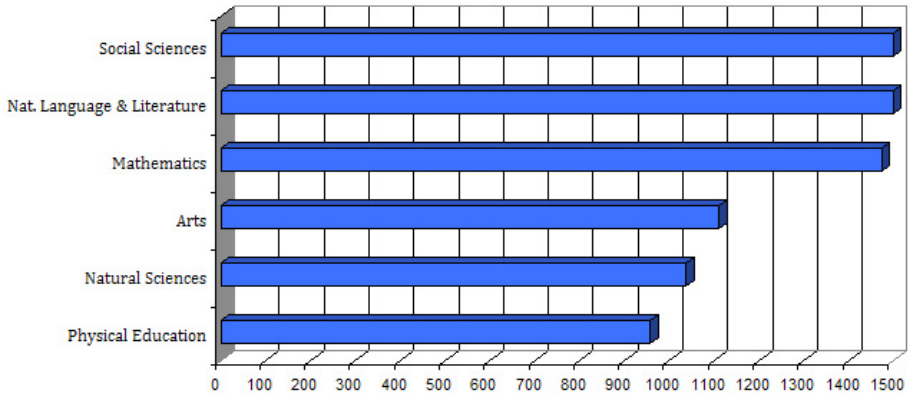
- ANEP:[46] Contains several websites, with informative purposed, targeting teachers, students, principals, parents, etc. These portals correspond to: CODICEN, CEIP, CES, CETP, and DFPD. Among these portals, only the CEIP has digital resources that were developed since 1998 until the portal Uruguay Educa was launched. They are available in the website "*Red de Enlace Didáctico con apoyo en Internet*"[47] aimed at sharing experiences and knowledge among teachers, pupils, schools and communities.
- EduMEC:[48] An educational portal administered by the Ministry of Education, with two main services:
  - An ICT resources repository[49] with more than 25 downloadable educational resources, to be used by teachers (including pedagogical guides); and
  - The "*Aula Virtual*"[50] (virtual classroom), available on a Moodle environment, with different ICT-related courses for teachers, such as "Internet and reading," among others.
- Uruguay Educa:[51] An online educational portal launched by ANEP, focused on promoting equal access to the opportunities given by ICT among teachers, students and their families. It offers numerous resources for teachers to use in their lessons, provides students with tests, exercises, presentations, software and other resources to be used together with their homework assignments. Basically, it helps to integrate ICT into the curriculum and improve the national education system, while generating opportunities for all people to have

46 www.anep.edu.uy
47 cep.edu.uy/index.php?option=com_weblinks&view=category&id=144&Itemid=372
48 www.edu.mec.gub.uy
49 www.edu.mec.gub.uy/br.html
50 aulavirtual.mec.gub.uy/login/index.php
51 www.uruguayeduca.edu.uy

access, and to broaden their knowledge. This website is part of a larger network of regional education portals, the Latin American Education Portals Network-RELPE (Gutterman and al, 2009).

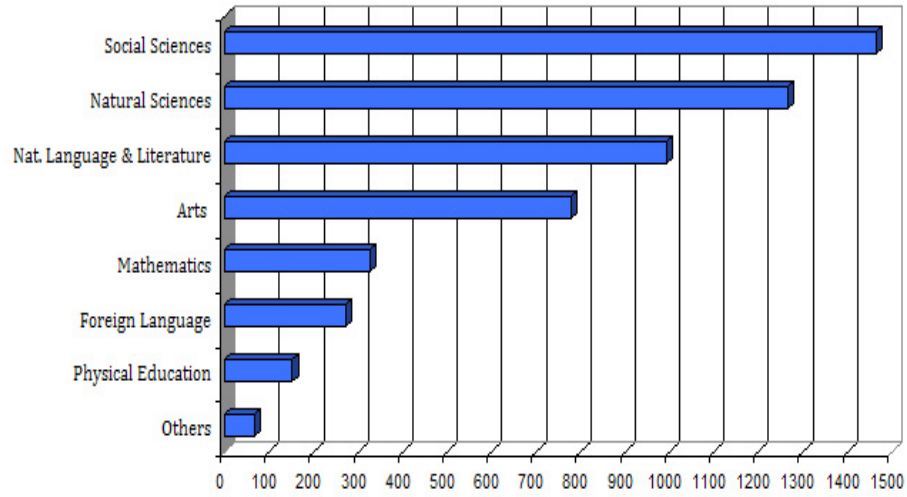
In addition, it is worth noting that this portal offers the largest number of ICT resources. Figures 7 and 8 show the amount of digital educational resources available for primary and secondary education, respectively.

Figure 7: Available Resources for Primary Education (*Uruguay Educa*)



Source: Portal Uruguay Educa, 2009

Figure 8: Available Resources for Secondary Education (Uruguay Educa)



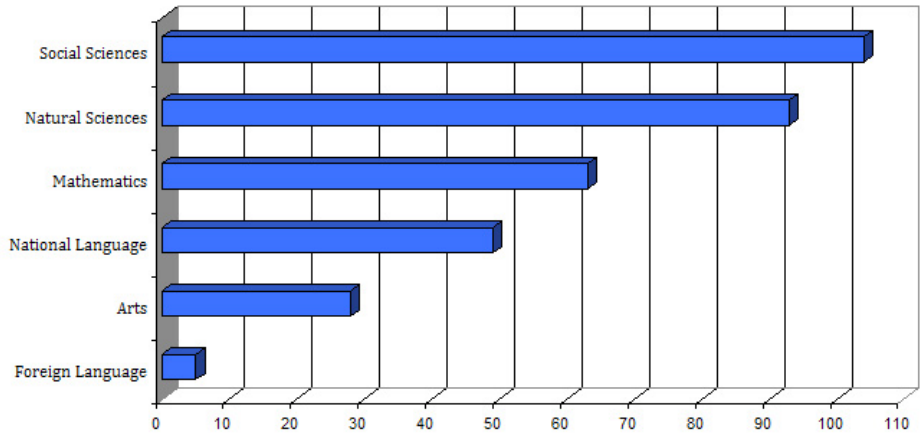
Source: Portal Uruguay Educa, 2009

- *Ceibal*:[52] Aimed at promoting the exchange of educational experiences, contents and good practices, as well as to foster the development of virtual communities of practices (de Cindio et al., 2003). This website encourages teachers to become not just consumers but active producers of digital learning resources to use in the classroom (i.e. through calls for presenting projects and proposals), to share them in the portal with the other members of the educational community.

52 www.ceibal.edu.uy

To illustrate the resources currently available, Figure 9 shows them grouped by curricular area.

Figure 9: Total Resources Available in Portal Ceibal



Source: Ceibal, 2009b

Within this portal, there is also a Moodle platform that offers e-learning courses and workshops. Until mid 2010, the portal had almost 5,000 registered users, and is also the only portal with access statistics.

Finally, it could be said that digital resources are mainly available in *Ceibal* and Uruguay Educa Web portals (more than 16,000 in total); however, not all of them are explicitly linked to national curriculum contents.

On the other hand, the "*Rayuela*" project (launched in November, 2008) is a three-year term programme implemented by the LATU (and financed by the IDB) that, among other goals, aims to transform Uruguay in an international referent regarding the design and development of digital learning contents in Spanish.

Plans/strategies related to ICT teacher training, technological training, pedagogical training

Teacher training was developed in two stages:

- *First stage – Cascade strategy*: started in 2008, focused on principals, inspectors and technology teachers, as intermediate actors, and it involved two steps; the first one tried to prepare teachers for the *Plan Ceibal* implementation, XO features and the preliminary strategies to integrate this technology into learning processes; and the second had as main goal to achieve a deeper knowledge about how to apply ICT to teaching; and
- *Second Stage – Face-to-face and e-learning strategy*: since 2009, it incorporated technology teachers ("Maestros Dinamizadores" and "Maestros Apoyo *Ceibal*") to mentor and train colleagues about the curricular ICT-integration, via collaborative activities, and by sharing the results of pedagogical experiences.

Until mid 2010, there were four main action lines in the complementary training component of *Ceibal*:

- Face-to-face courses;
- Educational Television: short programmes developed by LATU experts, emitted both on the official TV channel and others, and also available for downloading from the CEIP web portal;
- E-learning training: online courses and workshops about XO software, supported on a Moodle platform available in the *Ceibal* portal, and with the assistance of almost 40 tutors from CEIP. Some of these workshops are about: 1:1 models; collaborative work, ICT teacher skills; pedagogical use of XO-etoys; and digital learning resources, among others; and
- Digital resources on CD: to use in schools, as support to prepare lessons that include ICT use: tutorials, digital objects, etc.

Among others, the areas covered by the professional development opportunities include:

- General pedagogical use of the portable computers;
- Use of digital educational resources for teaching and learning;
- Use of virtual learning environments in education; and
- Management of the ICT infrastructure in schools.

In general, these courses were freely offered to teachers as a professional development option, through the official web portal. However, there was a low level of participation by secondary teachers in these professional development opportunities (less than 10%); but in primary level it was the opposite, mostly because primary teachers were almost compelled to participate in the training about the use of XO when these laptops were supplied to pupils, so the participation rate was about 87%. Nevertheless, from 62% to 75% of teachers and principals reported that they have enough competence for ICT use (ANEP, 2008a).

Still, many critical voices point out that there is a lack of teacher training in issues related to the pedagogical use of ICT, in general, and this kind of technology in particular.

Initiatives related to external support

A key component of *Ceibal* is the external support received from entities or strategies involving the participation of students, professionals and different community actors in order to help via support movements, projects, volunteers' work, etc. Even though these support activities exists from the beginning of *Ceibal*, LATU created in 2009 a *Support and Monitoring Programme* to coordinate and articulate the different supporting initiatives.

The main supporting initiatives are the following:

- RAP *Ceibal*:[53] network that emerged spontaneously and is integrated by approximately 1,000 volunteers, mainly professionals and technicians, grouped by city, that support the plan by training schools' staff, solving technical problems related to the laptops and disseminating the initiative. Outside schools are very important, as a support to families, teachers and communities, in order to help them to join the *Plan Ceibal* actively. These units deal with local problems that they try to solve with their own resources and if it is not possible, they ask for support using the virtual network of volunteers. They have a blog that is used by the majority of *Ceibal* participants and in which they have a calendar of activities, experiences and consultation materials (Bianchi, 2009).
- *Ceibal Jam*: started in 2009, by groups of engineering students and teachers interested in developing high value open source educational software for *Ceibal*[54]. Actually there are 21 teams working in different locations, involving 42 teachers and more than 500 students (Bianchi, 2009).
- *Flor de Ceibo*: group that gathers students and teachers from the University of the Republic, aiming to strengthen *Ceibal* via a research-based approach (studies and intervention activities).
- RUTELCO: is the Uruguayan Network of Community Telecentres (includes centres installed by the Ministry of Education, ANTEL company and the third sector organizations). MEC centres are places to develop activities of educational, cultural and social participation nature, as well as to get free access to ICT resources.

53 See http://rapceibal.blogspot.com.
54 See http://drupal.ceibaljam.org.

What are the national conditions that constrain the successful implementation and scaling of the programmes?

Among the more significant factors that could represent future barriers for this plan's success are the following:

- Teachers' lack of ICT appropriation and the heterogeneous levels of ICT-related skills and competencies, which created an issue for training.
- Slow connectivity with some problems in some rural regions, and rapidly saturated bandwidth in the cities.
- The complex organizational structure associated to the delivery and operation of *Ceibal* requires high levels of fast and good quality communications procedures, oriented to satisfy the needs for articulation and coordination among the different groups, agencies and institutions. This is a critical issue that could negatively affect the next stages of the programme.
- There are still voices criticising the apparent lack of pedagogical grounds of the *Plan*, and asking for new and better ICT use models that link its contents and the national curriculum.
- Some criticize the insufficient training for teachers on the pedagogical use of ICT (in general) and regarding the didactic implications emerging from the 1:1 model.
- *Ceibal* was created as a policy for social inclusion, but it was not previously included in the government programme or in the former political agenda.
- Many of the strategies of *Ceibal* were designed during its implementation. This situation generates doubts about the possible risk that *Ceibal* could only bridge the digital divide (in terms of access and connectivity), but no other gaps, such as those represented by social, cultural or economic inequalities (Rivoir, 2008).

In summary, although *Ceibal* was able to achieve its initial goals, they are currently facing new challenges related to its expansion to secondary education and the sustainability of the initiative.

Financing

Ceibal is financed by Uruguay's government with an initial spending of around $140 million dollars (annual average expenditure about 0.15% of GDP), including the spending in hardware, schools' connectivity, facilities' maintenance, development of digital contents, among others. This investment represents an average current and capital expenditures of US $40 and US $425 per student respectively. Table 10 summarized the current and capital expenditures by educational level, since 2007.

Table 10: Ceibal Current and Capital Expenditures 2007-2009

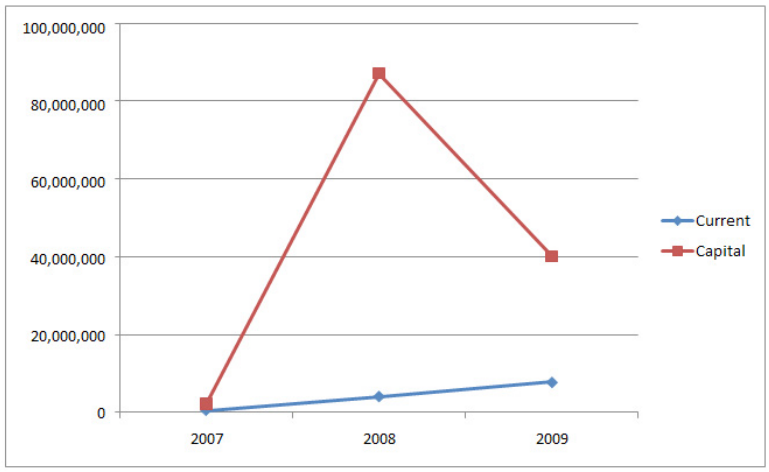
Educational level (or funding type)	2007		2008		2009		Total	
	Current Exp.	Capital Exp.	Current Exp.	Capital Exp.	Current Exp.	Capital Exp.	Current Exp.	Capital Exp.
Primary	$491,318	$2,233,938	$4,072,454	$87,170,732	$7,569,328	$38,246,974	$12,133,100	$127,651,644
Secondary	-	-	-	-	$204,407	$1,057,328	$204,407	$1,057,328
Private	-	-	-	-	-	$906,640	-	$906,640
Total	$491,318	$2,233,938	$4,072,454	$87,170,732	$7,773,735	$40,210,942	$12,337,507	$129,615,612

[a] Figures in US dollars (exchange rate: 1 US dollar = 19.5 Uruguayan pesos)

Source: E. Severín - IDB (personal communication, December 2009)

Looking closer at the government's efforts to provide universal access to ICT in primary education, Figure 10 shows the evolution of the expenditures for this level.

Figure 10: Evolution of ICT Expenditures for Primary Education (2007–2009)



Source: E. Severín (personal communication, December 2009)

Based on these figures, *Ceibal's* 2009 data shows that for primary education an average of US $300 has been invested, and the estimated recurrent cost is US $150 per student.[55]

Among the main positive factors that contributed to the financial viability of this project were the lack of geographical barriers that facilitated the installation of the required infrastructure to provide connectivity (basically consisting of a wireless network with a national scope); the demographic characteristics of the country (a population mostly composed of adults, with few children); the strong presence and institutionalism of the public education system; and the relatively high population's educational level – in general (Rivoir, 2008).

It is noteworthy that *Ceibal's* connectivity was provided by ANTEL, in partnership with the ANEP and the Presidency of the Republic, as part of the "*Educational Connectivity Program*" which preceded *Ceibal* (since 2001) having the aim of bringing the Internet to all schools and teacher training centres in the country (CITEL, 2008).

In order to support the educational consolidation of *Ceibal*, the Inter-American Development Bank has been supporting several initiatives focused on improving the pedagogical practices in the schools, to impact pupils' learning, as well as to strengthen the national capabilities to perform procedures oriented to supervise and evaluate the plan. In this vein, the "*Support Programme for the Consolidation and Expansion of* Plan CEIBAL" (*project* UR-L1058) is a US $6 million investment loan approved in December, 2009 for a 25-year term (the Government of Uruguay will provide an additional $2.5 million in local counterpart funds); its executing agency is the LATU.

This programme aims to improve educational and learning outcomes through the following action lines (IDB, 2009):

- Supporting technical and financial aspects of *Ceibal*, in order to boost institutional capacity to evaluate progress, and make adjustments resulting from this evaluation. This purpose intends to consolidate the first stage of the plan, focused on primary education and the expected results include the development of 600 items of digital content, projects carried out through collaboration between students and teachers; the development of 100 websites in as many schools; and the training of 1,200 teachers, 250 administrators, and 400 inspectors;
- Supporting the expansion of *Ceibal* to the basic stage of secondary education;
- Studying innovative experiences, by taking advantage of the installed technological infrastructure;
- Establishing and supporting the development of the institutional framework and ensuring the required capacities, tools and methodologies for managing, monitoring and evaluating *Ceibal* in order to ensure its sustainability; and

55 Figures from the presentation of Ceibal at the International Conference on 1-to-1 Computing in Education: Current Practices, International Comparative Research Evidence and Policy Implications, February 22–24 Vienna. OECD, IADB and the World Bank.

- Creating a grant fund for new social and economic initiatives based on *Ceibal*; promoting social initiatives that help increase its public impact; and a study evaluating such impact.

In summary, the implementation of *Ceibal* is being financed using local funds and resources available through international loans and/or governments' investments.

The Policy Rationale

What is the driving force leading to the formulation of such a policy?

As seems to be usual in these policies, the ICT in education policy in Uruguay responds to a combination of political and educational interests and to a lesser degree, technology related ones. First, *Ceibal* has a political component since it is part of the economic and social development vision of the country. It is anticipated that the widespread access to ICT in society will bring equity with regards to access to knowledge, which is one of the pillars in which countries are grounding their competitiveness and economic development that leads to equitable social development (Vázquez, 2006).

Secondly, *Ceibal* is conceived as an instrument to recover the historic role of public schools' ensuring equal opportunities for the Uruguayan citizens, which in one way or another is felt to be lost (Vázquez, 2006). In this sense, ICT are conceived as educational instruments that will enable all schools to achieve equivalent levels of quality. It does not seem to be part of the educational vision to radically transform teaching and learning processes, which is often included in these policies. Neither seems to be included in the more radical proposal of OLPC that claims that children will learn to learn thanks to their individual and collaborative interaction with or through ICT. Hence, Uruguayan educational vision keeps teachers at the centre of educational processes and proposes a shift of his/her role thanks to the possibility of having a new resource that allows children to engage in individualized and active work and that enables a direct relation with knowledge (ANEP-CEP, 2007).

In the initial descriptions of *Ceibal* there are no references to the development of an educational content industry, nor addressing the possibilities that due to this policy Uruguay becomes a technology development pole. However, perhaps due to Uruguay's leadership as the first country to fully implement the OLPC strategy, they are studying different approaches to capitalize this know-how in order to become leaders in digital educational content production and services delivery for the one-to-one model. In order to do this, *Ceibal* is developing a specific strategy called the "*Rayuela*" project, which is aimed at promoting the development of an industry of digital educational resources contents seeking to export these contents to other Latin American countries and develop a technical support industry able to provide the services required by Uruguayan schools and, eventually, assist other countries. Additionally, LATU seeks to become a leading consultancy firm to assist other countries implementing ICT in education policies inspired by the OLPC (Zignano, 2009).

Who are the stakeholders and what are the forces at stake (socio-political economy of the policy)?

The Presidency of the Republic, the highest political authority in Uruguay, drived *Ceibal* (Rivoir and Martinez, 2008). Although this commitment provided *Ceibal* with the needed thrust to incorporate and articulate the required social and political actors, it could also have been the case that it could have become the target of political criticism that could weaken its development. In any case, if that was the case, these criticisms did not have had enough echoes so as to jeopardize the implementation of the project, which in fact has had a growing positive reception among

Uruguayan citizens (see for example, El País, 2009). In this sense, civil society played a crucial role providing the required political and social floor for its implementation. In addition, the presidential commitment also facilitated the availability of the required resources to implement the project in a countrywide scale in relatively short time.

The support of the educational sector was not immediate. The ANEP and the Primary Education Commission, responsible for administering the primary educational system, were not present when the project was created, but soon thereafter they took an active role in its coordination, taking responsibility for the educational components of *Ceibal*.

The Uruguayan Federation of Teachers also supported the project from the beginning, participating in a special commission with the Primary Education Commission, to work in the implementation of *Ceibal*. Despite these supports, some groups of teachers manifested their reservations about the project and some of them even rejected it, claiming that there were other priorities in the educational system that needed urgent attention (see for example Rotulo, 2007, and Ibarra, 2008). This initial tension with the educational system may be explained by the fact that teachers were not asked about the project at its beginning or due to a legitimate doubt about the maturity of the idea to massively incorporate laptops for the children in the classrooms.

Other State agencies related to culture, education, research and innovation were incorporated from the start and provided academic and technological support to the initiative. These agencies, that are part of the Political Commission that coordinates *Ceibal*, are the "Agencia para el Desarrollo del Gobierno de Gestión Electrónica y la Sociedad de la Información y del Conocimiento (AGESIC)", and the "Agencia Nacional de Investigación e Innovación (ANII)".

Civil society and other social organizations supported the project through the formation of volunteer networks coordinated to provide any required help, especially in countries' interior zones. Industry and entrepreneurs also provided explicit support to this initiative that is considered a fundamental component for developing human capital and fostering the country's economic growth (see for example: LR21, 2007). Similarly, the Uruguayan press has been, in general, much kinder with *Ceibal* than the international press has been to Negroponte's proposals (see for example Shaikh, 2009, or Learning Review, 2009).

Ceibal is possibly a special case of an ICT in Education policy particularly in relation to how to articulate technology-related inputs required for its implementation. Typically governments require that the private sector provide computers, Internet access and support services to schools. In this case, computers were acquired from the OLPC Foundation by the government, the Internet was provided by the state-owned company ANTEL and the logistics for the distribution and support of this infrastructure was provided by LATU. It should be noted that regarding Internet development, some argue that there could be some conflict of interests between ANTEL and *Ceibal* that could hinder the project's development, since while *Ceibal* installs free public access to Internet antennas in schools and public areas the market for ANTEL is being reduced, especially in low income sectors (Ploskonka, 2009).

Additionally, many actors consider that the Internet provided is far beyond the one required for students to massively access the network's contents (in fact, teachers argue that they need to coordinate Internet use in schools, since not more than two groups of students can use the Internet simultaneously) and that its development could be slowed down due to inefficiencies of the State's company and the lack of a competitive market demanding better services (for example, higher bandwidth). Moreover, many discuss whether the services offered by the state's company to the homes do have the process and standards required for its effective large-scale deployment in Uruguay (Zarza, 2009).

Meanwhile and conscious of these limitations, the government launched the "Cardales" plan, aimed at providing access to telephone, Cable Television and Internet (convergence) services to all homes in the country based on a public-private partnership. Results of this plan are still to be acknowledged (LR21, 2008).

Summarizing, *Ceibal* is a policy driven and supported by the highest levels of the Uruguayan state that, despite certain initial resistance from some groups of teachers, receives support from practically all public and private sectors within and outside education.

Where is the leadership located for conducting this process and what are the implications of this choice?

Since the beginning of *Ceibal*, its leadership was in the Technology Laboratory of Uruguay, which was created in 1965 as a result of the joint efforts of the official and private sectors. It is managed by a Board of Directors integrated by three members: a delegate from the Government (Ministry of Industry, Energy and Mining), who presides; a delegate from the Uruguayan Chamber of Industry (Cámara de Industrias del Uruguay); and a delegate from Banco República. Its mission is to foster the sustainable development of the country and its international insertion through innovation and transfer of valuable solutions regarding analytical, metrological, technological, managerial and compliance assessment services, according to the applicable regulations (LATU, 2009).

LATU was responsible for leading the technical and operational implementation of the project (see presidential decree that created *Ceibal* in April 2007). *Ceibal*, as part of LATU, was able to create the technical and logistic management required to acquire, prepare, assign, distribute and provide technical support to the thousands of computers delivered. Additionally, it coordinated the volunteers' networks, develops an educational portal and works in coordination with special working groups of the agencies in charge of administering the educational system.

Additionally, ANEP and the Primary Education Council are responsible for the implementation of the educational aspects of the initiative, that is, pedagogical proposals, teacher training and contents development.

It is possible that the designation of LATU as the agency in charge of *Ceibal* did facilitate the implementation of the initiative in the promised time period. However, it is also possible that the fact that LATU was relatively distant from educational matters helped to install the idea that this was more a social project aimed at closing the digital gap, than an educational project, affecting somehow the adoption of *Ceibal* by the educational system.

Currently the coordination between LATU and ANEP seems to be well structured and the educational components of the project have been gaining relevance along its implementation.

The Policy Development Process

What have been the various steps of the policy development?

At the end of 2009 *Ceibal* finished its first implementation stage that had the goal of providing a laptop to each child and teacher of public primary education. One of the biggest challenges of the first implementation stage was the relatively limited time available to implement the project in the country. This expansion was planned in four stages (*Ceibal*, 2009b):

Stage 1 (first semester 2007): School N°24 of "Villa Cardal", department "Florida". "Villa Cardal" is a town with 1,290 inhabitants and just one school attending 150 students. For this stage, OLPC donated the computers;

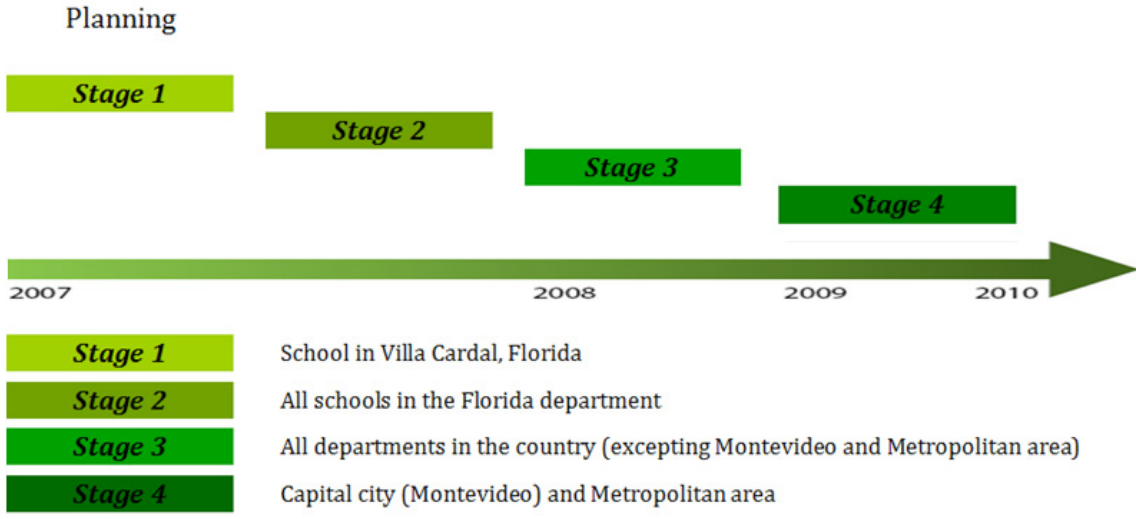
Stage 2 (second semester 2007): Rest of the "Florida" department until fully covered. In October of that year the first 100 thousand XO laptops and 200 servers were bought through a biding process. Children and teachers received these computers later that year;

Stage 3 (year 2008): More than 175,000 computers were delivered, completing all schools in the interior of the country, except part of the department of Canelones, Montevideo and its metropolitan area; and

Stage 4 (year 2009): The rest of the department of Canelones is completed together with Montevideo and its metropolitan area: With this, all children and teachers in primary public education received laptops, reaching 362,000 children and 18,000 teachers.

The next figure summarizes the four stages of the implementation of *Ceibal* in primary education (UNESCO, 2008).

Figure 11: Implementation Stages of Ceibal



However, finishing this first phase and the accomplishment of its goals was just the beginning of a long-term ICT in education policy, which now faces the following challenges:

- The expansion of *Ceibal* to teachers and students in secondary education: At the end of 2008, aware of the imminent arrival of students with laptops to secondary education, the government decided to initiate the expansion of *Ceibal* to secondary education (see presidential decree stating the expansion of *Ceibal* in December 2008). During 2009 some dissemination and training actions have been undertaken as well as a pilot experience in the department "Treinta y Tres" that includes 6,000 secondary education students. In this pilot XO laptops with Windows and Linux are being tested. This expansion will include students of the basic cycle of public secondary education (Garderes, 2009).
- Ongoing provision of infrastructure and services: After this initial delivery of infrastructure, *Ceibal* starts a second phase of consolidation of what was achieved in primary education, which involves the annual provision of computers to the children entering first grade, provision of maintenance and support for the existing equipments, strengthening the networks, provision of more and better educational contents, strengthening training and curricular integration of ICT strategies, implementing a detailed evaluation of the educational and social impacts of the project, among others.

What modalities/mechanisms instruments have been used?

In general, *Ceibal* appears to be a large initiative that trusted the government's internal capacity (LATU, ANEP, etc.) to provide the set of goods and services considered in this policy. However, upon closer examination, it can be noted that there are a variety of strategies and that some of them have evolved over time. To portray these differences it is useful to use the typology proposed by Barber (2007) to characterize the strategies used by different governments for the provision of public goods and services. Barber identifies three types of strategies:

- Command and control: When the government is the provider of the public goods and services and uses a top-down management approach from the centre to the decentralized government's service units;
- Devolution and transparency: When the government devolves responsibility and autonomy for the provision of public goods and services to the decentralized service units (frontline) and generates systems to measure performance that are public, in order to push for improvements; and
- Quasi-markets: When the government delegates the provision of public goods and services to the private sector, either fully privatizing the provision and implementing regulatory systems or sharing its property and control with other agents of the market.

Ceibal's strategies and action lines can be described as predominantly "command and control," since the provision of computers was organized centrally by LATU or ANEP using their respective internal structures, until reaching the beneficiaries. Some of the clearest examples are: (i) the set of actions implemented by LATU to distribute, install and provide technical support to the complete ICT infrastructure (computers, servers and networks) and (ii) the provision of digital educational resources implemented by ANEP and LATU.

Nevertheless, it could be argued that teacher training and ICT curricular integration strategies have elements of the second type of policies – "devolution and transparency". In fact, although the pedagogical project was centrally designed by a special commission led by ANEP and the first wave of teacher training courses was based on a cascade model from the centre to the teachers in schools, the same pedagogical project defines that curricular integration of ICT is within the decision scope of the groups of teachers in each school and, finally, up to each individual teacher. Consistent with this perspective, the current teacher training strategy is based on peer tutoring strategy in which "support teachers" from schools that show interest and special abilities in this area, devote half of their working time to assist their colleagues in school to integrate the use of ICT in their respective classrooms.

Both examples show the trust and delegation of responsibility to the teachers' professional base regarding the design and fulfilment of the promises related to the educational integration of ICT.

Finally, through the "Rayuela" project, *Ceibal* is actively involved in developing a digital educational market able to provide digital educational resources and technical support to the schools. Although this process that delegates the responsibility to the private sector is still in its initial stages and therefore it is not clear how and when will it end, it clearly shows the will of *Ceibal* that these services and goods are provided using a "quasi-market" approach.

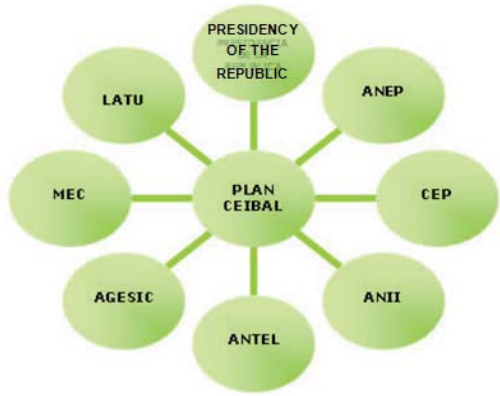
Given this scenario, it is possible to assume that, as the urgency for deploying the project diminishes and the need to diversify the solutions for each particular community grows, these factors – together with the demands for the project's sustainability – will require *Ceibal* to complement its government-oriented strategies with more decentralized modalities that also incorporate private sector actors.

Governance of the Reform Process

What institutional framework exists to oversee and guide the policy and what procedures and structures have been put in place to ensure inter-ministerial cooperation?

