ICTs for Education

A Reference Handbook

Part 2: Analytical Review

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The purpose of *ICTs for Education: A Reference Handbook* is to provide decision makers, planners, and practitioners with a summary of what is known about the potential and conditions of effective use of ICTs for education and learning by drawing on worldwide knowledge, research, and experience.

The handbook has four parts, each of which addresses different users and serves different functions. These parts are organized in a parallel manner for ease of use and to allow cross-referencing.

Part 1: Decision Makers Essentials
Part 2: Analytical Review
Part 3: Resources
Part 4: PowerPoint Presentation

Part 1 presents decision makers with a summary of:

- Challenges facing decision makers
- Characteristics and uses of ICTs
- Options and choices for leveraging the potential of ICTs in achieving national and educational goals and solving educational problems
- Prerequisite and corequisite conditions for effective integration of ICTs into the educational process
- Processes to integrate ICTs into education

This part (**Part 2: Analytical Review**):

- Analyzes the rationales and realities of ICTs for education,
- Examines the options and choices for leveraging the potential of ICTs in achieving national and educational goals and solving educational problems, and
- Outlines the prerequisite and corequisite conditions for effective integration of ICTs into the educational process

This Part includes many references to specific resources described in Part 3 of the Handbook.

Part 3 provides resources in the form of case studies, experiences, examples and demonstrations of the potential of ICT-enhanced policies and interventions outlined in Part 2. There resources are referenced in the respective sections of Part 2.

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1 Introduction

Thomas Edison, the father of electricity and inventor of the motion picture, predicted in 1922 that "the motion picture is destined to revolutionize our educational system and ... in a few years it will supplant largely, if not entirely, the use of textbooks."

Since then high levels of excitement and expectation have been generated by every new generation of information and communication technologies (ICTs): compact discs and CD-ROMs, videodiscs, microcomputer-based laboratories, the Internet, virtual reality, local and wide area networks, instructional software, Macs, PCs, laptops, notebooks, educational television, voice mail, e-mail, satellite communication, VCRs, cable TV, interactive radio, etc. The list of "hot" technologies available for education goes on and on.

Twenty years ago, Seymour Papert, when he was at the MIT Technology Lab, predicted that, "there won't be schools in the future.... I think the Computer will blow up the school, that is, the school as something where there are classes, teachers running exams, people structured in groups by age, [who] follow a curriculum—all of that."[1]

Where are we today?

ICTs have definitely revolutionized business processes and organizations, created a worldwide network of e-commerce, and turned the domain of entertainment into a fascinating experience. But can ICTs have a similar impact in education?

There are the believers, the skeptics, the agnostics, and the pragmatists.

- *Believers* think that under the right conditions technologies can have a monumental impact on the expansion of learning opportunities to wider populations, beyond the confines of teaching institutions and over the lifetime of the individual. Also, technologies can improve the teaching/learning process, enhance higher levels of cognition, and facilitate institutional management.
- The *skeptics* have been told many times before that certain technologies, from filmstrips to tape-recorders to television, would remake their world. Why is it any different this time?
- The *agnostics* are not sure. They have an open mind but do not think that there is enough evidence to incorporate ICTs into educational systems. They think that our empirical knowledge of the effectiveness of different ICTs is spotty, and that our experience with what works and does not is still tentative.
- The *pragmatists* are holding back. The technologies are changing so fast and prices are dropping so rapidly, that they are waiting for the technologies to stabilize and prices to hit bottom.

Yet almost every decision maker in every school system across the world is under tremendous pressure to provide every classroom (if not every student) with technologies, including computers and their accessories and connectivity to the Internet. The pressures are coming from vendors who wish to sell the most advanced

[1] Seymour Papert. 1984. "Trying to Predict the Future." *Popular Computing*, 3(13), pp. 30-44.

technologies; from parents who want to ensure that their children are not left behind in the technological revolution; from businesses that want to replicate in schools the dramatic impact that ICTs have had in the worlds of commerce, business, and entertainment; and from technology advocates who see ICTs as the latest hope to reform education.

The challenges facing education worldwide will escalate, and the struggle between needs and resources will deepen. The quest for radical solutions will intensify, and the pressure on decision makers to "do something" with ICTs will keep mounting. The temptation is to introduce ICTs immediately and full scale.

Experience has consistently taught us, however, that integrating technology into the educational process is not a simple, one-step activity. It is an intricate, multifaceted process that involves a series of deliberate decisions, plans, and measures:

- *Rigorously analyzing educational objectives and changes.* This step may involve rethinking educational policies and strategies to accommodate the new challenges and to exploit the potential of ICTs.
- *Determining which educational objectives are best pursued for ICT application.* This decision affects the choice of technologies and modalities of use.
- *Understanding the potential of different ICTs for different applications.*
- *Examining the appropriateness of specific technologies in light of educational objectives, desired roles of teachers and learners, and country realities and prospects.*
- *Sustaining a program of investment in the necessary human, physical, and instructional infrastructures.*
- *Implementing the pre- and corequisites of effectiveness of ICTs for education within the dynamics of educational change and reform.*
- *Continuous program evaluation and adjustment.*

Where does this leave decision makers and planners?

Questions about the potential of ICTs and their effectiveness will continue to linger, yet some decisions have to be made. The next set of questions has to do with how to rationally and realistically maximize the contribution of ICTs to the realization of effective learning and other educational goals.

The worst that could happen is for each country to deal with these issues in isolation by reinventing the wheel and failing to learn from the experiences (and mistakes) of others. It is therefore essential for decision makers, planners, and practitioners to be well aware of the wealth of worldwide knowledge, research, experience, and thinking. This awareness should not lead to transplantation of ideas and experiences but, rather, should enlighten, guide, and inspire locally conceived and implemented decisions and plans.

This **analytical review** draws on this worldwide body of knowledge and summarizes what is known about the potential and conditions of effective use of ICTs for education and learning.

More specifically, this review

- Analyzes the rationales and realities of ICTs for education,

- Examines the options and choices for leveraging the potential of ICTs in achieving national and educational goals and solving educational problems, and
- Outlines the prerequisite and corequisite conditions for effective integration of ICTs into the educational process

2 ICTs: Myths and Realities

In the environment surrounding the potential and use of ICTs, many myths and misconceptions have developed and are being promoted across countries and institutions. It is important for decision makers to be aware of these myths to avoid making decisions based on them.

2.1 Myth 1: ICTs are one monolithic entity

Decision makers frequently question the potential of technology ***in the singular***. Such inquiry is unanswerable for two reasons:

1. Technologies differ in their properties, scope, and potential. An audio technology can only capture sound, while a video technology depicts sound and motion. A CD provides multimedia digital content, while a Web version adds connectivity.
2. Different technologies can be used for different purposes. The potential of technologies is influenced by what we use them for. There are different levels at which technologies may be used, including:

    - Presentation of a piece of information
    - Demonstration of a concept, idea, phenomenon, law, or theory
    - Drill and practice to gain competence in applying knowledge
    - Research for certain topics or projects using multiple sources
    - Interaction—manipulation of variables to reach generalizations or to draw implications from a law or theory
    - Collaboration on projects with other students in the school or in other schools in the country or elsewhere or with scientists in the field
    - Production of educational materials

The questions here become:

- Which technology and what level of use? For instance, if technology is to be used for presentation and demonstration only, investment in computers and connectivity may not be justifiable. On the other hand, the potential for interactive and collaborative learning can best be achieved by networked computers and connectivity to the World Wide Web.
- What is the value added for using one technology compared to a simpler and cheaper one? For instance, why use a video instead of a photo, a digital text instead of a textbook, or a simulation instead of an animation?

2.2 Myth 2: The effects of ICTs are definite

Technology is only a tool: no technology can fix a bad educational philosophy or compensate for bad practice. In fact, if we are going in the wrong direction, technology

will only get us there faster. Likewise, distance learning is not about distance, it is about learning. Just as we can have bad education face to face, we can have bad education at a distance. Similarly, if teaching is demonstrating and telling, and if learning is memorizing and reciting, using learning technologies and multimedia programs for this purpose will not have the desired impact. Also, if students are not asked to search and work collaboratively, and if teachers function independently, investment in connectivity will not be cost effective.

Many of the factors that constrain the expansion and effectiveness of on-site education also work against ICT-enhanced education—sometimes more intensely. These factors include availability of affordable physical infrastructure, quality ICT-enhanced content, financial resources, and acceptability by the educational establishment, parents, and teachers. Additionally, in many countries the main hurdle is the legal frameworks. ICT-enhanced systems, with their ability to reach beyond political boundaries, defy many of the national and international legal frameworks that were created for a world with frontiers. Solutions, albeit necessary, have been difficult to find and implement. Distance education providers have to deal with telecommunication monopolies and restrictive regulations, accreditation and certification, and intellectual property.

2.3 Myth 3: ICTs mean computers and the Internet

Under pressures to be fashionable and adopt the latest educational innovations, the temptation is to limit ICTs to the Internet and exclude other technologies such as radio, television, and print. These technologies use reception equipment that is readily available in homes, have proven to be effective and inexpensive in packaging high-quality educational materials, reach “unreachable clientele,” and overcome geographical and cultural hurdles.

Experience is proving, to our surprise, that acquiring the technologies themselves, no matter how hard and expensive, may be the easiest and cheapest component in a series of elements that ultimately could make these technologies sustainable or beneficial. Effectively integrating technology into learning systems is much more complicated. It involves a rigorous analysis of educational objectives and changes, a realistic understanding of the potential of technologies, a purposeful consideration of the pre- and corequisites of effectiveness of ICTs for education, and the prospects of this process within the dynamics of educational change and reform.

To "tech" or not to "tech" education is, therefore, not the question. The real question is how to harvest the power of ICTs to make education relevant, responsive, and effective for school settings and lifelong learning.

2.4 Myth 4: ICTs are a substitute for schools and teachers

ICT-enhanced education activities should not be perceived as a substitute for conventional schools. Despite its shortcomings, the school system has been remarkable in its contribution to fulfilling basic learning needs, to skill formation, and to the preservation and evolution of cultures. We have reached the limits of this model, however, in providing high-quality education for all, anytime, anywhere, in an affordable and sustainable manner. ICTs can expand the potential of a conventional delivery system, complement its existing elements, and empower instructors to become better teachers. (See section 5.)

3 Challenges to Education Systems

3.1 Unfinished Business

Despite the dramatic progress in education achieved so far at the national and school levels, much remains to be done:

- Each country, to varying degrees, continues to struggle with issues of children out of school and illiterate youths and adults.
- The quality of learning and the capacity to define and monitor this quality is lacking in most developing countries.
- Inequities in educational opportunities, quality of educational services, and level of learning achievement continue to persist by gender, rural/urban locality, ethnic background, and socioeconomic status.
- The means and scope of education continue to be narrow and confined to historical models of delivery, and the use of other channels continues to be ad hoc and marginal.
- The increase in quantitative and qualitative demand for education is not matched by increase in resources.

3.2 Global Challenges

3.2.1 Globalization of the Economy

The world is faced with significant shifts in the global economic environment characterized by three major developments:

- Changing patterns of trade and competition
- Technological innovation
- Globalization of information

Together, these developments are producing a new worldwide economy that is global, high-speed, knowledge-driven, and competitive. Countries have to meet the competitiveness challenge in terms of agility, networking, and learning, and to arrange production to achieve quality, productivity, and flexibility. The good news is that, with the potential of human development and advanced technologies, developing countries can leapfrog. The bad news is that this process is not automatic. On the contrary, unless conscious efforts are made, countries are unlikely to be able to adapt to the demands of a globalized economy. They may even experience, on one hand, displacement of workers who lack the necessary skills and the prerequisite general education to learn new skills rapidly, and, on the other hand, a shortage of qualified workers for the new industries and modes of production.

3.2.2 Globalization of Knowledge

Generation, selection, assimilation, and application of knowledge are fundamental to the economic growth and well-being of any modern society. Economic growth today is a combination of capital accumulation and knowledge accumulation. Knowledge also

plays a crucial role in resolving social problems related to areas such as health (including HIV/AIDS), water supply and conservation, energy generation and use, food security, and environmental protection.

In fact, all facets of society are becoming knowledge dependent. The very participation in a modern technological world necessitates a significant level of scientific and technological understanding. This applies to all areas of everyday living, including banking, business transactions, health services, transportation vehicles, home appliances, utilities, communication, and information exchange. Without the essential knowledge and skills for modern living, people will remain on the margins of society, and society itself will lose their vast potential contributions.

Knowledge, both basic and applied, is being generated very fast and is growing exponentially. As rapidly as knowledge is being generated, there are growing means by which to disseminate that knowledge through printed, audio, video, and electronic media. The revolution in ICTs has made access to information less expensive, more feasible, and nearly universal. Unfortunately, though, most developing countries are behind on both generation of and access to knowledge. While modern technologies are broadening the knowledge base in high- and middle-income countries and transforming their economies and societies, they also are increasing the marginalization of low-income countries and communities. The digital divide among and within nations is real and intensifying.

3.2.3 "Marketization" of Educational Services

The relationship among the marketplace, the state, and the education sector is evolving significantly.

Education is no longer a monopoly of the state or a "protected industry." Local and transnational private entities have entered this field as a result of expanding economic liberalism, increasing political pluralism, and rising demand for education. Government funding has not been able to cope with the evolving demands, and new providers have entered the market in large numbers. In fact, the growth of private tertiary education institutions in developing countries has been more rapid than it has been in industrialized countries. A large number of the new providers are private, nongovernmental institutions, many of them established in partnership with American or European institutions of higher learning, and most are profit-driven and, therefore, accessible only to those who can afford them.

ICTs, which have facilitated this trend, allow for flow of information and educational services across borders and over geographic and social barriers. Open and virtual universities and high schools as well as Internet-based lifelong educational programs have simultaneously internationalized and decentralized education. Education and training can now be practiced by anyone, anytime, anywhere.

3.3 New Demands

The demands for providing educational opportunities are escalating.

- Modern economic, social, political, and technological requirements demand that all members of society have a minimum level of basic education; no country can afford

to leave anyone behind. But the biggest challenge continues to be reaching individuals and groups that are historically underserved with physically feasible, economically viable, and socially and culturally acceptable educational services.

- As countries achieve higher levels of basic education, there will be more demand for secondary, technical, and tertiary education. Providing such education across the country through efficient and affordable means is the next challenge, after the challenge of "Education for All."
- Similar pressures are coming from the workplace and the population at large for continuous learning to update existing knowledge and skills and stay current with advancements in knowledge and developments in technologies.

3.4 Financial Resources

As the demand for more and different tertiary education increases, financial resources are not increasing in the same proportion. Part of this constraint is self-inflicted because some of the conventional models for education are not sustainable.

3.5 Implications for Education

The above challenges pose serious questions for the planning of education and training systems and force rethinking in the way education is perceived, delivered, and managed. Where does this leave education development? With six far-reaching implications:

1. ***Holistic Education Structure.*** The workforce of the future will need a whole spectrum of knowledge and skills to deal with technology and the globalization of knowledge. It also will need to be agile and flexible, and to be able to adjust to continuous economic and social changes. This means that countries must embrace a holistic approach to education, investing ***concurrently*** in the whole pyramid of basic education, secondary education, skill training, and tertiary education.
2. ***Focus on Learning.*** The ancient objective of education, to teach how to learn, problem solve, and synthesize the old with the new, is now transformed from desirable to indispensable.
3. ***Education for Everyone.*** Modern economic, social, political, and technological requirements demand that all members of society have a minimum level of basic education.
4. ***Education Anytime.*** The need for continuous access to information and knowledge makes learning lifelong and the traditionally neat distinction between learning and work unreal. Education thus becomes a continuum, with no marked beginning and end, which provides opportunities for lifelong learning to help individuals, families, workplaces, and communities to adapt to economic and societal changes, and to keep the door open to those who have dropped out along the way.
5. ***Education Anywhere.*** To cope with the diversity, complexity, and changing nature of demands for education services, learning cannot be confined to the traditional classroom. It is unrealistic and unaffordable to continue to ask learners to come to a designated place every time they have to engage in learning. Delivery must extend beyond the face-to-face institutional modality to include distance education, enrichment mass media, and nonformal settings.

6. ***Preparation for the future.*** We are moving out of the industrial age into the age of free trade, information systems, knowledge economy, and technological innovations. The best and most efficient of our past and present schools have served a different age. Schools of the future have to meet the needs of the future. But what is the future, and can we predict it?

   We cannot predict the future. The only thing we can predict is that it will be beyond our wildest imaginations. The future is changing so dramatically and quickly that it poses a nightmare for the traditional educational strategist and planner. We can no longer draw occupational pyramids or do manpower planning. We are educating students for the unknown; **the best we can do is to equip them with the necessary conceptual, cognitive, attitudinal, and social tools to continue learning anytime, anywhere, on demand**. The skills include:

   - A conceptual open-ended foundation of the physical, human, environmental, and cultural world
   - Skills to access knowledge, assess it, and apply it.
   - Skills to analyze, critique, and apply knowledge to generate solutions and test options.
   - Interpersonal skills to interact and work collaboratively
   - Social skills to exercise good citizenship, tolerate diversity, and respect other perspectives and rationalities

4 The Role and Nature of ICTs

4.1 Necessity of ICTs

These five far-reaching implications pose a daunting challenge for the education strategist. On one hand, there is a backlog that must be fulfilled, a set of global challenges that must be faced, and an escalating demand for education in both traditional and uncharted territories. On the other hand is the need to provide the whole spectrum of education services to everyone, anywhere, anytime, with a focus on learning acquisition—all under conditions of an ever-expanding base of education clientele and limited physical and human resources.

