

# An Overview of Developments and Trends in the Application of Information and Communication Technologies in Education

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## The context

Over the last few years the use of information and communication technologies (ICTs) in all sectors of education has increased dramatically – and continues to do so. While the writer is not aware of supporting research specific to education, it is probable that the diffusion and adoption of ICTs in that context is following a pattern similar to that which has characterized the adoption of any innovation in other fields such as agriculture and medicine.

The pattern in those contexts has been that adoption is typically led by a small group of “innovators” who are able to imagine applications for the innovation, in this case ICT, and are able to acquire the resources needed to test it. This influences a larger group of “early adopters” to try the technology, largely on the basis of the “visions” created by the work of the “innovators” coupled with the advocacy and incentives that policy makers and institutional leaders may provide. At this point the adoption of the innovation is shifting from the periphery to mainstream practice and is starting to receive a great deal of attention. Practitioners want to see evidence of the benefits of adoption and are less likely to be influenced by the rhetoric of the advocates. As more evidence supporting adoption becomes available, the large body of “late adopters” will decide to get involved – and following these, a smaller group of practitioners who generally find change of any kind difficult, decide to adopt the innovation. This group is referred to as the “laggards”.

It is arguable that the adoption of ICTs in education has, in general terms, reached the stage of early adoption. Decision-makers and teachers want to know how this innovation will increase access to educational opportunities, what the costs will be, and what the impact will be on the quality of content and the learning experience. They need to be convinced by evidence before making wholesale changes to the way schools function and the way in which available resources are allocated. And their starting point, as it has been with farmers or physicians, is the question: “How will this help me improve what I am already doing?”

The need to encourage and facilitate the use of ICTs in education systems is urgent. The World Education Forum concluded at its Dakar conference in 2000<sup>1</sup> that, while there had been progress since the Jomtien conference a decade earlier, large numbers of people were still without a basic education and that more effort was required to meet the Education For All (EFA) goals. More use of distance education, telematics and broadcasting was urged. And, as will be seen from the examples that follow, that is happening.

The intent of this chapter is to provide a global snapshot of trends in the adoption of ICTs into educational practice and, thereby, to provide a backdrop against which to view applications in countries of the Asia-Pacific region that are described in the following section of this report. As we shall see, there are many examples of “innovators” who are trying new things. There are also some very successful examples of applications on a mass scale, and many more initiatives that hold much promise. Some of these examples will be used to illustrate the various trends happening in the areas of ICT infrastructure development, ICT applications in primary and secondary school systems, curriculum materials content development, and non-formal education. There is also a trend towards more emphasis on research and evaluation on issues related to ICT use in education including not only those related to efficiency and effectiveness, but also to the matter of gender equity in terms of access and involvement – an issue that will be reviewed in a separate section of this report. The description of trends that follows is not intended to be a listing of “good practice” but rather as examples selected to illustrate that trend. Taken together, the trends illustrate the growing contribution ICT applications are making to the achievement of EFA goals.

## Trends in emerging ICT infrastructure

There are many ways to look at the concept of infrastructure. A common framework is to think of infrastructure in terms of the following components: the hardware (the machines) that we use, watch or listen to such as computers, television sets, radios, etc.; the “libraries” where information is stored such as servers; the networks that enable information to move between and among machines and libraries such as satellites, wires and cables, and wireless networks; and the operating systems, such as Windows and Linux, that allow the interactions to take place. For the purposes of this discussion we shall include another component, the emergence of “management information” strategies that allow us to access information we want in an efficient manner.

It is also important to make clear that the definition of ICT used in the scope of this report is comprehensive. It includes not only the newer digital technologies of computers, Internet, e-mail, World Wide Web, wireless, etc, but also

the older technologies of print, radio and television that have been used extensively in both distance education and classroom instruction. Indeed, as many of the examples illustrate, these “older” technologies are still the mainstay of educational outreach in many parts of the world because the state of infrastructure development has not allowed the same degree of adoption as has taken place in more developed countries. This is often referred to as the “digital divide”.