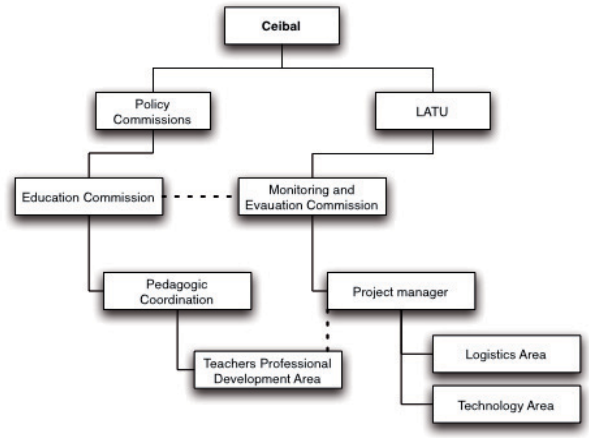
The central coordination of *Ceibal* was the responsibility of the Presidency of the Republic and LATU, and the co-direction was delegated to ANEP, the Council of Primary Education, the Ministry of Education and Culture, AGESIC, ANII and ANTEL (Garderes, 2009). Representatives of these entities conformed the Political Commission that was responsible for defining the conditions, pace, and contents required to accomplish the plan (Rivoir and Martinez, 2008). The following figure shows the entities and agencies that converged in the coordination of *Ceibal*.

Figure 12: Entities and Agencies Converging in the Coordination of *Ceibal*



The organizational structure of the implementation of *Ceibal* until 2010 is presented in the next figure.

Figure 13: Organizational Structure of *Ceibal* until 2010



The Political Commission (or policy commission) of *Ceibal* was assisted by an Educational Commission composed by MEC, CODICEN, CE3P and the Uruguayan Federation of Teachers.[56] This commission was responsible for developing the pedagogical proposal for the integration of computers in the classrooms and implementing all

56 It's the union that gathers all Uruguayan teachers (www.magisterio.org.uy).

required actions to materialize the proposal, especially with regards to teachers' training and support strategies (*Ceibal*, 2009b).

Additionally, during the implementation of the project, several commissions supporting the Political Commission were created aiming at designing and/or articulating different dimensions of *Ceibal*, including political areas as well as educational, logistic, training, technical, monitoring and evaluation and research topics (UNESCO, 2008).

What partnerships are in existence and what instruments are established to promote and regulate public/private partnerships?

Although *Ceibal* is a policy that has been transversally implemented through the Uruguayan state structure (ministries and other agencies), its delivery across the country has also involved other actors coming from different sectors that support and amplify the state's efforts (Rivoir and Martinez, 2008). Despite the fact that some of these initiatives originated from outside the government, they have been supported and coordinated through *Ceibal*, which enabled the mobilization of actors from the civil society, social organizations, universities and private sector.

The main support from the civil society is **RAP** *Ceibal* network committed to help *Ceibal* implementation. There are additional smaller support networks that were developed willing to contribute to the successful implementation of *Ceibal* such as *Ceibal***JAM!, Flor de Ceibo,** and volunteers networks of ANTEL, Catholic University of Uruguay, and RUTELCO among many other social organizations, government entities have also committed to support the initiative (Bianchi, 2009). Many of these external support initiatives were described in section 2.4.1.

In a different area, through the **Rayuela** Project, *Ceibal* is also involving the private sector partners in the project, in particular the software industry.

Finally, it is worth mentioning that despite the fact that *Ceibal* was oriented towards public education only, during its initial implementation a mechanism was created in order to incorporate private schools into the initiative. This expansion of *Ceibal* is called *Aula Ceibal* and allows private schools to purchase a maximum of two sets of 25 to 30 XO laptops similar to the ones provided to public schools, at special prices differentiated on the basis on the schools' annual fee (the higher the fee, higher the price). The model considered for private schools is that these sets of computers rotate in the different classrooms allowing all students to work with them at least once a week. Additionally, parents can acquire XO laptops for their children and in cases where the school participates in *Aula Virtual*, they can obtain special prices (*Ceibal*, 2009b).

Policy Alignment and Consistency

Uruguay's advances in the field of the investments on educational equipment, offered a significant and unique opportunity, assuming the hypothesis that the use of ICT contributes to social equity and reduces both access and knowledge divides, improving the competitiveness at national level via the development of social capital better prepared to fulfil the Knowledge Society demands (IDB, 2009).

Since 2005, Uruguayan strategies for development were reformulated and a new institutional arrangement was created to address the Information and Knowledge Society's issues. As it was said before (see section 1.3.), the more important new agencies were the AGESIC and the ANII. Both main documents produced by these entities, namely *Uruguay's Digital Agenda* 2008/2010-ADU (AGESIC, 2008) and the *National Strategic Plan for Science, Technology and Innovation*-PENCTI (Gabinete Ministerial de la Innovación, 2007), targeting human development and social inclusion, respectively (Rivoir, 2008).

In this context, the Digital Agenda, could be seen as a strategic political proposal, totally aligned and functional to the national policy of ICT and the Information Society (Ríos, 2008), by promoting transparency, democratic strengthening and digital inclusion to improve the quality of life in Uruguay. Moreover, in late 2006, the Presidency of the Republic launched the *Ceibal* plan, within the policy framework given by the Digital Information Access Equity Programme (*Programa de Equidad para el Acceso a la Información Digital* – PEAID), which, in turn, was part of the national Equity Plan. Therefore, articulation among different policies seemed to be ensured, and the plan for the integration of ICT in education emerged as an equity policy, a relevant tool to fight against social exclusion (Poggi, 2008).

Nevertheless, *Ceibal* was not a pre-designed policy previously included in the government programme. It was almost a personal initiative of the President of Uruguay, with the aim of using it to achieve higher levels of social inclusion, as well as to contribute to the general country's ICT policies (universalization of the access to telecommunications services; inclusion and appropriation of ICT; and enhancement of the capabilities in bandwidth, among others).

Regarding the general educational policies, and agreeing with the UNESCO general guidelines, the Uruguayan government opportunely expressed its engagement to improve students' performances, to increase public expenditure on education and to develop a public education service in consonance with the labour market demands (World Bank, 2007), but always putting the equity principle at the centre of the national policy.

However, regarding the compatibility between *Ceibal* and national policies in education, it is not clear whether *Ceibal* fits within the framework constituted by previous educational policies or if this context is being revisited and reframed because of *Ceibal*. As argued previously, *Ceibal* was not initially conceived as an educational programme, but as a project targeting social inclusion through access to ICT and the Internet. The absence of a formal education-based structure (and their associated entities) during its initial stages could represent a concrete evidence to support the preceding conjecture.

Considering the main features of the pedagogical project, it was natural that demands for the availability of opportunities for teachers' reflection and discussion about the consequences of ICT integration should emerge, before seeking to introduce new technology to schools (but this approach was not the case in *Ceibal*).

Taking for granted that pupils' learning outcomes will improve just by adding technology to the classrooms (or to other social contexts) could constitute a risky assumption, since international experience has shown that integrating ICT into educational processes does not necessarily guarantee positive outcomes in pupils' learning, and that these impacts are more strongly linked to the quality of the underlying pedagogical proposal. Indeed, success is very much predicated on how and when each teacher and each learning community decides to include these new available resources into their educational projects.

Monitoring and Evaluation

How is policy evaluation conceived?

Monitoring and evaluation of *Ceibal* is led by the Monitoring and Evaluation Team. It started in mid- 2008 and works in coordination with LATU and ANEP. Its aim is to produce valid and trustful information about the implementation, results and impact of the initiative, particularly regarding children, families, schools and communities in order to generate knowledge about the experience, overcome obstacles and deepen the positive outcomes. The main focus of the evaluation is the effect of *Ceibal* in reducing social inequity through the implementation of actions to ensure universal access and use of new technologies in the country (Martínez and Pérez, 2009).

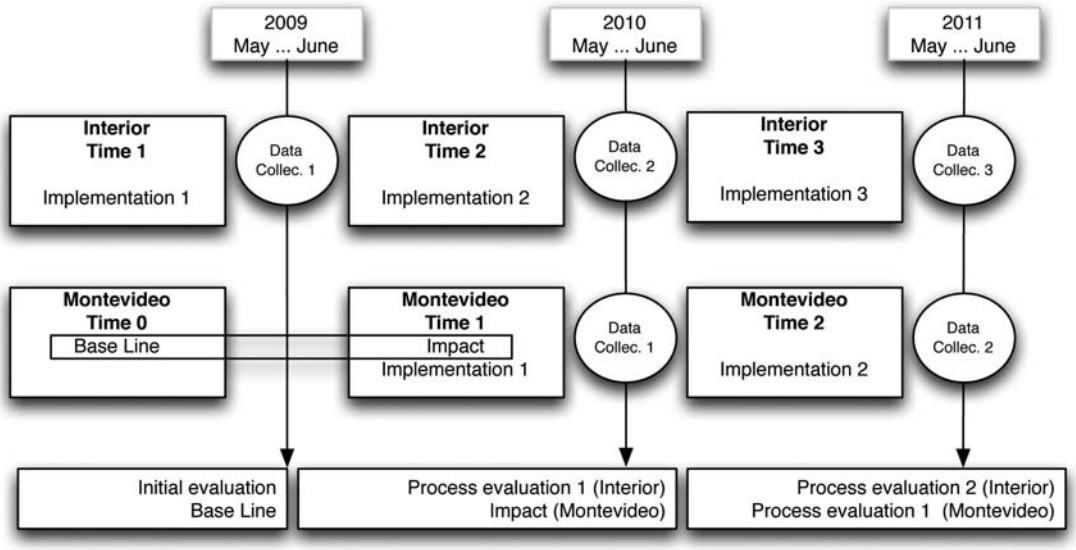
The design of the evaluation considers complementary strategies: the use of quantitative and qualitative methods and the use of primary and secondary data, considering two populations: the interior of the country and Montevideo. In the former the project started in 2008 and in the latter, in 2009.

The implementation of the monitoring and evaluation model was designed proceed in three stages:

- A pilot stage implemented in December 2008 that considered the implementation of a survey that included questionnaires for teachers, principals, children and families of 44 schools with short and long time of participation in *Ceibal*.
- Implementation of a survey in June 2009 that included questionnaires for a nationally representative sample of teachers, principals, children and families complemented by a qualitative study of 20 communities that included interviews and participatory workshops. In total, the data collection considered 5,682 children from third to sixth grades – 7,620 families, 1,050 teachers and 200 principals.
- Annual implementation of the survey over at least six years.

Additionally the model considers collecting data about indirect results and impacts, considering the reduction of the digital divide and the promotion of digital inclusion as multidimensional challenges that include the access to ICT, its use, the sense that having a computer makes to children and teachers and its impact at home.

Figure 14: Monitoring and Evaluation Model of Ceibal



Source: Martínez and Pérez, 2009

The monitoring and evaluation aims are (translated from Martínez and Pérez, 2009):

Diagnostic function:

- Elaborate a base line using indicators that can be used to measure impacts of *Ceibal* in social, cultural, economic and democratic participation dimensions.
- Identify and characterize the most relevant actors and groups (stratifying by socio-economic groups and ICT experience).
- Analyse the evolution over time of level and quality of use of the tools and social participation in the production of contents.

Process evaluation:

- Generate periodic information regarding the three main components of *Ceibal*: training, distribution and maintenance of laptops and its use.
- Identify training and support actions implemented by *Ceibal* and civil society as well as inter-institutional coordination.
- Based on the analysis of the information, provide recommendations for decision-making.

Results and impact evaluation:

- Know the level of usage of the tools by children and teachers (in and out of schools) and its impact on children's self-esteem, predisposition to innovate in teaching and learning practices, aptitude and attitude towards collaborative and networked work stratified by socio-economic groups and ICT experience. Know the use that families and children make of this technology outside schools and the process of appropriation of this tool.
- Study to what degree and under what conditions the new tool starts to be used in the community and what needs arise.
- Identify the changes in the opportunities, behaviours, knowledge, possibilities, perceptions and well-being of the families and community members participating in *Ceibal* and what factors contribute to or hinder these changes.
- Analyse the changes in the links and relations between schools and families and inside families; the changes in social practices and in the use of free time after introducing a laptop in the children's social environment.
- Analyse individuals' participation in networks, studying the impact due to the collaborative conception of *Ceibal*'s laptop.
- Study the impact in the children's self-esteem, in their motivation to learn and available opportunities for them.
- Follow the local social and economic development initiatives of that make use of *Ceibal*.

Additionally and as part of the collaboration with the IDB, *Ceibal* is designing the use of a comprehensive set of indicators that include:

Input

- Infrastructure: schools with electricity, telephone, Internet, local networks, students per computer, etc.
- Contents: availability of educational resources, average time of ICT use, number of lessons that incorporate ICT, number of teachers developing contents, etc.
- Human resources: integration of ICT in initial teacher training curriculum, percentage of teachers ICT certified, percentage of schools with support personnel, etc.
- Management: percentage of national spending in ICT, percentage of schools with ICT integration projects, percentage of students in different grades using ICT, etc.
- Policies

Outputs

- Results: percentage of certified teachers that integrate ICT in their lessons, average weekly time that teachers use ICT, percentage of lessons with ICT, changes in repetition and dropout rates, percentage of students certified in ICT, changes in students outcomes, etc.

In summary, the evaluation plan designed for *Ceibal* is quite comprehensive and if implemented according its design, it will provide valuable information for further research and policy design.

What ICT evaluation studies have been conducted?

In addition to the monitoring and evaluation initiatives implemented by the *Ceibal* evaluation commission, there have been many other initiatives that studied, or are currently studying, different aspects of *Ceibal*. Many of these

initiatives were part of the pilot stages of *Ceibal*, and were mainly case studies that looked at specific aspects of the project and others did not use rigorous evaluation methods, therefore reporting rather anecdotal information.

One interesting initiative is the "Flor de Ceibo" project in which, in 2008, students of the University of la República did field work in 97 communities participating in the project, gathered data about its implementation, and helped the communities in various ways.

However, in 2009, the evaluation initiatives (for example, the University of la República) implemented a competitive fund to develop studies about social inclusion and *Ceibal* and four projects to study *Ceibal* were approved that year (UDELAR, 2008):

- *Ceibal*: Impact on the community and social inclusion ("El Plan *Ceibal*: impacto comunitario e inclusión social") by Ana Rivoir, Martín Rivero and Lucía Pittaluga;
- Impact of *Ceibal* in the linguistic and cognitive development of the children ("Impacto del Plan *Ceibal* en el desarrollo cognitivo y linguístico de los niños") by Maren Ulriksen and Susana Martínez;
- A first evaluation of *Ceibal* using panel data, by Alina Machado ("Una primera evaluación del Plan *Ceibal* en base a datos de panel"); and
- Appropriation, imagination and technological development ("Apropiación, imaginación y desarrollo tecnológico") by Inés Bouvier.

In addition to these initiatives, there are at least two studies implemented in 2009 that already have some nationally representative data about *Ceibal*. These are:

- The report of the "Segundo Informe sobre Imaginarios y Consumo Cultural en Uruguay" (*Second Report of Cultural Images and Consumption in Uruguay*) that surveyed 3,421 citizens included questions regarding their perceptions about *Ceibal*.
- The report of the survey implemented in June 2009 by the Evaluation Commission of *Ceibal*.

It is interesting to note the interest that this latter report generated among the news media that reported extensively about *Ceibal* results.[57]

What were the findings?

Results from the "Segundo Informe sobre Imaginarios y Consumo Cultural en Uruguay" show that 85% of the respondents agree that *Ceibal* "improves the future of the children" and 92% answered that it puts the children "in contact with the world." Additionally, 49% agreed that it "puts the children in contact with harmful information."

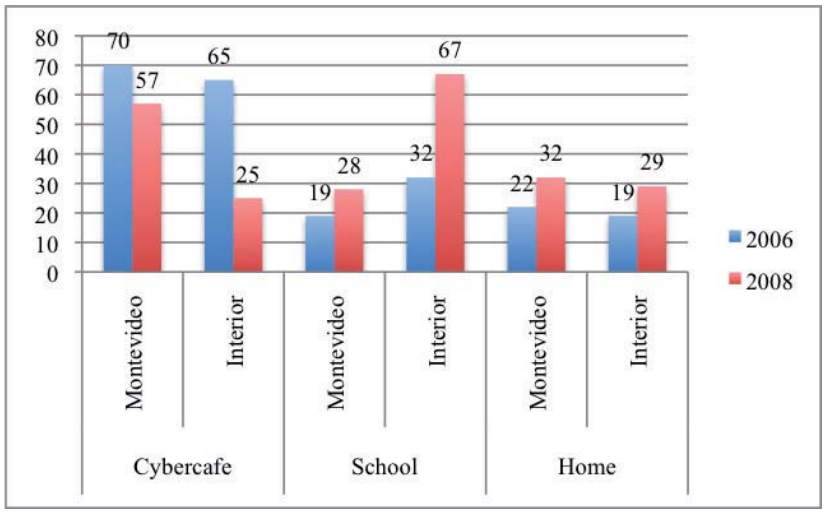
Regarding the survey implemented by the Evaluation Commission of *Ceibal*, the following sections report some of the initial findings that were released in late December, 2009.

Regarding Internet access, using secondary data, the study reports that between 2006 and 2008, due the implementation of *Ceibal* in the interior of the country, access to the Internet in schools has changed significantly: from 32% of the children accessing Internet in schools in 2006 to 67% in 2008 (see Figure 15).

Figure 15: Percentage of Children aged 8 to 11 that Attend to Public Schools

57 See:
http://www.larepublica.com.uy/comunidad/394191-ninos-miran-menos-tv-y-consultan-mas-fuentes-de-informacion-en-sus-laptops
http://www.elpais.com.uy/091224/pnacio-461827/nacional/plan-ceibal-desafia-rol-de-adultos-padres-y-maestros-necesitan-apoyo
http://noticias.latam.msn.com/xl/latinoamerica/articulo_montevideo.aspx?cp-documentid=23136633
http://www.presidencia.gub.uy/_Web/noticias/2009/12/2009122306.htm

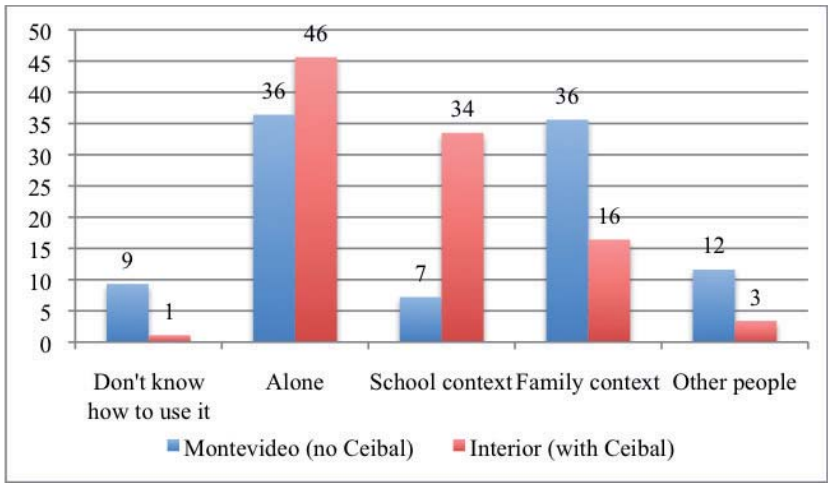
that Access Internet in Different Places in 2006 and 2008



Source: Ceibal, 2009c

With regards to the way in which children learn to use computers, the results of the survey show that in general terms, it takes less than two weeks for the children to learn how to use the XO laptops and that the majority of the children with and without *Ceibal* do this alone (Figure 16); however, with *Ceibal* a significant percentage of children also learn to use computers in a school context (34%), while without *Ceibal* they learn in a family context.

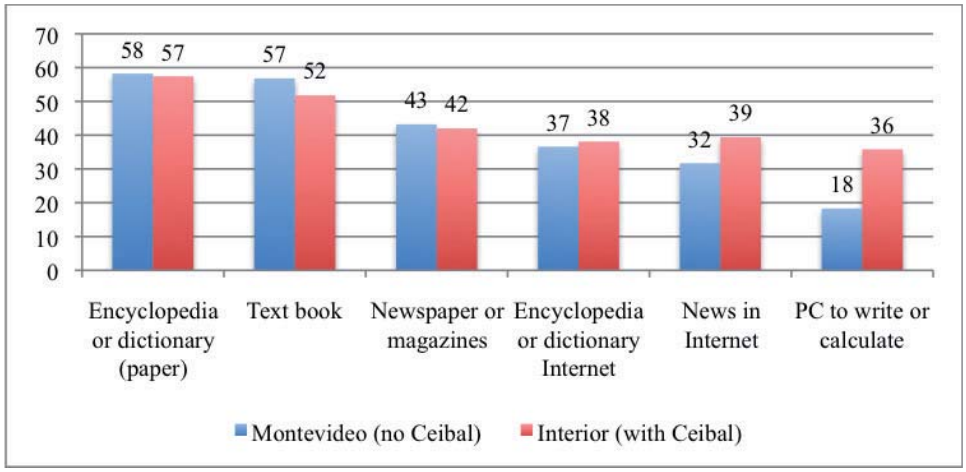
Figure 16: Percentage of Children that Learned to Use Computers in Different Ways in 2009



Source: Ceibal, 2009c

With regards to the resources that children use for their homework, 92% of the children in *Ceibal* declared that they used the laptops for their homework and 72% of the ones not in *Ceibal* also declared that they do so. More specifically, Figure 17 shows the resources used by children to do their homework. It is interesting to note that the percentage of children that use the computers to write and calculate is higher in the population in *Ceibal* than in the other (36% vs. 18% respectively).

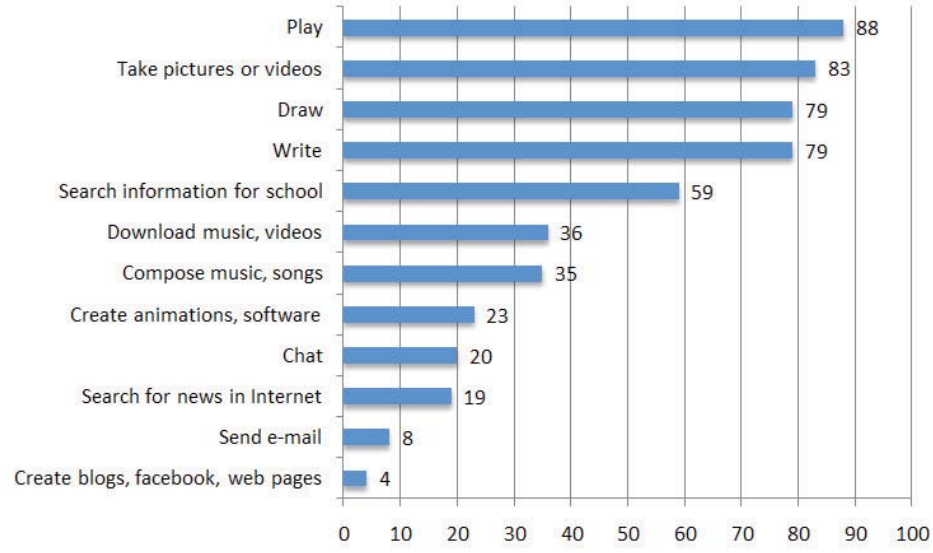
Figure 17: Percentage of Children that Use Different Resources for their Homework (2009)



Source: Ceibal, 2009c

Regarding children's use of the laptops in their free time, results show that the most frequent activities are to play, take pictures and videos, write and draw (Figure 18). Additionally, 77% of the children declared that they enjoy working with the XO in the lesson.

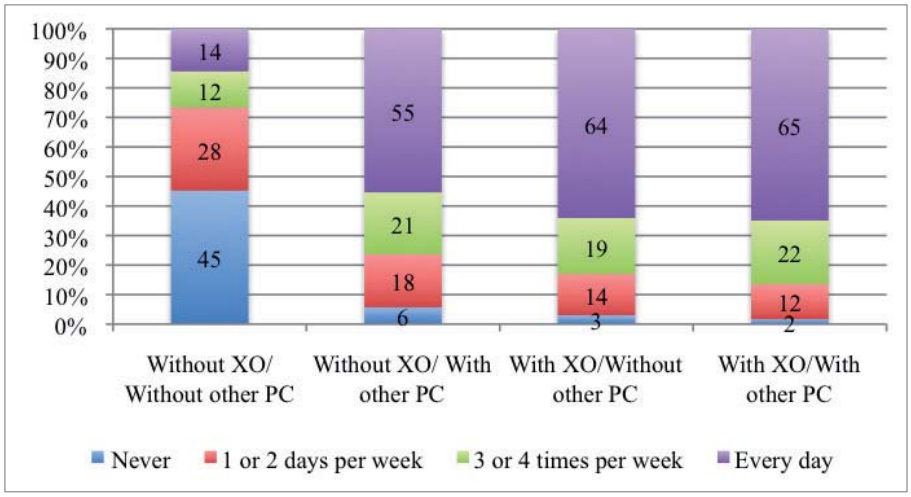
Figure 18: Percentage of Children Performing Different Activities with the Laptops (2009)



Source: Ceibal, 2009c

Regarding the frequency of use of computers, Figure 19 shows the percentage of children that use computers with different frequencies. As it can be noted, the possession of an XO shows an impact in the percentage of children that use computers every day.

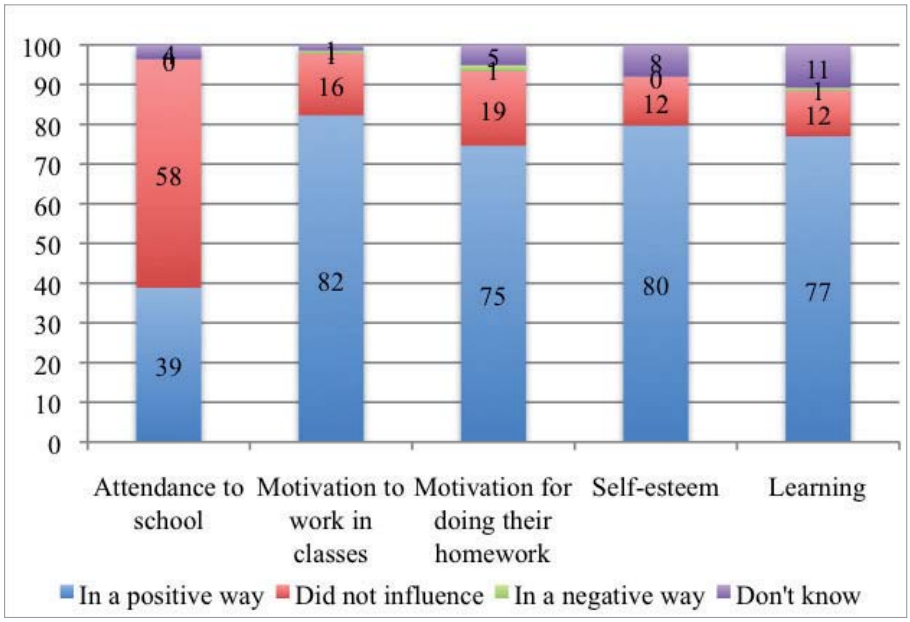
Figure 19: Percentage of Children that Report that They Use Computers with Different Frequencies (2009)



Source: Ceibal, 2009c

Finally, regarding principals' perception of the impact of *Ceibal*, in general terms the majority of them declared that it had positive impacts on children's motivation, self-esteem and learning. However, the majority declared that it did not influence school attendance (Figure 20).

Figure 20: Percentage of Principals Reporting the Impact of Ceibal on Different Aspects of the Children (2009)



Source: Ceibal, 2009c

Conclusion

The information presented in the previous sections allows for the following conclusions to be drawn.

Despite many initiatives implemented since 1990s, Uruguay has had problems sustaining a national policy to introduce ICT in schools, especially in primary education. However, in 2006 Uruguay started the *Plan Ceibal* that achieved the provision of laptops for all primary student and teachers in a period of three years and now it is starting a similar strategy for secondary education. In Uruguay today, every primary school – and very soon every secondary schools as well – their teachers, students and families have the opportunity to use and learn with ICT. Despite this accomplishment, *Ceibal* faces great challenges regarding technical and pedagogical support, contents and Internet provision and sustainability, among others. Moreover, even when integration of ICT into educational activities should be facilitated by wider access to laptops, the proper use of ICT in the classroom still seems to be one of *Ceibal's* main challenges, as is usual in these policies. In this sense, the long-term impact of this policy on educational indicators will likely emerge once *Ceibal* deepens strategies that consider detailed and coordinated actions addressing curriculum, evaluation, contents and teachers' professional development.

Although *Ceibal* has an explicit educational discourse and has been implemented across the educational system, its proposal goes far beyond schools. Indeed, this policy is first and foremost a social policy trying to impact directly children, families and the society and, secondly, an educational policy trying to have an impact on schools and on teachers' pedagogical practices. In this framework, *Ceibal* already shows an impact on Uruguayan society, which has transformed this initiative in a flagship for social justice in the twenty-first century.

It seems fair to claim that the fast implementation of *Ceibal* has been possible due to the commitment of the highest political authority, the President, who managed to align all the required political sectors, institutions as well as the civil society towards this aim. In this sense, it could be said that, together with the deployment of laptops, Internet and training, *Ceibal* has been able to mobilize Uruguayan society as if the policy were like a "crusade," – a twenty-first century renewal of the "Revolución Vareliana" that was the genesis of the national public school system in Uruguay in the nineteenth century. In addition, Uruguay has had institutions with the technical capabilities, organizational flexibility and leadership ready to manage and coordinate the implementation of the different dimensions of this complex policy. Undoubtedly, these supporting factors, not always easy to find in other countries, were key to facilitating the implementation of *Ceibal* in Uruguay.

So far, *Ceibal* has had an impact on the international community, compelling educational policy-makers around the world, especially in developing countries, to review their approaches to ICT in education policies in order to examine ideas and lessons learned from the OLPC and *Ceibal*.

In particular, *Ceibal* has shown that providing one laptop to each student is feasible and therefore policy-makers need to include this approach in their repertoire of possible models for the introduction of ICT in education. This new possibility adds additional complexity to the already broad range of technology delivery models for ICT in education policies (for example: computer labs, mobile computer labs, computers in the classrooms, computers for teachers, etc.), especially considering that decisions based on the educational benefits of each model are not easy due to the lack of conclusive evidence regarding their respective impact on students' learning achievements. Also, due to the relatively high level of investment required, in many developing countries the choice of the OLPC model could exclude the possibility of other investments.

In addition, as the international experience has demonstrated, *Ceibal* is also showing that regardless of the technology delivery model, policy-makers need to include complementary strategies to ensure teachers' professional development, the availability of adequate digital educational resources and the provision of technical and pedagogical support.

Finally, the Uruguayan model is seen by many countries with low access to ICT in their schools and homes as a way to move quickly towards a twenty-first century Information Society.

Chapter 7

Case Study: Rwanda

Shafika Isaacs

Executive Summary

Rwanda has been a beacon of hope for many in Africa, largely because of the contribution of its dynamic and visionary leadership in reconstructing Rwanda from the devastation caused by the 1994 genocide. Indeed, since 1994, Rwanda is on track to achieve its Millennium Development Goal (MDG) targets on universal primary education (MDG 1), on gender equality (MDG 3) as well as the targets for HIV and AIDS, Malaria and related diseases (MDG 6). Rwanda has also experienced significant economic growth over the past decade and has shown improvement in its Human Development Index (HDI) over the same period. However, by many indicators, Rwanda remains a poor country whose economy is still predominantly based on subsistence agriculture. MDG 1 on poverty and hunger, and MDGs 4 and 5 on child and maternal mortality, respectively, are unlikely to be achieved without a considerably scaled-up effort and Rwanda still has among the largest orphan populations in the world (UNDP, 2007).

The Government of Rwanda (GoR) has adopted a host of interrelated policies to transform the country into a middle income knowledge-based economy as stated in its overarching Vision 2020 policy. Integral to Vision 2020 is the contribution of information and communication technologies (ICT) towards Rwanda's socio-economic development including the transformation of its education sector. Science, Technology and ICT are considered as cross-cutting issues across six major pillars, one of which includes Human Resource Development and a Knowledge-based Economy.

Interconnected with Vision 2020, the GoR has also adopted a National Information and Communication Infrastructure Plan since 2002 which is its most comprehensive policy framework on ICT and development for Rwanda; as well as an Education Sector Strategic Plan (ESSP) which is the country's broader education policy framework that is strongly informed by the Education for All (EFA) goals. A central feature of the ESSP is the GoR's goal to achieve fee-free education for the first nine years of schooling, in line with the EFA. Against this backdrop a draft ICT in Education Policy (hereafter the Policy) and related Costed Strategic Implementation Plan for ICT in Education (hereafter Implementation Plan) have been developed by the GoR. The latter is focused on developing an education system enabled by ICT, which will harness learning, teaching and skill development for an envisaged knowledge-based labour market.

Abbreviations and Acronyms

EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy
EMIS	Education Management Information System
ESSP	Education Sector Strategic Plan
GOR	Government of Rwanda
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
ICTs	Information and Communication Technologies
ITU	International Telecommunications Union
LFA	Logical Framework Approach
LTSFF	Long Term Strategy and Financing Framework
MDG	Millennium Development Goals
MINEDUC	Ministry of Education
NICI	National Information and Communication Infrastructure
RDB-IT	Rwanda Development Board – Information Technology
RITA	Rwanda Information Technology Agency
RURA	Rwanda Utility Regulatory Agency
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa

ICT in Education Policy

The Policy and Implementation Plan focus on integrating ICT in education in order to achieve quality education, education access and equity as well as labour-market relevance. These principles balance education development with social redress and pragmatic economic and labour market imperatives.