It is going to be very difficult—if not impossible—for countries to meet the objective of ***effective learning, for all, anywhere, anytime***. Our inability to meet this challenge, however, is self-inflicted because we tend to think of linear scaling, that is, using the same model of education (a school constrained by space and time) but more of it and on a larger scale. What we really need is to think differently and radically. Through the advancement of ICTs, the world is experiencing a real revolution in the dissemination of knowledge and the enhancement of instruction. This is the third revolution in learning, the first being the invention of the written language and the second being the development of moveable type and books. ICTs make both the content of learning ***and*** the interactions of high-quality (and other) instruction affordable and available anytime, anywhere.

Section 5 of this paper describes in detail, supported by case studies and specific experiences, the potential of ICTs in:

1. **Expanding educational opportunities**
2. **Increasing efficiency**
3. **Enhancing quality of learning**
4. **Enriching quality of teaching**
5. **Facilitating skill formation**
6. **Establishing and sustaining lifelong learning**
7. **Improving policy planning and management**
8. **Advancing community linkages**

4.2 ICTs for Instructional Objectives

Learning objectives differ in scope, level and complexity. They relate to hierarchical levels of thinking and cognitive processing. When we design teaching/learning activities and experiences, as well as ICT interventions, we must plan explicitly for the type of cognitive processing that we hope to foster.

The Taxonomy of Educational Objectives was created by Benjamin Bloom in the 1950s to describe these levels. During the 1990s, Lorin Anderson (a former student of Bloom's) led a team of cognitive psychologists in revisiting the taxonomy to examine the relevance of the taxonomy as we enter the 21st century. Table 4.2.1 is a summary of the Revised Taxonomy. (For a full description with examples, see Resource 4.2.1 - Revised Bloom's Taxonomy.)

Table 4.2.1 Revised Bloom's Taxonomy of Learning Objectives

1. REMEMBERING *Recognize, list, describe, identify retrieve, name....* Can the student RECALL information?
2. UNDERSTANDING *Interpret, exemplify, summarize, infer, paraphrase....* Can the student EXPLAIN ideas or concepts?
3. APPLYING *Implement, carry out, use...* Can the student USE the new knowledge in another familiar situation?
4. ANALYZING *Compare, attribute, organize, deconstruct...* Can the student DIFFERENTIATE between constituent parts?
5. EVALUATING *Check, critique, judge hypothesize...* Can the student JUSTIFY a decision or course of action?
6. CREATING *Design, construct, plan, produce...* Can the student GENERATE new products, ideas, or ways of viewing things?

Selection of a technology and the way it is applied should be driven by the nature and level of the learning objective it is meant to stimulate and enhance. Table 4.2.2 translates the above taxonomy into ICT-fostered learning objectives. The lowest level of this taxonomy involves using technology simply to store or display material for students to use; it places them in a passive role. The highest taxonomic level represents active students synthesizing material and using ICTs to construct projects such as hypermedia presentations.

Table 4.2.2 ICT-Fostered Learning Objectives

ICT-Fostered Learning Objective	Description
1. Allow the **storage or display** Information	This level involves the passive hearing or viewing of stored information, individually or as a group.
2. Foster **exploration** of materials and ideas	At this level, the learner is engaged in the conscious pursuit of information that will lead to a better understanding of an existent issue, question, or concept.
3. Enable the **application** of understanding	At this level, ICTs can provide a powerful tool for applying a concept or understanding to a new situation.
4. Organize materials or ideas to foster **analysis**	Here ICT tools allow individuals to analyze materials or ideas by organizing and manipulating them as a means of understanding their relationship to one another.
5. Support **evaluation** and problem solving	This level represents the use of ICTs to support the process of evaluation. This can be done by compiling information and resources into a digital repository, developing simulations that will immerse students in an environment that will help them evaluate relevant dimensions and solve the problems that are posed, and collaborative Web-based environments that support or foster evaluation and problem-solving.

6. Facilitate **constructing or designing** projects	At the highest level, ICTs are used to foster the design or construction of integrating projects, whereby students must explore wide range of ideas and resources, analyze and evaluate them, and synthesize them in a project. ICTs can fully utilize the multimedia environment to support this process.

For further information, visit http://education.ed.pacificu.edu/aacu/workshop/reconcept2B.html.

Similarly, there are teaching objectives for the use of ICTs, such as

- Presentation of a piece of information
- Demonstration of a concept, idea, phenomenon, law, or theory
- Drill and practice to achieve student competence in the application of knowledge
- Simulations and animations to abstract reality and offer an efficient and inexpensive environment to reach generalizations or to draw implications from a law or theory
- Research for professional development and preparation of lessons
- Collaboration on projects with other teachers in the school or in other schools in the country or elsewhere, or with scientists in the field
- Management of student learning

Tables 4.2.3 and 4.2.4 depict the potential of use of different technologies to foster different learning and teaching objectives.

Table 4.2.3 Learning Objectives vs. Technologies

Learning Objective	Technology				
	Text	Audio	Video	Computer	Internet
Storage or display	x	x	x	x	x
Exploration	x	x	x	x	x
Application	x			x	x
Analysis				x	x
Evaluation	x			x	x
Constructing or design of project	x	x	x	x	x

Table 4.2.4 Teaching Objectives vs. Technologies

Teaching Objective	Technology				
	Text	Audio	Video	Computer	Internet
Presentation	x	x	x	x	x
Demonstration	x	x	x	x	x
Drill & practice	x	(e.g., language lab)		x	x
Animation and simulation				x	x
Research	x	x	x	x	x
Collaboration/communication				Networked	x
Management of student learning	x			x	x

Considering the variety and levels of learning objectives and teaching goals, the question for each objective becomes: What is the most appropriate technology, and what is the best way to apply it to get the best results in achieving the particular goal? If technology is to be used for presentation and demonstration only, investment in computers and connectivity may not be justifiable. On the other hand, the potential for interactive and collaborative learning can best be achieved by networked computers and connectivity to the World Wide Web.

Since there is no one-to-one correspondence between instructional objectives and technologies and their application, the next question becomes: What is the value added for using one technology compared to a simpler and cheaper one? For instance, why use a video instead of a photo, a digital text instead of a textbook, or a simulation instead of an animation?

4.3 ICTs and Learning Location

Technologies may be used to support learning and teaching on location or at a distance. In most cases though, technology-enhanced materials used on location can be used at a distance as well, using the appropriate dissemination technology. This makes it possible to invest in materials that may be used on location and at a distance, thus widening the circle of users and lowering the unit costs (see Table 4.3.1).

Table 4.3.1 Technologies on Location and at a Distance

Technologies on Location	Technologies at a Distance
Printed matter	Correspondence
Slides, transparencies	
Scanners	
Digital notepads and white boards	
Audiotapes	Radio
Films and videos	TV broadcasts
Digital books	Web pages
CDs	Web: Internet, intranet
Computer projection	Webcast

It is also important to distinguish between instructional technologies and dissemination technologies. Instructional technologies (print, audio, video, digital) foster learning and teaching in any location. Dissemination technologies foster the distribution of instructional technologies via media such as print, correspondence, radio, broadcast television, CDs, and the Internet.

4.4 ICTs and the School

ICTs do not substitute for the school or diminish its role. On the contrary, ICT tools can improve performance of conventional schools by improving teaching, learning, and management. More important, ICTs can broaden the concept of the school beyond the traditional confines of space and time, by evolving its components into the corresponding components of an enhanced model (see Table 4.4.1).

Table 4.4.1 Evolution of an Enhanced School Model

From	To
A school building	A knowledge infrastructure (schools, labs, radio, television, Internet, museums…)
Classrooms	Individual learners
A teacher (as provider of knowledge)	A teacher (as tutor and facilitator)
A set of textbooks and some audiovisual aids	Multimedia materials (print, audio, video, digital…)

Education will not be a location anymore, but an activity: a teaching/learning activity. This is the ultimate raison d'être of ICTs for education. The foundation of this "educational system" is a knowledge infrastructure that includes the traditional school, broadcast television, digital radio, virtual courses, Internet chat rooms, Web portals, telecenters, and other information and communication technologies that have not yet been conceived. In this learning structure, students will learn through a variety of ways: face-to-face, in groups, or in a synchronous or asynchronous online course. They will pursue expeditions with scientists on the Web, follow space flights, perform simulated experiments, take virtual archeological and geographic tours, do research in digital libraries, and perform collaborative projects with students in other schools in their country and all over the world.

5 The Potential of ICTs: Enhancement of Educational Objectives

5.1 Expanding Educational Opportunities

5.1.1 The Objective

Decision makers and beneficiaries alike now recognize that education is crucial for economic development, human welfare, societal advancement, and environmental protection. Looking into the future, the demand for education is going to escalate.

Countries have entered the 21st century with a basic education deficiency gap—in terms of children out of school and illiterate youths and adults. Equally pressing is the demand for higher levels of education, triggered by more completers of first-level education, higher ambitions of parents and students, and more sophisticated requirements of the marketplace. As developing countries are forced to contend with more developed countries in a competitive knowledge-based global economy, they find themselves behind in providing educational opportunities beyond the basic levels. Moreover, the fast changes in knowledge and skills require further education, upgrading, and reorientation of a significant segment of the population. If only 10% of the adult population needs such educational services, we are talking about a significant segment of the population.

The biggest challenge is to reach individuals and groups that are historically underserved:

- girls and women, who face cultural and physical obstacles to educational institutions;
- rural populations that are too thinly dispersed to populate “regular” schools with reasonable class sizes;
- adult workers who have no time to attend regular courses; and
- persons who cannot come to learning centers because of security hazards.

Here we need to be innovative and think radically. In some situations, we may need to go “over” the hurdles and provide education where these potential learners are—anywhere and everywhere.

5.1.2 The Potential

It is unrealistic to assume that conventional delivery mechanisms will provide educational opportunities for all in affordable and sustainable ways. ICTs have the potential to contribute to the realization of this objective. They can overcome geographic, social, and infrastructure barriers to reach populations that cannot be normally served by conventional delivery systems. Additionally, they provide feasible, efficient, and quick educational opportunities.

The potential of ICTs to reach large audiences was tapped initially in the late 1800s, when correspondence courses became an alternative means to educate individuals who could not attend regular schools due to geographical, social, or cultural barriers. Experiments with radio broadcast started in the early 1900s, and, in 1924, the British

Broadcast Corporation (BBC) began to air educational programs. Since then, radio has been instrumental in reaching scattered and rural populations.

Although experiments with televised broadcast began in the 1930s, it took another 20 years for television to become popular. Two of the most prominent examples are *Telecurso* in Brazil and *Telesecundaria* in Mexico (see section 5.1.3.2).

Computer-related technologies, which began to make inroads 30 years ago, are changing the concept of time and space rapidly. There are now virtual high schools, virtual universities, and virtual programs provided by campus-based universities. About 60% of U.S. universities provide virtual education programs. In addition, open universities expand opportunities to populations that traditionally have been excluded from education due to geographic, cultural, and social barriers: minorities, girls, rural populations and the elderly.

5.1.3 Specific Solutions

5.1.3.1 Radio

In the age of computers and the Internet, we tend to forget about simpler and less expensive technologies. Radio, almost universally available, has the potential to expand access to education. All countries have radio stations, and almost all households in developing countries have at least one radio. Radio is an inexpensive, reliable technology; it is easy to use and maintain, and it can be used where there is no electricity infrastructure.

Radio can offer many educational advantages:

- Stations may broadcast programs prepared by specialists in instructional design and production.
- Well-designed educational packages may use sound effects, drama, and other audio-enhancement mechanisms.
- Programs may be aired more than once without additional development costs.
- Radio breaks the isolation of schools by offering educational news, directives, pedagogical guidelines, etc.

Radio does have some drawbacks, however:

- Radio programs are restricted to the audio dimension of knowledge.
- Radio programs follow a prearranged schedule, to which learners have to adjust.
- There is no interactivity with broadcast programs. Since there is no explicit response from students, it is difficult to know how effective the program is. There are, however, mechanisms to deal with this issue, such as Interactive Radio Instruction (see Section *5.1.3.1.2* below).

5.1.3.1.1 Broadcast Radio

Broadcast programs usually entail an audio lecture or lesson, with printed materials for the students to follow. In this way, a “general” teacher or an underqualified subject-matter teacher can use the radio program as a main instructional source with his or her students. Broadcast programs follow the traditional model of education and can cover

every subject in many different languages, depending on the target audience. They also can be geared toward adults for lifelong learning.

Advantages of broadcast radio

- Programs prepared by specialists
- May use sound and other effects
- Programs aired again with no additional development cost
- Breaks the isolation of schools

Disadvantages of broadcast radio

- Restricted to audio dimension
- Pre-arranged schedule
- No interactivity

For specific cases, see Resource 2.1.1 Broadcast Radio Cases

5.1.3.1.2 Interactive Radio Instruction (IRI)[2]

Interactive radio instruction (IRI), developed in the early 1970s, turns a typically one-way technology into a tool for active learning inside and outside the classroom. It requires that the learners stop and react to questions and exercises through verbal response to radio characters, group work, and physical and intellectual activities *while the program is on the air*. For both teacher and student, the lesson becomes an immediate hands-on, experiential guide. Short pauses are provided throughout the lessons after questions and during exercises to ensure that students have the time to think and respond adequately. Interaction is also encouraged within the learning environment among the teacher and learners as they work together to conduct short experiments, do activities, and reach objectives using local resources and imaginative situations and stories.

IRI episodes guide learners through the learning process by means of a progression of activities related to measurable learning objectives. Educational content is organized and distributed across lessons so that learning builds on previous knowledge and new learners can construct an understanding of the subject being taught more easily. Activities and objectives are first modeled by radio characters so that the teacher and learners have an idea of the process they are undertaking and the skills and support that may be required. All of these elements are knit together through storylines, music, characterization, and other attributes available through the audio medium.

Advantages and disadvantages:
IRI has the same advantages and disadvantages as broadcast radio with two exceptions. Unlike broadcast radio, IRI allows for limited interaction between the scripted program and the learner and teacher. Also radio can be combined with other technologies, if available, to provide synchronous opportunities for interaction with tutors and students through e-mail and chat rooms
For specific cases, see Resource 2.1.2 Interactive Radio Instruction.

[2] Excerpted from: Andrea Bosch. March/April 2001. "Interactive Radio Instruction for Mathematics: Applications and Adaptations from Around the World." *TechKnowLogia.* Available at www.TechKnowLogia.org.

5.1.3.2 Television

Television, like radio, is widely available in households. There is also an abundance of national, regional, and satellite TV stations on which to piggyback. TV educational programming enjoys the same benefits of radio programming with the additional benefit of video. TV programs can bring abstract concepts to life through clips, animations and simulations, visual effects, and dramatization. They can also bring the world into the classroom. However, TV broadcast shares with radio programs rigid scheduling and lack of interactivity.

Experience has shown that TV can be successful in expanding educational opportunities through:

- Targeting young adults who left primary or secondary schools before graduation, allowing them to follow the curricula by watching television.
  (See *Telecurso* in Brazil in Resource 2.1.3 - Television)
- Facilitating effective installation and implementation of lower secondary schools in sparsely settled rural areas, whereby a complete curriculum can be covered cost effectively because:
  - most of the teaching is done through TV programs, and
  - one teacher covers all of the subjects rather than having specialized teachers for each one. (See *Telesecundaria* in Mexico in Resource 2.1.3 - Television)

5.1.3.3 Virtual High Schools

Virtual learning multimedia packages are excellent instructional aides to engage students in the learning process. They use the best specialists and experts who develop and make them available to learners ***anywhere, anytime***; they provide opportunities for independent pursuit of knowledge on demand; they can connect learners with other learners to exchange information and perform collaborative programs; and they may be the most cost effective (and in some cases the only) means of bringing the whole world into the realm of the learner.

Potential and Characteristics
Virtual education covers a variety of approaches:

- Full self-study program provided via the Internet and may be supplemented by printed materials
- Full self-study program supplemented by interaction with a tutor and other students through e-mail and chat rooms.
- Structured program of Internet-based materials and tutors, plus physical study centers where students can meet with tutors and other students and use library facilities

A **virtual school** can serve many clienteles:

- Students who are unable to attend regular schools for a wide range of reasons, including travel, medical conditions, or careers
- Students who have been suspended from their regular schools for long periods because of serious violation of the rules
- Students who need remedial work during summer vacations as a condition for promotion to the next grade level
- High achievers and gifted students by offering them enriched courses and advanced self-study programs

Because of their nature and cost, virtual schools need a large clientele to achieve reasonable unit per student costs. In such case, a collective effort by many countries to establish and support virtual institutions has many advantages:

- The developmental upfront component of virtual education is high. Distributing the initial cost across countries achieves linear economies of scale. Moreover, serving all of the countries increases the size of the clientele and thus lowers the unit per student cost.
- The development of multimedia materials—the backbone of virtual programs—requires highly specialized expertise, equipment, and software. Working together, countries will need only one team of experts, spread among them, and will not duplicate the required physical facilities.
- Students served by a regional virtual institution will interact and collaborate across country boarders, thus strengthening their regional ties.