It highlights four major focus areas to be addressed by the Ministry of Education (MINEDUC). These four areas relate to raising the awareness of all stakeholders in the education system about the value of investing in technology. This is linked to preparing schools to accept, procure and install technology. In addition it proposes to implement an Education Management Information System (EMIS) and provide on-going technical support. This is linked to developing and managing content, integrating the curriculum and providing technical and pedagogical support to schools for integrating ICT into Education.

The Policy proposes 12 programme areas and the Implementation Plan identifies seven priority objectives for delivery over the five years (2010–2015). The latter includes the expansion of ICT infrastructure to improve access and equity; developing capacity to integrate ICT in education practice, developing quality digital content and establishing Open and Distance e-Learning (ODeL).

The process of policy development has been consultative and involved a range of stakeholders in Government, the private sector and civil society. An institutional framework has been established to govern the implementation of the Policy and the relationships between partners and stakeholders. A Rwanda Education Board (REB) has been set up in the Ministry of Education, which includes a Department of ICT in Education and ODeL, tasked to coordinate the Implementation Plan.

A salient feature of both the Policy and Implementation Plan is the commitment to integrate Monitoring and Evaluation in the conceptualization and implementation of the Policy. This includes the development of a comprehensive M&E framework that is currently underway.

Their remains sober awareness within the GoR that the process of implementing the Policy will be fraught with systemic challenges such as infrastructure-readiness, resource and capacity constraints both at MINEDUC level and at school level. The integration of M&E is considered crucial to ensure that the process works within these challenges imbued with a culture of continuous stakeholder learning.

The Context

Background

For many, Rwanda has become the symbol of hope and prosperity in Africa. The country suffered one of the worst atrocities on African soil – the genocide and civil war in 1994 which killed one in seven Rwandans, left more than one-third of its population displaced and plunged 80% of its population into poverty. Within one year, the country lost a generation of trained teachers, doctors, public servants and private entrepreneurs.

Since then, however, Rwanda has reinvented itself through successfully enabling peace and reconciliation, building democratic institutions and promoting social and economic development. Key

to the country's shift towards sustainable development is the prominence given by Government leadership to ICT in general and in education in particular.

Socio-economic Profile

Rwanda is a small, landlocked country in Central Africa with 10.7 million people and a population growth of 2.87% per annum. The indigenous population consists of three ethnic groups: the Hutus who comprise the majority of the population (85%), the Tutsis (14%) and the Twa (1%). Table 1 below provides demographic indicators for Rwanda.

Table 1: Demographic Indicators Rwanda, 2009

Indicator	Performance
Population	10.7 million (2009)
Population Density	368 per square km (2008)
Population Growth Rate	2.87% pa (2009)
Age Structure	0–14 years: 42.7%; 15–64: 54.8%
Median Population Age	18.7 years (2009)
Life Expectancy	56.77 years (2009)
Infant Mortality	67.18 deaths for every 1,000 live births (2009)
% Urban Population	18% (2008)

Source: CIA, World Factbook, Rwanda, 2010

Table 1 shows that Rwanda has a very young, predominantly rural population and features among the most densely populated countries in Africa with 368 people per square kilometre.

Rwanda is also one of the fastest growing economies in Africa. Economic growth rates have averaged 5.8% per annum over the past ten years; and in 2007 it grew by 7.9% in 2007 and 8.5% in 2008. Between 1980 and 2007 Rwanda's Human Development Index (HDI) rose by 0.94% annually from 0.357 to 0.460 today, which is one indication of the country's progress over time. Increased productivity in the agricultural and service sectors, together with strong public and private sector investment, have been the main sources of growth, employment and poverty reduction in the short to medium term (World Bank, 2009).

Rwanda is also reportedly on track to achieve MDG 2 on universal primary education, MDG 3 on gender equality and MDG 6 on HIV/AIDS and malaria. Net primary enrolment (2007) is 95%, with 97% enrolment of girls. HIV prevalence is estimated at about 3% with female infection rates (3.6%) substantially higher than those of males (2.3%). Rwanda is also on track to achieve the targeted reduction in malaria incidence. Table 2 provides indicators of Rwanda's socio-economic development.

Table 2: Socio-economic Indicators, 2007

Human Development Index (HDI)[1]	0.460 (2007), ranking 167th out of 182 countries;
Human Poverty Index (HPI)	32.9%, ranking 100th out of 135 countries
Per Capita Gross National Income in US Dollars	$200 (2003), $230 (2005), $330 (2007)[2]

Source: Human Development Report, 2009

Despite the significant growth and progress however, Rwanda is still predominantly an underdeveloped agrarian economy with approximately 60% of its population reportedly living under the poverty line (GoR, 2000). The economy still suffers a host of structural challenges such as the low use of modern inputs and lack of extension services in

agriculture; poor infrastructure and a low base of technical and managerial skilled labour. Agriculture currently accounts for approximately 40% of GDP and more than 90% of the Rwandan labour force. Most Rwandans rely on subsistence agriculture; with limited participation in the market economy. Poor infrastructure such as the absence of a railway link and poor quality roads given the country's landlocked status with long distances from ocean ports, creates natural barriers to trade and hinder development.

The contribution of the private sector to the economy and poverty alleviation remains limited. Rwanda has about 400 enterprises of which half have less than 50 employees. Private sector development remains hampered mainly by a lack of infrastructure (especially roads and energy) services and, to a lesser extent; the weakness of the financial sector (World Bank, 2009).

Rwanda's poverty levels remain high. MDG 1 on poverty and hunger, and MDGs 4 and 5 on child and maternal mortality respectively are unlikely to be achieved without a considerably scaled-up effort. Even though malnutrition rates in children under 5 have been declining, much faster progress is required.

Rwanda still has among the largest orphan populations in the world and among the highest proportion of female-headed households (UNDP, 2007).

In general therefore, Rwanda remains at a low level of socio economic development that is also manifest when considering the country's ICT infrastructure.

ICT Infrastructure

Whilst the ICT sector in Rwanda has made significant progress in policy and regulatory reform to promote ICT as a catalyst for socio-economic development, there remains significant challenges with increasing access and use throughout the country, particularly in rural areas. The following table provides an indication of the status of Rwanda's ICT infrastructure.

Table 2: ICT Infrastructure Indicators

Indicator	Performance
Number of telephone lines	16,800 (2008)
Number of mobile telephones	1.323 million (2008)
Number of Internet Hosts	81 (2009)
Number of Internet Users	300,000 (2009)
Internet Users per 100 inhabitants	3 (2009)
Mobile phone users per 100 inhabitants	15.5 (2009)

Source: CIA World Factbook, 2009 and ITU 2009

According to research on ICT infrastructure in Rwanda conducted by the UN Economic Commission for Africa (2008), Rwanda reportedly does not have institutions that register the number of ICT per household. However, its *Population and Housing Census of* 2002 indicated that 61.4% of urban households and 40% of rural households have radios and that TV distribution is concentrated in Kigali where 90% of households have televisions. An estimated 800 cybercafés are reportedly operational with 65% in the capital Kigali.

This scan also reports on a survey of 256 schools, conducted in 2007-2008 which revealed that of the total number of 41,491 computers found in the various schools/institutions, 88 (2.1%) are located in the primary schools, 2,501 (60.3%) are found in secondary schools, 317 (7.6%) are found in the secondary technical institutions, 10 (0.2%) are available in teacher training colleges. The technical/commercial and vocational institutions have 331 in total, which represents 8.0% and the rest 402 (21.7%) are found in the other category (UNECA, 2008).

Rwanda ranks 143rd out of 154 countries on the ICT Development Index scoring an index of 1.17 in 2007 compared to 136th in 2002 with an index of 0.99 (ITU, 2007). These numbers show that compared to other countries, Rwanda has dropped in rank over the five-year period between 2002 and 2007 (ITU, 2009).

The low levels of ICT penetration are due mainly to the high cost of setting up and maintaining network infrastructure. Costs are further exacerbated by a shortage in electricity infrastructure, which contributes significantly to the high price of access and usage, especially for mobile and Internet services.

The country has gone through major economic reforms including telecommunications reforms that aim at increasing the competitiveness of the telecommunications industry and attracting foreign investment. Amongst those reforms, was the establishment of an independent regulatory body known as the Rwanda Utility Regulatory Agency (RURA). The main mission of RURA is to promote fair competition, improve quality of services, and create an enabling environment to attract investors with the intention of improving the provision of services to citizens in accordance to the Universal Access obligations set by the International Telecommunication Union (ITU). Due to market liberalization, the country has different companies operating in the fixed and mobile telephony, Pay TV and Internet service provision sub-sectors. The reforms adopted have seen a number of changes in the telecommunication market with the entrance of new players and introduction of new technologies and services to meet market demand.

Rwanda has however recorded spectacular growth in mobile phone penetration over the past decade especially when compared to growth in fixed phone and Internet subscription over the same period. In the broader East African Community, however, which includes Burundi, Kenya, Uganda and Tanzania, Rwanda has much lower levels of ICT penetration. Rwanda has the second least number of mobile subscribers as well as fixed-line users among the EAC countries (Usengumukiza, 2009).

ICT reportedly remain the most attractive area for Foreign Direct Investment, assuming 23% of the total investments in Rwanda in 2006. The country currently boasts a host of ICT projects which together will contribute significantly to the country's ICT infrastructure and its integration into the global economy:

- The Rwanda National Backbone Project;
- Regional Communication Infrastructure Project;
- Kigali Metropolitan Network;
- Kalisimbi Project; and the
- East African Submarine Cable System Project which aims to connect countries of eastern Africa via a high bandwidth fibre optic cable system, to the rest of the world (Usengumukiza, 2009).

The Rwanda Development Board – IT, which is the former Rwanda Information Technology Authority (RITA), has reportedly initiated dialogue with major telecommunication operators aiming at defining an innovative model of sharing network infrastructure. This sharing model is expected to reduce considerably the cost of network access and therefore will allow new service providers to enter into play with the hope that the price of usage will go down and this will increase the number of users especially ICT services in remote areas.

Education

The Government of Rwanda offers nine years of free basic education: six years of primary and three years of post-primary education as part of its attempt to expand access to basic education for all children. This policy sets it apart from other countries in the East Africa who mostly offer six years of free basic education.

Secondary education is divided into three levels. The lower level is a three-year programme of general studies for all students following primary education. The higher level, also three years, offers academic and technical /vocational options. (MINEDUC, 2009). Tertiary education is offered by the country's six public and 14 private universities as

well as by specialized public and private institutes (Rwanda Online, 2009). The country follows a 6-3-3-4 system as shown in Table 3 below.

Table 3: Structure of Education System, Rwanda

Level	Grade or Stage	Type	Number of Years
Primary	Primary		6
Secondary	Junior	General	3
	Senior	Academic or Technical	3
Tertiary	University Undergraduate	Degree	4
	Polytechnics	Higher National Diploma	3

Source: US Embassy of Rwanda, 2010

As indicated earlier, Rwanda has performed well in terms of primary enrolment. After the introduction of fee-free primary education, the gross enrolment rate increased to 147% in 2008. Part of this increase is accounted for by the catching up of out-of-age children who were unable to attend school during the war, as well as repetition rates of up to 20% and which boosted enrolment figures in the past. Importantly, the net enrolment rate has risen from 73.7% in 2001 to 94.8% (95%) in 2007, indicating that Rwanda is well on track to achieve some of the key MDG targets for education. However it is also noteworthy that completion rates particularly in secondary education is very low which remains a major challenge for Rwanda's education system. Table 4 provides an overview of the state of Rwandan education system, using standard education indicators.

Table 4: Education Indicators Rwanda, 2007[58]

Indicator	Performance
Gross Enrolment Ratio – primary (2007)	147%
Net Enrolment Ratio – primary (2007)	94.8%
Primary completion rate (2007)	75%
Lower secondary completion rate (2007)	23%
Upper secondary completion rate (2007)	12%
No of students enrolled in higher education (2006)	37000
Pupil Teacher Ratio Primary	1:71
Pupil Teacher Ratio Secondary	1:30
Gross Enrolment Ratio – secondary (2007)	18%
Gender Parity Index for Gross Enrolment Ratio (2007)	1.01
Number enrolled in primary school (2007)	2,019,991
Adult Literacy Rate (% aged 15 and above)	64.9% (HDR, 2009)

Source: UNESCO Institute of Statistics, 2009

In recent years the Rwandan Government's efforts to increase the number of students attending secondary school has been considerable. The Rwandan Government has contributed to the development of public schools and subsidized schools, as well as initiating a policy to encourage and mobilize the private sector and local communities to invest in education.

The majority of schools, however, are not equipped with enough desks and chairs. There is also a lack of play areas and sport facilities (Ministry of Educations, Science, Technology and Scientific Research, 2002). Many schools require additional classroom facilities. In order for some schools to function, they are obliged to borrow premises

58 UNESCO Institute of Statistics, 2009 http://www.schoolsandhealth.org/Lists/School%20Health%20Database/DispForm.aspx?ID=86 (20 November 2009

that are not designed for teaching and learning – for instance, churches, District Headquarters, individual houses and even aeroplane hangars. More than half of the classrooms constructed are built with "durable materials," while 38% are built with semi-durable building materials. However, there are still classrooms built with wattle and mud. In some cases, classes take place under plastic sheeting, under trees or without any premises (eAfrica Commission, 2007). It is also estimated that just 15% of Rwandan primary schools have access to electricity (MINEDUC, 2009).

In terms of bandwidth and connectivity, a mapping questionnaire sent to the Ministry of Education and principals in 2006 revealed that 10% of Rwandan schools currently have some level of Internet connectivity. Of these schools, it was estimated that 5% could be considered to have broadband access where individual users may have Internet access at 256Kb/s. The respondents also estimated that 4% of the overall education budget is utilised for connectivity. In terms of meeting the deliverables for bandwidth and connectivity, Rwanda indicated that it has reviewed the national strategies to deliver broadband connectivity to schools to ensure that all technological choices made within this strategy make provision for upgrading and replacement of technological options as new and cheaper choices become available, rather than locking schools and the system into single technological choices for extended periods (eAfrica Commission, 2007).

sRwanda also suffers from a severe shortage of professional personnel. A skills audit report in 2009 revealed that Rwanda's very low level of human capital which is the product both of underinvestment historically in education and workforce development, exacerbated by the 1994 genocide, constitutes one of the country's most critical challenges. Despite remarkable progress that has been made in higher education and capacity-building, evaluations of programmes still emphasize that capacity constraints are one of the most critical obstacles to programme implementation in the country. Respondents to the survey conducted for the skills audit, assessed their staff capacity at 60% of their short-term requirement, which shows a 40% staff deficit, with the private sector showing a deficit of 60% for their short-term needs. The public sector deficit is estimated at 30% and civil society at 5%. The skill deficit exists at all levels but is most acute at the technician cadre, where the gap is 60% of the requirement (Ministry of Public Service and Labour, 2009).

Rwandan Education Policy

The Government of Rwanda's primary education objective is to reach universal primary education by 2010 and to reach the Education For All goals by 2015. The country's specific educational priorities are outlined in its Education Sector Strategic Plan (ESSP). The ESSP's central objective is focused on the role of education in poverty reduction and its relevance for social and economic progress in Rwanda. The ESSP reiterates the education sector's mission to transform Rwandan citizens into skilled human capital for socio economic development by ensuring equitable access to quality education that combats illiteracy and promotes science and technology, critical thinking and positive values.

It emphasizes that the role of education as developing all girls and boys of school going age, into well-rounded personalities and to encourage their spiritual, moral, social, and cultural development. It also proposes to instil deep respect for human rights and fundamental freedoms, peace and understanding, tolerance, and friendship among all nations. The ESSP also states that Rwanda's education system will be characterised by the inculcation of good values and attitudes in Rwandan culture including the promotion of gender equality and equity.

The ESSP also emphasizes the development of life skills, practical and entrepreneurial skills all levels of the education system; that attention will be given to the quality and relevance of education content as well as the improvement of efficiency and cost-effectiveness through the improvement of management and administration capacities.

The ESSP involves five-year rolling plans geared towards achieving specific education policy objectives. Since 1996, the policy focus has been on achieving quality universal primary education by 2015, consistent with the Education for All goals. Linked to this is the introduction of nine years of free basic education for all Rwandans. In addition, the ESSP includes the increase in education opportunities for early childhood development, adult

literacy, secondary and tertiary education and special needs education. It also prioritizes improvement in the management, administration of education as well as enhancing its quality, efficiency and cost-effectiveness. Since ESSP 2006–2010, the focus has been on improving science and technology in education including incentives for science and technology teachers, with special attention on the integration of ICTs.

The latest ESSP2010–2015 reinforces the priority on fee-free education, HIV, Tri-lingualism as well as Science and Technology and ICT. It also places emphasis on achieving equitable educational access, improving the quality of educational provision and promoting skills development to meet labour market demands. The latter includes the establishment of a curriculum that promotes the development of skills including life skills and social cohesion and making stronger connections between the content of education and training programmes and the needs of the labour market. It also includes among its priorities the promotion of equal access to the most vulnerable groups in society, including special needs education and ensuring the reduction in regional disparities and an increase in gender parity, in keeping with the Education for All objectives. Furthermore, since the number of children in Rwanda with special educational needs comprises a much larger proportion of the school-age population than would normally be expected, due to the war and genocide, special provisions are considered either within the formal school system or in special facilities.

The above suggests that Rwanda's socio economic development has made significant progress since the ending of the devastating genocide in 1994. This is evident not only from its consistent economic growth over the past decade, but also from being on track to achieving key Millennium Development Goals including universal primary education. However, Rwanda remains a poor, low-income country with a very young population, and poor infrastructure with subsistence agriculture still occupying a significant proportion of economic activity.

From a policy perspective, education is a priority because it is envisaged to play a crucial role in the eradication of poverty which is strategically linked to Rwanda's strategy for socio-economic development and the growth of its labour market. Linked to this policy perspective is the broader policy vision for the country and the specific role that ICT in education can play within such a vision.

Policy Features

Overview

In January 2009, the Government of Rwanda published a draft ICT in Education Policy which was designed to guide the numerous initiatives and projects that have been mushrooming across the country over time. The Policy provides a common programme that coordinates new and existing initiatives. At this stage, the Policy is still in draft form and will reportedly be finalized soon.

Policy Objectives and Principles

The purpose of the ICT in Education Policy is to promote the creation and delivery of educational products more effectively by channelling the implementation of all ICT in Education projects through the agency of the Ministry of Education. Building a common understanding among all stakeholders on the meaning of ICT in education is a specific policy objective. The Policy also aims to define synergy between various implementers of ICT in Education in the country and to demarcate clearly between policy owners and implementers. The Policy serves to develop mechanisms for prioritizing projects on ICT in education especially in view of the rapid growth in the number of initiatives in Rwanda. Linked to this is the need to harmonize these efforts and those between the centralized and decentralized levels of the education system. The Policy also aims to strengthen Rwanda's efforts to export ICT in education models to the East African Community, the Common Market for Eastern and Southern Africa (COMESA) and the rest of Africa.

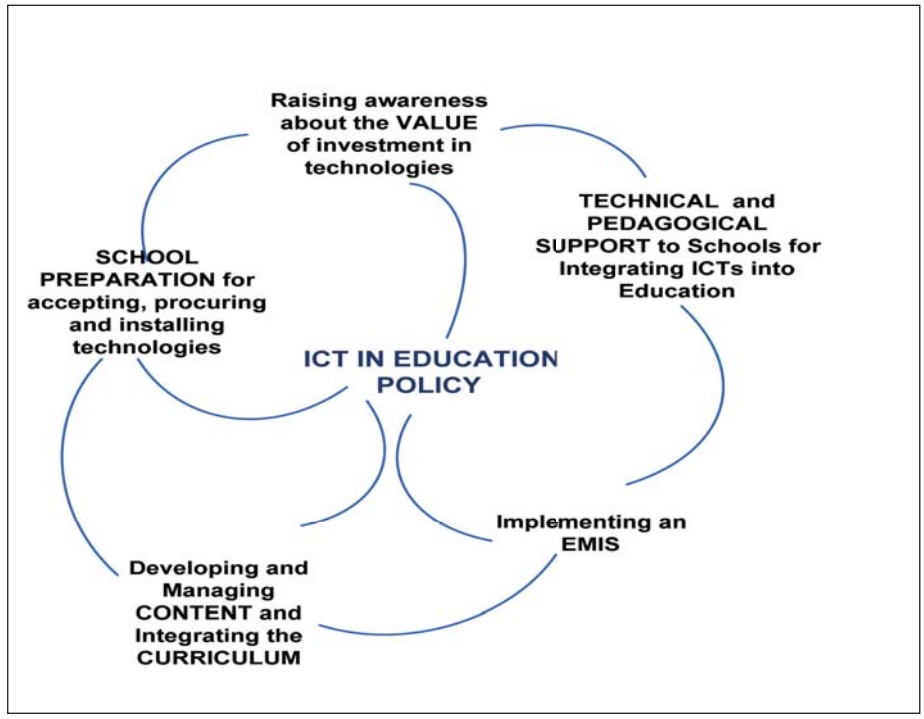
These policy objectives are informed by four key principles which include the maintenance of quality education, making education labour market relevant and promoting education access and equity in education. These principles balance education development with social redress and pragmatic economic and labour market imperatives.

The Policy states in its conclusion that, through ICT in education, it expects to achieve an increase in access to formal and informal basic education where ICT would be used as tools for learning, teaching and information sharing. It also hopes for an improvement in the quality of basic education and the promotion of independent and lifelong learning as well as the development of a workforce equipped with ICT skills needed for employment and use in a knowledge based economy. It also proposes that the ICT in Education Policy guide the drafting of ICT competencies with reference to knowledge, skills and attitudes in classroom practice. Here it identifies e-learning processes, operational skills and social and ethical competencies as three key categories for consideration. Finally, it envisages that the Policy will ensure that Rwanda has in place an ICT-driven process that supports effective decision making in resource allocation, strategic planning, and monitoring and evaluation of educational policy implementation.

Policy Content

The content of the ICT in Education Policy centres mainly on focus areas and policy priorities for intervention. It highlights four major focus areas to be addressed by the MINEDUC. These four areas relate to raising the awareness of all stakeholders in the education system about the value of investing in technology. This is linked to preparing schools to accept, procure and install technology. In addition it proposes to implement an Education Management Information System (EMIS) and provide ongoing technical support. This is linked to developing and managing content, integrating the curriculum and providing technical and pedagogical support to schools for integrating ICT into Education. The four focus areas are shown in Figure 1 below.

Figure 1: Policy Focus Areas



In addition, the draft Policy also includes 12 programmatic areas. These include, *inter alia*, the training and capacity-building of teachers and matters related to content, curriculum and assessment.

Teacher Professional Development

The GoR acknowledges in the ESSP that teachers are the main instrument for bringing about the desired improvements in learning and states that the education sector consists of policy-makers, administrators, teachers, students, and parents, and other relevant stakeholders all are responsible for contributing to the task of ensuring that educational goals are achieved. The ESSP also acknowledges that the use of ICT in learning, teaching and education institution management compels the emergence of a different skills, attitudes and pedagogical approaches that require continuous training programmes to build sufficient capacity among teachers, developers, educators and administrators. Here, the Policy suggests that training will take place in the form of pre-service, in-service and continuous professional development opportunities in areas of ICT literacy, content development, pedagogical teaching approaches using ICT, Educational Management Information System capacity-building and maintenance of ICT facilities to make sure they are available at all times to all users.

The draft ICT for Education Policy proposes that ICT-enabled training methods be explored, including distance education, e-learning, and blended learning and that training will be offered continuously to enable teachers to keep abreast of technological and pedagogical developments. The Policy specifically proposes a host of mechanisms for the continuous development of teachers, principals, inspectors and head teachers. These include pre-service teacher training, in-service teacher professional development, ICT literacy training programmes for all teachers as well as professional development opportunities for school inspectors on the integration of ICT in learning and teaching. It also includes supporting head teachers to establish an ICT vision for schools, training curricula developers on creating and developing digital learning materials, training education administrators, developing standards as well as a cadre of technical expertise to manage and maintain ICT facilities at all levels and to optimize uptime. It also proposes to use UNESCO's ICT Teacher Competency Standards to plan appropriate training for teachers; to develop mechanisms to manage the quality of training and to use ICT to scale innovations from training.

Since the development of the Policy, MINEDUC has been able to develop a draft ICT for Teacher Professional Development Matrix with the support of the Global eSchools and Communities Initiative. This matrix is based on the UNESCO ICT Teacher Competency Standards and considers the progressive evolution of teacher professional development from an emergent stage of integrating ICT in the classroom towards a "knowledge-deepening" stage where the integration of ICT in teaching and learning practice occurs at a deeper and more advanced level. This matrix is currently under discussion and aims to integrate the authentic contexts of Rwandan teachers more intimately.

Pedagogical and Curricula Change

The Policy proposes a host of measures to support the integration of ICT in the country's national curriculum reform process and in support of continuous pedagogical improvement. It does so by articulating what is possible in the short- to medium-term and how to consider longer-term curriculum and pedagogical reform enabled by ICT. The Policy recognizes that ICT can play an integral role in enhancing the relevance and quality of the national curriculum at all levels. Here the emphasis is on regular curriculum reviews to ensure that competencies are developed that are also "culturally aligned."

It proposes that in the short- to medium-term, available electronic content can be integrated in learning and teaching practice while Rwanda develops its locally relevant electronic content. In addition, educators are encouraged to conduct their own research and to create their own digital materials to be used in the classroom, and also to apply project-based learning, requesting learners to conduct research and prepare digital materials for their assignments. It proposes that content produced in this way has to be aligned with the curricular goals and objectives of the national education policy. It proposes that guidelines be developed to promote and encourage the development and regulation of high-quality local e-content, while ensuring that the content is made uniformly available in all learning institutions through the use appropriate ICT.

It also proposes that ICT be used in assessment, by developing means and services that can provide the Rwandan National Examination Council with the competitive edge it needs to align with the East African Community and to provide transparent, interactive and more customer driven services. Linked to this assessment process, the Policy proposes that a computer science curriculum be available for primary and secondary school students; that appropriate mechanisms and guidelines for regulating the development and use of electronic content be developed; that options for obtaining copyrights of existing electronic material in the medium term be explored; that national curriculum-aligned content in all subjects be produced in the long term; and that teachers be enabled to use Open Educational Resources, create and share knowledge.

The Policy also makes reference to the creation of a national education portal of digital learning material to be accessed by all schools and the development of training manuals for pre-service teachers, and calls for learners and educators to be empowered to encounter Internet-related risks to privacy and content quality and that guidelines be developed for the ethical use of ICT. It also highlights the contribution ICT can make with reference to examinations and tests. It calls for the use of ICT to design tests and collaboration with international bodies to build standardized tests and item banks; to align examination and testing tools with revised digital curriculum and incorporating ICT based student assessment tools. The Policy mandates Rwanda's National Curriculum Development Centre to lead the coordination for the development of electronic content.

Policy Implementation Framework

The framework for the implementation of Rwanda's ICT for education policy is outlined in its recently developed Costed Strategic Implementation Plan for ICT in Education.

The objectives and rationale for the Implementation Plan is to provide strategic direction by helping to shape, regulate and monitor initiatives in ICT in Education in response to new national requirements and opportunities. It also serves to provide a framework for coordinated action across economic and governmental sectors and a tool to overcome two major challenges: adaptation to change and coordination of ICT in Education initiatives.

The Implementation Plan also articulates more clearly an education-centred vision and mission statement. Its vision statement calls for "A nurturing, effective teaching and learning environment that will enable all Rwandans to reach their individual potential and to become well-rounded, critically thinking citizens of an innovative, knowledge-based economy" (MINEDUC, 2009).

Its mission is to harness the power of ICT to "increase access, enhance diversity, include new categories of learners, foster skills and build capacity of all those involved in providing education" (MINEDUC, 2009).

The Implementation Plan is designed for the period 2010–2015 and recognizes that process of enhancing education is a long-term objective that requires continuous and rigorous planning, monitoring and evaluation. To ensure sustainability, it proposes a realistic overview of ICT in Education programmes and activities, and monitoring and evaluation tools that will be designed for their optimal management.

This Implementation Plan outlines more clearly the value proposition for the investment in the integration of ICT in Rwanda's education system. This proposition is premised on the claim that ICT can enable the achievement of educational access, equity, quality and relevance.

With reference to expanding educational access it proposes various channels that can help reach learners outside the traditional classroom and will be extended to groups with the fewest educational opportunities. These channels include radio, television and the Internet, all of which can provide distance education opportunities to large numbers of learners. Isolated communities, early school leavers, young adults and people with special needs can shift learning from a one-time event to a lifelong learning process via the formation of new communities of learning.

The quality and relevance of teaching and learning is enabled by ICT through the integration of ICT in teacher professional development and the provision of range of educational resources for teachers.

The Implementation Plan also suggests that ICT can also be used to train new teachers and give ongoing support to in-service teachers, offering more immediate access to pedagogical resources and enhancing communication and collaboration. Access to quality educational materials benefits students as well, as they can use digital libraries and various online resources. Moreover, students are given the opportunity to acquire computer and information literacy and develop new technological skills, essential for a knowledge-based society. In this way ICT-enabled learning and teaching can make learning more relevant to the requirements of an evolving labour market.

It proposes the adoption of the Logical Framework Approach (LFA) to describe the major programmes and projects and a log-frame matrix be developed for each programme and project. Activities and programmes that are already implemented or planned will be reviewed, and priorities will be defined, in line with the Implementation Plan.

It also proposes that performance indicators be developed and reviews of programmes be conducted on a regular basis in order to evaluate the success of the Implementation Plan. This Plan will be updated regularly, in accordance with the results of the monitoring and evaluation processes

The Implementation Plan also states that a detailed road map with timelines and clearly defined roles and responsibilities of various players will also be developed subsequently to implement this Implementation Plan. The plan identifies seven key priority areas for implementation, which are drawn directly from the ESSP. These are outlined in Table 5.

Table 5: Priority Objectives and Anticipated Results

Objective	Anticipated Result
Promoting an ICT in Education Culture	Spread awareness, knowledge and use of ICT in Education
Foster and Manage ICT in Education Initiatives	Develop a framework and guidelines to attract initiatives
Expand ICT Infrastructure to Improve Access and Equity	Develop ICT infrastructure serving the education sector
Develop capacity to integrate ICT in education practices	Develop the capacity to use ICT among teachers, learners and administrators
Develop and distribute quality digital content	Develop and distribute quality digital content within the country and the region
Support the development of content networks	Support the development of national and regional content networks for research and academic purposes
Establish Open and Distance eLearning	Expand access and equity through ODeL

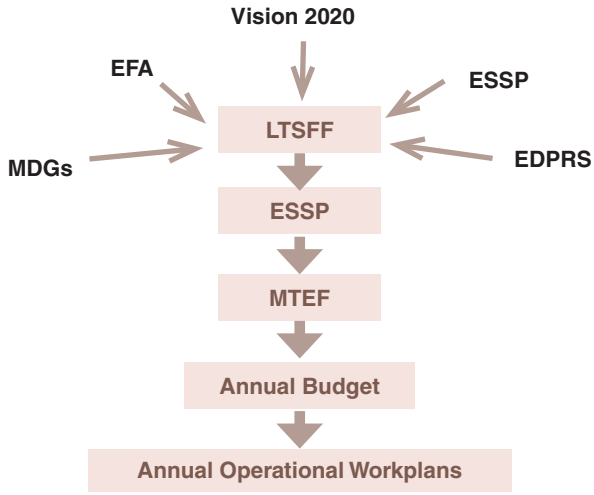
The Implementation Plan is referred to as a Costed Implementation Plan because it includes details of a cost model for each of the activities linked to the objectives stated in Table 5. This is linked to a proposed financing strategy that is not yet stated in the Implementation Plan.

Financing

The financing of the ICT in Education Policy and Costed Strategic Implementation Plan for ICT in Education in Rwanda has to be considered within the GoR's broader financing strategy for education. The GoR's education sector has a Long Term Strategy and Financing Framework (LTSFF) which spans over ten years from 2006 to 2015, and which is guided by Vision 2020, its EDPRS and the Education for All goals.

The ten-year LTSFF informs the ESSP, which spans over five-year rolling periods. The location of the LTSFF in relation to the other policy and planning instruments are shown in Figure 2 below.

Figure 2: Finance Planning Framework



This framework suggests that the total expenditure for education will require USD255 million by 2010 and USD400 million by 2015, using GoR resources, budget support and additional donor resources. Based on resource projections in 2006 for the period ending 2015, if the education targets are to be met, the LTSFF estimates that there is a significant financing gap in the medium to long term. This gap is estimated at USD81 million in 2010 and USD63 million in 2015 and the LTSFF suggest further that there is an urgent need to attract longer–term, more predictable and flexible financing.

According to the Implementation Plan, the indicative budget for the major activities as outlined in the log-frame which includes ICT infrastructure, content and capacity-building for a period of five years, is approximately USD79 million USD. The Implementation Plan does not indicate how this budget will be financed. It is understood that once the Ministry of Education has been able to finalize the Implementation Plan in terms of what will be required, a resourcing strategy will be developed accordingly.

The Policy Rationale

The 1994 genocide, the associated internecine ethnic rivalry and parochialism weigh on all Rwandans. This strengthens the resolve of the Government leadership to lead the country out of the dregs of grinding poverty, disease and devastation. During the period 1994 to 1998, much of the emphasis was on stabilizing Rwanda in the post-genocide period, largely through humanitarian assistance. Since 1998, the emphasis in Government thinking was on sustainable development and the enabling role of ICT.

The President of Rwanda, as head of state has demonstrated solid visionary leadership and serves as a dedicated driving force in an endeavour to reclaim a unified Rwandan identity and to leapfrog Rwandan society into the twenty-first century. These sentiments feature prominently in the GoR's policy rationale.

President Kagame and his office have demonstrated abundantly their belief that ICT have a powerful enabling role to play in the economic, social and cultural development of the country in the aftermath of the 1994 genocide. The GoR's Vision 2020 adopted in 2002 is the outward expression of the Government leadership's sentiment to fast-track the development process and its driving role for all other policies are clearly manifest in the ICT in Education Policy and the Costed Strategic Implementation Plan for ICT in Education. Vision 2020, the National Information and Communication Infrastructure Plans (NICI), the ICT in Education Policy and related Implementation Plan make significant reference to the role ICT can and will play in developing a Rwandan, knowledge-based society and economy. They also place emphasis on the role of ICT in preparing the future workforce for shifts in the country's labour market structure and in the integration of the Rwandan economy in the global economy.

That Vision 2020 is also embedded within the Millennium Development Goals and Education For All objectives reflects its pro-poor bias and here too, an understanding that ICT can play an enabling role in attempts to eradicate poverty. There remains a bold technology-centred focus in this Vision, although the educational imperatives are emerging increasingly strongly in subsequent iterations of ICT for Education policy documents. The latest version of the draft Costed Strategic Implementation Plan for ICT in Education underscores an educational rationale and the value that ICT can bring in delivering equitable, relevant, accessible and quality education. Whilst the latter does not provide a clear vision of curriculum reform and teacher professional development, the Implementation Plan is considered a starting point and considerations for curriculum reform and teacher development will be included as the strategy for the implementation of ICT for Education in the country evolves over time.

Another important rationale for an ICT for Education Policy is an attempt by the GoR to coordinate, harmonize and synchronize the increasing number of projects and programmes on ICT in Education in Rwanda. The added rationale is to guide the management of present and future partnerships, stakeholders and projects around a consolidated national programme in education.

While the leadership for the policy process related to Vision 2020 resides in the President's office, the leadership for ICT in Education resides within the Ministry of Education and within it, the ICT in Education and Open and Distance eLearning Department.

The stakeholders involved in the policy process are outlined in Table 5 below. The Government and their agencies play are leading stakeholders in this endeavour.

Table 5: ICT for Education Stakeholders, Rwanda

Stakeholder Category	Stakeholder	Role
Central Government	President's Office, Ministry of Education, Ministry of Infrastructure, Ministry of Finance, Ministry of ICT	Overall direction in line with national goals and priorities
Government Agencies	Rwanda Utilities Regulation Agency National Curriculum Development Centre Kigali Institute of Education Kigali Institute of Science and Technology incorporating the Regional ICT Research and Training Centre Rwanda Development Gateway Group	Support with delivery and implementation of ICT in Education programmes nationally
Ministry of Education	National Provincial District School management and administration Teachers	Coordination and oversight on all ICT in Education programmes and policies
International Private Sector	Agile Learning Microsoft Corporation Intel CISCO	Support and partnership with Ministry of Education and GoR in delivery of ICT in Education
Local Private Sector	Private Sector Federation Rock Global Consulting	Work with Government and its partners in delivery of ICT in Education programmes and projects
Donor and Development Agencies	USAID DFID UNESCO	Partnership with Government in delivery of broad education goals and with specific projects related to ICT in education
Civil Society and NGOs	OLPC Foundation Global eSchools and Communities Initiative Open Learning Exchange	Technical support to Government on matters relating to ICTs in Education
Community Organizations	CBOs Faith-based organizations Parents Parent–Teacher Associations	Support in local delivery of ICT in Education programmes and projects

The Policy Development Process

Steps in Policy Development

Generally, the policy development processes, from Vision 2020 to the draft Costed Strategic Implementation Plan for ICT in Education, have been consultative, inclusive and involve multiple stakeholder groups and communities.

Vision 2020 was developed through a process of national consultation between 1997 and 2000 through discussions and debates involving a wide range of stakeholders including leadership at all levels in the business community, Government, academia and civil society.

A national consultative process took place in Village Urugwiro in 1998 and 1999. Broad consensus was reportedly reached on the necessity for Rwandans to clearly define the future of the country.

In parallel, the process for developing the NICI plan began in 1998 with the support of the United Nations Economic Commission for Africa (UNECA) and involved a series of workshops which included a number of stakeholders. A document entitled ICT-led Integrated Socio-Economic Development Framework was released in 1999 for national debate and consultation. This document laid the basis for the first NICI plan. Multi-stakeholder workshops were organized by the Government of Rwanda, and those related to education were managed by the Ministry of Education. The NICI plan workshops repeatedly highlighted the critical importance of human resource development.

Similarly, the ICT for Education Policy was developed with the support of the Global Education Alliance (GEA) who supported a multi-stakeholder workshop and an international consultant to help with drafting the policy document. The ICT for Education Policy is in draft form and the Government of Rwanda has consistently encouraged comments and input from stakeholders before finalizing.

Similarly, the draft Costed Strategic Implementation Plan for ICT in Education was developed in consultation with a wide range of stakeholders and with the support of the Academy of Education and Development (AED) and the Global eSchools and Communities Initiative. The process began with the drawing up of the draft ICT in Education Policy and was followed successively by a presentation of the key focus areas to the main stakeholders, the mapping of the major ICT in Education initiatives and a Strengths Weaknesses Opportunities and Challenges (SWOC) analysis that was carried out with key partners in a workshop in June 2009. It is the product of much discussion and collaboration with a wide range of stakeholders and aims to encompass the visions and principles of all the parties involved (MINEDUC, 2009).

Figure 5 illustrates the steps in the policy development process in general and with particular reference to ICT for Education in Rwanda:

Figure 5: Steps in Policy Process

Governance of the Reform Process

Institutional Framework

The Rwandan Education Board (REB) was set up by the Government in October 2009 as an umbrella institution under the supervision of MINEDUC. It is mandated to contribute to education policy and coordinate and fast-track education activities. The education implementation agencies in Rwanda belong to the REB, including the ICT in Education and Open Distance and eLearning Department. This department was created in 2009 as an outcome of the ICT in Education Policy. Its core function is to coordinate ICT in Education initiatives and to promote partnerships.

An Executive Committee will oversee the department's activities and have representation from most relevant stakeholders from the Governments such as MINEDUC, the Ministry of Infrastructure and the Ministry of Economy and Finance and from the private sector at local, regional and global levels. The committee will examine the implementation and progress of the Department and will provide strategic direction.

The *Implementation Plan* contains an "institutional vision," which suggests that the ICT in Education and Open, Distance and eLearning Department will seek to be, "The strong and viable organization of choice that acts as an honest broker to promote ICT in Education within Rwandan society and beyond through public and private partnerships."

The department serves to coordinate activities, build collaboration with stakeholders and mobilize expertise. Its core functions are, *inter alia*, to support the implementation of the ICT in Education Policy and the Implementation Plan; develop total cost of ownership models, define technical standards; harmonize implementation efforts; strengthen public-private partnerships; supervise teacher training and capacity development; ensure monitoring and evaluation and manage relevant information systems.

Instruments to Regulate Public Private Partnerships

The Implementation Plan states further that the core values of the ICT for Education and ODeL Department serve as guiding instruments to regulate public-private partnerships. These include:

- *Collaboration* with partners from the public and private sectors, at the local, national, regional and international levels through a collaborative mechanism that will enable partners to interact and air their views.
- *Accountability* for its decisions by clearly articulating processes that guide multi-stakeholder partnerships and ensuring all decisions are made in a fair and equitable manner, in line with this Strategic Plan.
- *Pro-activeness* in all fields relating to its mission by consulting ICT in Education experts and staying abreast of innovations.
- *Community Consciousness* by ensuring that all its activities ultimately benefit the community by involving key players in the definition of activities and providing access to ICT in educational institutions.
- *Results oriented* by committing to results that will be measured, evaluated and adjusted periodically.
- *Responsiveness to changing situations by* identifying and adapting to change in a timely through rigorous monitoring.

Partnerships currently in Existence

The Rwandan Ministry of Education has already established a host of partnerships with donor, development agencies and private sector. Table 6 lists some of the key partnerships in existence and the projects currently under way.

Table 6: Current Partners in ICT for Education

Name of Partner	Projects
Global Learning Portal	Rwandan Education Commons
Global e-Schools and Communities Initiative	Strategic advice, technical support, capacity-building and partnership enablement
UNESCO	National Monitoring and Evaluation Framework for ICT in Education programmes and Projects
One Laptop Per Child Foundation	OLPC XO distribution to primary school learners
Intel	Classmate PC Pilot Project
Microsoft	OLPC on Windows Pilot; Partners in Learning Project
Agile Learning	EMIS Project
USAID	Rwandan Education Commons

Importantly too, Rwanda has developed partnerships with other African countries, particularly in the East African Community, a regional intergovernmental organization. Rwanda's President Kagame chairs the East African Community which includes representation from the Governments of Burundi, Kenya, Rwanda, Tanzania and Uganda. At its recent ten-year anniversary in November 2009 the EAC noted that Science and Technology as the strategic driver for EAC development. At the time, the EAC also endorsed a call for a laptop project for all children in the region and signed an Memorandum of Understanding with the One Laptop Per Child programme.

Policy Alignment and Consistency

There is strong alignment between the Government of Rwanda's ICT in Education Policy , its Implementation Plan and its umbrella policies and vision statements.

Vision 2020

The Government of Rwanda's long term vision for the country's socio-economic development is enshrined in its Vision 2020 document which was endorsed in 2002. This Vision drives and informs all of Government national policy, Government ministries and their relationships with partners. Vision 2020 aspires towards Rwanda becoming a modern, strong, politically stable and united nation built on sound fundamental values. The Vision serves as a beacon to mobilize Rwandans in a shared endeavour to build a better society and future and develop a "united and inclusive" Rwandan identity. In doing so, one of its key objectives is to transform Rwanda into a middle-income economy with a per capita income goal of $900 USD by 2020, a radical shift from the annual per capita income of $220 USD achieved in 2000. It also aims to develop Rwanda into a knowledge-based service hub in the African region, with high levels of savings and private investment. Vision 2020 is essentially based on the Millennium Development Goals and has a pro-poor bias.

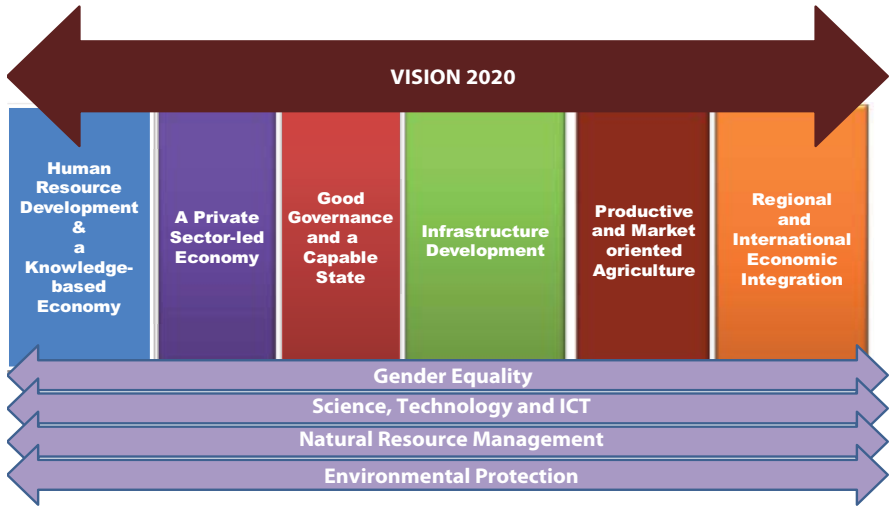
The Vision expresses short-, medium- and long-term objectives. In the short term, it places emphasis on macro-economic stability and wealth creation to reduce aid dependency. In the medium term, it focuses on the shift from an agrarian to a knowledge-based economy and in the long run, a shift from reliance on agriculture as an engine for growth and a move towards secondary and tertiary sectors, particularly the services sector. In the long term, it envisages the creation of a productive middle class and fostering entrepreneurship which includes the provision of high-quality educational services in science and technology. It also states the aim to find a niche market in becoming a telecommunications hub.

Realizing this Vision is dependent on the effective transformation of Rwanda's education system.

Figure 3 below depicts six interconnected pillars of this *Vision* and cross-cutting issues. The latter includes ICT. It shows that human resource development and a knowledge-based economy feature prominently as one of the six key pillars of the GoR's programmes for socio-economic development and it mainstreams ICT and Science and Technology throughout the Vision. With reference to the human resource development pillar, the Vision articulates a commitment to reach the Education for All goals and gives due recognition to education and training and education quality.

It places emphasis on vocational and technical training in technology, engineering and management, targeted at secondary school leavers as well as various sections of society. In an attempt to encourage skill development it proposes micro credited schemes to extend finance to self-employed young technicians and places special emphasis on innovative small-scale entrepreneurs. It also proposes to launch programmes that promote efficiency and continuous upgrading of skills through on-the-job training, in-service training and distant learning.

Figure 3: Vision 2020 Pillars and Cross-cutting Issues



The Vision's Infrastructure Development Pillar includes the liberalization of the telecommunications sector and sets the target for Internet access to all secondary schools and a large number of primary schools by 2020.

The gender-responsiveness of the Vision is noteworthy, particularly with gender equality as a cross-cutting theme. It specifically highlights the minority status of girls in secondary schools and the limited opportunities and decision-making positions of women at the time when the Vision document was formulated. It articulates a need to foster gender equality by promoting the secondary education of girls and promoting opportunities for women.

With reference to Science and Technology and ICT as a cross-cutting issue, the Vision proposes developing enough highly skilled scientists and technicians to satisfy the needs of the national economy.

Economic Development and Poverty Reduction Strategy

Nested within Vision 2020, is the Economic Development and Poverty Reduction Strategy, which translates and operationalizes the Vision into implementable programmes within a medium-term framework. It serves as a road map for Government, development partners, the private sector and civil society.

The EDPRS advocates the use of ICT for an education system tailored to the needs of the labour market and one that is regionally competitive. In terms of its educational policy objective it emphasizes the increasing coverage and quality of nine-year basic education, strengthening Technical and Vocational Education and Training (TVET), and

improving the quality of tertiary education. It also articulates a concerted effort to build scientific capacity through scientific research, knowledge transfer and developing a culture of innovation by protecting intellectual property. In relation to infrastructure objectives, the EDPRS states that efforts will be made to promote investment in, and the growth of the Information and Communications Technology industry.

National Information and Communication Infrastructure Plans

Integral to GoR's Vision and EDPRS is the GoR's National Information and Communication Infrastructure (NICI) Plan, which was first adopted in 2000 and which rolls out in subsequent phases of five-year cycles. The first cycle (2001–2005) and second cycle (2006–2010) represent the most comprehensive guiding document on ICT in Rwanda.

NICI Phase I had 24 of its 59 programmes linked to Education and Human Resources Development. In Phase II the GoR commits to:

- the use of ICT for formal education by encouraging and making more affordable the access of educational institutions to the Internet;
- the use of ICT in informal education by encourage the development of locally relevant informal educational material;
- the improvement of formal and informal education by the introducing certification and accrediting institutes that provide certified training, developing training schemes for teaching ICTs to teachers and encouraging continued ICT in Education and professional development.
- raising public awareness of ICT and encouraging the media to allocate time for news about general technological development, ICT educational programmes and ICT progress in Rwanda.
- helping educational institutional improve their business processes by promoting a mutually beneficial exchange between academia, civil society and the private sector which will be beneficial to all.
- promoting research and development by developing partnerships between the private sector and academia; encouraging the start-up of R&D centres both in Academia and outside it, encouraging the set-up of technological incubators and by encouraging the set-up of technological competence centres.

As part of this phase, the GoR is focusing on interventions among ten sectors where ICT in Education is given priority. In addition to completing any unfinished tasks of Phase I, the major initiatives for Phase II are:

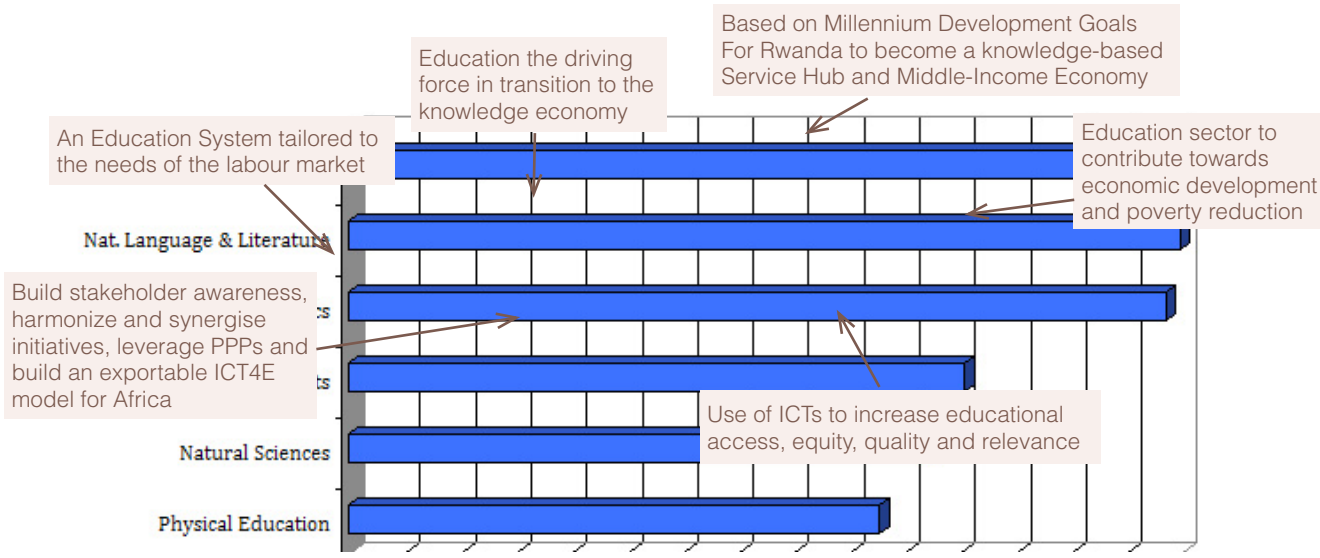
- training Primary and Secondary School Teachers on ICTs in Education;
- a Scholarship Management programme;
- a Rwandan National Library Network;
- developing New eLearning Content;
- implementing Education Management Information Systems;
- survey Educational Software; and
- converting Existing Computer Based Training and eLearning Content to Kinyarwanda.

It states the development of Rwanda's information and knowledge economy will depend heavily on how much its resources are invested in promoting the deployment utilization and exploitation of ICT in the Educational Systems (NICI, 2006).

Rwanda's specific educational priorities are outlined in its Education Sector Strategic Plan (ESSP) to which the Republic of Rwanda's Policy on Science, Technology and Innovation (2006) and later, the draft National ICT in Education Policy, are both linked. The former places emphasis on the importance of science and technology at all levels of human resource development including in primary, secondary and tertiary education. The National ICT in Education Policy elaborates further on the education objectives of the Government's Policy on Science Technology and Innovation and serves as a guiding framework for a Costed Strategic Implementation Plan for ICT in Education

(2010-2015), which is currently also in draft form. Figure 4 below demonstrates each of these key policy frameworks and how they are nested within Vision 2020.

Figure 4: From Vision 2020 to Costed Strategic Implementation Plan



Evidently, Rwanda has a clearly stated long-term vision that sets the broad framework for subsidiary policies and process that are interlinked to the country's socio-economic development and the transformation of its education system with ICT. This case study demonstrates the interconnectedness and alignment of each of these policies. The above has shown clearly the extent to which there is consistency and alignment between the broader Government Vision and socio-economic development policy and strategy, the country's education policy and strategy and the ICT for Education Policy and strategy.

There is also consistency and strong alignment with the international policy context with reference to sustainable socio-economic development. The GoR's vision statement and subsidiary policies related to education centre around meeting the Millennium Development Goals and Education for All goals. The Rwandan President joined 147 leaders at the Millennium Summit Meeting in September 2000 to commit to the Millennium Development Goals. The GoR also adopted the six EFA goals for implementation and added a seventh as a demonstration of its commitment to reaching these goals. The seventh goal includes preventing the propagation and limiting the expansion of HIV/AIDS infection within and outside the school environment (MINEDUC, 2009).

At every level of recursion, policies outline in more detail both conceptually and operationally how the targets set by Government will be realized.

There is thus policy consistency with reference to the provision of fee-free basic education for nine years; the pro-poor bias and alignment with international development goals for education; the value of investment in ICT for socio-economic development and for modernizing Rwandan economy and society and the value of ICT integration in the Rwandan education system.

The GoR has also declared as policy the compulsory use of the English language as a medium of instruction. However, the ESSP and NICI policy documents refer to the use of trilingualism and the development of content in Kinyarwanda and no explicit reference is made to the use of language and medium of instruction with reference to education content. This suggests that the role of ICT in supporting the language policy in education requires further clarity and elaboration.

Monitoring and Evaluation

The ICT in Education Policy and Implementation Plan both make extensive reference to the value of continuous monitoring and evaluation in order to improve impact. As shown earlier, the ICT for Education Policy includes M&E as one of its 12 priority areas and recognizes that the implementation of the policy requires systematic Monitoring & Evaluation (M&E) by all stakeholders. It suggests that the purpose of M&E will be to research and develop ICT integration; learn from past experiences; improve implementation and service delivery; assess and allocate resources; enable the MINEDUC to coordinate all activities and be accountable to key stakeholders

Similarly, the Implementation Plan indicates that the two major goals for introducing a monitoring process will be to monitor progress of the ICT in Education and ODeL Department activities and to enable partnerships by providing tools to agree on, track and adjust objectives and processes.

The Plan commits the ICT in Education and ODeL Department to the provision of periodic reports on the progress of activities and financial statements to MINEDUC. The department will also produce regular donor updates and an annual report for MINEDUC and donors.

It will seek to involve all relevant stakeholders in the setting of indicators and the monitoring process, and ensure they are committed to its goals.

Indicators for the monitoring of activities will be developed at two levels. Quantitative and qualtitative indicators will be developed to measure access to ICT in Education and the impact on education quality. However, the five-year period covered by this Implementation Plan is rather too limited for direct measurement of impact of ICT on education quality. Baseline indicators will therefore have to be carried through to a subsequent plan for precise results (MINEDUC, 2009).

Evaluation of Activities and Programmes

At this stage, the MINEDUC and GoR policy documents refer to their commitment to integrate Monitoring and Evaluation in their programmes, activities as well as institutional arrangements.

These evaluation activities will include:

- The ICT in Education and ODeL Department carrying out regular evaluation of its activities and programmes in order to ensure that they are adequate and have attained the set targets.
- Situation analyses to be conducted prior to the implementation of the activities and programmes in order to establish a baseline.
- Programme plans will be reviewed on a quarterly basis to determine whether priorities should be adjusted.
- Long-term programmes will be reviewed at mid-course to ensure they are delivering results, in line with the Strategic Plan objectives and targets.
- At the end of partnership agreements and before renewing Memoranda of Understanding, the programmes or projects that have ended will be evaluated to determine if the original objectives have been attained, and if not decide on the next steps to be taken.
- With reference to specific evaluation of teacher training and learner skills, competency standards will be developed. Grade-level performance of learners will be measured, and teacher training evaluation will be based on the ICT Competency Standards for Teachers developed for UNESCO by a group of experts from the public and private sectors.
- Strong monitoring and evaluation schemes will be designed to ensure that all ICT in Education programmes and projects in the above fields are functioning at their utmost potential and to track and adjust objectives and processes.

M&E Activities to Date

To date there has been very limited Monitoring and Evaluation of projects and programmes on ICT in Education in Rwanda. One project that integrated an M&E process throughout the project is the NEPAD eSchools Demonstration Project, which involved 16 African countries, including Rwanda. This project incorporated a systematic M&E process throughout the project which lasted for two years. The M&E process was supported by InfoDev in partnership with the Commonwealth of Learning. This process included consultations with major stakeholders and revealed a host of key findings which are listed below.

Table 6: Lessons from the NEPAD eSchools Demo Project

Lessons	Implications
Unique country contexts should inform appropriate ICT4E models	A contextually-relevant framework for each country
Existing examples of good practice need to be drawn upon	Draw on the NEPAD Guidelines for Good Practice
Existing projects and organizations need to be included	Encourage collaboration with existing initiatives
Superb management expertise is imperative and needs to be developed	Bolster the capacity of the management agencies and incorporate a multi-stakeholder management strategy
Management capacity at all levels needs to be developed	Build management capacity in governments and schools
Senior leadership commitment is critical for success	Urge leadership commitment where these do not exist
Education systems need to be assessed for their 'readiness' to facilitate interventions of this kind	Conduct e-readiness assessments of each country by drawing on the NEPAD eSchools Business Plan guidelines
Implementation is more effective when local companies are involved	Involve local companies in next phase implementation
Local models for ICT integration to enhance pedagogy and curriculum reform need to be considered	Consult existing NEPAD frameworks for the integration of ICT in curriculum and improving pedagogy
Technical support and maintenance provision at school level is imperative	Technical maintenance and support needs to be localized at school level
Utilizing schools as one of many community hubs needs to be enhanced	Develop the role of the school's ICT infrastructure in supporting community development

The findings in Table 6 are generalized to all 16 African countries including Rwanda.

The One Laptop Per Child (OLPC) pilot project on Windows supported by Microsoft which is currently underway includes a third-party monitoring and evaluation process which was concluded by the end of March 2010. In addition, UNESCO is currently working with the Ministry of Education in developing a comprehensive framework for the monitoring and evaluation of the GoR's ICT programmes and projects.

Conclusion

Even though the Government of Rwanda's ICT for Education Policy and Implementation Plan are still in draft form, they reflect strong commitment, political will and determination to harness the potential of ICTto enable the development of a modern, effective and efficient education system. The experience with ICT in education projects in Rwanda to date together with their more conscious integration of monitoring and evaluation mechanisms bode well for significant stakeholder learning including that of the Ministry of Education and the GoR at large, in the period that lies ahead.

The GoR has also successfully secured partnerships with a wide range of international and local stakeholders including communities where education institutions are based. The ICT in Education Policy and Implementation Plan provide clear guidelines for the management of relationships between partners. That the MINEDUC has established its Rwandan Education Board together with its ICT in Education and ODeL department with dynamic and committed individuals is an added strength of the ICT in Education process in Rwanda.

However, the realization of Vision 2020 and its related policies, including the ICT in Education Policy and the Implementation Plan, is also confronted with a host of challenges. The infrastructural challenges faced by schools across the country, their low levels of readiness for the transformation that accompanies the integration of ICT in schooling environments, the high cost of access and use of ICT and the limited human resource capacity, skills and high turnover of expertise both within MINEDUC, among its partners and in the schools, collectively add many layers of complexity to the process of implementing an ICT in Education policy. It suggests that the system for the implementation of the Policy will be challenging and fraught with unanticipated breakdown as has been the case in a number of African countries over the past decade. The approach of the GoR to integrate a process of collective learning through its proposed monitoring and evaluation framework is one way in which the complexity and change in the education system can potentially be managed over time. In this way, the exuberance with which the policy vision and plans are discussed will match the challenging parameters imposed by reality.

Chapter 8

Using ICT Policy to Transform Education

Tayseer Alnoaimi
J. Enrique Hinostroza
Shafika Issacs
Robert Kozma
Philip Wong[59]

59 Authors appear in alphabetical order.

Introduction

All of the countries reviewed in the case studies are committed to improving and even transforming their education systems by using ICT. All see a connection between ICT-based educational change and economic and social development more generally.

Each country, however, is unique. They are all relatively small in population but they range in per capita GDP from USD900 (Rwanda) to USD50,300 (Singapore). They also range in the percentage of GDP expenditure on education from 2.9% (Uruguay) to 6.5% (Namibia). Each brings a unique historical, cultural, political, social, and economic context to bear on policy and its formulation. And, while they are all still very much a "work in progress," these countries each provide a model and lessons that can help other countries in formulating their own policies regarding ICT in education.

In this chapter, we will look within and across the cases to draw out these lessons. While none of the countries used the Knowledge Ladder to formulate their policies, we will use this framework to structure our analyses. We will also, in turn, use the cases to analyze the Knowledge Ladder, its usefulness and limitations. At the same time, it is important to recognize the uniqueness of each case.

Summary of Cases

This section summarizes the ICT policies and programmes of the five countries in our case studies. We use the Knowledge Ladder to organize the summary, examining the policy goals and vision for each case, along with the other policy components. Policy goals and vision refers to the set of objectives set out by the policy and the rationale for accomplishing them. In particular, a country's policy goals and vision often articulate the intended impact of the policy on the educational system and all its beneficiaries, including students, teachers, and parents, as well as its impact on the economy and society at large. The other policy components refer to different strategic programmes and operational plans that realize the policy goals and vision. These components include: professional development, pedagogical and curricular change, assessment reform, schools restructuring, and technological infrastructure comprising hardware, software, networks and technical support. The goals, visions, programmes, and plans of a country may be articulated in a formal ICT policy document or they may be laid out in a more general education policy document. There may also be a set or series of documents that lay out the policies in more detail or as a progression of changes over time.

Singapore

Policy Goals and Vision

The ICT educational policy in Singapore aims at building the capacity of people through education, so as to maintain economic competitiveness of the country, develop lifelong learning as a national culture, and extend learning beyond schools to all life stages, especially among the workforces. The intention is to move the country towards a knowledge-based economy, be entrepreneurial and open to new ideas and be creative and innovative. In realizing these high-level goals, three Mater Plans (MP1, MP2 and MP3) of five years each have been prepared. MP1 and MP2 have been implemented while MP3 started last year. Each of these three master plans has specific detailed objectives; however, they worked in cohesion and harmony to achieve the above mentioned described goals.

Professional Development

In MP1, the target was to equip all teachers in Singapore with the necessary ICT skills – that is, teachers were mainly trained on basic computer operation and office productivity software. Professional development in MP2 emphasized

customization. Schools were given autonomy to decide on the types of professional development programmes for their teachers. Professional development guides were provided to help teachers and heads of departments identify their training needs. In the ongoing MP3, programmes are set so that teachers gain the capacity to plan and deliver ICT-enriched learning experiences for students to become self-directed and collaborative learners.

Pedagogical and Curricular Change

During MP1, ICT tools were leveraged to help students shift from acquisition mode of learning to one that engages higher order thinking like application, synthesis and evaluation. For example, Internet, email and video-conferencing tools were extensively used. In MP2, the programme continued to shift learning from information receiving to information processing and knowledge creation. To achieve this, it emphasized seamless integration of ICT into the curriculum and leveraging ICT for formative assessment and summative assessment. MP3 aims for better integration of ICT right from the planning of curriculum and assessment, and calls for teachers to consider pedagogical applications of ICT starting from lesson design and planning stage.

Assessment Reform

This component is part of the Pedagogical and Curricular Change referred to above.

School Restructuring

This component has not been addressed in the case study.

Technological Infrastructure

Hardware: Singapore secondary schools compare favorably with their international counterparts in terms of ICT infrastructure and support: the country is among five education systems in the world with 80% or more of secondary schools having a student–computer ratio of less than 10:1. The policy goal is to provide teachers and students with adequate access to hardware and Internet. Originally, teacher-to-computer ratio was set at 2:1 and a computer purchasing scheme was provided to subsidize teachers for purchase of personal computers. Currently, schools provide all teachers with a notebook computer. For students, a 2:1 student to computer ratio was targeted, starting with 6.6:1 student to computer ratio for primary schools and 5:1 for secondary schools and junior colleges. In addition, schools are provided with guidelines and budget to purchase necessary ICT equipment like projects, digital cameras and printers and to upgrade the school physical infrastructure with additional LAN points.

Software and content development: In MP1, software and Web-based resources were developed to meet the increasing demand of ICT-enriched teaching and learning environments. The Internet Education Resources portal was developed by the Ministry of Education to provide schools with information on relevant websites for teaching and learning. The Ministry also set up a central software clearinghouse to provide recommendation on software appropriate for local curriculum. Several digital learning resources were developed by the Ministry, sometimes in partnership with the software industry. In MP2, active experimentation on the use of ICT for engaged learning, by the Ministry's research and development unit explored innovative practices with the use of technology and investigated how these practices can be made sustainable and scalable. MP3 is concerned with improving the sharing of best practices and successful innovations. To encourage sharing of best practices and dissemination of research findings, a network will be set up comprising educational labs, as well as research labs.