General characteristics of virtual schools
Virtual schools generally provide all the services that a conventional school provides except physical facilities. Students enroll in courses, have teachers, do homework, and interact with other students and teachers. Teachers manage the learning process through a learning management system, address questions, give feedback, evaluate homework, tutor, confer with parents, etc.

There are presently hundreds of virtual schools, predominantly in the U.S., but also in Canada, Australia, and the UK. They are run by states, colleges and universities, and profit and nonprofit entities. It is important to distinguish between Websites that provide individual courses and entities that offer a complete online program through which a student can obtain a diploma.

Existing virtual schools vary in terms of scheduling and interaction.

- Some schools offer scheduled synchronous courses at particular times. These schools use new technologies to provide real-time interaction between teacher and students.
- Most virtual schools offer unscheduled asynchronous courses that are available on the Web. In these classes, exchanges between students and teacher and among students take place through e-mail, in a chat room, or on a dedicated listserv.

Issues with virtual schools
Virtual schools have great potential, but basic issues must be faced and dealt with during planning and implementation.

- ***Online courses require high expertise to develop***. To exploit the potential of ICTs fully, online courses must combine good instructional design, multimedia tools, and interactive techniques. They must be developed by highly trained and specialized teams to achieve economies of scale and expertise.
- ***Online instruction requires special skills***. Teachers who are effective in face-to-face teaching are not automatically capable of facilitating an online course. They need to be trained in the specialized area of online teaching, which includes understanding the technology that supports the course and the various tools that can to enhance it, such as video, audio, use of online chats and discussion spaces, groupware for common work on documents, etc.

- ***Online learning requires self-discipline***. Without the physical environment of the classroom, students should be intrinsically motivated and able to exercise self-discipline and time management. Many may have difficulty functioning without face-to-face peer interaction and teacher feedback.
- ***Virtual schools require management and support systems***. Virtual schools have management needs similar to those of conventional schools, with the exception of management of physical facilities. But they require additional management and support systems to develop and run the online environment. Above all, they need to maintain and support the technical infrastructure needed for instruction, interactivity, and management of the learning portfolios.
- ***Virtual schools cost money***. Although virtual schools may be less costly than campus-based ones, they still require money to create a virtual platform, develop and test courses, train teachers and pay their salaries, manage and maintain the system, and continue updating the content, the human resources, and technology.

For examples of virtual schools, see Resource 2.1.4.

5.1.3.4 Virtual Universities

A virtual university provides a significant supplement to the existing campus institutions by broadening learning opportunities, offering more flexible options, and serving a clientele whose needs are difficult or impossible to meet through on-site learning. Virtual universities are not a substitute for on-site, campus-based institutions. On-site institutions that are vibrant with research, exploration, and intellectual discourse are irreplaceable. The personal contact with peers and teachers in a good on-site institution is incomparable in its richness. Libraries also still serve as an unmatched resource for investigation and learning. Virtual learning, on the other hand, provides opportunities for those who cannot attend courses on campus because of cost and time constraints. Virtual learning increasingly provides rapid and personal interaction; can offer more reliable learning materials than inferior institutions; is generally far lower in terms of cost to the student; and often offers more for lower capital and recurrent costs.

There are at least three institutional models to explore:

- dual-mode, which offers both classroom instruction and virtual education programs;
- single-mode, which is a wholly dedicated virtual learning institution; and
- international partnership mode, under which an external provider of virtual education programs enters into partnership with local tertiary institutions to offer these programs jointly. This model offers many advantages to the local partner institution, among them it starts with a set of already developed courses and with the experience and expertise of the external partner.

Virtual universities face similar issues that virtual high schools face, and these must be taken into consideration during planning and implementation.

For some examples that demonstrate distinctive characteristics of different models of virtual universities, see Resource 2.1.5.

5.2 Increasing Efficiency

5.2.1 The Objective[3]

The internal efficiency of an educational system is measured by its ability to deliver quality education in cost-effective ways. The traditional model for providing primary through tertiary education, adopted across the world, relies on three basic principles.

- Learners must congregate in a building where the teaching/learning process takes place.
- There must be a predetermined path, divided into grades, that leads to a diploma, and students must follow this path.
- There must be a hierarchical structure where the instructor is the provider of knowledge and the students are the recipients.

The traditional school is, therefore, a physical entity organized into classrooms where learners congregate according to a grade structure and that is constrained by the limits of space and time. If a school serves students from grades 1 through 12, it must have at least 12 classrooms to accommodate each grade separately. Each classroom must have at least one teacher. A certain number of teachers requires a principal and, often, administrative and teaching support. If the number of students or grades increases, so must the number of classrooms, teachers, and support personnel. Generally, beginning in the seventh grade, another dimension is added to the classroom/grade framework: specialization. From then on, the number of teachers is related to the number of both classrooms and specialties offered. Each school must have at least one mathematics teacher, a science teacher, a social studies teacher, and so on. As the educational level advances, classroom organizations rely more on specialization than grade levels, but the framework is maintained.

To be cost-effective within this structure, the learning place must have a ***critical number of students*** to justify school construction and maintenance, particularly personnel costs. In areas of low population density, building and maintaining schools to serve the traditional paradigm is economically prohibitive. The requirement of one specialist per specialty makes secondary schools an even more expensive venture. Some countries sidestep this objective by leaving the solution to individual families, with catastrophic results. If the families choose to move to urban areas and ensure their children's education, they jeopardize their country's fragile economic balance and further deplete the economy of their native regions. If they decide to remain, they jeopardize the children's future.

Areas of high population density but weak economy are not free of objectives. In this case, the traditional model encourages administrators to accommodate as many students as possible in one classroom to control personnel costs, which leads to overcrowded and unsafe environments that are unfit for learning.

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[3] This section and the next contain excerpts from: W. Haddad and S. Jurich. 2002. " ICT for Education: Potential and Potency." In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects.* Paris: UNESCO, and Washington, DC: Academy for Educational Development.

In addition, to achieve efficiency, conventional educational systems offer limited flexibility. For bright students, these systems offer little motivation. Eventually, a few extraordinary students are able to skip a grade, but rushing through the system is not encouraged, and early graduates may find obstacles when they attempt to gain access to the next level.

For low-income students, the schools offer even less; the wealthier schools lure the best teachers, leaving the least prepared for schools in poor and remote areas. When the need to work interferes with school requirements, the student sees no reason to stay in school. As a result, these systems perpetuate social inequalities, lose many excellent students to boredom, increase the costs of education through high dropout rates and grade retention, and pass on to employers or other systems the costs of training their graduates.

5.2.2 The Potential

The capacity of ICTs to reach students in any place and at any time has the potential to promote revolutionary changes in the traditional educational model.

- First, ICTs eliminate the premise that learning time equals classroom time. To avoid overcrowded classrooms, a school may adopt a ***dual-shift system*** without reducing its students' actual study time. Students may attend school for half a day and spend the other half involved in educational activities at home, in a library, at work, or in another unconventional setting. They may be required to watch an educational radio/television program and complete related activities, or work on an online lesson at the school technology lab or in a community learning center.
- Second, ICTs can make ***multigrade schools***, in areas with low population density, viable institutions rather than a necessary evil. While the teacher attends to certain students who need individual attention, other students may listen to an educational program on the radio, watch a television broadcast, or interact with multimedia computer software.
- Third, ICTs can provide courses that ***small rural or urban schools*** cannot offer to their students because it is difficult for them to recruit and retain specialized teachers, particularly to teach mathematics, science, and foreign languages. Schools that do not need a full-time physics or English teacher can use radio, TV, or online instruction, utilizing already developed multimedia materials and sharing one "teacher" among several schools. Alternatively, retired or part-time teachers who live hundreds of miles away can be used to teach the online courses.

ICTs have the potential to bring the products of the best teachers to classrooms anywhere in the world. For self-motivated, disciplined students, ICTs can speed the path toward a degree and expand their learning options through self-study. Students can "shop" courses on the Internet and choose their own program of study and schedules. Students in virtual schools can take extra online courses to graduate earlier or fulfill specific interests and curiosity. For those who need to balance studies with work and family obligations—full- or part-time workers, parents of small children, homebound individuals—this flexibility may be most cost effective for them.

5.2.3 Specific Solutions

The same solutions discussed at length for the expansion of educational opportunities apply here. Broadcast radio, interactive radio instruction, educational TV, and virtual online courses provide the necessary supplements for dual-shift and multigrade schools, remedial offerings, accelerated programs, and flexible scheduling.

5.3 Enhancing Quality of Learning

5.3.1 The Objective

"Whether or not expanded educational opportunities will translate into meaningful development—for an individual or for society—depends ultimately on whether people actually learn as a result of those opportunities, i.e., whether they incorporate useful knowledge, reasoning ability, skills, and values." (*Jomtien Declaration*, article 4). This statement clearly has implications for how success is measured. High enrollments and efficient student flow, while necessary, do not indicate by themselves whether a country is achieving an acceptable level of education. Actual learning achievement is the real measure.

But what is learning? Studies in cognitive psychology and brain science are challenging the traditional model of learning as a matter of transmission and mastery of facts and concepts. They have identified several principles for effective learning:[4]

- ***Learning engages the entire physiology***, and some aspects of how the brain is wired are affected by experience.
- ***Learning is influenced and organized by emotions*** and mindsets based on expectancy, personal biases and prejudices, degree of self-esteem, and the need for social interaction.
- ***Memory is organized both spatially*** (allowing for "instant" memory of experiences that build on one another) and through a set of systems for rote learning.
- ***Humans need to make sense of the environment***, and they understand and remember best when facts and skills are embedded in natural, spatial memory or in ordinary experiences. Further, the search for meaning takes place by "patterning," or attempts to organize and categorize information meaningfully.
- ***The brain downshifts under perceived threats*** and learns optimally when appropriately challenged.
- ***Concepts are learned best when they arise in a variety of contexts***, when they are represented in a variety of ways, and when students have a chance to use the concepts on authentic tasks.
- ***Learning to do well involves practice in doing***. Students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do those things over and over in many contexts.

The implication of these understandings is that learning is an active process in which people construct their understandings, concepts, and ideas of the world around them

[4] Caine, G., Caine, R.N., & Crowell, S. (1994). *Mindshifts: A Brain-Based Process for Restructuring Schools and Renewing Education.* Tucson: Zephyr Press.

through active and personal exploration, experimentation, and discussion. To enhance such learning, the instructional environment should enjoy the following characteristics:

- ***Hands-on:*** Students are actually allowed to perform science, math, history, etc. (directly and vicariously), as they construct meaning and acquire understanding. Such activity takes these subjects out of the realm of the magical or extraordinary.
- ***Minds-on:*** Activities focus on core concepts, allowing students to develop higher-order thinking processes and skills, and encouraging them to question and seek answers that enhance their knowledge and thereby acquire an understanding of the world in which they live.
- ***Reality-on****:* Students are presented with problem-solving activities that incorporate authentic, real-life questions and issues in a format that encourages drawing on multidisciplinary knowledge, collaborative effort, dialogue with informed expert sources, and generalization to broader ideas and application. The objective is to promote students' insight into the real scientific, technological, business, social, cultural, and everyday world, along with the skills needed to live and work effectively.

A shift in objectives. The globalization of the economy and its concomitant demands on the workforce requires a shift in objectives: an education that enhances the ability of learners to access, assess, adopt, and apply knowledge; think independently; exercise appropriate judgment; and collaborate with others to make sense of new situations. The objective of education is no longer simply to convey a body of knowledge, but to teach how to learn, problem solve, and synthesize the old with the new. It is worth noting, also, that the emerging economy will no longer be centrally created and controlled by national governments. This environment, which will be dominated by private sector and not government jobs, will place a premium on creativity, initiative, and entrepreneurship. In addition, society is looking to the school of the future to produce good citizens. To meet these objectives, education must be engaging and authentic: engaging in the sense that students are involved in the learning process, and not viewed simply as "receptacles" for knowledge, and authentic in the sense that what they are learning has meaning to them as individuals, members of society, and workers in the marketplace.

The hard reality. This focus on a broader concept of learning is constrained by the limitations of the educational environment in most schools.

- The world that the student has to understand is multidimensional and dynamic, including sound and motion. Yet the learning environment is usually restricted to lectures, cluttered chalkboard presentations, static texts, and rote learning.
- Some subjects, notably science and languages, cannot be taught without interaction with and manipulation of their elements through sound, animation, and simulation—activities that are rarely provided for.
- In many schools, ***teachers*** are not well qualified to translate the curriculum into teaching/learning activities or to be the chief mediators between knowledge and learners. Their initial training, often all the training they receive, generally does not include preparation of teaching materials or use of contemporary technologies for teaching. Most teachers are reluctant to invest substantial amounts of their own time and resources in bringing their knowledge and competencies up to date in these areas, and few school systems provide time or incentives for this to take place.
- Students in any one class are at different levels—intellectually and academically—and they learn at varied speeds and paths. Research has shown that the most

effective way to allow for these individual differences is to have tailored instruction—tutoring individuals one-on-one. In conventional setups, tutoring is neither feasible nor affordable. Alternatively, teachers tend to focus on the average students in a class and leave the slower and faster students to take care of themselves.

5.3.2 The Potential

Integrating ICTs into the teaching/learning process has great potential to enhance the tools and environment for learning. Research and experience have shown that ICTs, ***well used in classrooms***, enhance the **learning process** in the following ways:

- They motivate and engage students in the learning process. Famed astronomer Carl Sagan used to say that all children start out as scientists, full of curiosity and questions about the world, but schools eventually destroy their curiosity. Research shows that students are motivated only when the learning activities are authentic, challenging, multidisciplinary, and multisensorial. Videos, television, and computer multimedia software can be excellent instructional aids to engage students in the learning process. In addition, sound, color, and movements stimulate the students' sensorial apparatus and bring a sense of enjoyment to the learning process.
- They bring abstract concepts to life. Teachers have a hard time teaching and students have a hard time learning abstract concepts, particularly when they contradict immediate intuition and common knowledge. Images, sounds, movements, animations, and simulations may demonstrate an abstract concept in a real manner.
- They foster inquiry and exploration. The inquiry process is a source of affective and intellectual enjoyment. This sense of adventure is taken away in a traditional classroom, where questions and answers are established a priori and are unrelated to students' interests, and where research is reduced to a word in the textbook. The problem for many educators is that inquiry and exploration require resources that are unavailable in traditional classrooms, such as large databases and well-equipped laboratories. ICTs have the potential to let students explore the world in cost-effective and safe ways. Videos and computer animations can bring movement to static textbook lessons. Using these tools, students can initiate their own inquiry process, then develop hypotheses and test them. In a virtual reality setting, students can manipulate parameters, contexts, and environments and try different scenarios.
- They provide opportunities for students to practice basic skills on their own time and at their own pace.
- They allow students to use the information acquired to solve problems, formulate new ones, and explain the world around them. For instance, computer applications have the potential to store massive amounts of data, plot curves, conduct statistical tests, simulate real-life experiments, build mathematical models, and produce reports—all with speed and accuracy.
- They provide access to worldwide information resources.
- They offer the most cost-effective (and in some cases the only) means for bringing the world into the classroom.
- They supply (via the Internet) teachers and students with a platform through which they can communicate with colleagues from distant places, exchange work, develop research, and function as if there were no geographical boundaries.

Research has shown that the difference in learning between tailored instruction (tutoring) and conventional classroom instruction is very large. Perhaps the greatest

potential of ICTs is their ability to make such individualized learning feasible and affordable. More specifically, research and experience have shown that:

- Technology-based instruction increases learning achievement by no less than one-third.
- The level of interactivity found in technology-based instruction is comparable to one-on-one tutorial instruction.
- ICT-enhanced programs allow materials to be presented in multiple media for multichannel learning, so that students can learn according to their individual speeds and paths.
- Overall, ICT-based instruction reduces the time it takes students to reach a variety of learning objectives by an average of 30%.
- Savings in learning time reduce educational expenditures without the need to lower student/instructor ratio.

For more information on the effect of technology-based tutoring on learning, see Resource 2.2.1 - Value of Tailored Instruction.

5.3.3 Specific Solutions

5.3.3.1 Radio and Television Programs

Interactive radio instruction (IRI), broadcast television, and stand-alone audio and video programs have the potential to enhance the quality of learning by enriching the learning environment with sound, color, and motion and by injecting instances of the real world into the classroom. They also bring variety that offers motivation and opportunities for multichannel learning.

For examples of use of radio, TV and videos, see Resource 2.2.2.

5.3.3.2 Electronic Multimedia Learning Modules

Multimedia modules combine conceptions of effective learning with appropriate ICTs: computer technologies (including text, graphics, digitized audio and video, and interactive multimedia) and online technologies. They are multimedia (e.g., paper, video, software, World Wide Web, etc.) units on focused topics where the unique advantages of electronic technologies (including the ability to model, simulate, quantitatively analyze, and so forth) may be leveraged. Some modules may provide linear video (on videotape, CD-ROM, DVD, or, possibly, via the Web) to introduce the module (e.g., offering real-life examples of a concept at work), to provide conceptual or operational instruction, or to emphasize the outcomes from an experiment or application of a concept. Because the modules must fit into existing instructional flows, each one should be designed carefully to focus on a particular skill or knowledge.