Network: A network was developed to connect all the schools to the Ministry and to provide teachers and students with adequate access to Internet. The government is currently investing in a new and advanced network that will boost a nationwide ultra high-speed fibre access infrastructure to all homes and offices and a pervasive wireless network. This broadband fibre-optic network will support industries, education, and commercial companies to develop and utilize ICT-based services and products.

Technical support: Schools enjoyed sufficient funding and flexibility in developing their infrastructure and engaging technical support. Singapore schools reported high levels of maintenance, technical and pedagogical support.

Uruguay

Policy goals and vision

The ICT in education policy in Uruguay responds to a combination of political and educational interests and, to a lesser degree, technology-related ones. The driver behind this is to bring equity in the knowledge access in order to ground competitiveness and economic development that leads to equitable social development. Another driver is to recover the historic role of public schools and ensure equivalent levels of quality.

Stated differently, the main objectives of ICT in education policy in Uruguay are:

- Provide all children and teachers of public primary schools universal and free access to portable computers in order to reduce the digital gap in the country.
- Promote social justice establishing the conditions to have equal access to information and communication possibilities for all the people in the country.
- Facilitate the construction of new learning environments and the generation of an adequate context for children to respond to a knowledge-based society.
- Stimulate the active participation of students and teachers and increase their knowledge and awareness of the importance of lifelong learning.

Professional Development

Uruguay's policy pointed clearly to plans related to ICT teacher training, technological training and pedagogical training. These types are implemented in two stages. The first stage involves cascaded training strategy that focuses on principals, inspectors and technology teachers to help classroom teachers implement the country's ICT policy and apply ICT to their teaching. The second stage involves face-to-face and e-learning strategies that help technology teachers to mentor and train other teachers about the curricular ICT integration, via collaborative activities and the sharing of pedagogical experiences. In addition to a face-to-face training approach, professional development also includes other complementary training approaches, such as educational television, available through TV broadcasting or Web portal downloading, e-learning, available through online courses and workshops, and digital resources on CDs to use in schools. Among others, the areas covered by the professional development opportunities include:

- General pedagogical use of portable computers.
- Use of digital educational resources for teaching and learning.
- Use of virtual learning environments in education.
- Management of the ICT infrastructure in schools

Pedagogical and Curricular Change

The policy calls for an ICT integration process that promotes students' learning in a collaborative way and encourages their creativity. The main aspects of the integration of ICT in the curriculum are:

- The integration of ICT as a content into the formal curriculum of primary education is currently not compulsory. However, different activities are frequently performed for learning in a collaborative way.
- Technology is used as a subject and a vital resource that could be used in other disciplines of secondary education.

- Recent calls and initiatives have targeted the development of pedagogical activities, involving contents related to disciplines such as: Language, Mathematics, Arts, Social Sciences, Natural Sciences and Physical Education.

Assessment Reform

Although ICT is not regularly used to assess students' learning outcomes in Uruguay, a first experience was performed in late 2009 in all primary schools of the country, in order to assess second grade students' learning in math, language and natural sciences. The test was performed online using the laptops, and children received immediate feedback of their performance.

School Restructuring

School restructuring is not explicitly addressed in the ICT policies of Uruguay. However, a Web portal has been developed to encourage teachers to exchange educational experiences, content and good practices, and to develop virtual communities of practices that cut across school boundaries.

Technological Infrastructure:

Hardware: By the end of 2009, almost 370,000 laptops had been delivered to students and teachers, loaded with educational software. The student-per-computer ratios are now 9.9 in primary schools; 42.95 in secondary and 24 in technical high schools.

Software and content development: The strategy to provide digital contents is mainly based on the development of educational portals. In fact, there are four main educational Web portals in Uruguay. One of the portals contains several Websites, aimed at sharing experiences and knowledge among teachers, students, schools and communities. Another is an educational portal repository with downloadable educational resources. A third portal helps to integrate ICT into the curriculum and improving the national education system. A fourth portal promotes the exchange of educational experiences, contents and good practices, as well as to foster the development of virtual communities of practices.

Network: The Government of Uruguay has designed networks for providing Internet access to all public primary, secondary, technical and tertiary schools and teacher training centres. More 1,400 educational institutions have been connected to the Internet – more than 81% of all schools – and more than 3,000 hotspots, or WiFi zones have also been deployed. This is being achieved through an educational connectivity program, which began as a presidential initiative in a joint effort with telecommunications companies owned by the government.

Technical support: The policy implementation has arranged, through a professional agency, the provision of free technical support for monitoring and repairing servers, laptops and connections, as well as for deployment. Additionally, a minibus loaded with equipment, hardware/software technicians and even ICT/technology teachers travels across the country visiting schools, providing support and helping teachers.

Jordan

Policy Goals and Vision

The core goal in Jordan's education policy is to provide Jordan's citizens with knowledge, skills, and a lifelong learning capability to make the economy competitive in the global marketplace and to maintain and extend the security and stability of Jordanian society. To fulfill these goals, Jordan has set its long-term educational policy and strategic plan tuned to four main themes. These themes are:

- structuring the education system to ensure lifelong learning;
- ensuring responsiveness of the educational system to the knowledge-based economy;
- accessing and utilizing information and communications technologies to support effective learning and system management; and
- ensuring quality learning experiences and environments.

Professional Development

Jordan has in place specific professional development programmes that are designed to complement each other in ways that help realize Jordan's strategic policy goals. Relevant to their involvement in achieving policy goals, Ministry of Education personnel also receive relevant training. These programmes are:

- ICT literacy training that culminates in undergoing a certified proficiency test. All employees of the Ministry were required to receive the training and successfully pass the proficiency test.
- ICT integration in teaching and learning. This training component has been implemented using different platforms and approaches. All approaches train the teachers to integrate ICT into different subjects of curriculum.
- Advanced ICT integration into the curriculum, which moves toward knowledge deepening and a pedagogy that promotes content creation.

Pedagogical and Curricular Change

The Ministry of Education issued its Curriculum and Learning Assessment Framework, which guided the rewriting of curriculum in all subjects for all grades between 2004 and 2008. This Framework also provided a broad programme of e-learning content which is now in full implementation and ongoing development. The new curriculum reflects national and cultural goals translated into knowledge, skills, and attitudes that learners must acquire. Jordan is also planning a convergence toward international standards in terms of basic skills, critical thinking, problem solving, decision making, numeracy, communication skills, managing information, learning continuously, entrepreneurship, adaptability, teamwork, innovation and creativity.

Assessment Reform

The assessment reform has been part of other educational policy activities. In particular, the development of learning assessment tools has been tied to the new curriculum, teacher guides, and learning resource materials for all subjects, using authentic-type testing supported by online testing techniques. The assessment reform is intended to reflect Jordan's national and cultural goals translated into knowledge, skills, and attitudes that learners must acquire at the school level.

School Restructuring

Although school restructuring is not explicitly addressed in policy goals, the Ministry has established a web-based portal, as well as a school technology innovation centre, to disseminate ICT in education best practices and facilitate the establishment of communities of practice among teachers and schools.

Technological Infrastructure

Hardware: Jordan's implementation programme has given considerable attention to equipping schools with the necessary ICT equipment and particularly personal computers (PC). The student-to-PC ratio in Secondary schools varies from below 10:1 to 40:1. Almost 70% of schools have a ratio that ranges between 10:1 and 30:1. However, for elementary schools, more than 40% of the schools have a ratio below 30:1. Among 3,300 public schools, more than 85% of schools are equipped with PC and more than 82% are connected to Internet. The policy includes continued support for schools to acquire more computers and computer labs. The scheduled is based on schools' access to

data lines and a strategy of improving the student-to-computer ratio in each school, as well as providing other ICT-related equipment.

Software and Content Development: The Ministry of Education has worked with a number of independent Jordanian software developers to prepare e-content for a range of subjects under close supervision by the Ministry's representatives. This work ran in parallel with the Ministry's efforts to rewrite its curriculum. During a three-year period, e-content was prepared and released for Science, Math, Civics, ICT, Arabic, English, geography, ICT and management and information science. The Ministry also produced extensive instructional ICT support materials and resources to assist teachers in developing e-content.

Network: Currently, the Government plans to create a fibre-optic high-capacity link between all of the nation's schools and education establishments. This national broadband network will provide high-speed fibre connectivity to public universities and public schools and is expected to substantial increase in human capital development. Currently, more than 82% of all national schools are connected to Internet only via leased lines or ADSL.

Technical Support: The Ministry of Education has an ICT Directorate that organizes the provision of technical support for ICT equipment and tools in schools. The ICT Directorate provides schools with technical support, either directly from the Ministry or through private-sector service providers. The Directorate works closely with the Ministry of Information and Communications Technology.

Namibia

Policy Goals and Vision

According to official reports, only a small number of Namibians are achieving senior secondary education and very few complete vocational or tertiary educations. Moreover, the education system to date is not adequately addressing the creation of a knowledge-based economy. The policy considers the growth in ICT sector to be a national imperative that will support economic growth, industrial development, poverty eradication, equal opportunity and regional coordination. Therefore, the purpose of this policy is to prepare all Namibian education stakeholders to meet the challenges of the twenty-first century skills required by a knowledge-based economy. The policy envisages broaden access to quality educational services for all so that all Namibian citizens will become ICT literate and capable of participating in the new economies that emerge from ICT and related developments.

Professional Development

The policy identifies a staff training component which encompasses all people involved in the educational system of teachers, lecturers, principals, administrative staff and other stakeholders. According to the nature of their work, this component recognizes that these people require varying levels of training. Teachers are targeted for pre-service and in-service training to build their confidence in ICT, including communicating via email, understanding the value of integrating ICT in learning and teaching. Similarly, principals, advisors and inspectors and administrators are required to develop their confidence in the use of ICT and preferably work towards an ICT qualification. The use of ICT is conceptualized as an ability to search for, retrieve, prepare, and present materials using a computer; communication via email and an understanding of management and administrative ICT systems.

At the time when the policy was adopted, there was not yet a clear plan related to ICT and teacher professional development, as such, that considers the systemic integration of ICT. Originally, training was conceived and practiced as a short-term, often one-off learning opportunity focused more on learning about the technologies and less on using them in the practice of teaching, learning and administration. Teacher professional development, as opposed to "training," is now considered to be a continuous, modular process based on the authentic contexts of teachers and the development of individual learning pathways for teachers.

Pedagogical and Curricular Change

The Namibian policy is very clear about pedagogical and curriculum reform, with reference to the integration of ICT in education. It suggests that the curriculum should promote skills of accessing, managing, and processing information, as well as promote collaborative work skills, problem solving, and learning to learn capabilities. It proposes that the curriculum must be explicit in providing guidance to all teachers on these matters. In particular, the policy identifies three aspects to the role of ICT in the curriculum:

- Curriculum for ICT skills and knowledge which is referred to as ICT literacy skills;
- ICT as a Subject, which implies the study of computer studies and information technology geared towards more advanced technical skill development; and
- Curriculum for the use of ICT within subjects, which is referred to as cross-curricula ICT.

This suggests that the policy focuses more on the integration of ICT in curriculum development and less on the pedagogy of curriculum delivery. Furthermore, the policy also expresses an openness to acquire and use content that are produced elsewhere, if it is considered suitable.

Assessment reform

The policy states that curricula make explicit what is expected of learners, students, and teachers with reference to ICT in education. This includes guidance to teachers on how to present the relevant assessment criteria to learners and students. However, the case study of Namibia does not provide any additional information on assessment reform.

School restructuring

The Namibian case study did not address this particular component.

Technological infrastructure

The Namibian case study states that the World Economic Forum's *Global Competitiveness Report* 2009 confirms that the quality of Namibia's infrastructure, including its ICT infrastructure, is in excellent condition. However, the case study does not show how this will positively affect the implementation plan of the policy. Nevertheless, the status of other policy technological infrastructure components are:

Hardware: No specific information is given regarding the hardware that is, or will be, available and deployment plans.

Software and content development: The policy poses the option of acquiring content, adapting content that is acquired, or creating content, depending on which is suitable and cost effective. It also specifies the creation of local Namibian content wherever the need is perceived in subjects such as history, social studies, geography, language and literature. A Digital Library is also proposed in order to provide educational materials to support the curriculum, the administration, and the training of the education community.

Networks: Currently, the Government of Namibia is making plans for direct Internet connection in their attempt to lower the costs of bandwidth and accessibility. Namibia has many direct links to other neighboring countries that provide the necessary Internet capacity. However, the case study provides no specific information regarding the local connectivity or bandwidths in the country either through wire-lines or wireless arrangements. The policy proposes to promote reliable information on a range of platforms including audio and video and relevant websites.

Technical support: A crucial component of Namibia's ICT in education implementation framework was the establishment of the National Education Technology Service and Support Centre. The main purpose of the centre is to serve as a one stop ICT shop for the deployment and support of ICT in all educational institutions and take

oversight responsibility for sourcing, refurbishing, installing and supporting ICT in these institutions. It was to serve as a distribution hub for ICT hardware and software and provide maintenance and technical support to institutions via local support, although there are indications that this has not happened as planned.

Rwanda

Policy Goals and Vision

As the country suffers from a severe shortage of professional personnel and very low secondary school completion rate, the draft ICT policy of Rwanda published in 2009 aims at developing a workforce equipped with ICT skills needed for employment and use in knowledge-based economy. The policy envisages that using ICT as a tool will achieve the following goals:

- Increase access to formal and informal basic education for teaching, learning and information sharing.
- Improve the quality of basic education.
- Promote independent and lifelong learning.
- Build an effective decision-making ICT-driven process in resource allocation, strategic planning, and policy implementation, monitoring and evaluation.

The rationale of the Rwandan ICT policy focuses mainly on delivering equitable, relevant, accessible and quality education. The policy also serves to coordinate different ICT initiatives and projects in the country around a national consolidated national program.

Professional Development

The draft ICT in education policy acknowledges that teachers are the main instruments for bringing about the desired changes. The policy suggests three components of training. These are:

- Pre-service teacher training;
- In-service teacher training; and
- Continuous professional development.

The policy specifically proposes a host of mechanisms for the continuous development of teachers, principals, inspectors and head teachers. These include the ICT literacy training programmes for all teachers as well as professional development opportunities for school inspectors on the integration of ICT in learning and teaching. It also includes supporting head teachers to establish an ICT vision for schools, training curricula developers on creating and developing digital learning materials and training educational administrators on technical expertise to manage and maintain ICT facilities at all levels.

Since the issuance of the policy, the Rwandan Ministry of Education and the Global eSchools and Communities Initiative developed a draft ICT for Teacher Training Matrix based on UNESCO's ICT Teacher Competency Standards. The Matrix considers the progressive evolution of teacher professional development from an emergence stage of integrating ICT in classroom towards the knowledge-deepening stage, paralleling the knowledge-deepening approach of the Knowledge Ladder, used in this report.

Pedagogical and Curricular Change

The policy recognizes the integral role that ICT can lay in enhancing the relevance and the quality of national curriculum at all levels. In particular, the policy proposes that in the short to medium terms, the available electronic content can be integrated in the teaching and learning processes. In longer terms, teachers are encouraged to conduct their own research and develop their own digital materials to be used in classrooms. They are also

encouraged to apply project-based learning, and request students to do so for their assignments. This implies that students will learn more than how to operate equipment and run useful software, but rather go to a knowledge-deepening phase. The policy proposes developing guidelines to promote and encourage the production of high-quality local "culturally aligned" e-content, and ensuring the availability of this content through the creation of a national educational portal accessible by all schools.

Assessment Reform

The policy proposes that ICT be used in assessment, by developing means and services that can provide the Rwandan National Examination Council with the competitive edge it needs to provide transparent, interactive and more customer driven services. It also highlights the contribution ICT can make with reference to examinations and tests. In particular, it calls for the use of ICT to design tests and collaboration with international bodies to build standardized tests and item banks, align examination and testing tools with revised digital curriculum and incorporate ICT-based student assessment tools.

School Restructuring

The Rwandan case study did not address this particular component.

Technological Infrastructure

Although the Rwandan case study shows the ICT indicators of Rwanda in terms of fixed lines, mobile and Internet penetration, which seem to be very low, it does not address specific ICT policy components like hardware, software, networks and technical support. However, it indicates the following:

- The country boasts a host of ICT projects which together will contribute to country's ICT infrastructure. These projects include the Rwandan National Backbone Project, Regional Communications Infrastructure Project, Kigali Metropolitan Network, Kalisimbi Project and the East African Submarine Cable.
- The indicative budget for the major activities of the implementation plan including ICT infrastructure, content and capacity-building for a period of five years is approximately USD 79 million.

Contextual Factors that Influence Policy and its Implementation

Drawing from the five case studies, it is clear that each country's initiative aims to tap into the potential of ICT to improve and support their education system. All countries believe that ICT can to a certain extent support economic changes to the country. As noted in Chapter I, many countries view the use of ICT as a tool for the economic development of the country. Promoting the use of ICT in schools and in society in general is also used as a form of social change for the society. Many countries would like to see their citizens be technologically literate and they want to use this tool to balance social inequality. Yet, each country has its own ICT plans – each unique, although there are many similarities, as well. The objective of this section is to lay out and explore the economic and social context that may influence the design, development and implementation of ICT in education plans for the country.

Singapore

The country has no natural resources and depends solely on the human capital to spur and develop the economy. The Government believes that human capital development is this small country to successfully compete with larger countries in the global economy. The country strives to add value by purchasing raw materials and exporting them

as manufactured goods. It also has a strong service industry in the areas of oil processing, transportation, banking, and financial services, and sees its future tied to the development of a knowledge economy. Singapore has been ranked one of the top ten countries on global competitiveness.

The country gained its independence in 1965 and one party has been in political power since independence. This offers great political stability and to a certain extent, enables a continuity of government policies. This stability enables a continuation of a number of education, social and health initiatives to spread over a number of years.

Singapore is ranked 15th in the world, based on ICT development index. Since 1990, the country has had national ICT master plans for the development of IT infrastructure, services, products, and employment. The Master plans set directions in the use of IT for business, e-government, and education. In their latest ICT infrastructure plan, there will be fibre-optic connections to all homes, schools and businesses. This high-speed broadband network will promote digital media and bio-informatics and will benefit industries, finance, banking, and media services.

Singapore has a national education policy but with variations in the curriculum to cater to different needs and abilities of students. It has a bilingual education where English is used as the medium of instruction with their mother tongue as a second language. There are a number of initiatives to improve the education system and these are strongly linked to it economic development policies. Among the most important education initiatives are the three ICT in education master plans to leverage on the use of technology for administration, teaching and learning.

Uruguay

The country has a prominent situation among Latin American countries in economic and human–social development. The country's main economic activity is centred on export-oriented agricultural sector and services. In addition, Uruguay has a well-developed service industry with a highly trained workforce. The county has a high literacy rate and the government has instituted a social security system with even distribution of income and a large middle-income population. For Uruguay, there were many national-level policies, directions and plans and some of these were personally led by the President. For example, P*lan Ceibal* was launched by the President, showing political support at the highest level from the government.

Uruguay has a high proportion of people living in urban areas, making it easier to build ICT infrastructure. Consequently, Uruguay has a high penetration rate of ICT compared to other countries in the region. It has the highest number of landline telephones among the Latin America countries. As a result of several ICT policy initiatives and implementation, the country has developed a vibrant ICT industry. In 2000, the National Committee for Information Society was set up under the President and, in 2005, a new national Technology Development Plan was launched. It focused on two areas – promote the use of technology among the citizens and to improve research and development in ICT. In 2008, the second part of the technology plan was launched and it focused on business, science and technology services, and innovation. The government is also providing funds for the use of ICT to tackle social issues, poverty reduction, and environment protection.

Uruguay has a strong education system and has instituted compulsory education for all children from 5–14 years. The enrolment rates are above the Latin America countries average and they have the highest literacy rate (98%) among the countries in the region. The government has implemented many initiatives to develop new and integrated curriculum, reduce dropout rates, invest in school infrastructure, provide more support staff in libraries and labs, improve student learning outcomes.

Jordan

Jordan is one of the smallest and poorest economies in the Middle East ,and the country faces a number of regional political and security issues. It has limited natural resources and depends on the development of human resources

to spur the economy. The country is the primary destination for foreign investment in the region. Annually, 60,000 people join the labour force and the economy finds it hard to meet this demand for employment. The unemployment rate is about 12%. Every year, there are about 5,000 ICT graduates but annual growth is only 1,500 ICT job-related vacancies. The government human resource development plan focuses on reducing poverty and unemployment and expansion of access to public schooling. The government sees the use and development of ICT as part of the process for poverty reduction. In 2002, the King of Jordan launched the vision for the future of education in Jordan. In the vision, there was a strong emphasis of ICT at all levels in order to build country's human resource capital and to promote country as an ICT hub. There was royal support again when, in 2004, Queen Rania launched the Jordan Education Initiatives. The Initiatives focus on providing 100 public schools in the area of in-classroom technology, e-curriculum development and training. The Government has put in place many ICT plans for the improvement of infrastructure and services to the people. For example, they have initiated building better Internet connection by installing additional submarine cable connecting to US and Europe.

Namibia

Namibia gained independence from South Africa in 1990. It had been under either German or South African rule for over 100 years. The new Government started a series of reforms for the country. In education, reform focused on ensuring education addressed a number of concerns, including equality for all, easy access to education, high quality education, democracy, and life-long learning.

Namibia is a lower-middle-income country. The country is highly dependent on mining of minerals but this industry only employs 3% of the workforce. Although its gross National Income per capita is more than USD 3,600, about one-third of the population survives on less than a dollar a day. The country is not able to address the needs of a knowledge-based economy due to a lack of students with higher education, poor quality education, poverty, and the impact of HIV. The country faces a number of health issues, such as high incident rate of tuberculosis and HIV, which impacts heavily on the economy. In addition to the impact of HIV, the influx of refugees stretches the resources of the education system. Namibia used to have twelve different languages for medium of instruction in the lower primary but has slowly replaced this with English as a medium of instruction.

In terms of ICT infrastructure, Namibia is well developed and reasonably competitive with seven registered Internet service providers in the country. However, the country's Internet and broadband sector has been held back by high prices caused by the lack of direct connection to submarine cables. Namibia has to connect its Internet to the submarine cables through other neighbouring countries. Because the cost of Internet is high, there are few Internet users. Recently, plans have been made for satellite connections to Indian higher education and health institutions and for direct connections to submarine cables which, it is hoped, will make bandwidth costs more affordable.

Rwanda

Rwanda is a poor country with a highly underdeveloped agrarian sector and 60% of its population living under the poverty line. Civil war and genocide in 1994 killed one in seven Rwandans, left more than one in three people displaced, and plunged 80% of the country into poverty. Within that period, the country lost a generation of doctors, teachers, public servants, and entrepreneurs.

After the genocide and civil war in 1994, leadership in the new government emphasized the process of peace and reconciliation, and the building of democratic institutions. The leaders' vision is to leverage on the use of ICT as a social and economic tool. They believe that ICT will help society heal, engage citizens for the future, and allow them view the ICT programme as a catalyst for economic reform. At the same time, the country faces a lack of expertise and professionals and a skill audit shows low human capacity. In terms of education, enrolment rates in primary schools have improved especially for those who had missed out because of war. However, the completion rate for secondary education remains low. The Government has embarked on a number of education reforms to promote

basic education and education for all. The country is ranked at 143 out of 145 based on ICT Development Index. The high cost of setting up and maintaining infrastructure and the high prices for Internet access have slowed down the implementation of their technology plans. However, the government has started reforms in ICT and there are a number of infrastructure projects in the pipeline to improve connectivity.

Table 8.1: Summary of Key indicators of Five Case Countries.

Indicators[1]	Singapore	Uruguay	Jordan	Namibia	Rwanda
Size of country (sq km)	697	176,215	89,000	824,000	26,388
Population (million)	4.66	3.5	6.3	2.1	10.7
Annual population growth	0.998%	0.466%	2.2%	0.95%	2.87%
Age: Median age	39 years	33.4 years	24.3 years	21 years	18.7 years
0–14 years 15–64 years 65 years and over	14.4% 76.7% 8.9%	22.4% 64.3% 13.3%	36% 59.4% 4.6%	35.9% 60.2% 3.9%	42.7% 52.8% 2.5%
Urban population	100%	92%	78%	37%	18%
Economy					
GDP – PPP3 (Billion)	$235.7	$44.52	$33	$13.58	$10.13
Comparison to the world	49	92	104	138	147
GDP – per capita (2009)	$50,300	12,700	$5300	$6400	$900
Comparison to the world (out of 227)	8	88	139	130	216
GDP – by sector Agriculture Industry Services	 0 26.8% 73.2%	 9.5% 22.5% 68%	 3.7% 29.9% 66.5%	 9.2% 34.8% 56.0%	 42.6% 22.2% 35.2%
Gross National Income per capita (2007)	$35,083	$6791	$2708	$3607	$351
Health & Social					
HIV/AIDS prevalence rate	0.2%	0.6%	Less than 0.1%	15.3%	2.8%
Infant mortality rate / 1,000 births	2.3	11.32	17.4	45.5	67.2
Education					
Literacy rate2	98.6%	98%	89.9%	85%	70.4%
Expenditure (of GDP) Total govt. expenditure	3.2% 11.6%	2.9% 11.6%	4.9% 22.4%	6.5% 22.4%	4.8% 19.0%
Enrolment Primary Secondary Tertiary	 98.1%[5] 87.2% 66.4%	 98% 68% 64%	 96% 86% 38%	 90% 54% –	 97% 20% –
ICT infrastructure					
Land lines	1.86 million	959,300	503,000	140,000	16,800
Mobile/cellular	6.38 million	3.51 million	5.9 million	1.05 million	1.32 million
Networked readiness Index4 (133)	5.64 Ranked 2	3.81 Ranked 57	4.09 Ranked 44	3.40 Ranked 89	No data
Internet users	3.37 million	1.34 million	1.5 million	113,500	300,000
Internet hosts	864,943	498,232	28,896	17,840	81

1. Data obtained from CIA World Facts book (https://www.cia.gov/library/publications/the-world-factbook/. All currency expressed in US $.
2. Literacy rate – age 15 and over who can read and write
3. GDP (2009) based on Purchasing power parity
4. World Economic Forum, Global Information Technology Report 2009–2010
5. Data obtained from Educational statistics, Singapore 2009. Figures represent those who passed the exit level examinations. Tertiary consists of Universities and three-year Polytechnic.

Enablers

This section focuses on the policy development process, particularly on those elements that seem to have contributed to the implementation of the policy by significantly helping to unfreeze the status quo of the system and making it more dynamic and open to change. However, it is important to note that since all of these country cases are still "works in progress," it is not yet possible to say which particular arrangement is better. Also, many different elements interact with each other to create an unique system or context for each policy and successful implementation does not depend on a single factor. Moreover, it is quite difficult to establish an objective judgment to qualify the implementation of the policy. Nonetheless, the following factors seem important implement enablers, based on the case studies presented.

Political Support

Some educational policies are conceived at the highest level of the government. Often, these policies are presented as a national initiative that transcends educational goals, aiming, in the first place, to produce social and/or economic transformations and in a second place, to have an impact in students' educational outcomes.

For example, the ICT policy in Uruguay was an initiative conceived and fostered by President Tabaré Vázquez who defined its aims by saying the initiative will ". . . provide a computer for each child and teacher, with the long-term purpose of promoting social justice ensuring equal access to information and communication tools of all the people" (translated by the authors from Vázquez, 2006). In concordance with this general statement, Vázquez also declared that "the strategic principles embedded in this project are equity, equal opportunities for all the children and youngsters, democratization of knowledge, as well as the availability of resources to learn, and learning not only what is taught in schools, but also to learn by him/herself to use modern technology". In this case, the ICT in education policy for Uruguay was conceived as a vehicle for social transformation, as a lever that will help to enhance equity and social justice.

Other ICT in education policies are conceived as part of a larger education reform process and are presented as key initiatives to reach the expected educational goals, which in turn can be aimed at social or economic transformation. Such is the case of Jordan's Educational Reform for Knowledge Economy (ERfKE) that was launched in 2002, by King Abdullah II, who placed a strong emphasis on the integration of information technology at all levels of education in order to build the country's human resource capital. In this case the ICT in education policy is part of an educational reform that aimed at economic transformation.

Rwandan President Paul Kagame promoted ICT in education primarily as a vehicle for educational transformation that would increase access to formal and informal basic education. ICT was also identified as a lever to improve the quality of basic education and promote lifelong learning. Finally, it was seen a way to develop a workforce equipped with ICT skills needed for employment and use in a knowledge-based economy.

Similarly, the Ministry of Education in Singapore, in coordination with the country's economic plan, developed a series of ICT master plans that are in alignment of the country's push to a knowledge-based economy and were framed in larger educational transformation process guided by the vision "Thinking Schools, Learning Nation" in which the introduction of ICT followed the idea that education should anticipate the future needs of society and work towards fulfilling those needs. Three plans were conceived as a lever to progressively improve the quality of teaching and learning through the innovative use of ICT for teaching and learning, particularly in developing students' twenty-first century skills in the students.

Based on these examples, it appears clear that the political support at the highest levels for the use of ICT in education policy not only guides the strategies and priorities for its implementation, but connects educational transform with economic and social development. Commitment at this political level gives ICT policy national relevance and transcendence that engages the general public and ensures their buy-in.

Institutional Arrangements for Implementation

While the responsibility for the implementation of the ICT in education relies in the government and its partners, the organizational arrangement can be quite different from country to country. For example in Singapore, the Ministry of Education established the Educational Technology Division to provide professional development for teachers, assist them in designing ICT-based lessons, identify and recommended appropriate software or technologies to schools, provided guidance in planning and setting up physical infrastructure in schools and implement research projects in the field. Both units are also responsible for the coordination with other units of the Ministry. In Jordan, policies related to ICT in education are implemented through a mix of arrangements that involve a central government unit (the Development Coordination Unit) in the Ministry, and an external autonomous body (the Jordan Education Initiative), which is a public-private partnership.

A different approach was implemented in Namibia, where an Executive Committee has the role of administering the policy, deciding the implementation strategies and reporting on its implementation. In addition, a Steering Committee was established to coordinate the policy implementation which, in turn, defined Working Groups that implement the different action lines.

In other cases, governments set up agencies that, while having an administrative dependency on the government, also enjoy a high degree of autonomy in the implementation process. Such is the case of Rwanda, where the government created the Rwandan Education Board as an umbrella institution under the supervision of the Ministry of Education mandated to contribute to education policy and coordinate and fast-track education activities. Within this institution, the ICT in Education and Open Distance and eLearning Department, is responsible for the coordination of the ICT in education policy and to promote partnerships. Following a similar structure, other governments decided to delegate the implementation of the policy to external agencies, such as in the case of Uruguay, where the implementation of *Ceibal* was coordinated by the Technology Laboratory of Uruguay (Laboratorio Tecnológico del Uruguay). Additionally, in both cases, the coordinating agencies have the mandate to interact with various units and institutions of the Ministry of Education and ICT-related institutions within the government.

In general terms, these cases show the importance of defining and empowering a unit responsible for the implementation of the initiative in order to ensure the coordination required during the implementation, as well as the coherence with other government initiatives. It is interesting to note that in none of the cases was the implementation of ICT policy embedded in an existing unit of the Ministry. However, coordination with existing units was required in all cases.

Implementation Capacity

From a different perspective, independently of the organizational arrangements, a key aspect of the implementation of the policy is the existing administrative capacity in the responsible unit. In this case differences are very much related to the governments' experience in the implementation of national strategies. In many countries, government employees are in the process of acquiring the skills and knowledge to effectively implement the required actions. In countries where ICT policies are financed by international agencies, the procedures and regulations used by these agencies can bring additional administrative complexities to the implementation and eventually could conflict with the local regulations and standards. In these cases, policies can be well-formulated and properly financed but badly implemented due to inefficient administration resulting from inexperience, lack of capacities, obsolete or conflicting regulations and/or overwhelming bureaucracy.

A good counter example of this type of situation is Singapore, which started the implementation of its ICT in Education policy in 1997. After having already acquired experience through the first ICT master plan, the country has built capacity and expertise to implement the two successive versions of its ICT master plans. Jordan has also a rather long experience in the implementation of ICT in education initiatives, starting in 2002.

On the other hand, the case of Uruguay is interesting. Since the Ministry lacked internal capacity, it decided to delegate the implementation of the policy to an institution (i.e. LATU) that did have the experience and capacity to implement national ICT strategies.

Finally, in many cases ICT in education policies are implemented in close interaction with the private sector, acting as providers, donors and/or strategic partners. This is the case of Jordan, where the Government promulgated an investment environment that nurtured strong public and private sector partnerships integral to ongoing policy development and ICT implementation. Similarly, Rwanda initiated a policy to encourage and mobilize the private sector and local communities to invest in the education and, consequently, to develop the system's capacity for further innovation.

Based on these examples, it can be argued that it is not a prerequisite that the government or Ministry have the implementation capacity in place when starting to implement the policy. However, having capacity clearly helps to ensure programme sustainability and it is reasonable to assume that such capacity will need to be developed.

Implementation Strategy

There are different strategies that can be used to implement ICT in education policies, they can differ in the way they are planned and managed, the structure used for its implementation and stages that countries follow to implement them.

For example, Singapore, developed a very well structured, progressive approach to the implementation of its ICT in education policy, defining the phases, activities, products and responsible party for each step of the implementation. By implementing a feedback loop, results of each ICT master plan were analyzed in order to incorporate the lessons learned into the design of the subsequent one. However, Uruguay defined the overall goal of the process and started the implementation being aware that they would need to adjust their plans while solving often emergent problems along the way. This is also the case of Jordan where the Jordan Education Initiative has developed a well structured, progressive approach for the implementation of ICT in education policy. The outcomes and lessons learned through JEI helped the Ministry to develop its ICT plan for all schools. The interesting lesson is that all of these countries where able to reach their implementation goals.

Also, depending on the structure of their educational systems, some countries implement the policy through a central unit responsible for the decisions and other aspects of the implementation, while other countries delegated the responsibility to intermediate agencies and/or to schools. All the cases presented here implemented the policy based on a centralized approach.

Finally, a common approach taken by many countries is to start by piloting models or strategies and then to scale up the initiatives that show positive impact. A different approach is to start the implementation at a small scale and then up-scale the project at certain pace. This is the case of Uruguay that started the implementation in 2007 as a pilot in one school and then expanded to the rest of the country in 2008, finalizing in 2009 when the capital, Montevideo, was covered. It is also the case of Jordan which used and is still using JEI as a test bed for innovations of ICT in education in 100 Discovery Schools that may be taken to scale it to all schools, based on lessons learned from implementation during pilot phase.

In general, these different implementation models have not shown to be more or less effective, rather the factors that appear to be more important is to have a strategy and to find the appropriate unit that has the capacity to effectively implement it.

Teacher Professional Development

A crucial factor that affects implementation is the capacity of the system to adopt and benefit from the ICT policy, particularly, the teachers' capacity to make effective use of the new tools and resources in their lessons and link that with policy goals. In order to ensure this, countries offer teacher training courses for ICT skills, for pedagogical use of ICT in their instructional practice, and for use of ICT in educational management. For example, in Jordan in 2003, all individuals were required to complete ICT skills course so that teachers could integrate e-content in curriculum and use ICT in management. Additionally, a wide range of programmes was also provided for teachers, principals, and supervisors to give them the skills needed to integrate ICT in instruction.

Also, in Namibia, the ICT policy includes the training of teachers, lecturers, principals, administrative staff and other stakeholders to integrate the use of ICT in their practice. In this case, the use of ICT in conceptualized as an ability to search for, retrieve, prepare, and present materials using a computer; communication via email and an understanding of management and administrative ICT systems. The effort in Namibia represents a shift from training conceived and practiced as a short-term, often one-off opportunity to learn about the technologies, to the use of ICT in the actual practice of teaching, learning and administration.

In the case of Rwanda, the ICT in Education policy is very comprehensive, suggesting that training will take place in the form of pre-service, in-service and continuous professional development opportunities in areas of ICT literacy, content development, pedagogical teaching approaches using ICT, and educational management information systems. Since the development of the policy, the Ministry has been able to develop a draft ICT for Teacher Professional Development Matrix based on the UNESCO ICT Teacher Competency Standards, which parallels the Knowledge Ladder. This approach considers the progressive evolution of teacher professional development from ICT as a subject to the use ICT in the classroom, towards a knowledge-deepening stage, where the integration of ICT in teaching and learning occurs at a deeper and more advanced level.

Uruguay started with a cascade model focused on principals, inspectors and technology teachers, as intermediate actors, the first part of the training was related to ICT skills and the second had as main goal to achieve a deeper knowledge about how to apply ICT to teaching. After this initial model, they started to implement a strategy based on a mixture of face-to-face and e-learning courses, short courses on television, and educational resources on CDs.

Finally, the series of master plans in Singapore evolved from providing standard basic ICT training for all teachers to emphasizing the skills needed to support collaborative learning and student-centred learning. In this regard, the Ministry gives schools autonomy to decide on the types of professional development programmes for their teachers while the Ministry provided guides to help teachers and heads of departments to identify their learning needs. The strategies used are mainly based on courses, but greater emphasis was given to professional sharing among teachers.

Complementing the training strategies, many countries recognized the need to provide concrete incentives to motivate teachers to participate in the training and/or integrate ICT in their practice. For example, in Jordan all ICT in education training programmes were officially recognized by the Ministry as part of teacher ranking system and in Singapore the Ministry of Education worked with industry to provide several awards to encourage innovative use of ICT.

It can be observed from the cases that in all five countries professional development is a central part of the implementation strategy. All emphasize the use of ICT in classroom practice. Many include not just teachers, but principals, curriculum coordinators, and technical support. Many of them also recognize the difficulty in teachers' adoption of new ICT-based pedagogical strategies.

Monitoring and Evaluation

The policies in some countries include the implementation of evaluation activities and some also refer to monitoring activities. For example, in Jordan, evaluation was an integral part in the reform programme and was considered to be an important way of providing feedback to guide policy. Furthermore, an independent evaluation centre was commissioned by the Government to conduct evaluations mainly focused on the impact of reform initiatives. Similarly, in Singapore the Ministry has implemented both mid-term and summative evaluations of the master plans and encouraged participation in the international comparison studies.

The ICT in Education policy in Rwanda recognizes that policy implementation requires systematic monitoring and evaluation by all stakeholders. However, at the time of this report, there has been very limited monitoring and evaluation of ICT projects and programmes in education. Similarly, the national ICT for education initiative in Namibia makes explicit reference to the inclusion of comprehensive monitoring and evaluation. But at this time there has been limited monitoring and evaluation of ICT projects and programmes. However, in 2008, an independent evaluation of Global eSchools and Communities activities in Namibia was conducted and in 2009, GeSCI conducted a Review of Tech/Na! to which the Ministry of Education substantially contributed.

In Uruguay, the monitoring and evaluation team aims to produce valid and trustful information about the implementation, results and impact of the initiative, particularly regarding children, families, schools and communities in order to generate knowledge about the experience, overcome obstacles and deepen the positive outcomes.

Results of these evaluations serve different purposes. On the one hand, in many cases they are used to provide public accountability of the implementation of the policy, showing the progress in the implementation indicators (for example, number of schools with computers, teachers trained, etc.) or perceptions of the beneficiaries in different areas (self confidence in the use of ICT, perceived improvement in students' outcomes, etc.). On the other hand, results are also used to reflect on the quality of the expected outcomes and thereby identify the needs and required improvements of the policy.

For example, one of the conclusions of the evaluations in Jordan was that despite substantial success at creating and providing e-learning resources to schools, the common uses of these new resources did not yet align with the policy's vision of ICT use desired. Teacher-centred practices still predominated among most of the teachers interviewed and observed and current in service training programmes were primarily guided by ICT literacy skills and less by a focus on new uses of ICT in the teaching–learning process.

Similarly, in Singapore, a comprehensive analysis of Master Plan 2 showed that schools were sufficiently funded for ICT and had flexibility in developing their infrastructure. The study found that digital resources were an important component of the master plan. However, a number of important shortcomings were also identified. Among the findings, was that teacher's capacity to effectively integrate ICT into the curriculum remained a key challenge, particularly the ability to apply pedagogical principles in designing ICT-based lessons. There was also an identified need to foster the formation of community of practice among teachers. More time and space was also needed for teachers to design and implement ICT-based lessons, and to share, discuss and reflect on their implementation with their colleagues.

As important as monitoring and evaluation is and as often as it is mentioned in ICT policies, it is not always properly or completely implemented. This reduces accountability to the public for such programs. But just as important, feedback is not available that would increase the prospects for success.

Financial Arrangements

ICT policies often use high-minded rhetoric to justify ICT investments. But the details of financial arrangements are often left out. In some countries, it is unclear that the total cost for implementation was well thought through. In other countries, it is not clear that the funds are available to implement the program, as valuable as it might be.

In Jordan, for example, it is unlikely at least in the short term that the country will be able to finance the programme from its own resources or scale up the e-learning for all schools. The policy document states that such financing would have to be accomplished in planned stages over a number of years and would depend critically on the availability of external funding and partnerships. According to the Rwandan implementation plan, the budget for the major activities, which includes ICT infrastructure, content and capacity-building for a period of five years, is approximately USD 79 million. But in both Rwanda and Namibia, the financial arrangements for the implementation of the ICT in education policies were largely based on external funding.

However in Uruguay, the implementation of *Ceibal* was financed using national funds and resources available through international loans and government investments. The Government of Uruguay invested US $140 million in its *Plan Ceibal*, which is equivalent to an average of US $300 per student with an estimated recurrent cost of US $150 per student for a total of US $450 per student, total cost. In Singapore, the master plans were also financed using national resources. The Government of Singapore committed a budget of Singapore dollars (S$) 2 billion US $1.2 billion from 1997 to 2002 for the implementation of the first ICT Master Plan. In addition, S$ 600 million (US $375 million) was provided to replace hardware, develop new software for teaching and learning and for teacher professional development. It should be noted that these two are the most prosperous of the five countries.

In general terms, the financial resources needed to implement significant ICT programmes – those that would transform education systems – are a major challenge for developing countries. This does not diminish the importance of doing so and these least developed of our case countries were undaunted by this challenge. In addressing the challenge, arrangements must include both internal and external sources based on loans and/or private partnerships. And the real cost of the implementation of the policy must be clearly identified.

Scalability and Sustainability and Systemic Change

This section discusses the extent to which the ICT in Education policies and programmes of the five countries have considered scalability and sustainability in their design and implementation. In doing so, it recognizes that it may be too soon to confirm the nature and extent of scalability and sustainability in each of the countries because the timeline for such consideration is limited by the few years that have passed since the adoption of these policies and their implementation plans.

Scaling Up and Scalability

As shown above, the policy of each of the five countries is underscored by a clearly stated vision of social and economic transformation which includes the integration of ICT in the education system as a crucial catalyst for such transformation. Often this vision is linked to the goal of universal access to ICT including affordable Internet connectivity. Indeed, each of the five countries explicitly states their commitment to transform their education systems and endeavor to promote widespread access to ICT. Having such a vision is valuable, perhaps essential, in determining the goals that scaling up ICT-based education interventions.

Scaling up in the context of this publication's focus, alludes to the extent to which an ICT in education policy recognizes and commits to the system-wide expansion of quality learning, teaching and education management enabled by ICT. Scalability however, refers to the extent to which a given ICT-based education intervention can be scaled up to permeate throughout the national education system and the extent to which the system itself is endowed with the requisite intellectual, human and financial resources to enable the achievement of scale-up.

Whilst each country's policy stems from varying infrastructural, financial and socio-economic bases, their entry points in the use of ICT in education began with smaller scale, experimental, often pilot initiatives of varying degrees. This experimental, testing phase seemed crucial in the evolution towards more widespread and effective educational initiatives that integrate the use of ICT.

Rwanda's entry into ICT integration in education included pilot projects such as the NEPAD eSchools Demonstration Project involving six secondary schools in 2006 and the One Laptop Per Child project targeted at selected primary schools in 2008. The latter is currently planned to roll out on a much larger scale to reach a targeted 1.3 million primary school learners by 2012 with the XO laptop. This planned rollout will test the system's assumptions about scalability. Rwanda's Costed Implementation Strategic Plan for ICT in Education makes reference to the integration of monitoring and evaluation in order to learn from the experience of going to scale with the XO laptop for primary school children.

Similarly, the Jordanian Education Initiative targeted an initial 100 Discovery Schools where it tested its public private partnership model. Namibia through its SchoolNet programme reached an initial 300 schools and the Tech/Na! Implementation Framework was designed to reach the full complement of the country's schools through the establishment of its NETTS Centre and the Tech/Na! public-private partnership model. Uruguay seems to have gone further in an attempt at reaching larger number of schools and children. After initial pilot phase, Uruguay's *Plan Ceibal* had begun with a strong social agenda to reach 362,000 children and 18,000 teachers.

These examples show strong references to numerical targets in their implementation design some of which also include large ICT infrastructure projects to enable higher levels of affordable access to ICT and Internet connectivity, as evidenced in Jordan, Namibia, Rwanda and Uruguay.

Whilst much of the attempts at reaching scale include numerical targets, which is also evident in the Singaporean case, Singapore appears to have placed stronger emphasis on expanded reach in educational quality through the use of ICT. In the Singaporean context, scalability is a reference to the ubiquitous reach of high quality models of learning and teaching with ICT. Even though Singapore had implemented two master plans of five years each, they were still a number of major hurdles to overcome, which the third master plan attempts to address. This includes the scalability of good projects and good practices, hence a stronger emphasis on the quality imperative. Arguably this could be because Singapore also operates on a higher developmental base relative to Rwanda and Namibia, which began from a very low resource base and whose systems remain fraught with structural challenges.

Sustainability

A crucial determinant of the success of an ICT in Education Policy and Implementation Plan is their sustainability. Cisler (2002) suggests that sustainability has an economic component which refers to the ability to finance an ICT-based initiative over the long term; a social component which is a function of community and multi-stakeholder involvement; political component which refers to policy and leadership and technological component which entails making sound technology choices that can be sustained over time.

The policy and implementation frameworks of Rwanda, Jordan, Uruguay and Namibia do not make any explicit reference to sustainability. However they each provide references to partnership models structured to foster social sustainability. In these countries, public-private partnerships are a key feature and involve the active partnership participation of multi-national corporations, local companies as well as community-based and civil society

organizations including parents and youth from these communities. In the case of Jordan, a McKinsey Report mentions significant contributions by a range of partners including Government, towards the implementation of the Jordan Education Initiative. This, too, is the case of Tech/Na! in Namibia.

While reference is made to the value for sustainability in multi-stakeholder partnerships in education, these cases provide limited if any reference is to fostering the economic sustainability in particular. These Policies provide estimates of budgets that are broadly required. In the case of Rwanda and Jordan, specific references are made to a shortfall in budget. As mentioned, the budget for the Rwandan implementation plan is approximately US $ 79 million. But the Implementation plan does not indicate how this budget will be financed. In South Africa it is understood that once the Ministry of Education is able to finalize budget for the Implementation plan, a resourcing strategy will be developed accordingly.

In contrast, the Singaporean government appeared to have over-budgeted for its first five-year ICT Master Plan. The Government committed a budget of S$2 billion (US $1.2 billion from 1997 to 2002 for the implementation of the first ICT master plan and an additional S$ 600 million (US $375 million) for equipment replacement, software, and teacher professional development. As it turned out, the expenditure based on this budget was actually less due to, *inter alia*, bulk purchases and lower equipment costs. Subsequent master plans included careful budgeting which had been sustained by the Government. Similarly, in Uruguay, the Government invested US $ 140 million in its P*lan Ceibal*. The financial viability of such investment is assisted by structural factors in Uruguay such as the lack of geographical barriers that facilitated the installation of the required infrastructure to provide connectivity; the country's demography, which is characterized by lower numbers of children; the strong presence and highly-organized nature of the public education system; and the relatively high level of education of the Uruguayan population.

In the case of Jordan and Rwanda however attempts at economic sustainability is partially addressed by incentives to encourage Foreign Direct Investment in the ICT sector. ICT reportedly remain the most attractive area for Foreign Direct Investment in Rwanda, assuming 23% of the total investments in Rwanda in 2006. The country currently boasts a host of ICT projects which together will contribute significantly to the country's ICT infrastructure and its integration into the global economy. Similarly in Jordan, the Government has been proactive in incentivizing FDI. In 2007, FDI in the IT sector reportedly amounted to some Jordanian dinars (JOD) 12 million and ICT sector revenues were JOD 1,657 million.

However, despite these attempts which may support longer-term economic sustainability in these countries, unlike Uruguay and Singapore, a host of systemic factors also militate against the attainment of sustainability. These include amongst others, the severe lack of human resource capacity and skills in Government and the private sector in Rwanda which are also manifest in Namibia, the low levels of education of their population, the very low levels of ICT infrastructure and their demographics characterized by a high proportion of youth under the age of 18 and high proportion of rural population. Whilst the assumption is that consequent economic development will provide a base for subsequent growth and sustainable reinvestment in programmes such as these, the fact is that additional resources are needed by developing countries for initial investments in education and other social programmes that support economic development.

Moving Toward Knowledge Creation and Transformation

The pervasive introduction of ICT in the private sector has resulted in significant changes in business practices and organizational structures. These have resulted in significant productivity gains. Yet around the world, little has been changed in education by the introduction of ICT. However, all countries in this study aspire to develop information economies and knowledge societies and they are using ICT policy to achieve that. They see ICT as a

way of transforming education so as to move society and the economy toward this goal. Implementation plans were developed, tasks were assigned, and significant resources were allocated for investments in ICT with the aim of moving in this direction. Movement can be seen in these countries but their education systems have yet to be transformed. What do these case studies say about what it takes to transform education and move along the Knowledge Ladder toward knowledge creation?

Where Are You? Where Do You Want to Go?

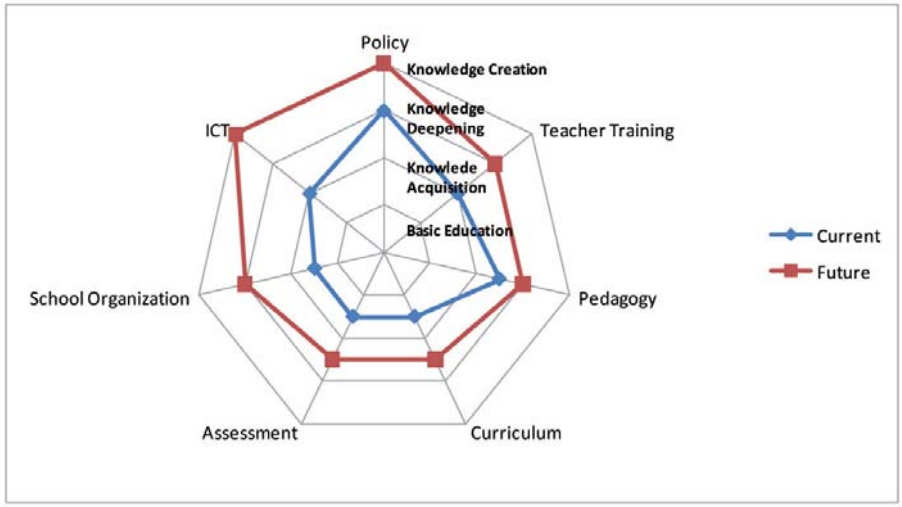
The Knowledge Ladder is a development tool designed to help policy-makers envision goals for change linked to social and economic goals, assess their current situation, and formulate policies and programmes to move forward. Policy-makers can use the Knowledge Ladder table in Chapter 2 to assess the current status of their system and display this in a radial diagram, such as in Figure 8.1. Similarly, they can determine the goal state that they hope to achieve with their new policies and programmes. The goal state should be coordinated with the nation's broader social and economic development goals.

Selecting Levers for Change

When considering systemic change, policy-makers are faced with a tactical decision about where to start: What are the levers that will launch system-wide change? Over the years, the interconnected components of any education system have become finely tuned to the prevailing techno-socio-economic paradigm. Policies often reflect the prevailing socio-economic goals of the country. Examinations are based on these policies and tightly linked to the curricula; pedagogy is driven by the tests, and so on. These linkages improve the efficiency and effectiveness of the system but also work against change. Alterations to any one component rub against the workings of the entire system and make change difficult.

However, shifts in the prevailing paradigm have put tremendous pressure for change on education systems around the world. The response to date within a given system may have created openings and provide levers for change. As well, systems are not totally uniform. There may be pockets of experimentation in certain schools or among some innovative teachers. These are important resources for policy-makers. Policy-makers may also find that different components within their education system are more or less advanced, relative to the Knowledge Ladder. This, too, is an important source of leverage. The key to moving the system forward is to leverage current strengths in one or more areas so as to advance other components of the system. Because in some cases ICT is novel or has not yet settled into the traditional paradigm, it can be introduced as a lever. If hooked to changes in one or two other components, it can launch planned change that, over time, can become systemic. This is illustrated in figure 8.1 below.

Figure 8.1: Radial Diagram of Education Reform Components



In this hypothetical example, a developing country with a thriving commercial economy makes a long-term decision to move toward knowledge creation and policy-makers articulate a vision of an educational system in which students, teachers, and citizens generally would be engaged in continuous, lifelong learning and in the creation and sharing of new ideas. The decision is built on a previously successful education reform effort that, over five years, improved the country's basic education system and increased the technology skills of students. New efforts are funded by a vigorous economy that despite the recent global downturn still runs a very positive trade surplus. As a result of the earlier reform effort, many of the components of the system moved from the basic education approach to a knowledge acquisition approach. For instance, to improve students' mathematics and science scores on nation's standardized exams, the curriculum and textbooks emphasize the learning of facts and computations and teachers reinforce this with classroom pedagogy that emphasizes drills and individual seat work. Schools are organized as hierarchical structures, with head masters and teachers responsible for student performance on exams.

These conditions are significant improvements over a system that previously focused on primary school attendance and basic literacy and numeracy. But they are serious impediments to moving the system toward knowledge deepening and knowledge creation. Yet at the same time, the system has certain strengths, relative to knowledge creation goals. Teachers have a high degree of professionalism and training and a significant number are engaged in pedagogical practices that go beyond memorization to promote understanding. There was a significant ICT investment as part of the previous reform effort and there is now a fairly high penetration and use of networked computers in schools, although they are concentrated primarily in computer labs that were used for ICT literacy courses. Science teachers are starting to use simulations as part of the science curriculum and a small but growing group of teachers and students across the country have been involved in an international project where computers are used for collaborative projects.

In this case, the Ministry chooses to use a strong vision of educational change and new ICT resources as a lever to build on current teacher skills and initial efforts in new pedagogies to extend knowledge deepening pedagogical practices and begin experimentation with knowledge creation practices in select classrooms. A new education policy is linked to an ICT master plan that provides for additional networked computers in the classroom. The master plan also provides for additional teacher professional development that includes the integration of new pedagogical practices and computer applications that emphasize understanding. As these efforts take hold, plans for future policies will target changes in curriculum and assessment that go beyond memorization and begin to measure deep understanding and, ultimately, knowledge creation and twenty-first century sills. Lighthouse schools will be identified where ICT experiments are ongoing and new, more participatory organizational structures will be field tested.

In this hypothetical, the country used its relative strengths as levers for change. Each of our case study countries has relative strengths that they are using as levers to bring about change. Of course, all have policies that are moving their countries toward information economies and knowledge societies. Singapore has a highly trained cadre of teachers and a very strong ICT infrastructure. They are using these as levers to bring about significant changes in pedagogy that promote student-directed learning and collaborative learning that will move Singapore toward a knowledge society. Jordan is tying ICT policy to teacher professional development and curricular change that promote critical thinking, problem solving, decision-making teamwork and other skills that will help their country achieve a knowledge economy. In their effort to develop and ICT-literate workforce and move toward a knowledge-based economy, Namibia is using ICT along with staff training and curricular reform to integrate ICT into the curriculum so that students can access, manage and process information. Rwanda is using ICT and the UNESCO ICT Teacher Competency Standards to move their teachers toward knowledge deepening and, ultimately, knowledge creation. And Uruguay is using widely distributed ICT coupled with pedagogy that promotes students' collaborative learning to move toward equitable access to information and communication possibilities and toward a knowledge-based society.

Is Leap-frogging Possible?

The efforts above bring up an intriguing prospect, that education systems can "leap frog" from a basic stage to a much more advanced one without going through the intermediate stages. All of our case study countries strive toward a knowledge society and information economy. Yet several of the countries are in relatively early stages of economic development. The education policies of Rwanda aim to prepare students for a knowledge-based economy. Yet the per capita GDP for Rwanda is USD 900. There are only 300,000 Internet users in a country of nearly 11 million people. Both Jordan's economic plan and their education reform plan are built on a vision of a knowledge economy. Yet the current per capita gross national income for Jordan is US $ 5,300. Only 7% of Jordanians have a personal computer and only four people out of 100 have Internet access, according to 2007 World Bank figures.

The ability to move ahead in the economy or the education system is both enabled and constrained by current capacity. It is an open question as to whether or not a country can develop a knowledge economy until the information technology infrastructure is in place, the use of technology is widespread, there is a significant domestic skill base, and there is a large demand for knowledge products and services. In education, it may be difficult to move from a system tuned to basic skills to knowledge deepening or from knowledge acquisition to knowledge creation. It may be difficult to incorporate pedagogies that emphasize deep understanding of school subjects if teachers themselves have only a rudimentary education. Incorporating knowledge-building skills into the curriculum may be constrained by assessments that measure only the basics of literacy and numeracy. Providing computers to all classrooms in the system may not be beneficial (or even possible) if the economy has not yet produced the skilled technology workers that would install and maintain the system. And preparing students for a knowledge economy may not make sense if, for example, the economy is not yet in the process of creating knowledge-worker jobs and businesses and homes do not yet have access to the Internet that would allow them to take advantage of knowledge products and services.

Most likely, governments and education systems that aspire to significant advances in social and economic development must plan for the long-term with an extended series of policies and programmes that incrementally move the system forward, building teacher expertise, advancing the curriculum, refining the assessments, and developing technological capacity, as the accomplishments and proceeds of successful economic development support it.

Policy Implications of Lessons Learned

Many other countries are facing the same challenges and opportunities as those we feature in our case studies. These countries provide many lessons that are useful in formulating ICT policies for education. In addition, the Knowledge Ladder gives policy-makers a way of thinking about the introduction of ICT in a coordinated way that is sensitive to the current development context and can advance economic and social development goals. Here are eight guidelines that help policy-makers do that.

Create a vision and align education policies with national goals

To maximize the impact of education investments, strategic educational policies must be aligned with national social and economic development goals. Each of our case study countries did this, each in its own way. As with our case study countries, the national goals should be based on the current development context but lay out a vision and trajectory by which the country builds on its current resources and competitive advantages to accumulate additional resources that can support improved social welfare and economic growth. Education policy can be an important – indeed, central – part of the vision and trajectory.

In some countries, policy alignment can be facilitated by a cross-ministerial decision-making and coordinating committee that may consist of the ministers of economic development, finance, ICT, rural development, education, and others, as is the case with Singapore's economic master plan. In other countries, it may be facilitated by a multi-stakeholder commission or groups composed of cabinet officials and representatives from business,

academia, non-governmental organizations, foundations, and civil society, as in Jordan. In either case, education policy-makers should participate in these deliberations and align subsequent education policies with the results. The Knowledge Ladder provides education leaders with a means for connecting education policy to economic and social policy to transform education and move the entire economic and social system towards the information economy and knowledge society. Specific decisions about economic and social policies can be mapped onto education policy goals with implications for other components of the education system.

Align education programmes with education policies

Strategic education policy aligned with development goals can guide ICT operational policies, programmes, and initiatives, as well as those of other components of the education system. Alignment among the various components of the system is crucial for significant change. The K*nowledge* L*adder* allows policy-makers to think about the implications of a particular policy position for each of the components of the educational system: professional development, pedagogy, curriculum, assessment, social organization, and ICT use. Specific initiatives can be crafted that connect change in each component with that in the others and contribute to overall economic and social development goals. Thus, policy-makers can achieve both vertical alignment with national social and economic development goals and horizontal alignment among departments and programmes within the education ministry. This process can be facilitated by a cross-unit committee, perhaps headed by the minister of education or permanent secretary, composed of the departments of curriculum, assessment, teacher training, higher education, and technology. This committee can use the Knowledge Ladder to design specific programmes and initiatives in their departments that tie teacher professional development with computer applications, for example, or curriculum reforms to assessment revisions that work together to advance education transformation and the broader economic and social goals of the country.

The Knowledge Ladder is particularly good at helping ICT leaders make specific technology decisions in a way that advances education reform and national development goals. Questions about the number of computers, where they are located in schools, the networking architecture, how teachers are trained are considered in terms of how they fit into a particular model – Basic Education, Knowledge Acquisition, etc. – rather than, or in addition to, technical or budgetary considerations. An ICT master plan can spell out these programmes, align them with policy goals, and connect them to a vision of social and economic development. The UNESCO ICT Teacher Competency Standards and the UNESCO ICT Policy Toolkit are particularly good resources for this purpose.

Use ICT as a lever for change

ICT was a lever for change in all of our case study countries. ICT leaders can use the Knowledge Ladder to make decisions about the number and location of computers, the type of network, the training of teachers, and the purchase of software. More importantly, the Ladder can be used to position ICT as a lever for changing other components of the education and, ultimately, overall change in the system and do it in a way that supports broader development goals. As technology is introduced or expanded, ICT decision-makers can work with others in the education system and use the opportunity to coordinate changes in pedagogy, for example, through teacher professional development that not only includes training on the new technology but shows how it can be used in the classroom to promote new teaching methods that advance development goals. For example, ICT policies in Singapore and Uruguay use ICT as a way of supporting pedagogical innovation and student-centred learning.

When selecting ICT, it is important to keep other technologies in mind, in addition to computers. Some African countries have used television broadcast as a medium for delivery of education content, as is the case with Mindset Network and the Learning Channel in South Africa, the Talk Back TV on HIV/AIDS programme in Botswana, and the Centre for Technology Development and Decision-making Support inEgypt (Farrell & Isaacs, 2007). Organizations like the Open Learning Systems Education Trust, based in South Africa, developed audio- and print-based distance education programmes for direct use in classrooms. Interactive radio instruction has also been used extensively by organizations like the Kenya Institute of Education, which has a radio broadcast studio and which has reached up to 400 schools via satellite radio in partnership with WorldSpace. The Knowledge Ladder can help policy-makers select

the appropriate ICT resources and position them in a way that advances education reform and links it to economic and social development. One computer per child is not necessary if the goals of the education system emphasize basic skill development but it can be very beneficial if the goals emphasize knowledge creation.

Plan a Trajectory

Transformation takes time. Those countries that have been successful at development have developed a series of policy statements and programmes that have laid out long-range, incremental advances in economic development and education reform over a five, ten, or fifteen year time span. Singapore is an excellent and successful example of this approach. The country has a 50-year history of building economic development by strengthening their education system. From 1997 to the present, Singapore developed its three ICT Master Plans that began with building school infrastructure and teacher's ICT skills, and moved to integrating ICT into the curriculum, and on to using ICT to promote teacher knowledge building and sharing and student self-directed learning and collaboration skills. In the context of economic and social development goals, policy-makers can use the Knowledge Ladder to select levers that will launch change and plot out strategic path of subsequent policies and programmes that can advance change. As detailed above, policy-makers can begin by identifying future goals and current capabilities and laying out a path of increasingly advanced policies and programmes that level current strengths to develop capabilities and move toward transformation.

Monitor and evaluate

Knowing whether the system is moving from one stage of development to another requires information on infrastructure development, teacher skills and classroom practices, and, of course, student performance. Monitoring and evaluation is the key to measuring progress and providing information that can be used to make adjustments and to refine policies and programs. This is important both at the classroom level, where continuous assessment is an important part of the learning process, and at the system level, where evaluation serves an important management function.

International comparative data can also be important, in this regard. Standard indicators have been established for the regular international reporting on a nation's ICT infrastructure through the World Bank, UNESCO, and the ITU. A number of useful indicators have been developed in education for measuring ICT resources, teacher training, and classroom pedagogy, as well as student learning of school subject matter and student attitudes (Kozma & Wagner, 2005). And occasional international studies of educational ICT infrastructure have been conducted, such as the SITES studies of the International Association for the Evaluation of Educational Achievement (IEA).[60] However, these studies are limited in their international scope and regularity of data collection. Standard indicators have not yet established for uniform, regular international reporting of educational ICT, although UNESCO Institute for Statistics is working on this issue (UNESCO Institute for Statistics, 2009). Regular, periodic reporting of student achievement is done by both the IEA (Trends in International Math and Science Study or TIMSS) and the OECD (Programme for International Student Assessment or PISA), however, only a select group of countries participate in the studies. Of course, periodic national assessments often suffice to measure student progress. The frequent shortfall in this area is the measurement of what are called "twenty-first century skills", such as critical thinking, collaboration, problem solving, communication, and ICT literacy. Many national educational leaders in OECD countries indicate that these skills are important and are taught in their schools, but very few countries actually assess them (Ananiadou & Claro, 2009). Australia (Ministerial Council on Education, Employment, Training, and Youth Affairs, 2007) and Hong Kong (Law, et al., 2007) have begun to measure ICT literacy skills. And efforts are underway to develop measures of other twenty-first century skills.[61] But without such measures it is difficult to know if progress is being made toward Knowledge Creation goals.

60 http://www.iea.nl/completed_studies.html
61 http://atc21s.org.