To be effective, learning modules should be developed and used under a comprehensive set of parameters:

- They have to be well connected to the curriculum and must supplement the textbooks.
- They should be developed by specialized teams that include teachers, instructional designers, software specialists, and graphic designers.

- They should be tested for implementability and effectiveness before distribution to schools.
- Teachers should be well trained in the use of modules as an integral part of the teaching/learning process.
- They can be distributed over the Internet, but should also be available on CDs and proxy server where the Internet is not available or is very slow or costly.

A representative case of this approach is the International Virtual Education Network (IVEN) for the Enhancement of Science and Mathematics Learning, a pilot collaborative, cross-country project in Latin America. For more information, see Resource 2.2.3 The Case of IVEN.

5.3.3.3 Virtual Labs

All school systems want to provide labs because science is empirical. Few schools have them, however, fewer have them equipped, and fewer yet are willing to risk using them. Technology allows for video and digital demonstrations as well as digital simulations of lab activities in a very real manner, but without the risks and costs associated with lab experiments. Simulations of science lab experiments can also use real data. Datalogging is a type of software that enables the use of actual sensors and probes connected to the computer. Rather than an individual having to feed the information to the computer manually, the sensor directly uploads the measurement, thus reducing the margin of error and reproducing circumstances that are closer to an actual experiment.

Computer simulations are particularly helpful for learning science in the following situations:

- Experiments that are too risky, expensive, or time-consuming to be conducted in a school laboratory, such as those involving volatile gases
- "Tidy" experiments that require precision so that students can see patterns and trends or ones where students may not be able to achieve the necessary precision without simulation tools
- Experiments that break the laws of nature, such as exploring kinematics collisions that violate conservation of momentum law
- When ethical issues are at stake, such as in the case of some biology experiments

Simulations should not replace hands-on activities totally. Rather, they should prepare the learner to conduct real-life experiments—in the same manner that flight simulations prepare the student-pilot for test flying.

For examples of science and math simulations, see Resource 2.2.4.

5.3.3.4 Connecting with the World[5]

ICTs can take students on exciting journeys through time and space. Movies, videos, audio technology, and computer animations bring sound and movement to static textbook lessons and enliven children's reading classes. They also enable social studies and foreign language students to experience distant societies and bygone times vicariously. The Internet offers virtual reality settings where students can manipulate parameters, contexts, and scenarios.

[5] Excerpted from: W. Haddad & S. Jurich. 2002. " ICT for Education: Potential and Potency." In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects*. Paris: UNESCO, and Washington, DC: Academy for Educational Development.

Videos and computer animations enable students to "witness" a volcano eruption to learn about pressure, rock formation, or psychological and sociological responses to crises. A simple radio or tape recorder can allow students in a foreign language class to listen to native speech regardless of their teachers' origin. Better yet, with interactive technologies—such as two-way radios or videoconferencing—students can communicate with native speakers without leaving their classrooms. Videos, DVDs, computer software, and the Internet bring to schools anywhere in the world information that can be obtained only through the use of powerful scientific instruments that no single school can afford. For instance, at the Website of the Space Telescope Science Institute (http://opposite.stsci.edu), students can observe planets and stars through the lens of the Hubble space telescope, and at the Molecular Expressions Website (http://micro.magnet.fsu.edu), they can examine tiny insects under fluorescence microscopy or study details of DNA structure.

More than any other technology, the Internet opens new opportunities for collaborative work. From group discussions to full collaborative research projects, the Internet has the potential to connect classrooms to research centers and students to actual scientists. For a description of some examples, see Resource 2.2.5.

5.3.3.5 Designing and Creating Things

Learners can use computers to design and create things—Web pages, music, simulated environments and events, etc. The Massachusetts Institute of Technology (MIT) Media Lab and the Boston Museum of Science have established a network of learning centers in economically disadvantaged communities. At these centers, called Computer Clubhouses, young people use leading-edge software to create their own artwork, animations, simulations, multimedia presentations, musical compositions, Websites, and robotic constructions. For more details see Resource 2.2.6 MIT Clubhouses.

5.4 Enhancing Quality of Teaching

5.4.1 The Objective

Teaching is one of the most challenging and crucial professions in the world. Teachers are critical in facilitating learning and in making it more efficient and effective; they hold the key to the success of any educational reform; and they are accountable for successful human development of the nation and for preparing the foundation for social and economic development. Yet, they are usually ill-prepared and left on their own to understand and address the needs of students, parents, administrators, society, the economy, and the past, present, and future.

Modern developments may have eased some teaching burdens, but they certainly have not made life easier for teachers:

- The objectives of education have become more complicated. It is no longer sufficient to teach a certain body of knowledge and skills. Teachers are expected to help students to acquire higher levels of cognitive skills—problem solving, creativity, collaborative learning, synthesis, and, above all, the skill to learn new knowledge and apply that knowledge to new situations.
- Our understanding of the nature of learning has evolved. For learning to take place, learners have to be active, learning has to be meaningful and authentic, and the

learning environment should be challenging but not stressful—all easier said than done!

- Knowledge is expanding rapidly, and much of it is available to teachers and students at the same time. This puts an unavoidable burden on teachers to continue updating their knowledge and exposing themselves to modern channels of information.
- The social environment in many countries is making it more difficult for teachers to manage classrooms and learning processes. Teachers' authority is challenged and their knowledge questioned continually. Students, in many instances, are becoming less respectful and more belligerent, and in some extreme cases, teachers must function in the face of physical threats and psychological duress.
- Information and communication technologies have brought new possibilities to the education sector, but, at the same time, they have placed more demands on teachers. They now have to learn how to cope with computers in their classrooms, how to compete with students in accessing the enormous body of information—particularly via the Internet, and how to use the hardware and software to enhance the teaching/learning process.

Obviously, teachers cannot be prepared for these unfolding challenges once and for all. One-shot training, no matter how effective and successful, will not suffice. A new paradigm must emerge that replaces training with lifelong professional preparedness and development of teachers, along the following continuum:

- **Initial preparation/training** that provides teachers with a solid foundation of knowledge; proficiency in pedagogical, social, and organization skills; deep understanding of the teaching/learning policies and materials they will deal with; and broad familiarity with sources of educational materials and support. It is equally crucial that candidates have a sophisticated grasp of continuous exploration, assessment, and acquisition of new knowledge and competencies, according to future demands.
- **Structured opportunities for retraining, upgrading, and acquisition of new knowledge and skills.** Many professions require practitioners to renew certification for practice. It is only logical for the critical profession of teaching to demand recertification every two or three years based on evidence of professional upgrading, and it is equally imperative for education authorities to ensure that opportunities and facilities for such upgrading are available.
- **Continuous support** for teachers as they tackle their day-to-day responsibilities.

5.4.2 The Potential

Implementing the emerging paradigm with conventional measures and techniques faces, in most countries, insurmountable financial, organizational, and institutional obstacles. ICTs may make the difference and can contribute significantly to all three components of the continuum:

- First, ICTs and properly developed multimedia materials can enhance teachers' initial preparation by providing good training materials, facilitating simulations, capturing and analyzing practice teaching, bringing into the training institution world experience, familiarizing trainees with sources of materials and support, and training potential teachers in the use of technologies for teaching/learning.
- Second, ICTs open a whole world of lifelong upgrading and professional development for teachers by providing courses at a distance, asynchronous learning,

and training on demand. ICTs' advantages include ease of revision and introduction of new courses in response to emerging demands.
- Finally, ICTs break the professional isolation from which many teachers suffer. With ICTs, they can connect easily with headquarters, with colleagues and mentors, with universities and centers of expertise, and with sources of teaching materials.

5.4.3 Specific Solutions

The above potential can be translated into a variety of ICT-enhanced interventions. Among them are:

5.4.3.1 Multimedia Training and Support

See the cases of South Africa and Aula Mentor, Spain, in Resource 2.3.1.

5.4.3.2 Videos for Training

Videos can serve an important role in microteaching, demonstration of special instructional techniques, on-demand training, and uncorrupted expert instruction—in contrast with the cascade model (whereby training flows down through levels of less experienced trainers until it reaches the target group; in the process, complex information tends to be lost). See Resource 2.3.2.

5.4.3.3 Teacher Development Portal

Teacher development portals provide an integrated teacher development program using the potential of ICTs. The portal can provide the resources, tools, and platform for all three phases of the teacher development continuum: initial training at teacher training colleges, in-service training opportunities, and continuous teacher support.

More specifically, a portal provides the following resources, tools, and collaborative channels:

- *Simulation and good practice.* New technologies, both computer- and Web-based, allow for simulation of specific skills through mini- and micro-lessons that can be watched, manipulated, and tested. Also, demonstrations of real teachers in real classroom settings, representing different subjects, approaches, and methodologies, may be brought into the teacher education center without having to travel to schools. More important, these good practices can be dissected, analyzed, watched again, and assessed over time without disrupting an actual class.
- *Multimedia modules.* These are teaching/learning activities related to specific pedagogical skills.
- *Resource materials*, including solutions to common teaching problems, innovations in teaching specific concepts, lesson plans, and links to other portals developed by centers of excellence and professional organizations. The portal site not only finds and links to these other sites, it also provides a special directory or search engine to help users find what they want and avoid the rest.
- *Moderated and unmoderated chat room, bulletin boards, discussion forums, and virtual conferences.*
- *Synchronous and asynchronous online seminars on specific topics*, using Webcasting and audio technology.
- *Free e-mail and personalized Web space.*
- *Free educational software for downloading.*

- *Policies and procedures* can be posted on the portal for easy access by teachers and administrators. This also allows revisions to be made inexpensively and distributed immediately to all schools with Internet access. Furthermore, through the e-mail link, teachers and administrators can provide feedback on the postings to policy makers.
- *Resource teachers*, assigned full-time or part-time, provide, through the portal, advice to classroom teachers about problems and best practices. They can also prepare and provide supplemental lesson plans to capitalize on learning opportunities created by new developments. Furthermore, resource teachers can help design lesson plans and curriculum when textbooks and other traditional sources are unavailable. The resource teacher can be available by e-mail, portal chat rooms, and bulletin boards. Chat rooms and bulletin boards allow easy archiving and retrieval of earlier queries and answers, which can substantially reduce the number of times the resource teachers have to respond to similar inquiries.

5.4.3.4 Internet Resources for Teachers[6]

There are thousands of Websites for educators which provide assistance to teachers in a wide range of needs, including lesson plans, instructional tools, student activities, and professional development opportunities. Resource 2.3.3 contains a selective list of Websites that are intended to provide assistance to a wide range of teachers in their day-to-day classroom work. The sites have been selected to illustrate the variety of supports that can be provided to teachers through the Web. Although most of the sites are in English, they serve as models of the types of resources that can be prepared to serve other language groups.

5.5 Facilitating Skill Formation

5.5.1 The Objective

There was a time when planning for vocational and technical training was a straightforward exercise: manpower planners mapped out needs of the different sectors of the economy with reasonable precision, classified corresponding jobs by level, defined skill requirements for each job, and subsequently projected the manpower needs. It was then fairly easy for educational planners to take this "dependable" information and build technical and vocational education programs on it.

Life is not that easy anymore. Everything is changing faster than the life cycle of a training program: sectoral needs, job definitions, skill requirements, and training standards. Countries, firms and workers are all feeling the effects of the changing patterns of trade and competition, technological innovation, and globalization of information.

- **First**, producers of tradable goods and services now must operate in a global marketplace. They are more interdependent, more susceptible to external economic shocks, and more vulnerable to international changes in demand for types and quality of products and services. The situation also makes it hard to predict the skills that will be needed in the future.

[6] Gregg Jackson & Nina de las Alas. November/December 2000. "WorthWhileWebs." *TechKnowLogia*. Available at www.TechknowLogia.org.

- **Second**, the production of manufacturing and high-valued services no longer filters down "naturally" from high-income to middle- and low-income countries based on labor costs alone. The location of manufacturing and high-value service depends on the producer's ability to control quality and manage flexible, information-based systems.
- **Third**, the emerging economy will no longer be centrally created and controlled. As countries become more open to international trade, production will reflect international and not just national demand. This environment will place a premium on entrepreneurship, or the ability of individuals and institutions to respond to market changes through evolving their own businesses or creating new ones.

These facts change the rules of the game for economic success:

- Countries and firms can no longer rely on a low-wage edge; industry has to develop and mature technologically and managerially and needs to place greater emphasis on productivity, quality, and flexibility in production.
- Workers can no more be trained once for life. They need to acquire flexible training to cope with the changing nature of their existing tasks and the requirements of new tasks. Acquired skills have a short life, and many new skills are needed during an individual's lifetime.
- Learning new skills required by emerging jobs necessitates a solid scientific and technological foundation as well as an array of higher-order cognitive and social skills, such as problem solving, flexibility, agility, resourcefulness, collaboration and teamwork, "how to learn," and entrepreneurship.
- Everyday living is becoming more and more technologically sophisticated. Citizens need technical skills to cope with home appliances, entertainment devices, communication equipment, and marketplace processes. They need to continuously update and upgrade these skills; otherwise, and in a very short time, they will find themselves in a way "disabled" and outdated.

This situation calls for a high-quality and efficient training system to enhance the quality and efficiency of product development, production, and maintenance. Ideally, this system of skill training has the following characteristics:

- Train workers as quickly as possible and immediately place them in jobs that use their skills.
- Have the technology and expertise to train in both traditional and newly emerging skills.
- Immediately incorporate into training content changes in the economy and marketplace.
  Provide ordinary individuals with access to training opportunities to learn skills necessary for them to lead active lives in modern society.

5.5.2 The Potential

Traditional training programs cannot address these new realities adequately; they are costly in terms of travel and lost time on the job, disruptive, slow to be modified, and incapable of responding to new needs and provisions in a timely fashion.

Historically, the technical and vocational training sector has been very innovative and daring in the use of technology for instruction, training, and practice. In the face of the emerging challenges facing countries, firms, producers, and consumers, the

advancements in ICTs offer real hope to meet these challenges in a timely, effective, and sustainable manner. ICTs can be very powerful as an instructional and distributional tool over the whole range of skill training: basic and advanced; synchronous and asynchronous; individual and group; residential and at a distance; and virtual, simulated, and hands-on.

ICTs have the potential to contribute to skill formation in the same way that they enhance the quality of learning and teaching in general (sections 5.3 and 5.4 above). Additionally, network technologies have the potential to deliver the most **timely and appropriate** knowledge and skills to the **right** people, at the most **suitable** time, in the most **convenient** place. E-training allows for personalized, just-in-time, up-to-date, and user-centric educational activities.

E-training has been most popular (and successful) in the corporate world, probably due to the culture of innovation and light bureaucracies, the feasibility of having limited and clear educational objectives, and the existence of quantifiable trade-offs. Consumers also use e-training for informal skill formation and for professional training and upgrading in certain specializations; however, corporate and consumer e-training modalities have opened new paths, raised new ideas, and generated new approaches.

5.5.3 Specific Solutions

Specific solutions described earlier to advance educational opportunities (section 5.1.3), efficiency (section 5.2.3), quality of learning (section 5.3.3), and quality of teaching (section 5.4.3) are also applicable for improving skill formation. Certain solutions, however, have been particularly effective in this area:

5.5.3.1 Simulations

Simulation has long been used by trainers to facilitate skill formation. They offer a safe, efficient, and economical "virtual reality" that replicates actual events and processes under controlled conditions.

Perhaps the most notable example is the flight simulator, which offers a safe environment to train pilots. This and other simulators allow training under virtual hazardous and emergency scenarios and permit errors without expensive or devastating consequences. Simulations have also been used in such areas as:

- Reproduction of the operation of numerically controlled machine tools (known as CNC machines)
- Troubleshooting of electronic circuits
- Training for manual dexterity as in welding
- Use of computers to simulate electrical and electronic circuitry
- Use of software to emulate hardware

For more on simulations, see Resource 2.4.1.

5.5.3.2 Competency-Based Multimedia

Competency-based multimedia programs enhance the quality and efficiency of classroom-based vocational and technical education. They provide an explicit link between training and skill competencies and may lead to teaching methods that avoid conventional lectures, as is the case at Francis Tuttle (see Resource 2.4.2), where all live

lectures have been eliminated. Videotaped lectures, written materials, and computers are used instead.

5.5.3.3 Video and Interactive Media

Videos and interactive media are valuable for firms that want their employees to upgrade their skills and for citizens who wish to learn new skills through "do-it-yourself" or "how-to" mechanisms. Television and the Internet have created a new category of programs, sometimes called "edutainment," that combining education with entertainment. These include programs on such skills as home design and building, woodwork, and remodeling. For a sample of interactive media (videos and CDs) for skill enhancement and training, see Resource 2.4.3.

Videos, CDs and DVDs have great potential for skill training in classrooms and at home. They are now easy to produce with the introduction of digital camcorders which are relatively cheap and user friendly.

5.5.3.4 Workplace Training

Training in the workplace has become a continuous need as firms find it necessary to provide their staff with opportunities to upgrade their skills and acquire new ones to adjust to new market demands. However, traditional face-to-face training is costly—particularly in terms of trainees' time and travel. Firms have introduced different levels of e-training—providing synchronous and asynchronous opportunities through the Internet, videoconferencing, videos, CDs, television, etc. For examples of e-training applications in specific enterprises (Axa, Carrefour, Cisco, Lucent Technologies, and corporate universities), see Resource 2.4.4.