Build capacity

High-quality teachers are the key to high quality education systems (Barber & Mourshed, 2007). Professional development of teachers and school leaders should be a central part of any ICT policy connected to systemic school reform. As described above, efforts in Singapore, Jordan, and Rwanda feature professional development as a core component of ICT policy. In Europe, Ministries of Education urge that school leaders be given the skills needed to develop ambitious but realistic local visions and plans, undertake complex management, coordination, and evaluation functions, and engage in continuous professional development of their staffs (Van den Brande, Carlberg, & Good, 2009). In other African countries, UNESCO's Teacher Training Initiative for Sub-Saharan Africa (TTISSA) and the African Virtual University Teacher Education Project feature among the most significant, multi-country regional programmes promoting teacher professional development and ICT integration (Farrell & Isaacs, 2007). The Knowledge Ladder and the parallel UNESCO ICT Competency Standards for Teachers can be used as a way to position ICT professional development in a context of systemic education reform formulate professional development programmes that contribute to education transformation and broader social and economic development goals.

Provide funding and resources

Funding education reform is as necessary as it is difficult, especially for developing countries and especially in an economic downturn. Lack of financial resources is clearly inhibiting the progress of ICT programmes in Rwanda. Yet education reform which is tied to economic and social development is the sort of investment that will make significant returns over the long term. For developed and emerging economies, it is a matter of assigning priorities for spending resources that are available. This is demonstrated by the priority given to education development by Singapore where spending on education improvement has increased by 5.5% despite a significant worldwide recession (Hen, 2009). But for less developed countries, funding government initiatives of any sort is always a problem. Corporate, multi-national, and NGO partners can help. Both developed and developing countries have worked with telecommunications agencies to fund infrastructure capacity in schools, as in Chile (Hinostroza, Hepp, & Cox, 2009) and Brazil (Litto, 2009). The World Bank, UNESCO, ITU, regional development banks and many other multi-national development and national agencies have mounted programmes to assist developing countries in building their educational ICT capacity. For example, with UNESCO and InterAmerican Development Bank funds, Brazil, Venezuela, and Peru developed a collection of digital resources for education that included animations, simulations, diagrams, texts, and videoclips (Litto, 2009). UNDP supported a programme in the People's Republic of China to give teachers access to distance education and ICT teaching methods (Hu & Law, 2009). Canada's International Research and Development Centre (IDRC) has funded telecentre development throughout rural Africa in support of local development goals (Etta & Parvyn-Wamahiu, 2003).

Private-public partnerships

The changes discussed here often require a significant shift in priorities and resources. This shift is particularly challenging for less developed countries. But no government, however advanced, can bring about all of these changes on its own. The effort requires a multi-sector approach to educational improvement that involves government, business, and civil society. All sectors benefit from education change that promotes development and all sectors must participate in that change. Again, ICT can play a central role in building partnerships. By connecting education change to development goals, education policy-makers can use the ICT opportunity to recruit partners who bring technological resources, expertise, and help that can support education change and, in turn, advance development goals.

The private sector has played an important role, in this regard, particularly high tech companies that collaborate with governments and NGOs to promote education reform and economic development. Intel, Microsoft, Cisco, Apple, and HP all have international programmes to support infrastructure development in schools. These companies have not only brought financial resources to the table but significant expertise. For example, Intel's has mounted a major effort, the *Teach* program, in which over 6 million teachers in over 50 countries have been trained in both

technological literacy and pedagogical skills.[62] The Cisco Networking Academy is a global education programme that teaches students how to design, build, troubleshoot, and secure computer networks.[63] As of late 2009, the programme had more than 9,000 academies in 165 countries and has trained more than 800,000 students each year since its launch in 1997. Microsoft offers national teacher forums in more than 100 countries where teachers have an opportunity to build communities of practice, collaborate with colleagues, access quality content developed by their peers, and develop their use of technology. The most innovative teachers are selected to participate in regional and worldwide forums[64].

Conclusion

The ever-increasing capabilities and decreasing costs of ICT have had a profound impact on society and the global economy. The growth of the technology sector has empowered and drawn on a major shift from a manufacturing-based economy to one based on information services and products. The widespread access to ICT has spawned significant social trends and reshaped social behaviors. The pervasive presence of ICT in offices, shops, and factories has enabled and required major changes in business practices and organizational structures. And its extensive use has corresponded to increased profitability of companies, productivity of economies, and prosperity of countries.

As in the private sector, the capabilities of ICT can be harnessed to bring about significant change – indeed, transformation – in educational practices and structures. This has yet to happen. Despite significant investments in hardware, software, and networking, ICT is typically not associated with large gains in student assessments. ICT is, however, still rarely used; classroom practices have yet to change; schools have yet to reorganize. If research on the impact of ICT on the economy and on business structures and practices is any indication, the gains associated with ICT will only be realized when it is accompanied by other organizational changes and classroom practices that work to align the education system with the social and economic goals of the country.

With the conceptual framework presented in this book and the initial lessons learned from our five case study countries, educational decision-makers can craft ICT policies that support education transformation and move the country toward an information economy and knowledge society. This involves coordinated change in all the components of the system; not just ICT but teachers' professional development, curriculum, pedagogy, assessment, and school organization – all aligned behind policies that support social and economic development. This approach envisions a cluster of changes that can support and constitute this transformation. ICT can be used to support teachers as they collaborate with their colleagues to learn best practices and model for their students the learning process. Students use ICT to engage in the sustained, collaborative process of building on current knowledge and cultural artifacts to create and share new contributions. As they do so, students develop the ability to use a range of technology tools to search for, organize, and analyse information; to communicate effectively in a variety of forms; to collaborate with others of diverse skills and backgrounds; to think critically, innovatively, and creatively; and to continue their learning throughout their lifetimes. Head teachers continuously monitor their progress of their students, review the school's goals and vision, and work with their staff to adjust to new circumstances. As a result, schools become learning organizations in which principals, teachers, and students all participate in knowledge creation and sharing and are all involved in the learning process. In this way, ICT and education reform can make their greatest contribution to social and economic development.

62 http://www.intel.com/education/teach/index.htm
63 http://www.cisco.com/web/learning/netacad/academy/index.html
64 http://www.microsoft.com/education/pil/partnersInLearning.aspx

References

Ahmad, N., Shreyer, P., and Wolfl, A. 2004. ICT I*nvestment in* OECD C*ountries and its* E*conomic* I*mpacts*, *the* E*conomic* I*mpact of* ICT: M*easurement*, E*vidence and* I*mplications*.

Agency for e-Government and the Information and Knowledge Society (AGESIC). 2007. L*ibro Verde de la* SIC *en* U*ruguay*. A*nálisis general y* D*iagnóstico sobre la* S*ociedad de la* I*nformación y el* C*onocimiento*. Agencia para el Desarrollo del Gobierno de Gestión Electrónica y la Sociedad de la Información y del Conocimiento, Montevideo (May, 2007). Retrieved December 14, 2009 from http://www.agesic.gub.uy/innovaportal/file/298/1/LibroVerdeUruguay.pdfAndo, R., Takahira, M., and Sakamoto, A. 2004. Effects of Internet use on attitude toward learning: A panel study of 5th- and 6th-grade elementary students in Japan. I*nformation and Systems in* E*ducation*, Vol. 3, pp. 67–73.

—. 2008. A*genda* D*igital* U*ruguay* 2008-2010 *para la* S*ociedad de la* I*nformación y del* C*onocimiento* (ADU 2008-2010). Agencia para el Desarrollo del Gobierno de Gestión Electrónica y la Sociedad de la Información y del Conocimiento, Montevideo. Retrieved December 11, 2009 from http://www.agesic.gub.uy/innovaportal/file/297/1/Agenda_Digital2008-2010.pdf

—. 2009. A*gencia para el* D*esarrollo del* G*obierno de* G*estión* E*lectrónica y la* S*ociedad de la* I*nformación y del* C*onocimiento*. Retrieved December 21, 2009 from http://www.agesic.gub.uy

National Agency for Public Education (ANEP). 2007. D*iagnóstico sobre* E*quipamiento* I*nformático en escuelas públicas*. ANEP-CODICEN. Departamento de Investigación y Estadística Educativa (October 2007). Retrieved December 20, 2009 fromhttp://www.anep.edu.uy/observatorio/documentos/infoequipamiento_ep.pdf

—. 2008a. C*enso* N*acional* D*ocente* ANEP – 2007. ANEP-CODICEN. Dirección Sectorial de Planificación Educativa. División de Investigación, Evaluación y Estadística. Retrieved December 21, 2009 from http://www.anep.edu.uy/documentos/pdf_%20censo/dspe_censo_completo.pdf

—. 2008b. A*cceso y uso de las* TIC *en educación media*. U*n análisis internacional comparado en base a* PISA 2006. U*ruguay en el* P*rograma* PISA. Boletín N° 3 (December 2008) Retrieved December 20, 2009 from http://www.anep.edu.uy/documentos/pisa/Boletin_3_PISA_2008.pdf

—. 2009. P*olíticas educativas y de gestión* 2005-2009 / ANEP-CODICEN. Administración Nacional de Educación Pública. Consejo Directivo Central. Montevideo: CODICEN

ANEP-CEP. 2007. CEIBAL. Proyecto Pedagógico. September 2007. Retrieved December 24, 2009 from http://www.bellaunion.com.uy/cultura/Proyecto%20CEIBAL.pdf

Angrist, J. and Lavy, V. 2002. New evidence on classroom computers and pupil learning. T*he* E*conomic* J*ournal*, Vol. 112, pp. 735-765.

National Agency for Research and Innovation (ANII). 2009. Agencia Nacional de Investigación e Innovación. Retrieved December 21, 2009 from http://www.anii.org.uy

ANTEL. 2009. Administradora Nacional de Telecomunicaciones. Retrieved December 21, 2009 from http://www.antel.com.uy

Apte, U., Kamakar, U. and Nath, H. 2008. Information services in the US economy: Value, jobs, and management implications. *California Management Review*, Vol. 50, No. 3, pp. 12–30.

Arab Advisors Group. 2009. Online Survey. Press Release, August 11, 2009.

Arvanitis, S. 2005. Computerization, workplace organization, skilled labour and firm productivity: Evidence for the Swiss business sector. *Economics of Innovation and New Technology*, Vol. 14, No. 4, pp. 225–249.

Askenazy, P., Caroli, E., and Marcus, V. 2002. New organizational practices and working conditions: Evidence from France in the 1990s. CEPREMAP Working Papers, No. 0106, downloaded on October 4, 2009 from http://www.cepremap.cnrs.fr/couv_orange/co0106.pdf.

Autor, D., Levy, F. and Munane, R. 2003. The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics*, Vol. 118, No. 4, pp. 1279–1334.

Azar, P., Llanes, J., Sienra, M., Capurro, A. and Velázquez, C. 2008. *Informe sobre el Gasto Público en Infancia en Uruguay* 1990-2009. Cuadernos de la ENIA (Estrategia Nacional de la Infancia y la Adolescencia). Gasto Público en la Infancia. Montevideo, ENIA.

Balanskat, A. 2007. STEPS: *Study of the Impact of Technology in Primary Schools*. Brussels, European Schoolnet.

Banks, D., Cresswell, J. and Ainley, J. 2003. *Higher-order Learning and* ICT *amongst Australian 15-year Olds*. Melbourne Australian Council for Educational Research.

Barber, M. 2007. *Three Paradigms of Public-Sector Reform*. Confidential Working Paper. McKinsey & Company.

Barro, R. 2002. *Education and Economic Growth*. Paris, Organisation for Economic Cooperation and Development (OECD).

Bassi, R. *What Do We Know about* OLPC *Pilots Worldwide*? Retrieved on December 20, 2009 from http://www.olpcnews.com/implementation/evaluations/what_do_we_know_about_olpc_pil.html

Batchelor, S., Evangelista, S., Hearn, S., Peirce, M., Sugden, S., and Webb, M. 2003. ICT *for Development. Contributing to the Millennium Development Goals: Lessons Learned from Seventeen infoDev Projects*. Washington, DC, infoDev.

Batchelor, S., Scott, N., and Taylor, N. 2005. *The Contribution of* ICTs *to Pro-poor Growth*. Paris, OECD.

Bentancur, N. 2007. *Education reform and school performance. Some thoughts on the experiences of Argentina, Chile and Uruguay*. Cuad. CLAEH, 3. Montevideo

Bereiter, C. 2002. *Education and Mind in the Knowledge Age*. Mahwah, NJ, Lawrence Erlbaum Associates.

Bianchi, L. 2009. *Las redes de apoyo al plan Ceibal y su contribución a la alfabetización digital de la comunidad*. Primer Evento Internacional sobre experiencias del Plan *Ceibal*, *Ceibal*.

Bibolini, L. and Baker, L. 2009. *Latin America - Mobile Communications Statistics*. Paul Budde Communication Pty Ltd., May 2009, 8th Edition. Retrieved December 13, 2009, from http://www.budde.com.au/Research/Latin-America-Mobile-Communications-Statistics-tables-only.html

Birdsall, N., Levine, R. and Ibrahim, A. 2005. *Toward Universal Primary Education: Investments, Incentives, and Institutions*. New York, United Nations Development Program.

Black, S. and Lynch, M. 2003. What's driving the new economy: The benefits of workplace innovation. *The Economic Journal*, Vol. 114, pp. 97–116.

Blackmore, J., Hardcastle, L., Esme, B., and Owens, J. 2003. *Effective Use of Information and Communication Technology* (ICT) *to Enchance Learning for Disadvantaged School Students* (Technical Report). Melbourne, AU, Institute of Disability Studies, Deakin University.

Blumenfeld, P., Kempler, T., and Krajcik, J. 2006. Motivation and cognitive engagement in learning environments. In: Sawyer, R. K. (ed.), *Cambridge Handbook of the Learning Sciences*, p. 475-488. Cambridge: Cambridge University Press.

Borghans, L., and ter Weel, B. 2001. *Computers, Skills and Wages*. Maastricht, Netherlands, MERIT.

Borlaug, N. and Dowswell, C. 2001. *The Unfinished Green Revolution–The Future Role of Science and Technology in Feeding the Developing World*. Paper presented at the Seeds of Opportunity Conference, School of Oriental and African Studies, London, May 31, 2001.

Bransford, J., Brown, A., and Cocking, R. 2000. *How People Learn: Brain, Mind, Experience, and School*. Washington, DC, National Academic Press.

British Council. 2006. Regional ICT in Education Project: Near East and North Africa.

Brynjolfsson, E. 1993. The productivity paradox of information technology: Review and assessment. *Communications of the* AMC, Vol. 41, No. 8, pp. 49–55.

Cardozo, S. 2008. *Políticas educativas, logros y desafíos del sector en Uruguay* 1990–2008. Cuadernos de la ENIA, Políticas educativas. Montevideo, Ministerio de Desarrollo Social. Retrieved December 17, 2009, from http://www.oei.es/pdf2/politicas_educativas_logros_desafios_uruguay.pdf

Ceibal 2010. *Informe de Monitoreo y Evaluación del Plan Ceibal*. Retrieved February 17, 2011 from http://www.ceibal.org.uy/docs/el-plan-ceibal-a-2010-avances-y-desafios.pdf

Ceibal. 2009a *Primer Evento Internacional sobre Experiencias del Plan Ceibal*. Folleto *Ceibal*, Montevideo, December 2009.

—. 2009b. *Plan Ceibal*. Retrieved December 10, 2009 from http://www.ceibal.edu.uy

—. 2009c. Monitoreo y evaluación educativa del Plan *Ceibal*: Primeros resultados a nivel nacional. Montevideo: *Ceibal*.

CEP. 2009. Consejo de Educación Primaria [*Council of Primary Education*]. Retrieved December 21, 2009 from http://www.cep.edu.uy

Centre for Educational Research and Innovation (CERI). 2009a. *Beyond Textbooks: Digital Learning Resources as Systemic Innovation in the Nordic Countries*. Paris, Organization for Economic Cooperation and Development (OECD).

—. 2009b. *Working Out Change: Systemic Innovation in Vocational Education and Training*. Paris, OECD.

Centre for Educational Research and Innovation. 2010. *Are the New Millennium Learners Making their Grades? Technology Use and Educational in Performance on* PISA. Paris, OECD.

Choy, D., Wong, A. and Gao, P. 2008. *Singapore's Preservice Teachers' Perspectives in Integrating Information and Communication Technology* (ICT) *during Practicum*. Paper presented at AARE conference.

Christensen, C., Horn, M., and Johnson, C. 2008. *Disruptive Class: How Disruptive Innovation Will Change the Way the World Learns*. New York, McGraw-Hill.

Chua, H. H. 2009. Youth stuck on video games: Young Singaporeans spend 27 hours a week playing games, which raises fears over impact. The *Straits Times*. 5th Ocotber , 2009.

CIA. 2009.*The World Factbook*. US Central Intelligence Agency. Retrieved Dec 12, 2009, from https://www.cia.gov/library/publications/the-world-factbook/geos/uy.html

—. 2009. *The World Factbook*. https://www.cia.gov/library/publications/the-world-factbook/geos/wa.html Retrieved on December 17, 2009.

—. 2009. CIA *World Factbook Rwanda*. https://www.cia.gov/library/publications/the-world-factbook/geos/rw.html

CITEL. 2008. Proyecto CEIBAL. *Boletín electrónico*, 46 (Apr, 2008).Comisión Interamericana de Telecomunicaciones. Organización de los Estados Americanos. Retrieved December 19, 2009 from http://www.citel.oas.org/newsletter/2008/abril/ceibal_e.asp

Clegg, A. and Van Graan, M. 2002. *Science, Mathematics and* ICT *Education in sub-Saharan Africa – the* SMICT *Study*. Namibia Country Paper. http://cbdd.wsu.edu/edev/Nigeria_ToT/tr510/documents/SMICT%20Namibia%20v1.41.pdf Retrieved on December 17, 2009.

Cogburn D L and Adeya C N. 1999. *Globalization and the Information Economy: Challenges and Opportunities for Africa*. United Nations University.

Cohen, D. and Hill, H. 2001. *Learning Policy: When State Education Reform Works*. New Haven, CT, Yale University Press.

Coldevin, G. 2006. Teacher Training in ICT in Jordan (updated 2009

Collins, A. and Halverson, R. 2009. *Rethinking Education in the Age of Technology*. New York, Teachers College Press.

Commission on Growth and Development. 2008. Growth report: Strategies for sustained growth and inclusive development. Washington, DC, World Bank.

Crespi, F., and Pianta, M., 2008. Demand and innovation in productivity growth. *International Review of Applied Economics*, Vol. 22, No. 6, pp. 655–672.

De Armas, G. and Garcé, A. 2004. *Política y conocimiento especializado: la reforma educativa en Uruguay* (1995–1999). In *Revista Uruguaya de Ciencia Política*, 14, pp. 67–83. Montevideo, ICP-UdelaR.

de Cindio, F., Gentile, O., Grew, P., and Redolfi, D. 2003. *Community Networks: Rules of Behavior and Social Structure*. In *The Information Society*, 19(5), pp. 395–406.

Delors, J., et al. 1999. *Learning: The Treasure Within*. Paris, UNESCO.

Dickerson, A., and Green, F. 2004. The growth and valuation of generic skills. *Oxford Economic Papers*, Vol. 56, pp. 371–406.

Dravis, P. 2003. *Open Source Software: Perspectives for Development*. Washington, DC, infoDev, World Bank.

Economic Restructuring Committee Report 2003. Singapore: Ministry of Trade and Industry.

Education Statistics Digest. 2009. Singapore, Ministry of Education. http://www.moe.gov.sg/education/education-statistics-digest/files/esd-2009.pdf. Accessed December 20, 2009.

Elmore, R. 2004. *School Reform from the Inside Out: Policy, Practice, and Performance*. Cambridge, MA, Harvard Education Press.

El País Digital. 2009. Luces y sombras en números sociales y de la enseñanza. November 30, 2009. Retrieved December 20, 2009 from http://www.elpais.com.uy/091130/pnacio-457314/nacional/luces-y-sombras-en-numeros-sociales-y-de-la-ensenanza

Empirica. 2006. *Benchmarking Access and Use of* ICT *in European Schools*. Brussels, European Commission.

European Commission. 2010. *New Skills for New Jobs: Action now*. Brussels, European Commission.

Eurostat. 2009. *Youth in Europe*: A *Statistical Portrait*. Luxembourg, European Commission.

Fallows, D. 2008. *Search engine use*. Pew Internet and America Life Project. http://www.pewinternet.org/reports.asp, accessed on 7-1-08.

Farrell, G. and Isaacs, S. 2007. *Survey of* ICT *and Education in Africa*. Washington, DC, infoDev.

Freeman, C. and Louca, F. 2001. *As Time Goes by: From the Industrial Revolutions to the Information Revolution*. New York, Oxford University Press.

Friedman, T. 2006. *The World is Flat*: A *Brief History of the* 21st *Century*. 2nd ed. New York, Farrar, Straus, and Giroux.

Fuchs, T. and Woessmann, L. 2004. *Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and School*. Munich, Centre for Economic Studies.

Fullan, M. 2007. *The New Meaning of Educational Change* (4th ed.). New York, Teachers College Press.

Furlund, Eivind. 2008. *Singapore from third to first world country. The effect of development in Little India and Chinatown*. Master's thesis. Department of Geography. Norwegian University of Technology and Science. Trondheim.

Gabinete Ministerial de la Innovación. 2007. *Plan Estratégico Nacional de Ciencia, Tecnología e Innovación* (PENCTI). *Lineamientos fundamentales para la discusión*. Retrieved December 15, 2009 from http://www.anii.org.uy/imagenes/pencti.pdf

Garderes, D. 2008. *El Plan* CEIBAL: *una Experiencia Uruguaya de Acceso Escolar Universal a las* TIC. In *Revista Enlaces, un Espacio de Reflexión Digital*. Retrieved December 20, 2009 from http://www.enlaces.cl/index.php?t=54&i=2&cc=1374&tm=2

Gera, S., and Gu, W. 2004. The effect of organizational innovation and information technology on firm performance. *International Performance Monitor*, No. 9.

Gerster, R. and Zimmerman, S. 2005. *Upscaling Pro-poor ICT Policies and Practices: A Review of Experience with Emphasis on Low-income Countries in Asia and Africa*. Geneva, Swiss Agency for Cooperation and Development.

GeSCI. 2009. ICT *Teacher Professional Development Matrix*. http://www.gesci.org/teacher-education-and-icts.html Retrieved on January 5 2010

Goh, C.T. 1997. Speech by PM Goh Chok Tong at the Opening of the 7th International Conference on Thinking, 2nd June 1997, Singapore. http://app.internet.gov.sg/data/sprinter/pr/archives/1997060209.htm. Accessed November 30, 2009.

Gómez Monroy, C. 2008. OLPC *Uruguay/Ceibal*. Retrieved December 21, 2009 from http://wiki.laptop.org/go/OLPC_Uruguay/*Ceibal*

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., and Brenwald, S. 2008. *Highlights From* TIMSS 2007: *Mathematics and Science Achievement of* U.S. *Fourth- and Eighth-Grade Students in an International Context* (NCES 2009–001 Revised). National Centre for Education Statistics, Institute of Education Sciences, US Department of Education. Washington, DC.

Government of Jordan. 1995. National Agenda. Government of Jordan. http//www.nationmaster.com/graph/edu_on_tea_mat_education_spending_on_teachinh_material

Government of the Republic of Namibia. 2004. *Vision* 2030: *Vision for Long Term National Development*. Office of the President, Namprint, Windhoek, Namibia. http://www.tech.na/download/Vision2030.pdf Retrieved on December 20, 2009.

Government of the Republic of Namibia. 2005. ICT *Policy for Education*: ICT *Integration for Equity and Excellence in Education*.

Government of Rwanda. 2000. *Vision* 2020. Retrieved on November 27, 2009 from Error! Hyperlink reference not valid.

Gutterman, B., Rahman, S., Supelano, J., Thies, L. and Yang, M. 2009. *White Paper Information & Communication Technologies* (ICT) *in Education for Development*. The Global Alliance for ICT and Development (UNDESA-GAID). New York, United Nations. Retrieved Dec 20, 2009 from http://unpan1.un.org/intradoc/groups/public/documents/gaid/unpan034975.pdf

Hannushek, E. and Woessmann, L. 2009. *Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes and Causation*. NBLR Working Paper No. 14633. Washington, DC, National Bureau of Labor Relations.

Hargreaves, A. 2005. *Teaching in the Knowledge Society: Education in the Age of Insecurity*. New York: Teachers College Press.

Harrison, C.; Comber, C.; Fisher, T.; Haw, K.; Lewin, C.; Lunzer, E.; McFarlane, A.; Mavers, D.; Scrimshaw, P.; Somekh, B.; and Watling, R. 2003. *ImpaCT2: The Impact of Information Communication Technologies on Pupil Learning and Attainment*. Coventry, UK, British Educational Communications and Technology Agency.

James, T. and Miller, J. 2005. Developing a monitoring and evaluation plan for ICT for education. In: Wagner, D., Day, B., James, T., Kozma, R., Miller, J. and Unwin, T. *Monitoring and Evaluation of* ICT *Projects for Education*: A *Handbook for Developing Countries*. pp. 33–44. Washington, DC: infoDev, World Bank.

Jones, R. 2003. Local and national ICT policies. In: Kozma, R. (ed.), *Technology, Innovation, and Educational Change*: A *Global Perspective*. pp. 163–194. Eugene, OR, International Society for Technology in Education.

Ibarra, M. L. 2008. *Profesores rechazan Plan Ceibal y reclaman mejoras en salarios*. In *El País Digital*, April 1, 2008. Retrieved December 20, 2009 from http://www.elpais.com.uy/08/04/01/pnacio_338558.asp

Ilukena, A. 2006. ICT *Policy for Education*: A *Tale of Two Countries* in Digital Learning: Learning Through ICT, Centre for Science, Development and Media Studies (CSDMS), India http://www.digitallearning.in/sept06/coverstory.asp (21 December 2009)

Infocomm Development Authority. 2009a. Statistics on telecom services for 2009. http://www.ida.gov.sg/Publications/20090304182010.aspx Accessed December 15, 2009.

—. 2009b. Infrastructure overview. http://www.ida.gov.sg/Infrastructure/20060411230420.aspx Accessed December 15, 2009.

—. 2009c. Neu Pc Plus. http://www.ida.gov.sg/Publications/20061130175201.aspx). Accessed December 15, 2009.

INSEAD 2009 *Global Information Technology Report* 2008-2009. World Economic Forum http://www.slideshare.net/victori98pt/the-global-information-technology-report-20082009

Intaj. 2009. Jordan's ICT Sector Capacity in Education.

Intaj. 2007. IT industry Statistics.

International Development Bank (IDB). 2000. UR0110: *Technological Development Program*. Inter-American Development Bank. Retrieved December 12, 2009 from http://www.iadb.org/Projects/project.cfm?id=UR0110&lang=en

—. 2001. UR0132 : *Secondary School and Teacher Training*. Inter-American Development Bank. Retrieved December 18, 2009 from http://www.iadb.org/Projects/project.cfm?lang=en&query=&id=ur0132&project=ur0132

—. 2005. IDB *Country Strategy with Uruguay* (2005–2009). Inter-American Development Bank. Retrieved December 12, 2009 from http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum-697957

—. 2008. UR-L1030: *Technology Development Programme* II. Inter-American Development Bank. Retrieved December 12, 2009 from http://www.iadb.org/Projects/project.cfm?id=UR-L1030&lang=en

—. 2009. UR-L1058: *Programa de Apoyo a la Consolidación y Expansión del Plan* CEIBAL. *Perfil de Proyecto*. Inter-American Development Bank. Retrieved December 18, 2009 from http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=2223751

International Network for the Availability of Scientific Publications (INASP). 2004. *Empowering Youth and Connecting Schools. Lessons from the SchoolNet Namibia Approach*. In: INASP *InfoBrief* 2. INASP, Oxford, UK. http://www.inasp.info/file/0a8e7bb09c7c8c8d42ff0f0043ca3415/infobrief-2.html Retrieved on December 20, 2009.

International Society for Technology in Education (ISTE). 2007. *National Educational Technology Standards and Performance Indicators for Students*. Eugene, OR, ISTE.

International Telecommunication Union (ITU). 2007. *World Information Society Report* 2007: *Beyond* WSIS. Chapter 3 – *The Digital Opportunity Index* (DOI), pp. 35–55. ITU and United Nations Conference on Trade and Development (UNCTAD). Retrieved December 14, 2009 fromhttp://www.itu.int/osg/spu/publications/worldinformationsociety/2007/WISR07_full-free.pdf

——. 2009. *Measuring the Information Society – The ICT Development Index, 2009 Edition*. Geneva, International Telecommunications Union. Retrieved December 14, 2009 from http://www.itu.int/ITU-D/ict/publications/idi/2009/material/IDI2009_w5.pdf

——. 2009. *Measuring the Information Society. The ICT Development Index*. Geneva, Switzerland: ITU. Retrieved on March 25, 2010 from Error! Hyperlink reference not valid.

IST-Africa. 2009. *Regional Impact of Information Society Technologies in Africa: Overview of ICT Infrastructure in Namibia*. http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=3581 Retrieved on December 20, 2009.

IT News Africa. 2009. *New Study Lauds Namibia's ICT Infrastructure*. http://www.itnewsafrica.com/?p=2914 Retrieved on December 21, 2010http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=3581.

Jacobs, C. 2009. *Namibia: Education System Faces Many Challenges*. http://allafrica.com/stories/200909250379.html Retrieved March 13, 2010.

Jara, I. 2001. Plan de Operaciones. Programa de Conectividad Educativa. Uruguay, BID.

Jiang, S. 2008. ICT Sector Profile, Jordan.

Kaapanda, J. 2010. Speech by Honorable Minister Joel Kaapanda at the launching of the MICT Strategic Plan: 2009-2014, 18 February 2010, Windhoek http://209.88.21.36/opencms/export/sites/default/grnnet/GRNPress/2010/download/MICT_launches_its_Strategic_Plan_x3x.pdf Retrieved March 21, 2010.

Kamakar, U. and Apte, U. 2007. Operations management in the information economy: Information products, processes, and chains. *Journal of Operations Management*, Vol. 25, pp. 438–453.

Kaplún, G. 2009. *Uruguay: country report*. In GISWatch, *Global Information Society Watch 2009 report* (pp. 220–222). Retrieved December 11, 2009 from http://www.giswatch.org/2009report/pdf/country/uruguay.pdf

Karpati, A. and Horvath, A. 2009. National policies and practices on ICT in education: Hungary. In: Plomp, T., Anderson, R., Law, N. and Quale, A. (eds.). *Cross-national Information and Communication Technology: Policies and Practice in Education* (rev. 2nd ed.), pp. 349–368. Greenwich, Connecticut, IAP.

Kiboss, J. 2000. Teacher/pupil perspectives on computer-augmented physics lessons on measurement in Kenyan secondary schools. *Journal of Information Technology for Teacher Education*, Vol. 9, No. 2, pp. 199–218.

Koh, T. S. and Lee, S.C. 2009. *Information Communication Technology in Education: Singapore's ICT Master Plans 1997–2008*. Singapore, World Scientific

Kozma, R. 1991. Learning with media. *Review of Educational Research*, Vol. 61, No. 2, pp. 179–212.

Kozma, R. 2003. (ed.). *Technology, Innovation, and Educational Change: A Global Perspective*. Eugene, OR, International Society for Technology in Education.

——. 2005. National policies that connect ICT-based education reform to economic and social development. *Human Technology*, Vol. 1, No. 2, pp. 117–156.

——. 2006. ICT, broadband and rural development in Africa. *Connect-World: Africa and the Middle East*, Issue 2006 , pp. 11–13.

—. 2008. Comparative analyses of policies for ICT in education. In: Voogt, J. and Knezek, G. (eds.), *International Handbook of Information Technology in Education*, pp. 1083–1096. Amsterdam, Kluwer.

—. 2009. Assessing and teaching 21st century skills: A call to action. In: Scheuermann, F. and Bjornsson, J. (eds.), The transition to computer-based assessment: New approaches to skills assessment and large-scale testing (pp. 13–23). Brussels, European Communities.

—. 2010. Relating technology, education reform, and economic development. In: Baker, E. and Peterson, P. and McGaw, B. (eds.) *International Encyclopedia of Education*. 3rd ed. , Vol 8, pp. 81–87. Oxford, Elsevier.

Kozma, R., McGhee, R., Quellmalz, E., and Zalles, D. 2004. Closing the digital divide: Evaluation of the World Links program. *International Journal of Educational Development* , Vol. 24, No. 4, pp. 361–381.

Krajcik, J. and Blumenfeld, P. 2006. Project-based learning. In: Sawyer, R. (ed.), *Cambridge Handbook of the Learning Sciences*, pp. 317–334. Cambridge, Cambridge University Press.

Kramer, K., Dedrick, J. and Sharma, P. 2009. One laptop per child: Vision and reality. *Communications of the* ACM, Vol. 52, No. 6, pp. 66–73.

Kulik, J. 2003. *The Effects of Using Instructional Technology in Elementary and Secondary Schools: What Controlled Evaluation Studies Say*? Menlo Park, CA, SRI International.

Latin American Laboratory for Assessment of the Quality of Education (LLECE). 2008. *Los aprendizajes de los estudiantes de América Latina y el Caribe. Primer reporte de los resultados del Segundo Estudio Regional Comparativo y Explicativo* (SERCE). Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación. Santiago: OREALC/UNESCO.