5.6 Sustaining Lifelong Learning

5.6.1 The Objective

For many years, lifelong learning has been a permanent fixture in international education pronouncements and national policies and strategies. How can anyone disagree with the need for people to continue their learning to enjoy personal fulfillment, economic advancement, and social development? As early as 1972, one of the four basic assumptions that underpinned UNESCO's classic report, ***Learning to Be***, was that:

> Only an over-all, lifelong education can produce the kind of complete man the need for whom is increasing with the continually more stringent constraints tearing the individual asunder. We should no longer assiduously acquire knowledge once and for all, but learn how to build up a continually evolving body of knowledge all through life—"learn to be."

In 1990, participants in the Jomtien ***World Conference on Education for All*** gave a special focus to lifelong learning:

> Every person—child, youth and adult—shall be able to benefit from educational opportunities designed to meet their basic learning needs. These needs comprise both essential learning tools (such as literacy, oral expression, numeracy, and problem solving) and the basic learning content (such as knowledge, skills, values and attitudes) required by human beings to be able to

survive, to develop their full capacities, to live and work in dignity, to participate fully in development, to improve the quality of their lives, to make informed decisions, and to continue learning.

Despite the radical pronouncements, investments, strategies, and measures to make lifelong learning a reality, efforts have been static and marginal compared to those made in expanding and improving schooling. Except for some targeted programs here and there, lifelong adult learning has been assigned as the personal responsibility of the individual—both organizationally and financially.

Section 3.5 pointed out that the modern demands on countries, societies, and individuals further necessitate lifelong learning for all, anywhere and anytime. Some of the reasons for such a need are:

- The fast-changing, technology-based economy requires from workers the flexibility to adjust to new demands and the ability to learn new skills.
- The increasing sophistication of modern societies demands constant updating of the knowledge and skills of their citizens.
- The escalating knowledge makes the "educated" obsolete unless they continuously update their knowledge.
- As society evolves, we are unlikely to continue the present life-cycle pattern of prolonged education at the beginning of life and an extended retirement period at the end.
- Lifelong learning provides opportunities for those who are unemployed to reenter the workforce.
- Given the importance of learning foundations, and of continued learning in knowledge-intensive societies characterized by rapid change, those who miss out—either initially or later on—are effectively excluded.

These needs give rise to a wide range of activities that come under the rubric of lifelong learning—some formal, some workplace related, some informal, and some ad hoc and spontaneous. This is a nightmare for the "rational" planners. It is for this very reason that lifelong education cannot be considered another subsector of the educational system, subject to the same dynamics and modalities. The weak record of formal adult education attests to that.

The all-embracing nature of lifelong learning has many implications:

- Initial education is no longer a preparation for life and career but a preparation, in terms of concepts, cognitive tools, attitudes, and values, for a lifelong learning process.
- The learner and his or her needs are central, which puts the focus on the demand side of educational opportunities.
- Learning cannot be constrained by time and place; it must take place in all settings and at any time.
- Lifelong education cannot be restricted to predetermined delivery systems, no matter how effective they are. Evolving needs and conditions should lead to new and innovative delivery systems.

Clearly, adult learning involves a wide range of stakeholders and beneficiaries. Does that mean that there is no role for public policy and input? Not so fast! The strong economic and social rationale for lifelong learning justifies public involvement and support. Also, leaving such learning to market forces alone creates obvious distortions that work against the poor, the rural communities, the undereducated, and the poorly equipped.

Public policies, strategies, and provisions must, therefore, redress these distortions and seek to ensure that lifelong educational opportunities are available for all, and that conditions are in place to encourage and enable everyone to participate.

Certainly, formal traditional systems cannot cope with this demand, even if they are well financed, run, and maintained. It is not possible to bring learning opportunities to all of the places where adult learners are. Likewise, it is not feasible to accommodate all learners in adult education centers and offer them programs that meet their many needs. The diversity of requirements and settings calls for a diversity of means.

5.6.2 The Potential

ICTs may provide their most valuable contribution in this domain. They are flexible, unconstrained by time and place, can be used on demand, and provide just-in-time education. They have the potential to offer synchronous as well as asynchronous learning opportunities. But, above all, if well prepared, they can pack a wealth of expertise and experience in efficient packages that can be modified and updated constantly in response to feedback, new demands, and varied contexts. Possibilities fall in a wide range of technologies, including videos, correspondence, Internet, and e-learning superstructure.

This may be the first time in the history of the human race when lifelong learning is not only desirable and urgent, but feasible as well. However, successful exploitation of technology for lifelong learning for all depends on a number of factors:

- Adults need to have a minimum level of basic education, including literacy. Technology should not blind us to the fact that there are still millions of adults who cannot read or write, and, because of that, they cannot use educational programs offered through information technologies, or even through classical correspondence.
- Schools should equip individuals with the necessary cognitive and technical skills to pursue and manage their own continuous learning—how to search, assimilate, define problems, apply knowledge to problem solving, etc.
- Technology literacy—the ability to use technology hardware and software—should be part of basic education and a prerequisite for adults to make good use of ICTs throughout their lives.

5.6.3 Specific Solutions

5.6.3.1 Expansion of Educational Opportunities and Skill Formation

Many of the specific solutions cited for expanding education opportunities (section 5.1) and for skill formation (section 5.5.3.3) are equally relevant for providing and sustaining lifelong learning. Two additional solutions are increasingly adopted:

5.6.3.2 Open Universities

In many countries, open universities provide opportunities for lifelong learning, not only through degree programs but also through nondegree offerings to enhance knowledge and skills for occupational, family, and personal purposes. (For specific examples see Resource 2.5.1.)

5.6.3.3 Universities for the "Third Age"

The greatest social challenges of the 21st century will be the aging of human society. By the year 2025, the number of persons age 60 and over (the "***third age***") will increase from today's 590 million to 1.2 billion. In Japan, by 2020, more than 25% of the population will be 60 or older. A few decades later, nearly every country in the world, with the exception of sub-Saharan Africa (because of the AIDS epidemic), will have a similar proportion of the population age 60 and over.

Lifelong learning for the "third age" will be an essential part of the new set of public policies and programs for at least three reasons:

- Learning for individual health will help to reduce the human and financial burden of chronic health problems.
- Lifelong learning will help the elderly to increasingly remain in the work force, as a means of reducing poverty, increasing economic growth, and giving a stronger sense of self value to the elderly themselves.
- Learning for self-enrichment and empowerment of the elderly will clearly lead to better individual and social mental health.[7]

Some countries have created special universities for the third age. The University of the Third Age in China has been one of the most successful programs in promoting lifelong learning (see Resource 2.5.2).

5.7 Improving Policy Planning and Management

5.7.1 The Objective[8]

Compared with any other national activity, the education enterprise is huge and intricate. It involves educational institutions all over the country, teachers and administrators in large numbers, and students of every age, who can account for up to 30% of the population. For instance, the educational system of a middle-income country of about 10 million people can easily encompass more than 11,000 educational institutions, 140,000 teachers, and 3 million students. The budget of this enterprise may reach 20% of the government budget and 3%–5% of the gross national product (GNP). By any measure, this is an enormous enterprise to manage and maintain, and for which to ensure quality of input, process, and output.

Recent reforms within the education enterprise have resulted in observable successes in making educational opportunities more accessible and equitable and the teaching/learning process more effective. Yet, these successes are making an already unwieldy system even more complicated:

- Expanding educational opportunities means more schools in isolated rural areas and more diversified modes of delivery.
- Aiming for education for all means including students from underserved populations who require special measures to reach and have special needs that must be met.

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[7] Laurence Wolff. September/October 2000. "Lifelong Learning For the Third Age." *TechKnowLogia*. Available at www.TechKnowLogia.org.

[8] This section and the next are excerpted from: Wadi D. Haddad. January/February 2001. "The Education Enterprise: Is It Manageable?" *TechKnowLogia*. Available at www.TechknowLogia.org.

- The accent on learning requires setting reliable and measurable standards and attending to individual differences.
- Decentralization and devolution of decisions to district and local levels require better information systems and management procedures.
- Involvement of more stakeholders in the education process (parents, employers, unions, political parties, etc.) is resulting in more transparency and accountability. These developments demand a consistent flow of information and force the education enterprise to be managed better and more efficiently.

Any business that is even a fraction of the size and complexity of a country's educational enterprise and uses the management techniques of most educational systems will go out of business in no time. Big businesses have discovered how important management is to keep their companies well run, efficient, and competitive. In so doing, they have used the potential of technology to restructure their procedures and overhaul their production, distribution, training, feedback, maintenance, and administration processes. However, education systems have been slow in exploiting the power of technology.

5.7.2 The Potential

Many educational institutions and systems have introduced simple management and statistical information systems. But this should be only the beginning. Two interrelated measures are needed:

- First, education systems need to undergo structural reengineering of their processes and techniques and to modernize their procedures and applications—at different levels of decision making and administration.
- Second, communication and information technologies must be an integral part of the restructuring design and application.

More specifically, technology for management may enhance reform in two areas:

Management of institutions and systems. The same elements of computing and telecommunications equipment and services that made businesses more efficient and cost effective can be applied to schools and school systems to enable principals and superintendents to streamline operations, monitor performance, and improve use of physical and human resources. Technology also promotes communication among schools, parents, central decision makers, and businesses that fosters greater accountability, public support, and connectivity with the marketplace. At the school/institution level, technologies are crucial in such areas as admissions, student flow, personnel, staff development, and facilities. At the system-wide level, technologies provide critical support in domains such as school mapping, automated personnel and payroll systems, management information systems, communications, and information gathering, analysis, and use.

Management of policy making. The process of policy analysis and development is a sophisticated and strategic exercise. It is, by necessity, an intricate, nonlinear process in which a variety of people and organizations with diverse perspectives are actively involved in the process through which issues are analyzed and polices are generated, implemented, assessed, adjusted, and redesigned. Here ICTs can be valuable in storing and analyzing data on education indicators, student assessment, educational physical and human infrastructure, cost, and finance. Technology not only can help in diagnosis

but, more important, it can also assist in constructing scenarios around different intended policy options to determine requirements and consequences. Each scenario can then be systematically analyzed and evaluated, not only in terms of its educational desirability but also in terms of financial affordability, feasibility, and sustainability over a sufficient period to show results. During policy implementation, technology can facilitate tracer studies and tracking systems as well as summative and formative evaluation.

5.7.3 Specific Solutions

5.7.3.1 Education Management Information System (EMIS)[9]

An Education Management Information System (EMIS) is a comprehensive system that brings together people, process, and technology to provide timely, cost-effective, and user-appropriate information to support educational management at whatever level is needed.

Most educational establishments have some type of management information—even if it is just a blackboard outside a school listing every week's enrollment by grade. Information is being provided to those who might want to use it. But a modern system needs more than this on a supported basis. At a minimum, upgrading, modernizing, and seizing on new approaches to improve education delivery using EMIS requires the following:

1. Determine who the stakeholders are for education information.
2. Assess who needs information for what decisions.
3. Determine which functions need to be supported and at what level.
4. Assess available resources. This means not only financial, but also material, personnel, time, and commitment. More EMIS efforts have failed because of the unavailability of good personnel and commitment than for any other cause.
5. Set priorities (short-, medium-, and long-term), get some knowledgeable review, and set a time frame.
6. Get multiple commitments.
7. Get sufficient resources for people, for the process, and then for the technology.
8. Stay clear about outcomes and monitor them.

EMISs have a technical element, but they are primarily about the use of information. Using information is a highly specific, often personal activity that affects work habits, work style, and work flow. Many old-style information systems have ceased to work, not because they are obsolete, but because the people supporting them failed to maintain them properly. EMIS will involve several elements that are critical to success:

1. Setting standards for information.
2. Setting timing for gathering and processing information. Information will vary simply by being gathered at a different time; if you measure enrollment in January, rather than April, the counts will be different—both accurate, but different.

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[9] Excerpted from:

- Kurt D. Moses. January/February 2001. "Education Management Information System: What Is It and Why Do We Not Have More of It?" *TechKnowLogia*. Available at www.TechknowLogia.org;
- Kurt Moses & Vivian Toro. January/February 2001. "Education Management Information Systems (EMIS): Available Software and Guidelines for Selection." *TechKnowLogia*. Available at www.TechknowLogia.org.

3. Defining the level of possible accuracy.
4. Defining formats early, so that people get used to and understand how information is presented.
5. Ensuring that the providers of information quickly see the results of their work. The quicker and closer information processing is to the source, the higher its level of accuracy and speed of correction.
6. Measuring the cost of producing information.

Resource 2.6.1 is a sample list of single-function as well as integrated education-oriented management software. The list is indicative and not exhaustive. As you review it, keep in mind that software suitability is highly dependent on the local situation, particularly in terms of functions, support, training, and cost.

5.7.3.2 Simulations for Policy Analysis and Formulation[10]

Simulations offer a means by which to study situations of rapid change and high complexity that conventional empirical research cannot handle. Suppose, for example, that you want to assess the possible impact of new forms of education. A conventional experiment will take years to deliver results, but simulation of critical elements in the new forms may yield valuable insights into problems and promises.

Simulations for policy analysis can be sorted into two categories: structured and unstructured.

- ***Structured simulations*** use algorithms to simulate how a system operates. Users' choices and possible outputs are specified in advance. Operation of the simulation points to a "best choice" policy. Early applications constituted single-step, noninteractive simulations to estimate the feasibility of different kinds of policies in the context of a national reform or to estimate the sensitivity of the (assumed) situation to a series of policy decisions.

  Multistep or interactive simulations are most appropriate when more than one decision maker is involved in setting policy, that is, when the policy process is seen as requiring political as well as technical inputs. Because such simulations can be used to generate more than one feasible and likely outcome, they are used primarily to identify alternative policy packages and a range of outcomes rather than to identify a "best answer." Exemplary of this kind of simulation are four models cited in Resource 2.6.2.

- ***Unstructured simulations*** are based on transactions among several actors with competing objectives; constraints become known through action. Policy is the result of negotiation, a product of multiple decisions by several actors. The well-known ***Delphi technique*** serves this purpose. The technique was developed originally by the U.S. military to anticipate possible Soviet reactions to an accidental missile launch by the United States. U.S. participants took the roles of Soviet officials and responded within their roles to an extensive set of questions. Answers were collated and presented to participants, and those with deviant responses were asked to justify their position. This process was continued until participants reached a stable set of positions.

[10] Excerpted from: Noel F. McGinn. January/February 2001. "Computer Simulations and Policy Analysis." *TechKnowLogia*. Available at www.TechknowLogia.org.

Some Latin American countries recently applied the Delphi technique with respect to educational policy alternatives. One study asked experts to comment on the effectiveness, cost, and likelihood of implementation of a wide variety of policies for primary education for which there is insufficient empirical research. Those who varied from the central tendency on a given alternative had to explain their reasoning. The final product is a set of simulated data, based on informed speculation. In this case, the study produced several conclusions that contradict current policy initiatives.[11]

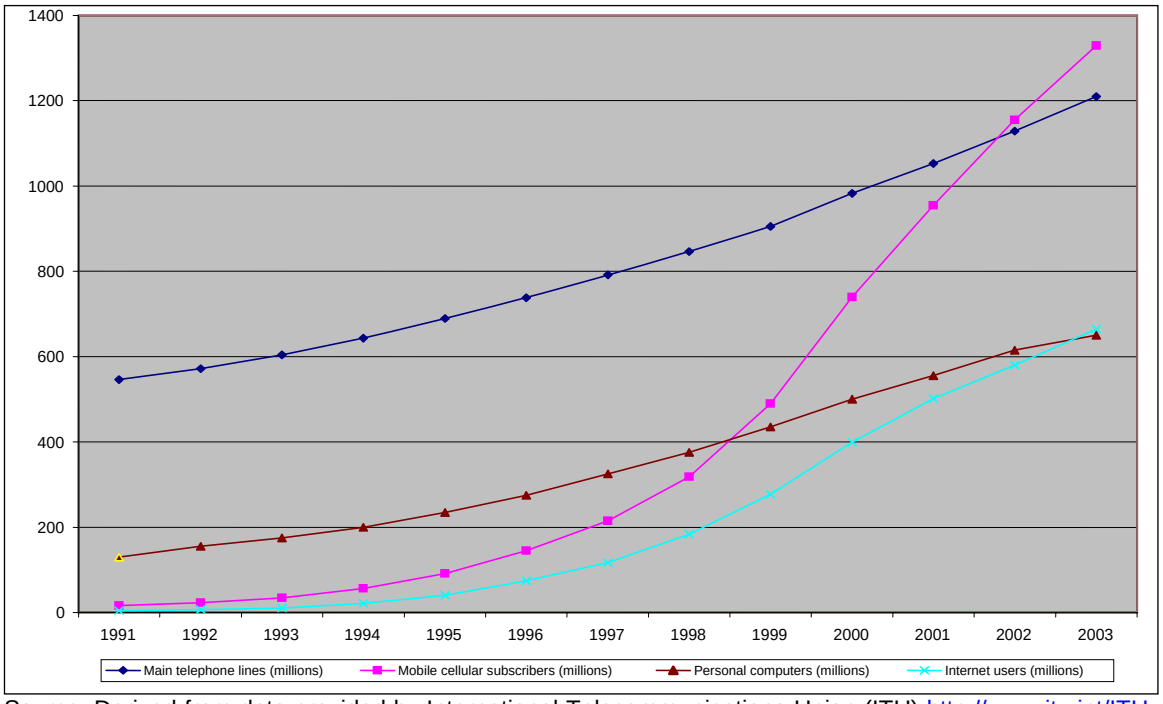
5.8 Advancing Community Linkages

5.8.1 The Objective

5.8.1.1 The ICT Gap

The spread and use of ICTs (telephone, radio, television, computers, and the Internet) have grown exponentially. Radio broadcasts cover vast areas; satellite television encircles the globe; personal computers that were little known or used in the 1950s have, within a generation, become essential tools for work and communication; and Internet use has increased beyond imagination. Table 5.8.1.1 shows the growth over the last 13 years in telephone lines, cellular subscribers, PCs, and Internet users.

Table 5.8.1.1 Growth in ICT Access

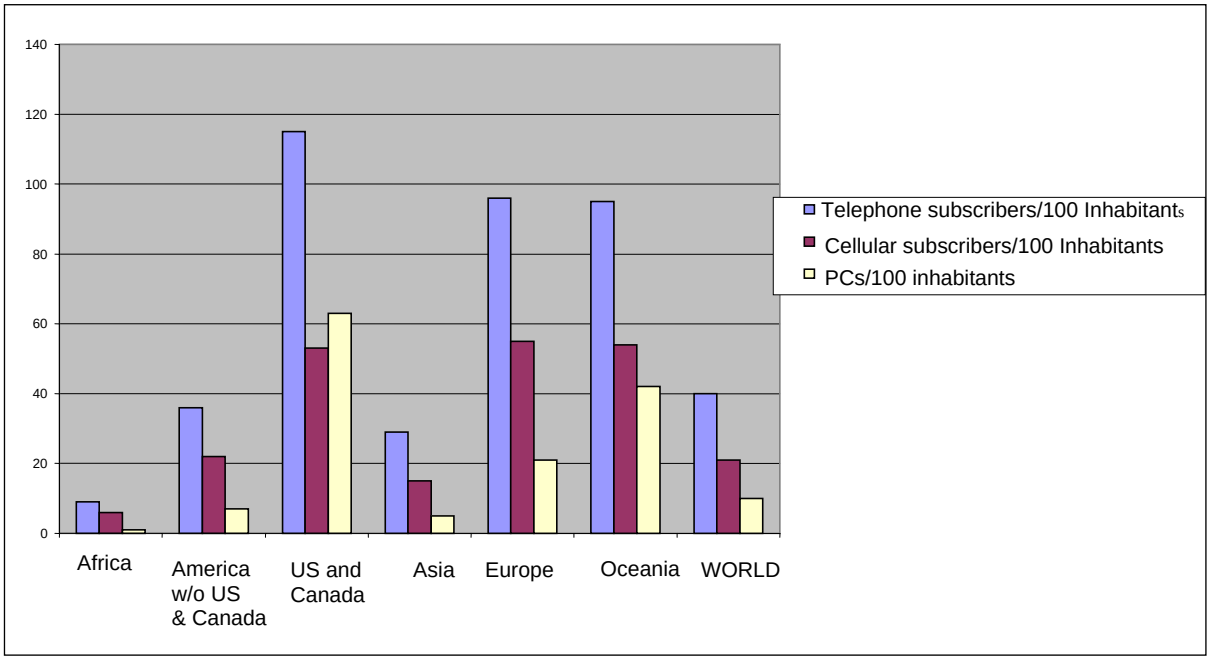


Source: Derived from data provided by International Telecommunications Union (ITU) http://www.itu.int/ITU-D/ict/statistics/.

[11] E., Schiefelbein, L. Wolff, & P. Schiefelbein. 1999. *El Costo Efectividad de las Politicas de Educacion Primaria en America Latina: Estudio basado en la opinion de expertos*. Boletin del PREALC, 49.

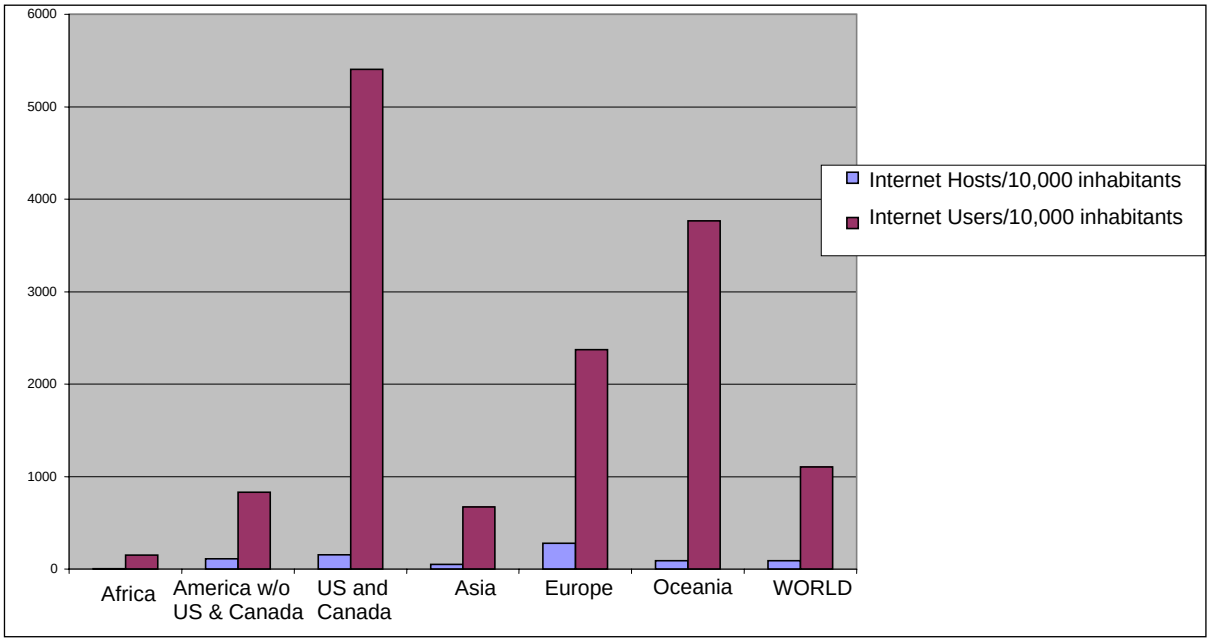
Despite this phenomenal growth, access varies significantly across the world (Tables 5.8.1.2 and 5.8.1.3).

Table 5.8.1.2 Telephones, Cellular Phones, and PCs per 100 Inhabitants



Source: Derived from data provided by International Telecommunications Union (ITU) http://www.itu.int/ITU-D/ict/statistics/.

Table 5.8.1.3 Internet Hosts and Users per 10,000 Inhabitant



Source: Derived from data provided by International Telecommunications Union (ITU) http://www.itu.int/ITU-D/ict/statistics/.

Cross-regional and cross-country differences manifest themselves in striking disparities within a country. Modern ICTs have not corrected the already existing divide between technology-rich and technology-poor areas. As before, ICT access is related positively to economic development—the higher the income, the greater the ICT access. But income is not the only variable that influences access to technology. There are documented inequities across and within countries by location, gender, and age. More recently, the limited access to ICTs by persons with disabilities and special needs has also been highlighted.

The technology gap is not the result of the choices made by individual households, rather, poor neighborhoods and rural communities lack the necessary infrastructure available in affluent and more populated areas. This leads to a vicious circle. Businesses and economic investments are not attracted to areas that are "underwired," thus maintaining the state of underdevelopment and poverty—which, in turn, is not conducive to the use of ICTs.

Should this vicious cycle be broken? Underdeveloped areas within a country lack access not only to ICTs but also to safe water, health services, and good education. Hunger and disease are rampant, and war and civil strife still deprive millions of people of their basic daily needs. In such a situation, is access to ICTs a necessity?

5.8.1.2 The Need for ICT Access

Although lack of ICTs does not constitute a dramatic component of poverty, access to ICTs is increasingly recognized as a significant contributor to efforts to ***escape*** poverty. Access to ICTs opens vast opportunities for individuals and communities to improve their economic and social well-being, and to bring them from the margins of society into the mainstream.

More specifically, community ICT linkages can contribute to a variety of objectives:

- **Income generation.** There is documented evidence on the utility of broadcast media as a tool for improving incomes. The same is true of providing telephone centers. Small manufacturers of traditional handicrafts are also discovering how ICTs can assist in the marketing and distribution of their wares to a worldwide client base. In Kenya, for example, the Naushad Trading Company[12] (http://www.ntclimited.com), which sells local woodcarvings, pottery, and baskets, has seen revenue growth from US$10,000 to more than US$2 million in the two years since it went online. Consumers and shopkeepers can access constantly updated color pictures of NTC Limited's product line, place orders, and inquire about other types of handicrafts.
- **Education and lifelong learning**. ICTs are an increasingly important means of providing educational opportunities to remote areas and offering a setting for lifelong learning (see specifically sections 5.1 and 5.6 above).
- **Improvement of health services.** ICTs provide information about health issues and good preventive practices.
- **Reduction in the isolation of rural communities.** ICTs offer opportunities for communication and information sharing.
- **Increased efficiency of management of government services in remote areas** using networked computers and the Internet.

[12] Charles Kenny. July/August 2001. "Information and Communication Technologies and Poverty." *TechKnowLogia*. Available at www.TechKnowLogia.org.

- **Encouragement of small businesses.** Communities with ICT access provide incentives for individuals and companies to start small businesses, some of which may involve provision of ICT services, such as telecenters (see section 5.8.3.2 below) and cyber cafés.

5.8.1.3 The Gender Divide

Where there is a technological gap, a digital divide, there is also a gender divide. This divide cannot be attributed to inherent female characteristics, as evidenced by the high proportion of female users of ICTs in the industrialized world, and by the thousands of offices around the world where women are frequently more competent in dealing with computers and the Internet than are men.

Where access to ICTs is limited, there seem to be extra barriers that hinder women's access to and use of ICTs. Some of the barriers have to do with disadvantages that women have in terms of education, social value, and economic status; others include the following:

> Psychological barriers, perhaps due to the perception of technology as a male domain, include ambivalence and even fear—technophobia—accompanied by a lack of information about the possibilities and potential of ICTs and a lack of confidence about mastering them, even among women who might have access. Of course, it is the most marginalized of women who are least likely to have access—minorities, the poor, non-speakers of mainstream languages, the elderly, and the disabled.
>
> Training in the use of ICTs—by knowledgeable trainers—is a serious shortcoming. For the most part, women have little or no previous experience with technology, and many feel confused when confronted with the sudden appearance of computers and the Internet. Merely getting access to the hardware or connecting groups to the Internet without an adequate introduction to what it is and how it works - and in the absence of policies or guidance about usage, etiquette or communication techniques—is proving insufficient to promote intelligent usage.
>
> Outside of urban areas, women in developing countries are far less likely to come into contact with ICTs and tend not to perceive a need for them. In some places, this is due to a lack of telephones, electricity and infrastructure. In others, it is because women often control indigenous, traditional and popular forms of media which, many caution, should not be ignored in the rush to embrace computer facilitated communication.[13]

5.8.2 The Potential

The vision of ICTs for all communities is easy to justify but hard to achieve. An implementation strategy must recognize the constraints and devise sustainable mechanisms to overcome them.

- The first and obvious constraint is ***infrastructure***. Until recently, most ICTs depended on electric power and telephone lines. Other sources of energy (e.g.,

[13] Mary Fontaine. March/April 2000. "A High-Tech Twist: ICT Access and the Gender Divide." *TechKnowLogia*. Available at www.TechKnowLogia.org.

solar) and technologies (wireless, radio, and satellite) offer new opportunities for access, bypassing the traditional technologies.

- ***Cost*** is another obvious constraint, despite reduction in unit costs of ICT investments and services. ICT projects require start-up investments that may challenge the limited resources of poor countries or locales. However, technologies also offer solutions that help to defray costs without jeopardizing the quality of the projects. Creativity is essential to overcome potential barriers. Also, public-private partnerships should be explored and encouraged.
- Attention must be paid to ***laws and regulations*** that could facilitate or hinder ICT plans. ICTs, with their ability to reach beyond political boundaries, defy many of the national and international legal frameworks that were created for a world with frontiers. Solutions, albeit necessary, are difficult to find and slow to implement. The balance among national and global interests, rights of individuals, and freedom of information is a challenge that must be faced if the potential of ICTs is to be fulfilled.
- Ensuring access to ICTs is just one step; securing ***acceptance and use*** is equally important. Cultural and political factors may promote or create obstacles to the use of ICTs or limit their use to certain subgroups of society. Likewise, the structure and organization of local educational systems may favor integration of technology, or it may create a technophobe atmosphere that hinders efforts to change.

Despite these constraints, the potential to secure community linkages to ICTs is feasible and attainable. Among the reasons for optimism are:

- ***Acceptance***: ICTs have been well received worldwide, and it appears that older technologies have opened the door for the more recent ones. To reach 50 million users, the telephone took 74 years, the radio 38 years, the PC 16 years, the television 13 years, and the WWW only four years. In India, places that did not have a telephone now have Internet kiosks where families can e-mail their relatives abroad. Likewise, homeless children in Asunción, Paraguay, are learning to read and surf the Web at telecenters where commuters send e-mail messages while waiting for buses on their way to or from work.
- ***Reduced costs***: Increased use of ICTs is associated with reduced costs and improved technology. Computer hardware prices have fallen, despite significant increases in memory and speed. Likewise, Internet access growth has been accompanied by some cost reduction.
- ***Simplification***: ICTs strive for simplicity of use, even when the technology becomes gradually more complex. The first disk operating system (DOS)-operated PCs required some training for simple tasks. Nowadays, children have no problems dealing with modern PCs. This concern with the user may explain, at least partially, the rapid popularity of the medium.
- ***Efficiency***: Perhaps more than any other technology, ICTs strive for efficiency: they are getting faster, simpler, less costly, more user-friendly, and more productive. Auto industries have relied on one source of fuel for the past 100 years, despite warnings ranging from potential depletion of this sole source to environmental disasters. In less than 50 years, telecommunications has experimented with simple telephone lines, fiber optic cables, satellites, and wireless technologies, and the search continues.

These trends encourage us ***not*** to think in terms of linear projections. Also, countries and communities can leapfrog from pretechnology stages (e.g., the absence of

telephone lines) to state-of-the-art strategies (e.g., wireless technologies), thus bypassing less efficient and generally more expensive alternatives.

5.8.3 Specific Solutions

5.8.3.1 Radio

In the rush to wire villages to the Internet, we sometimes forget that already well-established and simple technologies, such as the radio, can be very effective and efficient in connecting communities to the outside world. Broadcast radio has its limitations, but it also has its advantages in terms of its coverage, simplicity, acceptance, and availability.

Despite radio's numerous advantages, many communities cannot use it because of lack of sufficient access to electricity, and batteries are expensive. Alternatives in solar and windup technology have been developed and are gradually making their way to the village level (see Resource 2.7.1). Also, new technologies are making radio a truly two-way system (see Resource 2.7.2).

There is a distinct radio broadcasting gap to the rural corners of many countries caused by the lack of service by national broadcasters who in some cases have weak or nonexistent signal coverage. The Commonwealth of Learning has sponsored development of a portable FM radio system. The station configurations range in price from US$3,000 to US$5,000, including all elements: antenna, transmitter, console, mixer, microphones, and CD and tape decks The stations can be powered by 12 V DC or 120/240 AC. Where electricity is not available, the station can be powered by solar energy (see Resource 2.7.3).

5.8.3.2 Community Telecenters

5.8.3.2.1 What Are Telecenters?

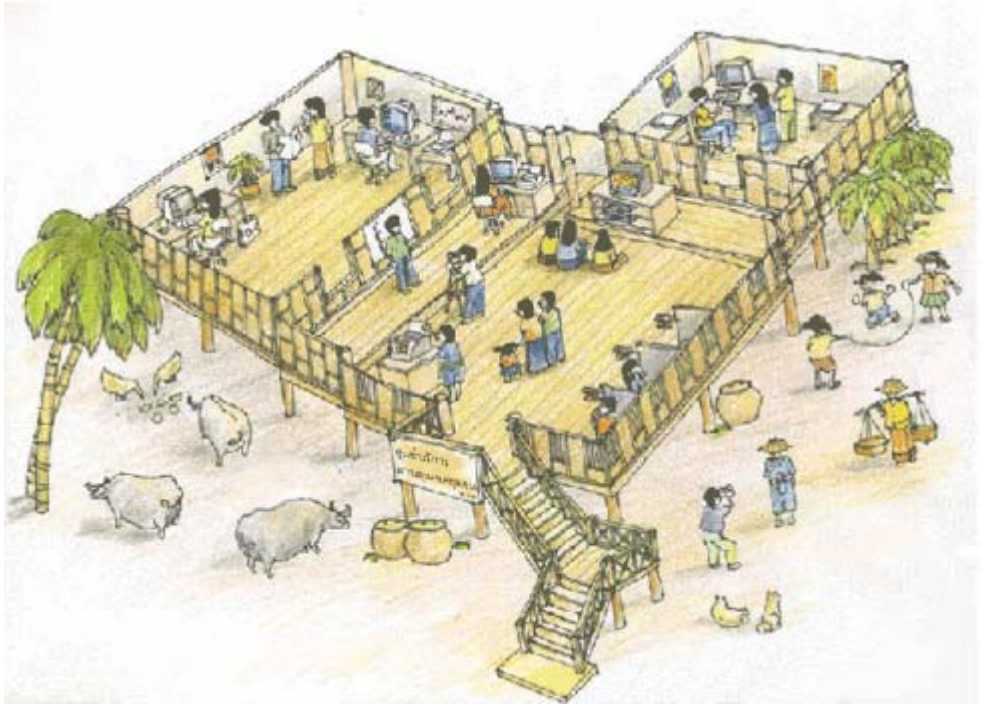
Despite the importance of access to ICTs, achieving it at the home or individual levels in poverty-stricken areas is untenable because of barriers of infrastructure, ICT literacy, and costs. The community telecenters, one answer to this problem, is a public facility that allows individuals within the served community to have access to ICTs on demand for free or at low cost to the user.