Law, N., Pelgrum, W. and Plomp, T. 2008. *Pedagogy and* ICT *Use in Schools around the World: Findings from the* IEA SITES 2006 *Study*. Hong Kong, Springer.

Technology Laboratory of Uruguay (LATU). 2009. Laboratorio Tecnológico del Uruguay. Retrieved December 20, 2009 from www.latu.org.uy

Learning Review. 2009. Críticas al programa One Laptop per Child. Retrieved December 20, 2008 from http://www.learningreview.es/tecnologias-formacion-274/noticias-temas-231/1413-criticas-al-programa-one-laptop-per-child

Lederman, D. and Saenz, L. 2005. *Innovation and Development around the World*, 1960–2000 (World Bank Policy Research Working Paper 3774). Washington, DC, World Bank.

Leiponen, A. 2005. Organization of knowledge and innovation: The case of Finnish business services. *Industry and Innovation*, Vol. 12, No. 2, p. 185–203.

Lenhart, A., Madden, M., Macgill, A., and Smith, A. 2007.*Teens and Social Media*. Pew Internet and America Life Project. Accessed on July 1, 2008 from http://www.pewinternet.org/reports.asp

Lewin, K. 1947. Frontiers in group dynamics: Concept, method, and reality in social science; social equilibria and social change. *Human Relations*, Vol. 1, No. 5, pp. 5–41.

Lewin, K. 1958. Group decision and social change. In: Maccoby, E., Newcomb, T., and Hartley, E. (eds.), Readings in social psychology, pp. 197–211. New York, Holt.

Linden, L., Banerjee, A., and Duflo, E. 2003. *Computer-assisted Learning: Evidence from a Randomized Experiment*. Cambridge, MA, Poverty Action Lab.

Lisbon Council. 2007. *Skills for the Future*. Brussels, Lisbon Council.

Litto, F. 2009. National policies and practices on ICT in education: Brazil. In: Plomp, T., Anderson, R., Law N. and Quale, A. (eds.), *Cross-national Information and Communication Technology: Policies and Practice in Education* (rev. 2nd ed.), pp. 103–118. Greenwich, Connecticut, IAP.

Litto, F. 2009. National policies and practices on ICT in education: Brazil. In: Plomp, T., Anderson, R., Law N. and Quale, A. (eds.), *Cross-national Information and Communication Technology: Policies and Practice in Education* (rev. 2nd ed.), pp. 103–118. Greenwich, Connecticut, IAP.

LR21. 2007. *La CUTI convoca a empresas a colaborar con Plan Ceibal*. In *La República Edición Digital*, N° 2719. November 4, 2007. Retrieved December 21, 2009 from http://www.larepublica.com.uy/economia/282817-la-cuti-convoca-a-empresas-a-colaborar-con-plan-ceibal

LR21. 2008. *Plan Cardales: Inclusión e igualdad de oportunidades*. In *La República Edición Digital*, N° 3135; December 30, 2008. Retrieved December 21, 2009 from http://www.larepublica.com.uy/politica/347054-plan-cardales-inclusion-e-igualdad-de-oportunidades

Martínez, A. L., and Pérez, M. 2009. *La evaluación de impacto del plan Ceibal: Metodología y principales resultados y La evaluación educativa del plan Ceibal*. Paper presented at the 1er Evento Internacional sobre Experiencias de Plan Ceibal, MontevideoMartinis, P. 2009. Apuntes sobre modelos escolares y tecnologías de la información y la comunicación. In M. Báez and al., *Las Tecnologías de la Información y la Comunicación en el aula* (pp.50–53). Plan CEIBAL, MEC, Uruguay. Montevideo, UNESCO-MEC

Maurin, E., and Thesmar, D. 2004. Changes in the functional structure of firms and the demand for skill. *Journal of Labor Economics*, Vol. 22, No. 3, pp. 639–644.

McKinsey and Company. 2005. *Building Effective Public-Private Partnerships: Lessons Learnt from the Jordan Education Initiative*. Geneva: World Economic Forum.

Means, B., and Olson, K. 1995. *Technology's Role in Education Reform: Findings from a National Study of Innovating Schools*. Washington, DC, US Department of Education, Office of Educational Research and Improvement.

Means, B., Roschelle, R., Penuel, W., Sabelli, N., and Haertel, G. 2004. Technology's contribution to teaching and policy: Efficiency, standardization, or transformation? In: Floden, R. (ed.), *Review of Research in Education*, Vol. 27. Washington, DC, American Educational Research Association.

Ministry of Basic Education Sport and Culture. 2004. *National Report on the Development of Education in Namibia*. International Conference on Education, Geneva.

Ministry of Education and Culture (MEC). 2007. *Anuarios Estadísticos*. Ministerio de Educación y Cultura de Uruguay. Retrieved December 15, 2009 from http://educacion.mec.gub.uy/estadistica/anuarios.htm

—. 2009. *Anuario Estadístico de Educación* 2008. Ministerio de Educación y Cultura de Uruguay. Área de Investigación y Estadística. Montevideo. Retrieved December 20, 2009 from http://educacion.mec.gub.uy/estadistica/mec_24_11.pdf

Ministry of Education (MOE). 1997. *Launch of National Education*. Press Release May 16, 1997. (http://www.moe.gov.sg/media/press/1997/pr01797.htm Accessed November 30 2009.

—. 2002a. Ministry of Education. *Master Plan for* IT *in Education*: IT H*andbook for Schools*.

—. 2002. J*unior College/Upper Secondary Education Review* 2002.

—. 2008. H*elping Students Who Are At-risk of Dropping-Out Stay in School*. Press Release March 4, 2008.

—. 2008. International Education Leaders' Dialogue: Third Conference Recent Developments in Singapore's Education System: Gearing Up for 2015. http://www.eduweb.vic.gov.au/edulibrary/public/commrel/events/ield/singaporecasestudy.pdf. Accessed 20 Dec 2009.

—. 2009. I*naugural International Education Roundtable Shares Insights on Expectations and Challenges for Top Performing Education Systems for the Future*. Press Release July 7, 2009.

Ministry of Economy and Finance. 2008. D*ecreto Presidencial* E/1190. Ampliación cobertura Plan C*eibal*. December 15, 2008. Retrieved December 21, 2009 from http://ceibal.edu.uy/portal/images/stories/decreto_ceibal_2.pdf

Ministry of Education. 2004. C*urricula and Assessment Framework*, p. 4

—. 2005. C*omputerization Strategy for Ministry of Education Schools and Data Centre*.

—. 2006. National Education Strategy

—. 2007. Classroom and Computer Lab Deployment Strategy in Government Schools Grades 1–12.

Ministry of Education. Namibia, 2004. E*ducation and Training Sector Improvement Programme* (ETSIP). Error! Hyperlink reference not valid. Retrieved November 23, 2009.

Ministry of Education. 2006. Education Sector: Long Term Strategic Finance Framework. Retrieved on December 23, 2009 on http://planipolis.iiep.unesco.org/upload/Rwanda/Rwanda%20LT%20Strategy%20and%20financing%20framework%20Sept%2006.pdf

—. 2009. F*ee-free Education*. Retrieved on December 20, 2009 from http://www.mineduc.gov.rw/spip.php?article21

Ministry of Education, Science, Technology and Scientific Research. 2002. Rwanda Ministry of Education. Retrieved July 15, 2006 from http://www.mineduc.gov.rw/minenglish.htm

—. 2005. N*ational Science, Technology, Scientific Research and Innovation Policy, Conference Draft*. Retrieved on December 28, 2009 on http://www.rwandagateway.org/IMG/pdf/Rwanda_Conference_Draft_ST_Policy_document.pdf

Ministry of Finance and Economic Development. 2007. E*conomic Development and Poverty Reduction Strategy* 2008-2012. Retrieved on December 19, 2009 from http://mininfra.gov.rw/index.php?option=com_content&task=view&id=209&Itemid=351

Ministry of Health and Social Services. 2009. HIV/AIDS *in Namibia*: B*ehavioral and Contextual Factors Driving the Epidemic*. USAID Namibia www.safaids.net/files/HIVAIDS%20Behavioural%20Report%20Nam_May2009.pdf Retrieved March 2010.

Ministry of Information and Communication Technology. 2009. J*ordan's* ICT S*ector in World Competitiveness Report*. In Arabic.

Ministry of Public Service and Labour. 2009. N*ational Audit Report*. Retrieved in December 2009 from http://www.rdb.rw/download/Skills%20Audit%20Report_January%2028%202008.pdf

Miniwatts Marketing Group. 2009. *Uruguay: Internet Usage Stats and Telecommunications Market Report*. Retrieved December 11, 2009, from http://www.internetworldstats.com/sa/uy.htm

Mislevy, R., Steinberg, L., Almond, R., Haertel, G., and Penuel, W. 2003. Improving educational assessment. In: Haertel, G. and Means, B. (eds.), *Evaluating Educational Technology: Effective Research Designs for Improving Learning*, pp. 149–180. New York, Teachers College Press.

Mullis, I.V.S, Martin, M.O., Kennedy, A.M., and Foy, P. 2007. PIRLS *International Report*, 2006. International Association for the Evaluation of Educational Achievement.

Murphy, M. *Organizational Change and Firm Performance*. 2002. OECD Working Papers. Retrieved on October 3, 2009 from http://puck.sourceoecd.org/vl=18659355/cl=20/nw=1/rpsv/workingpapers/18151965/wp_5lgsjhvj7m41.htm.

Namibian Ministry of ICT and Palladium Consulting Pty Ltd. 2008. *Information Technology Policy for the Republic of Namibia*. http://www.ncc.org.na/admin/data/Publications/IT%20Policy%20Final%20draft.pdf

National Centre for Educational Statistics (NCES). 2001a. *The Nation's Report Card: Mathematics* 2000. Washington, DC, NCES.

—. 2001b. *The Nation's Report Card: Science* 2000. Washington, DC, NCES

National Centre for Human Resources Development (NCHRD). 2008. Evaluation of ICT Resources Provision, Access and Utilization. THESE NEED RENUMBERING a/b/c

—. 2008. Baseline Data Report.

—. 2008. Learning Readiness Report.

—. 2008. Evaluation of the *Jordan Education Initiative. Synthesis Report. Overview and Recommendations to the Jordanian Education Initiative*; EDC, RTI *International and* USAID, http://pdf.usaid.gov/pdf_docs/PDACL689.pdf

National Institute of Statistics (INE). 2009. *Encuesta Nacional de Hogares* 2009. Instituto Nacional de Estadística del Uruguay. Retrieved March 28, 2010 from http://www.ine.gub.uy/microdatos/microdatosnew2008.asp

Ng, E. H (2009). Bigger Education Budget, The Straits Times, February 10, 2009.

Nonaka, I., and Takeuchi, H. 1995. *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York, Oxford University Press.

Nusseir, J. 2005. Knowledge Stations initiative: A nationwide network. In: Haddad, W. (ed.), *Technologies for Education for All: Possibilities and Prospects in the Arab Region* (pp. 43–48). Washington, DC, Academy for Educational Development.

Observatorio de la Educación-ANEP. 2009. *Matrícula de la Educación Pública y Privada* (*Órbita* ANEP) *por años seleccionados* (2000–2008), *según subsistema y tipo de oferta*. Retrieved December 17, 2009 from http://www.anep.edu.uy/observatorio/paginas/matricula_general.htm

Organisation for Economic Co-operation and Development (OECD). 2006. *Database* PISA 2006. OECD's Programme for International Student Assessment, PISA 2006.OECD. Retrieved December 12, 2009 from http://pisa2006.acer.edu.au/downloads.php

Organisation for Economic Cooperation and Development (OECD). 2007. ICTs and gender. Paris: OECD.

Ofcom. 2008. Social networking. London: Ofcom.

One Laptop Per Child (OLPC). 2009. ¿Qué es OLPC?. México, una laptop por niñ@. Retrieved December 20, 2009 from http://1laptop1nino.blogspot.com/2008/10/que-es-olpc.html

Organization for Economic Cooperation and Development (OECD). 2007. *Broadband and the economy*. Paris, OECD. http://www.oecd.org/dataoecd/62/7/40781696.pdf Accessed June 1, 2009.

—. 2009. OECD *Factbook*. Paris, OECD. http://www.sourceoecd.org/factbook Accessed June 1, 2009.

Partnership for the 21st Century. 2003. Learning for the 21st century. Washington, DC: Partnership for the 21st Century.

—. 2005. A *Report on the Landscape of 21st Century Assessment*. Washington, DC, Partnership for the 21st Century.

Pelgrum, W. and Plomp, T. 2002. Indicators of ICT in mathematics: Status and covariation with achievement measures. In: Beaton, A. and Robitaille, D. (eds.), *Secondary Analysis of the* TIMSS *Data*. Dordrecht, Netherlands, Kluwer Academic Press.

Pedro, F. *The New Millenium Learners. Challenging our Views on* ICT *and Learning*. OECD-CERI

Pellegrino, J., Chudowsky, N., and Glaser, R. 2004. Knowing what students know: The science and design of educational assessment. Washington, DC, National Academy Press.

Perez, C. 2002. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Cheltenham, UK, Edward Elgar.

Pilat, D. 2004. *The Economic Impact of* ICT: A *European Perspective*. Paper presented at a conference on IT Innovation, Tokyo.

Ploskonka, Y. 2009. *Is Everything Really Shiny & Bright in* OLPC *Uruguay*? In OLPC/*News Blog*, April 13, 2009. Retrieved December 19, 2009 from http://www.olpcnews.com/countries/uruguay/olpc_uruguay_tabare_vazquez.html

Poder Legislativo. 2008. *Ley* N° 18.437 *Ley General de Educación*. Senado y Cámara de Representantes de la República Oriental del Uruguay. Montevideo.

President's Committee of Advisors on Science and Technology. 2000. *Wellspring of Prosperity: Science and Technology in the* US *Economy; How Investments in Discovery Are Making our Lives Better.* Washington, DC, Office of the President.

Presidencia de la República. 2003. *Uruguay en Red. Programa de Conectividad Educativa*. Memoria 2003. Retrieved December 21, 2009 from http://www.presidencia.gub.uy/mem2003/URUGENRED.pdf

Presidencia de la República. 2007. *Decreto Presidencial* N° 144/007. *Creación Plan Ceibal*. April 18, 2007. Retrieved December 20, 2009 from http://www.elderechodigital.com/newsletter/Tics/TIC14_02.html

Pringle, I. and Subramanian, S. 2004. *Profiles and Experiences in* ICT *Innovation for Poverty Reduction*. Paris, UNESCO.

Psacharopoulos, G. and Patrinos, H. 2002. *Returns to Investment in Education*: A *Further Update* (Policy Research Working Paper 288). Washington, DC, World Bank.

Quale, A. Trends in instructional ICT infrastructure. 2003. In: Plomp, T., Anderson, R., Law, N., and Quale A., (eds.). *Cross-national Information and Communication Technology Policies and Practices in Education*, pp. 31–42. Greenwich, Connecticut, IPA.

Quellmalz, E. and Zalles, D. 2009. *World Links for Development: Student Assessment Uganda Field Test*. Menlo Park, CA, SRI International.

Ríos, M. 2008. *La Agenda Digital Como Instrumento Estratégico*. AGESIC. Retrieved Dec ember14, 2009 from http://www.asiap.org/jiap/JIAP2008/PDF/119-AGESIC.pdf

Rivoir, A. 2008. *Plan Ceibal en Uruguay: apuesta a la inclusión digital para la inclusión social*. IX Congreso Latinoamericano de Investigadores de la Comunicación. México.

Rivoir, A. and Martinez, A. 2008. *Acceso digital para la inclusión social: el Plan Ceibal en las escuelas del Uruguay*. In *Newsletter* #6 (October 2008). EDUCACION eLAC 2010, Santiago, CEPAL.

Rodríguez Zidán, E. 2007. *El Proyecto de Centro y la Coordinación Docente: un estudio sobre dos innovaciones de la Reforma Educativa en Uruguay*. In *Educere*, 36, pp. 137–153.

Rotulo, M. 2007. *Primaria observará reacción de niños al utilizar computadoras del Plan Ceibal*. In *La República Edición Digital*, N° 2453; February 6, 2007. Retrieved December 20, 2009 from http://www.larepublica.com.uy/larepublica/2007/02/06/comunidad/245467/primaria-observarareaccion-de-ninos-al-utilizar-computadoras-del-plan-ceibal

Sachs, J. 2005. *The End of Poverty: Economic Possibilities for our Time*. New York, Penguin Press.

Sachs, J. 2008. *Common Wealth: Economics for a Crowded Planet*. New York, Penguin Press.

Scaradmalia, M. and Bereiter, C. 2006. Knowledge building: Theory, pedagogy, and technology. In: Sawyer, R. (ed.). *Cambridge Handbook of the Learning Sciences*, pp. 97–115. Cambridge, Cambridge University Press.

Schreyer, P. 2000. *The Contribution of Information and Communication Technology to Output Growth: A Study of the G7 Countries*. STI Working Papers 2000/2.

Schrum, L. and Levin, B). 2009. *Leading 21st Century Schools: Harnessing Technology for Engagement and Achievement*. Thousand Oaks, CA, Corwin.

Sciadas, G. 2007. *From Digital Divide to Digital Opportunities*. Montreal, Orbicom.

Science Syllabus, Lower Secondary. 2007. Ministry of Education, Singapore. http://www.moe.gov.sg/education/syllabuses/sciences/ Accessed 20 December 2009.

Senge, P., Cambron-McCabe, N., Lucas, T., Smith, B., Dutton, J., and Kleiner, A. 2000. *Schools that Learn: A Fifth Discipline Fieldbook for Educators, Parents, and Everyone who Cares about Education*. New York, Doubleday.

Shanmugaratnam, T. 2003. Speech by Mr Tharman Shanmugaratnam at the joint investiture ceremony of Chinese High School and Hwa Chong Junior College, 1st August 2003. http://www.moe.gov.sg/speeches/2003/sp20030801.htm Accessed 15 December 2009.

Shaikh, A. 2009. *One Laptop Per Child - The Dream is Over.* In UN *Dispatch Global News and Views*. September 9, 2009. Retrieved December 20, 2009 from http://www.undispatch.com/node/8859

Sianesi, R. and Van Reenen, J. 2002. *The Returns to Education*: A *Review of the Empirical Macroeconomic Literature*. London, Institute for Fiscal Studies.

Singapore Department of Statistics. 2009a. Statistics Singapore. http://www.singstat.gov.sg/stats/latestdata.html (Accessed 15 December 2009).

——. 2009b. Population trends 2009. http://www.singstat.gov.sg/pubn/popn/population2009.pdf Accessed 15 December 2009.

Singapore Economic Development Board. 2009. Singapore facts and figures. http://www.sedb.com/edb/sg/en_uk/index/why_singapore/singapore_facts_and_figures.html Accessed 15 December 2009.

Slater, D. and Tacchi, J. 2004. *Research*: ICT I*nnovations for Poverty Reduction*. Paris, UNESCO.

Social studies syllabus, Lower Secondary, Normal (Technical). 2005. Ministry of Education, Singapore. http://www.moe.gov.sg/education/syllabuses/humanities/ Accessed December 20, 2009.

Stevens, P. and Weale, M. 2003. E*ducation and Economic Growth*. London, National Institute of Economic and Social Research.

Stiglitz, J. and Walsh, C. 2002. P*rinciples of Macroeconomics* (3rd ed.). New York, Norton.

Stiroh, K. J. 2003. Growth and innovation in the new economy. In: Jones, D. (ed.). N*ew Economy Handbook* (723-751). San Diego and London: Elsevier/Academic Press.

Swarts, P, Bassie, R and Wachira, E 2009. F*inal Report*. R*eview of Tech/Na*! I*mplementation Progress*. Global eSchools and Communities Initiative.

Tan, S.C., and Koh, T.S. 2006. Translating learning sciences research into classroom practices. E*ducational Technology*, 46(3), 15–21.

Takahira, M., Ando, R., and Sakamoto, A. 2007. Effect of internet use on the development of information literacy: A panel study with Japanese elementary school children. C*omputers in Schools*, Vol. 24, No. 3/4), pp. 65–82.

Teo, C.H. 1997. O*pening New Frontiers in Education with Information Technology*. Opening address at the launch of the Master Plan for IT in Education, 28 April 1997, Suntec city, Singapore. http://www1.moe.edu.sg/iteducation/Master Plan/speech.htm Accessed November 30, 2009.

Teo, C.H. 1998. I*ntellectual Capital as a Key Tool in Advancing Asian Modernisation*. Speech delivered at the 1998 East Asia Economic Summit, World Economic Forum, on Tuesday, 13 October 1998 at Suntec City, Singapore. http://www1.moe.edu.sg/speeches/1998/13oct98.htm Accessed November 30, 2009.

Tyack, D., and Cuban, L. 1995. T*inkering toward Utopia*. Cambridge, MA, Harvard University Press.

UDELAR. 2008. P*rograma Proyectos de Investigación Orientados a la Inclusión Social* 2008. I*nforme de evaluación de los proyectos presentados en el tema Plan Ceibal*. Universidad de la República Montevideo. Retrieved December 31, 2009 from http://www.csic.edu.uy/nuevos-programas/informes_programas/2008/inclusion_social_ceibal.pdf

Ulku, H. 2004. andR*and*D, I*nnovation, and Economic Growth*: *An Empirical Analysis* (IMF Working Paper WP/04/185). Washington, DC, International Monetary Fund.

United Nations Development Programme (UNDP). 2007. *Turning Vision 2020 into Reality: From Recovery to Sustainable Human Development, National Human Development Report 2007. Executive Summary*. UNDP Rwanda.

—. 2009. *Human Development Report, 2009: Overcoming Barriers: Human Mobility and Development*. Retrieved on November 25, 2009 from http://hdr.undp.org/en/reports/global/hdr2009/

United Nations Development Programme (UNDP). 2009. *Human Development Report* 2009.United Nations Development Program. New York, UNDP. Retrieved December 16, 2009 from http://hdrstats.undp.org/en/countries/data_sheets/cty_ds_URY.html

United Nations Economic Commission for Africa. 2000. *An Integrated Socio-economic and* ICT *Policy and Strategies for Accelerated Development. Retrieved on* 21 *December* 2009 http://www.uneca.org/aisi/nici/country_profiles/rwanda/rwanpap3.htm

—. 2008. *Scan*ICT *Baseline Survey Report. ICT Indicators. Measuring Usage and Penetration*. Retrieved on 23 December 2009 http://www.uneca.org/aisi/docs/RWANDA_SCAN_ICT_REPORT.pdf

UNESCO-IBE. 2006. *Uruguay. Principios y objetivos generales de la educación*. In *World Data on Education*, 6th Edition, 2006/07. Retrieved December 15, 2009 from http://www.oei.es/pdfs/Uruguay_datos2006.pdf

UNESCO. N.d. *Configuration of Radio Stations and Media Centres*: A *Practical Guide to Procurement of Technical Equipment for Community Media Initiatives*. Paris, UNESCO.

—. 2002. *Information and Communication Technology in Education*: A *Curriculum for Schools and a Programme of Teacher Development*. Paris, UNESCO.

—. 2005a. *Links between the Global Initiatives in Education*. Paris, UNESCO.

—. 2005b. *Towards Knowledge Societies*. Paris, UNESCO.

—. 2007. *Education in Uruguay*. UIS *statistics in brief*. UNESCO Institute for Statistics. UNESCO. Retrieved December 15, 2009 from http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=121&IF_Language=eng&BR_Country=8580

—. 2008. ICT *Competency Standards for Teachers*: *Policy Framework*. Paris, UNESCO.

—. 2008. CEIBAL *en la sociedad del siglo* XXI: *Referencia para padres y educadores*. OREALC UNESCO, Montevideo. Retrieved December 20, 2009 from http://www.ceibal.edu.uy/gobiernoelectronico/pdf_libro/Libro_CEIBAL_en_la_sociedad_del_siglo_XXI.pdf

UNESCO Institute for Statistics. 2009. *Guide to Measuring Information and Communication Technology* (ICT) *in Education*. Montreal, UNESCO Institute for Statistics.

UNESCO Institute of Statistics. 2009. (http://www.schoolsandhealth.org/Lists/School%20Health%20Database/DispForm.aspx?ID=86 (21 December 2009)

United Nations. 2008. *United Nations e-Government Survey* 2008: *From e-Government to Connected Governance*. New York: United Nations. Retrieved December 16, 2009 from http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN028607.pdf

United Nations Economic Commission for Latin America and the Caribbean. 2002. *Roadmaps toward an Information Society in Latin America and the Caribbean*. New York: United Nations.

United Nations Industrial Development Organization (UNIDO). 2002. *Industrial Development Report* 2002/2003: *Competing through Innovation and Learning*. Vienna: UNIDO.

Unwin, T. 2007. No end to poverty. *Journal of Development Studies*, Vol. 43, No. 5, pp. 929–953.

USAID. 2008a. *Evaluation of the* JEI *Initiative, The Emerging Paradigm of Teaching and Learning in Discovery Schools*.Education Development Centre Inc.

USAID. 2008b. *An Evolving Partnership for Change: Stakeholder Reflections on the* JEI. Education Development Centre Inc.

USAID. 2008c. Cost Assessment of Teacher Support for E-Learning in Jordan. Research Triangle Institute International.

USAID. 2009. *Cost Assessment of Technology Support for* E-*Learning in Jordan*. Part of a series of JEI assessment activities. Vázquez, T. 2006. *Discurso lanzamiento* PEAID-*Ceibal*, Dec 2006.

Usengumukiza, F. 2009. *Overview of Rwanda's* ICT *Context*. Retrieved on December 21, 2009 from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/FELICIEN%20%20AfDB%20ICT%20Situational%20analysis%20in%20Rwanda.ppt

Verocai, A. and Marroig, J. 2003. *Uruguayan Educational Reform: Dogma or a Possible Road Forward*? Innodata Monographs 14. Geneva, International Bureau of Education, UNESCO.

Wagner, D.A. and Daswani, C.J. 2005. *Impact of* ICT *on Learning in Out-of-school Youth in Andhra Pradesh* (*India*): *Preliminary Results*. Technical Report. Philadelphia, PA, International Literacy Institute, University of Pennsylvania.

Wagner, D., Day, B., James, T., Kozma, R., Miller, J. and Unwin, T. 2005. *Monitoring and Evaluation of* ICT *Projects for Education*: A *Handbook for Developing Countries*. Washington, DC, infoDev, World Bank.

Ward-Brent, M. Sesame Street along the Nile. In Haddad, W. and Draxler, A. (eds.) 2002. *Technologies for Education*: *Potentials, Parameters, and Prospects* (pp. 154–157). Paris, UNESCO.

Warschauer, M. and Matuchniak, T. 2010. New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Educational*, Vol. 34, p. 179–225.

Weigel, G. and Waldburger, D. 2004. ICT4D: *Connecting people for a better world*. Geneva, Swiss Agency for Development.

Wenglinsky, H. 1998. *Does it Compute*? *The Relationship between Educational Technology and Student Achievement in Mathematics*. Princeton, NJ, ETS.

Wolff, L., de Moura Castro, C., Navarro, J. C., and Garcia, N. 2002. Television for secondary education: Experience of Mexico and Brazil. In: Haddad, W. and Draxler, A. (eds.). *Technologies for Education*: *Potentials, Parameters, and Prospects* (pp. 144–153). Paris, UNESCO.

World Bank. 2005. *Information and Communication Technologies for Rural Development*: *Issues and Options*. Washington, DC, World Bank.

World Bank. 2008a. MENA Development Report. The *Road Not Traveled, Education Reform in the Middle East and North Africa*. World Bank. Washington DC. http://siteresources.worldbank.org/INTMENA/Resources/EDU_Flagship_Full_ENG.pdf

World Bank. 2007. *Uruguay. Equidad y Calidad de la Educación Básica. Informe* N° 38082–UY. Montevideo: Banco Mundial. Retrieved December 13, 2009, from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/10/24/000310607_20071024104856/Rendered/PDF/380820UY0Educacion0white0cover01PUBLIC1.pdf

—. 2008. *Uruguay at a glance*. The World Bank Group, Development Economics LDB database, September 2008. Retrieved December 10, 2009, from http://devdata.worldbank.org/AAG/ury_aag.pdf

—. 2009a. *World Development Indicators database* (April 2009). The World Bank Group. Retrieved December 11, 2009, from http://ddp-ext.worldbank.org/ext/ddpreports/ViewSharedReport?&CF=&REPORT_ID=9147&REQUEST_TYPE=VIEWADVANCED

—. 2009b. *Uruguay brief report*. The World Bank Group. Retrieved December 11, 2009, from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/URUGUAYEXTN/0,,contentMDK:22256166~pagePK:1497618~piPK:217854~theSitePK:331609,00.html

—. 2009c. ICT *at a Glance*. Information and Communications for Development 2009 (p. 303). Retrieved December 12, 2009, from http://devdata.worldbank.org/ict/ury_ict.pdf

—. 2009d. *World Bank List of Economies* (July 2009). Retieved December 13, 2009, from http://siteresources.worldbank.org/DATASTATISTICS/Resources/CLASS.XLS

—. 2009e *Country Brief*: *Namibia* http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/NAMIBIAEXTN/0,,menuPK:382303~pagePK:141132~piPK:141107~theSitePK:382293,00.html Retrieved December 16, 2009.

—. 2009f *World Development Indicators*. Retrieved on November 29, 2009 from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTPUBREP/EXTSTATINAFR/0,,contentMDK:21105703~menuPK:3083953~pagePK:64168445~piPK:64168309~theSitePK:824043,00.html

World Economic Forum (WEF). 2008. *Executive Opinion Survey*: *Capturing the Voice of the Business Community* (Chapter 2.1.). In*The Global Competitiveness Report* 2008–2009 (pp. 67–77). Geneva: WEF.

—. 2009. *The Global Competitiveness Report* 2009–2010. http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm Accessed November 30, 2009.

—. 2009. *The Global Information Technology Report* 2008–2009. *Mobility in a Networked World*. Geneva: World Economic Forum. Retrieved December 15, 2009 from http://www.weforum.org/pdf/gitr/2009/gitr09fullreport.pdf

—. 2010. *Global Competitiveness Report* 2010-2011 http://www.weforum.org/reports

Wong, P. 1999. IT in Singapore Schools. In Tan, F., Corbett, A, Wong, YY. (Eds). Information Technology Diffusion in the Asia Pacific: Perspectives on Policy, Electronic Commerce and Education. Hershey, USA, Idea Group Publishing.

Zagler, M. and Zanzottera, C. In press. Do we need top PISA scores for innovation and growth? In: Baumeiter, H.-P., Kramer, M. and Seiter, S. (eds.). *Knowledge Economy*: A *Multilayer Challenge for European Regions*. Marburg, Germany, Metropolis-Verlag.

Zarza, M. 2009. *Plan Ceibal y* ANTEL. In *Bitácora*, suplemento semanal del diario La República. Retrieved December 21, 2009 from http://www.bitacora.com.uy/noticia_2741_1.html

Zignago, A. 2009. *El proyecto Rayuela*. Primer Evento Internacional sobre experiencias del Plan *Ceibal*. December 2009

Zohgi, C., Mohr, R., and Meyer, P. 2007. *Workplace Organization and Innovation* (Working Paper 405). Washington, DC, Bureau of Labor Statistics.

Zucker, A. and Kozma, R. 2003. *The Virtual High School: Teaching Generation* V. New York, Teachers College Press.

Zucker, A. and Light, D. 2009. Laptop programs for students. *Science*, Vol. 323, pp. 82–85.

Zulkifli. 2008. FY 2008 Committee of Supply Debate: 4th Reply by Senior Parliamentary Secretary Mr Masagos Zulkifli BMM on Attrition and School Matters. http://www.moe.gov.sg/media/speeches/2008/03/04/fy-2008-committee-of-supply-de-3.php Accessed November 30, 2009.

For more information about the publication please contact:

The Director

Division for Planning and Development of Education Systems (ED/PDE)

UNESCO, 7 place Fontenoy
75352 Paris 07 SP, France

Tel: +33 1 45 68 08 80
Fax: +33 1 45 68 56 28

Information and communications technologies (ICT) in schools are seen by education policy-makers as an opportunity. Yet, once policy-makers consider making significant investments in ICT, a host of questions emerge, from how many computers are needed in a school to how teachers can use them. While such questions represent important implementation issues, they are not the ones that should frame ICT policy. ICT can have a greater impact when the policies and programmes designed to implement them are crafted in the broader context of social and economic goals, aligned to a vision of economic development and social progress – in other words, when ICT policies and programmes support educational transformation.

This timely book reviews policies, programmes, and experiences in a range of regional and developmental settings – Jordan, Namibia, Rwanda, Singapore, and Uruguay. Each brings a unique historical, cultural, political, social, and economic context to bear on policy and its formulation. These case studies provide models and lessons that can help other countries in formulating their own policies regarding ICT in education. In addition, drawing on the analyses of the findings across case studies, the book considers their implications for educational policy, change, and transformation.

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