A telecenter may offer a combination of the following tools and services:

- Telephoning and faxing
- Basic computer applications, including word processing and spreadsheets
- Internet access
- E-mail accounts to allow in-country and international linkages
- Printing, copying, and scanning
- A digital camera and/or a video camera
- A television with VCR and/or DVD player
- Meeting rooms

Also, some centers provide training in the use of ICTs, and others offer educational opportunities through the use of ICTs.

Figure 5.8.3.2.1 below, depicts what a telecenter may look like in Thailand.



Source: Royboon Rassameethes. Community Telecenter. NECTEC, Thailand. Available at http://www.hpcc.nectec.or.th/PNC/presentation/Telecenter.pdf.

5.8.3.2.2 Types of Telecenters

Public ICT access centers are diverse, varying in the clientele they serve and the services they provide. Types of telecenters include NGO-sponsored, municipal, commercial, school-based, and university-related. Each type has advantages and disadvantages when considering attempts to link communities with ICTs and to bridge the digital divide.

- NGO-sponsored telecenters are hosted by an NGO, which manages the center and integrates it, to one degree or another, into the organization's core business;
- Municipally sponsored telecenters seek to further local development; they often disseminate information, decentralize services, and encourage civic participation, in addition to providing public ICT access.
- Commercial telecenters, launched by entrepreneurs for profit, with "social good" services offered as well, have limited capacity to benefit low-income populations with little education.
- School-based telecenters can be structured to involve community members during off-school hours, but costs need to be shared by the school system and the community.
- University-related telecenters can offer social outreach to disadvantaged and community groups, provide training, develop locally relevant content, and establish and facilitate virtual networks.

For examples of telecenters of different types, see Resource 2.7.4.

Telecenters now exist in most parts of the world. There are several efforts to capture experience with telecenters and offer suggestions for the establishment and evaluation of such centers; see Resource 2.7.5.

5.8.3.2.3 Participation in Telecenters: Obstacles and Strategies[14]

Providing telecenters is not sufficient; participation of individuals and communities is crucial to their success; therefore, it is important to identify obstacles to participation and devise strategies to encourage community and individual involvement in these centers.

What are the obstacles to use of telecenters?

- *Economic obstacles*. Can the community pay for the services? If we are considering a business model for a telecenter, for projects targeted at the most disadvantaged areas, it is important that the planners have in mind poverty demographics: are the villagers able to pay for the services offered? If not, is the community at large, or are other groups, willing to pay?
- *Physical obstacles*. Do community members have problems in accessing the center? Where is the telecenter located? It is clear that if the telecenter is away from the usual community meeting points, it might hinder participation.
- *Social obstacles*. Are there any social (including gender and age) or ethnic reasons that impede the participation of some community members in telecenter activities? How can we identify these differences, and how can we deal with them?
- *Political obstacles*. Are there political reasons hindering the participation of some people? If a telecenter is politicized, it can create power struggles.
- *Educational obstacles*. Are we going to deal with technophobia and literacy problems? Technophobia is one of the obstacles that prevent the community from getting involved in the activities offered by telecenters. Beyond technology (because technology is just a tool) and fear of technology, what strategies do we use to reach illiterate people and nonusers?
- *Does the community know about the telecenter?* The obstacle to participation here is very straightforward: simple ignorance of the existence of the telecenter. This question is seemingly superfluous because it is often taken for granted that the community knows what a telecenter is, where it is, and what it offers. But we need to ask ourselves this question, too. Active marketing and awareness creation are possible responses to this threat. A related question is, *do community members feel that what the telecenter offers is relevant and useful to them?*

How can these obstacles be overcome?

- *Develop an explicit participation strategy in the planning stages.*
- *Make a commitment to training* and have a comprehensive training program regarding the role of information and accessing it through ICTs.
- *Build research and monitoring into startup and ongoing operations.* In efforts to get the Internet hooked up and computers operational, often relatively little attention is given to assessing community information needs, including the felt needs of the people and

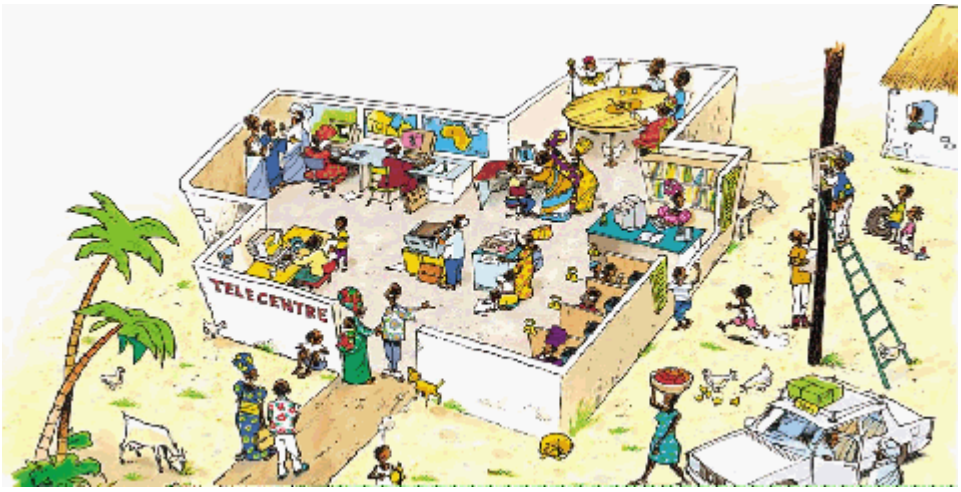
[14] Excerpted from: Raul Roman and Royal D. Colle. May/June 2001. "Digital Divide or Digital Bridge? Exploring Threats and Opportunities to Participation in Telecenter Initiatives." *TechKnowLogia*. Available at www.TechKnowLogia.org.

normative needs (those seen, for example, by professionals). A continuous program also needs to monitor ongoing telecenter services to the community (and its perceptions about them), and try to measure the telecenters' impact.

5.8.3.2.4 Women and Telecenters[15]

Many telecenter projects have crafted outreach efforts carefully and creatively to attract women to the centers. Dr. Eva Rathgeber, Joint Chair of Women's Studies at the University of Ottawa and a leading telecenter researcher, states, "Preliminary evidence suggests that telecentres in developing countries are not particularly effective in helping women…gain access to better economic, educational and other opportunities. Women use telecentres much less than men, and when they do use them, it is usually for non-Internet related purposes." Reasons she cites for this failure include a focus on machines that women find "unfriendly," cramped premises with little privacy and no child care facilities, male managers and technical assistants, an inconvenient location with unsuitable hours of operation, fees beyond the financial reach of poor women, and, perhaps most important, content that is perceived as irrelevant. In short, Dr. Rathgeber suggests that, like other technological innovations before them, telecenters often are designed without adequate attention to the needs, capacities, and preferences of local communities in general and of women in particular.[16]

A hypothetical telecenter mini-model illustrates the elements that are conducive to women's participation. The Canadian International Development Research Center (IDRC) produced a wonderful drawing of a telecenter, a comfortable, convivial place with men, women, and children and goats and chickens wandering about, each taking care of his or her or its own business. The center is rich with personality and community spirit, one of those welcoming public square-type places where people congregate to meet friends and exchange news while accomplishing some information or communication task. One gets the feeling that almost everyone stops by the center almost every day, if not to conduct specific business, then just to see what's new.



[15] Excerpted from: Mary Fontaine. March/April 2000. "A High-Tech Twist: ICT Access and the Gender Divide." *TechKnowLogia*. Available at www.TechKnowLogia.org.
[16] Eva M. Rathgeber. 2002. "Gender and Telecentres: What Have We Learned." Delivered at the Gender and the Digital Divide Seminar on "Assessing the Impacts of Telecenters." World Bank. Available at http://www.worldbank.org/gender/digitaldivide/telecenterpanel.htm.

Several features of this telecenter stand out as particularly important for women.

- Contrary to the notion of ICTs as intimidating and inappropriate in a "low-tech" village setting, the center presented in the drawing appears to be integrated seamlessly into its surroundings. Rather than appearing sophisticated, high-tech, and out of place, the telecenter seems to be a natural extension of life, combining computers with more traditional ICTs, such as photocopiers, telephones, and a meeting room. The relaxed atmosphere blends in beautifully with the palm trees, grazing goats, and napping dogs outside, and men, women, and children of all ages are clearly comfortable inside, working, chatting, and learning together. **The telecenter has been set up to harmonize with the village, building on tradition and accepted cultural norms and fostering a sense of familiarity among people of both genders.**

- With a house, a car, and a woman carrying a basket on her head, the physical location of the center appears to be at a community crossroads, not in an isolated spot that is difficult for women to reach. **It seems that women do not have to travel far to use this telecenter** but can walk there in the course of their daily activities. Moreover, while studies suggest that many people in communities with telecenters do not even know where they are located, one senses that the entire community knows where to find the center in the drawing.

- One also gets the sense that what is going on in this telecenter is relevant to the lives of the visitors. Just as people frequent the market to find the necessities of life, here, too, they obviously are engaged in meaningful activities—perhaps researching a topic for a school assignment, sending an e-mail to a loved one, or checking market prices. The people seem to be aware of what can be accomplished with ICTs, and to understand and appreciate ICT applications, and the community as a whole is taking advantage of the opportunities ICTs present. **Clearly, the information and communication needs of the community have been ascertained, and the telecenter has been set up to meet the priorities and interests of both male and female users. These are not just machines for men.**

- Child care seems not to be an issue or problem. Indeed, children are clearly welcome, whether outside playing or inside with their mothers. While no organized child care is apparent—an addition that, if designed properly and affordably, would likely enhance the female friendliness of the telecenter—**children seem not to be a deterrent to women's use of the center**. The "open door" atmosphere appears to extend to all age groups.

- At this particular moment, the center in the drawing is accommodating approximately 20 people, some working alone and others in a group, even though the center has only 10 or so computers, which seems to be sufficient. No one is waiting, and the **space is roomy enough to provide people with adequate privacy to do their work**.

- Most important, women appear to be comfortable engaging in telecenter activities alongside men. While research suggests that women sometimes do not feel at ease with male technical assistants, the center depicted in the drawing reveals no such difficulty. Indeed, **the staff is so integrated into the telecenter activities that, aside from two men who appear to be employees**—one at the back with

outstretched arms and another at the front door welcoming a women who is entering—**differentiating between clients and staff members is not easy**.

Of the several approaches to introducing ICTs in developing countries—access, awareness, and diffusion—only the last is likely to reach women effectively. *Diffusion* involves a preplanned, systematic program of activities designed to spread the message broadly. (The *message* includes "What are ICTs?" and "How can ICTs help you?") Diffusion is time-consuming and resource-intensive, but it is how disadvantaged groups are reached. Effective diffusion programs should focus on local needs and priorities, in terms of both the message conveyed and the method used for conveyance. What works in one environment may not work in another.

A new survey undertaken by the International Telecommunications Union (ITU), the UN agency dealing with telecommunications, indicated that "women from all regions of the world showed a striking solidarity in the belief that ICTs are critical to them in meeting their personal and professional goals." More specifically, "99% of the women surveyed said that access to ICTs is important to women entrepreneurs, with 97% agreeing that ICTs helped them to meet their professional goals."[17] Even women who lack a specific understanding of how ICTs can benefit them seem to know, almost intrinsically, that computers represent a hope for the future—if not for themselves, then for their children. And they are right. What is needed now is for development planners, donors, and practitioners to build on this hope by addressing the same old issues that have confounded development for women for years—to approach development, finally, as if women really mattered. In truth, we know what needs to be done; it is merely a matter of doing it.

[17] ITU. May 20, 2002. "ICT for all: Empowering People to Cross the Digital Divide." Available at http://www.ictdevagenda.org/frame.php?dir=07&sd=10&id=187.

6 From Potential to Effectiveness

If ICTs possess all the potential, cited above, to improve the teaching/learning process significantly and revolutionize the education enterprise, in the same manner that they revolutionized business and entertainment, why have we not experienced such drastic effects? ***If technologies are the solution they claim to be, then what or where is the problem?***

In attempting to answer this question, it is essential to distinguish between potential and effectiveness. No ICT potential is realized automatically—not in education, in business, or in entertainment. In fact, many computerized businesses are managed badly and go bankrupt, and many movies are a complete failure. Placing a radio and TV in every school, putting a computer in every classroom, and wiring every building for the Internet will not solve the problem automatically. The problem is not strictly technological; it is educational and contextual; constraints must be alleviated and conditions met. Experience points to eight parameters necessary for the potential of ICTs to be realized in knowledge dissemination, effective learning and training, and efficient education services.[18]

6.1 Educational Policy

Technology is only a tool; no technology can fix a bad educational philosophy or compensate for bad practice. In fact, if we are going in the wrong direction, technology will only get us there faster. Likewise, distance learning is not about distance, it is about learning. Just as we can have bad education face to face, we can have bad education at a distance. Therefore, educational choices first have to be made in terms of objectives, methodologies, and roles of teachers and students before decisions can be made about the appropriate ICT interventions (see section 4.2 above).

For instance, if teaching is demonstrating and telling, and if learning is memorizing and reciting, using learning technologies and multimedia programs for this purpose will not have the desired impact. Also, if students are not asked to search and work collaboratively, and if teachers function independently, investment in connectivity will not be cost effective. The effectiveness of different levels of sophistication of ICTs depends to a large extent on the role of learners and teachers as practiced in the educational process and on the reasons behind using ICTs for student learning and for teaching; see figures 6.1.1 and 6.1.2. Before investing in ICTs, therefore, it is essential to determine:

- The roles expected of teachers and learners
- The educational purposes for which ICTs are to be used

[18] This section draws on: W. Haddad & A. Draxler. 2002. "The Dynamics of Technologies for Education." In Wadi D. Haddad & Alexandra Draxler (Eds.) *Technologies for Education: Potential, Parameters, and Prospects.* Paris: UNESCO, and Washington, DC: Academy for Educational Development.

Figure 6.1.1 Levels of ICTs for Different Learning Objectives and Roles of Learners

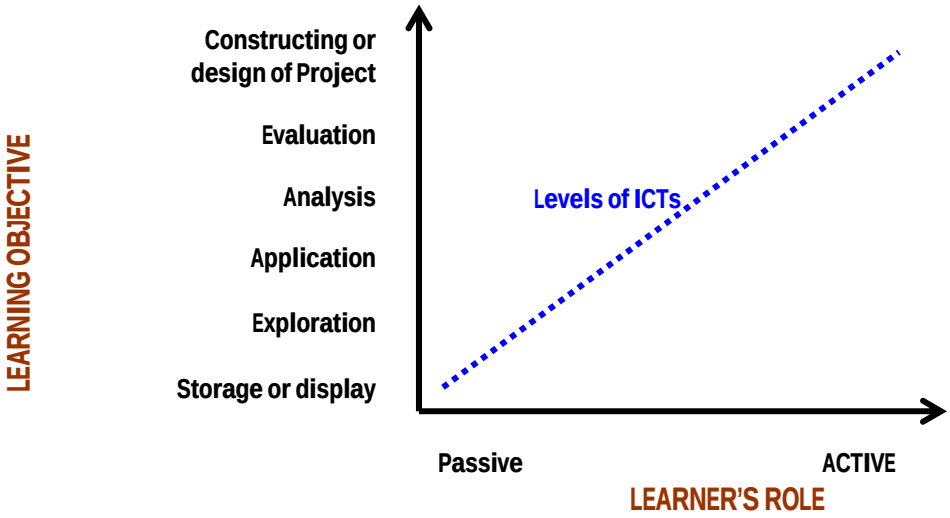
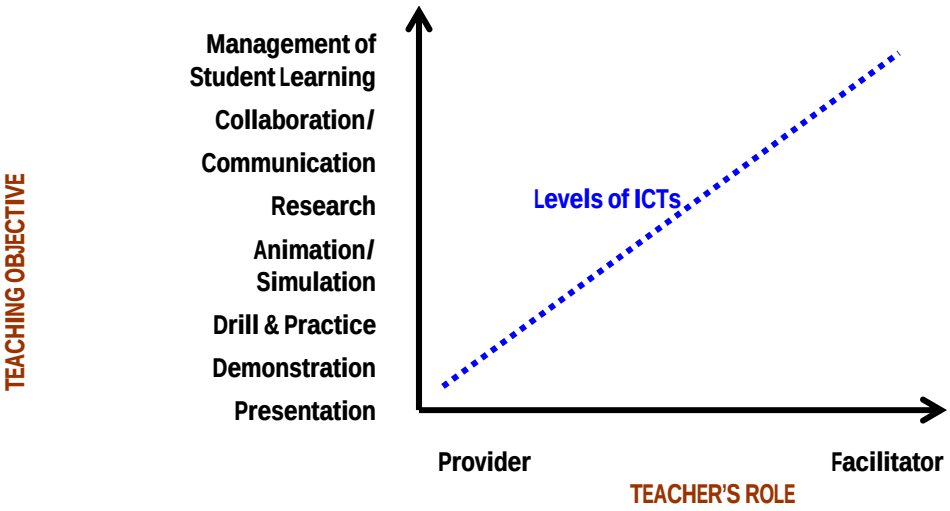


Figure 6.1.2 Levels of ICTs for Different Teaching Uses and Roles of Teachers



6.2 Approach to ICTs

Classrooms are constrained environments, and conventional instructional materials are static. If technology-enhanced education programs are taped classrooms, digital texts, and PowerPoint transparencies, then we are missing out on the tremendous potential of technologies that can animate, simulate, capture reality, add movement to static concepts, and extend our touch to the whole universe. Movies and TV programs are not replicas of theater—packaged theater plays; they tell the same story in a more dramatic and multifaceted manner. So should ICT-enhanced education.

In October 2001, the Organisation for Economic Cooperation and Development (OECD) issued *Learning to Change*,[19] the results of a study of how ICTs are being put to use in the most advanced countries. Essentially, according to the report, they are being used to do traditional things in different ways. Examples include "putting on screen what can be found on the page of a book," using material from the Internet to "support conventional teaching practices," and employing didactic software to rehearse basic skills. This merely replicates existing learning methods in technological form. If ICTs are to fulfill their potential, "innovation and change are called for at all levels of the school environment." And that requires "a far-reaching review of teaching policies and methods."

The challenge, therefore, is to rethink learning objectives and teaching methodologies, and to align learning technologies with them. It was never satisfactory merely to be efficient in helping learners to achieve mastery of content and basic skills, but the issue has now become vital. As knowledge in itself becomes a perishable item, the ability of learners to think independently, exercise appropriate judgment and skepticism, and collaborate with others to make sense of their changing environment is the only reasonable aim for education. Perhaps the most profound shift is from systems of teaching and supervision of learning to systems of learning and facilitation of learning. These shifts will be difficult in different ways for both rich and poor school systems. In advantaged communities, change is an upheaval for established authorities, systems, and capacities. In disadvantaged communities, the infrastructure must be put into place, along with serious attention to pedagogy.

There is also a basic difference between using technology as an add-on to make the current model of education more efficient, more equitable, and cheaper, on the one hand, and integrating technology into the entire education system to realize structural rethinking and reengineering, on the other. It is the difference between a marginal addition and a radical systemic change. It is in the second scenario that technology can have the greatest impact. This opportunity was articulated by Louis V. Gerstner Jr., chairman and CEO of IBM, in a 1995 speech to the U.S. National Governors' Association:

> Information technology is the fundamental underpinning of the science of structural re-engineering. It is the force that revolutionizes business, streamlines government and enables instant communications and the exchange of information among people and institutions around the world. But information technology has not made even its barest appearance in most public schools.... Before we can get the education revolution rolling, we need to recognize that our public schools are low-tech institutions in a high-tech society. The same changes that have brought cataclysmic change to every facet of business can improve the

[19] OECD. October 2000. *Learning to Change: ICT in Schools*. Paris: OECD.

way we teach students and teachers. And it can also improve the efficiency and effectiveness of how we run our schools.[20]

6.3 Infrastructure

There is a temptation these days to equate technology with computers and the Internet. As pointed out earlier, there is still an important place for other technologies, depending on how they are used. The application of each technology covers a wide spectrum, from the simplest to the most sophisticated. It is important, therefore, to identify the most appropriate, cost-effective, and sustainable technology and level of application for the different educational objectives. Then the whole prerequisite hardware infrastructure needs to be in place with its supporting elements, such as electricity, maintenance, and technical services.

Many communities do not have reliable electric source to power radios, televisions, and computers. Some are experimenting with solar energy (Resource 3.1.1), wind power (Resource 3.1.2), and pedal power (Resource 3.1.3) to run their hardware.

In the case of computer infrastructure, questions about what is appropriate are more complicated.

- Selecting a computer involves decisions about technical specifications: speed, memory, type and size of monitor, etc. Selecting a computer for educational purposes involves decisions about educational goals, classroom methodologies, teachers' role, students' role, modalities of group work, role of the textbook, external sources of knowledge, etc.

- Although the price of computers is coming down, these costs are still prohibitive for many developing countries if their goal is to provide computers across the school system in numbers that serve their educational objectives. There have been some promising efforts in countries such as Brazil and India to address this issue and produce a less costly computer with a longer operational life. Other attempts to develop affordable PCs include Intel's Affordable PC and Classmate PC, and the US$100 laptop designed by MIT Media Lab (see Resource 3.2.1).

- Where and how should computers be distributed, connected, and used in schools? Different educational and institutional objectives are served by different configuration options: computers in classrooms, on wheels, in computer rooms or labs, or in libraries and teachers' rooms. Should computers be stand-alone or connected to form a network? If the latter, which network option is the most cost effective: peer-to-peer, client/server, or thin-client/server? (A thin client is a low-cost, centrally-managed computer usually without CD-ROM players, diskette drives, and expansion slots.) Finally, should computers be connected by wiring the classroom or the school, or should they be wireless?

[20] Quoted in: T. Glenman & A. Melmed, 1966. *Fostering the Use of Educational Technology: Elements of a National Strategy.* Santa Monica, California, USA: Rand.

- Turning computers into powerful communication tools requires access to the Internet; however, getting a school online, particularly in a developing country, is not a straightforward task. First, schools need to figure out why they need to connect and to what. The next problem is communication infrastructure; in many areas, it is either nonexistent or expensive to use. Some forms of terrestrial wireless and satellite technologies are being introduced that do not require installation of wireline networks and are ideal for remote and isolated areas (see Resource 3.1.4). Finally, schools need to determine whether they have the resources, beyond the initial investment, to cover connectivity's operating costs.

- Computers are not dying of old age; however, every so many years they need to be replaced because they cannot handle new operating or application software. This creates a major problem for schools and national governments with limited financial resources. In fact, school systems spacing the introduction of computers over a period longer than the life of a computer will never be able to cover all of their schools. Some organizations are trying to address the problem by providing software packages that can be run on any computer, from a 286 to the newest Pentiums (see Resource 3.2.2).

- ICTs in schools require supporting infrastructure, including electricity, communication, wiring, and special facilities. Just as countries are experimenting with wireless connections, some are using solar energy to run computers (and radios) in remote and isolated areas.

Tools 3.2 and 3.3 help strategists and planners consider appropriate aspects of infrastructure and hardware and their use in schools and other learning centers.

6.4 ICT-Enhanced Content

ICT-enhanced instructional content is one of the most neglected areas, but, evidently, the most crucial component. Introducing TVs, radios, computers, and connectivity into schools without sufficient curriculum-related ICT-enhanced content is like building roads but not making cars available, or having a CD player at home when you have no CDs. Development of content software that is integral to the teaching/learning process is a must.

Should countries or institutions acquire or create ICT-enhanced content? This is one of the most difficult questions to answer. Should a country acquire existing educational radio and TV programs and educational software, or should it develop new ones in accordance with its curricular and instructional framework? Acquisition saves time but not necessarily money. In most cases, a country has to buy the material or pay a licensing fee. There are also important suitability issues from the point of view of both learning objectives and acceptability of the means of communication. On the other hand, creating new materials requires sophisticated expertise, substantive time, and significant upfront financing. Depending on the number of schools using the materials, the unit use cost may be very high.

This question of whether to acquire or create may be answered in different ways for different available materials and different instructional units. Ideally, the aim should be to

- acquire, as is, when suitable and cost effective;
- acquire and adapt when not exactly suitable but cost effective; or
- create when no suitable or cost-effective materials are available

To follow this decision chain, three interrelated mechanisms are needed:

- Reliable information on available audio, video, and digital materials, as well as relevant educational Websites
- An evaluation scheme to ascertain the quality of available materials or Websites
- Identification of specific sections of Websites and relating them to curricular and instructional needs. Selecting relevant Websites is like building a large reference library that is cumbersome and overwhelming to the user. Experience is proving that students and teachers make better use of the Web if their needs are linked to specific sections.

Toolbox 4 deals with these issues of planning for ICT-enhanced content. It contains a set of tools that:

- offers a system to evaluate the quality and adequacy of existing courses/materials in addressing identified educational problems or issues;
- provides guidelines to ensure quality products for users who are planning to develop their own courses/materials; and
- supplies assistance in extracting educational content from the Web.

The toolbox contains the following five tools:

Tool 4.1 - ICT-Enhanced Content Requirements

Tool 4.2 - Identification and Evaluation of Existing ICT-Enhanced Content

Tool 4.3 - Exploration of the Web for Educational Content

Tool 4.4 - Evaluation of Course Authorship and Management Systems

Tool 4.5 - Design and Development of Curricular ICT-Enhanced Content

6.5 Committed and Trained Personnel

People involved in integrating technologies into the teaching/learning process have to be convinced of the value of the technologies, comfortable with them, and skilled in using them. Therefore, orientation and training for ***all concerned staff*** in the strategic, technical, and pedagogical dimensions of the process is a necessary condition for success.

Cuban examined the history of attempts to use technology to promote school reform; his 1986 conclusions apply equally to present-day practices:

He concludes that most of these attempts failed to adequately address the real needs of teachers in classrooms. Instead, the efforts too often attempted to impose a

technologist's or policymaker's vision of the appropriate use of the technology in schools. Teachers were provided inadequate assistance in using the technology, and the technology itself was often unreliable. As a consequence, the technology was not used by teachers or became very marginal to the schools' instructional activities.[21]

Appropriate and effective use of technologies involves competent, committed interventions by people. The required competence and commitment cannot be inserted into a project as an afterthought, but must be built into conception and design with participation of those concerned.

Tool 3.4 assists in planning for orientation and training of educational personnel involved in the implementation of ICT-enhanced interventions decided upon by the appropriate authorities.

6.6 Financial Resources

As mentioned earlier, acquiring the technologies themselves, no matter how hard and expensive, may be the easiest and cheapest element in a series of elements that ultimately will render these technologies sustainable or beneficial. Computers, in particular, need highly skilled and costly maintenance to operate most of the time. Yet, in almost all cases, schools invest in buying and networking computers but do not budget sufficiently for their maintenance and technical support. It is important, therefore, to plan and budget for the total cost of ownership (TCO).[22] Elements contributing to TCO include:

- acquisition of hardware and software;
- installation and configuration;
- connectivity;
- maintenance;
- support, including supplies, utilities, and computer training;
- retrofitting of physical facilities; and
- replacement costs (in five to seven years).

The annual costs of maintenance and support for a healthy education computer system are estimated to be 30%–50% of the initial investment in computer hardware and software. This makes some donated computers quite expensive, especially when they are old, outdated, and require a lot of maintenance.

Substantive additional costs include:

- Acquisition and creation of content materials
- Orientation and training of staff
- Testing, monitoring, and evaluation

[21] L. Cuban. 1986. *Teachers and Machines: The Classroom Use of Technology Since 1920*. New York: Teachers College Press. Quoted in: http://www.rand.org/publications/MR/MR682/ed_ch2.html#fn30.

[22] K. Moses. January 2002. "Educational System Computer Maintenance and Support: They Cost More Than You Think!" *TechKnowLogia*. Available at www.TechKnowLogia.org.

Tool 2.2 (Section 3) of the Toolkit provides an interactive mechanism, Scenario Cost, to calculate the capital/development and recurrent costs as well as unit costs of an ICT intervention, to assist planners in comparing the affordability and sustainability of different ICT options. Tool 5.1 of the Toolkit provides an instrument to budget the necessary resources for the selected ICT intervention.

6.7 Integration

The success of ICTs in education depends on how they are introduced into the system. Here are some strategic options:

- ICTs may be used as an additional layer of educational input that leaves the current system intact but adds hardware and software for enrichment. The problem here is that both students and teachers may not take the additional materials seriously or know how to relate them to the current program. Also, this may not realize the full potential of, and consequently returns from, ICTs.

- ICTs may be treated as an integral part of the existing instructional system. This strategy involves articulating learning objectives, translating objectives/standards into teaching/learning activities, producing multimedia curricular materials, training staff, establishing a distribution communication network, assessing learning achievement, and evaluating the program. Here, ICTs are not a substitute for the classroom setting; rather, they enhance the role of the teacher as facilitator and the role of the student as learner.

- ICTs may be introduced through a parallel system such as distance education or e-learning. This option may be used in situations where schools are not available or cannot be provided, or where individuals cannot enroll in regular schools because of lack of availability or for personal reasons, as in the case of working youth and adults.

From an instructional architecture perspective, technology-enhanced materials may be designed in one of three ways:

- They can be enrichment materials that are used in addition to existing materials at the discretion of the teacher or learner, in the same manner as a library book is used.

- They can be a structured multimedia program that covers a particular course—similar to a textbook-plus that is used by all students in all schools in the same way. Many publishers have evolved their textbooks into packages of printed (or digital) text plus related slides, videos, audiotapes, and CDs.

- They can be multimedia modules that are constructed in a flexible way to serve as building blocks of different curricula and teaching practices. Here, each module is broken down into educational subobjectives to be met with specific technologies, such as video, animation, simulation, real-life exploration, etc. Not only can the modules be put together in different ways, the submodules can be reconfigured to form different versions suitable for different teaching styles and learning needs.

6.8 Piloting and Evaluation

The strong belief in the potential of technology, market push, and enthusiasm for introducing technology into schools creates the temptation to implement them immediately and full scale. Integrating technologies into education is a very sophisticated, multifaceted process, and, just like any other innovation, it should not be introduced without piloting its different components on a smaller scale. Even the technologies we are sure about need to be piloted in new contexts. No matter how well an ICT project is designed and planned for, many aspects need to be tested on a small scale first. Among these aspects are appropriate technologies, suitability of instructional materials, production process, classroom implementability, learning effectiveness, and cost-benefit ratio.

Depending on the results of the evaluation of a pilot scheme, modifications may need to be made to the elements of implementation or to the ICT-intervention policy itself. Then plans need to be drawn for scaling up the ICT intervention. At this stage, more care needs to be given to implementation planning because of the higher risks, larger scope, and more intricate application issues.

Monitoring and evaluation should not be limited to the pilot phase, but should continue during the large scale implementation for the following reasons:

- The translation of abstract plans into concrete implementation will generate problems and surprises, such as inappropriate technologies, insufficient personnel commitment and engagement, inadequate infrastructure and hardware, unclear educational objectives, etc. With systematic monitoring, the nature and scope of implementation problems are detected in a timely manner, and remedial adjustments and redesigns can follow.
- ICT interventions are not an end in themselves. They are made for educational purposes based on estimated potential and effectiveness. Only through a systematic summative and formative evaluation will the degree of fulfillment of the potential of an ICT intervention be evidenced and its educational effectiveness proven.

Tool 6 assists planners in the design of monitoring and evaluation schemes for the different phases of introducing ICT policy interventions.

7 Conclusion

To "tech" or not to "tech" education is ***not*** the question. The real question is how to harvest the power of technology to meet the challenges of the 21st century and make education relevant, responsive, and effective for anyone, anywhere, anytime.

Technologies have great potential for knowledge dissemination, effective learning, and efficient education services. Yet, if the educational policies and strategies are not right, and if the requisite preconditions for using these technologies are not met concurrently, this potential will not be realized.

Two final thoughts:

In the dazzling environment of technologies we should not lose sight of the focus of education:

> It is amazing what a child can do for us as adults. We are sucked into the whirlwind of jobs, stocks, houses, recipes, and technologies…until we look into the face of a child. Life regains perspective. We see the mystery of life unfolding and we realize what is important and what is marginal. So it is with technology. We are sucked into the wonders of fast chips, intelligent toys and games, and fascinating virtual domains, and we get taken by the miraculous potential of these technologies for us and our children…until we look into the face of a child. There we see the miraculous transformation of life at work. Only then do we see with clarity the distinction between means and ends, between tools and objectives, between touching buttons and touching hands, between technologies and the child.[23]

The most successful technologies are those that become taken for granted:

> We do not think anymore of the spectacle of printing every time we read a book, the phenomenon of TV every time we watch a movie, or the miracle of the telephone every time we make a call. The ultimate success of **ICTs for learning** will be attained when we stop marveling about the **ICTs** and apply our minds and emotions to the wonders of **learning**.[24]

[23] Wadi D. Haddad. September/October 2001. "The Child between Touching Buttons and Touching Hands." *TechKnowLogia*. Available at www.TechKnowLogia.org.
[24] W. Haddad & A. Draxler. 2002. " Are we There Yet?" In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects.* Paris: UNESCO, and Washington, DC: Academy for Educational Development.