### *Combined Use of “Old” and “New” Technologies*

What follows illustrates ways that “old” and “new” ICTs are being used together to add value to educational endeavors around the world and, in the process, are providing bridges to the digital divide. The examples also illustrate the importance of not “throwing the baby out with the bath water” as is often the case when “old” ICTs are abandoned in the rush to incorporate the new.

1. One of the best school-based examples of this trend can be found in **Mexico’s Telesecundaria**, which is described in detail later in this chapter. The school uses television, print, and, more recently, the Internet to support classroom-based learning.
2. Another, more recent, example is the Philippine government’s **Integrated Distance Learning Programme (IDL P)**, which uses satellite, television, computers, the Internet, and solar power to target some 3,000 communities, or barangays, across the island of Mindanao. Enrollees in remote highlands and evacuation centres will take a qualifying exam to determine the programme most appropriate for them. The programme is designed to address the low quality of education among indigenous peoples. More information is available at [www.digitalopportunity.org/article/country/970/](http://www.digitalopportunity.org/article/country/970/)
3. **Radio Sagarmatha** in Nepal is broadcasting the Internet over the radio – something that is in direct contrast to the more common practice of simulcasting radio over the Internet. [www.digitaldividenetwork.org/content/stories/index.cfm?key=252](http://www.digitaldividenetwork.org/content/stories/index.cfm?key=252). While this example relates to education in a general sense, it illustrates how community radio can be enriched as an information source through the use of the Internet. Listeners can learn about the Internet and its uses, and also phone in their queries for Internet searching and have the information broadcast for all to hear.
4. **Interactive Radio Instruction**<sup>2</sup> is not new. It has been used for nearly 30 years in over 20 countries around the world. However, it illustrates how the combination of “old” technologies, radio and print, can effectively improve the quality of education in remote schools. In many ways the model resembles the Farm Radio Forum started by the Canadian Broadcasting Corporation and replicated in India and other parts of the world. Modern

day versions now incorporate Internet-based interactivity as well.

5. The **Kothmale Internet Radio** project in Sri Lanka<sup>3</sup> is an add-on to a community radio that was set up 20 years ago by the Sri Lanka Broadcasting Corporation when the construction of the Kothmale dam displaced entire villages. Local radio was chosen as a strategy for helping to rebuild the social fabric for those displaced within this rural community and KIR became an important part of many people's lives.

Several community telecentre facilities were developed to enable Internet access for members of the communities so they could do "radio browsing" of websites. In this way community radio is used as a gateway for a poor community to actively participate in the global knowledge society. At present, the radio browsing formula is the only means to overcome the language barrier entirely, as information on English-language websites is explained and discussed directly in Sinhalese and Tamil. One advantage for Kothmale is the existence of many regionally based English-language sites carrying a vast range of information relevant for much of the Asian region. The number of students at KIR centres after school hours, surfing the web in English and using English for their e-mail exchanges, indicates that language is far less of a barrier for the younger generations than it is for adults.

### ***Growing Interest in "Open Source" Operating Systems***

Operating systems enable computers, and the networks that connect them, to function. They are comprised of two main types of software: those that control the workings of the computer, and those that allow computer users to undertake specific sorts of tasks such as word processing, using spreadsheets or developing and manipulating graphics.

Some of the most commonly used operating systems, such as Windows, are referred to as "proprietary" software. Use of this type of software usually requires the payment of a license fee and, even then, the user is not able to access the source code or inner workings.

Open source software on the other hand, refers to any software which may be copied and used freely. The software is often available free of charge on the Internet. And, unlike proprietary software, open source software can be copied, used, studied, modified, distributed, etc., with little or no copyright restrictions. It is royalty and license free, and is therefore substantially cheaper to acquire than branded alternatives. The reason for this is that open source software is developed by volunteer collectives who are not seeking to profit from its sale. In addition, just as the recipe for generic drugs is made public, so the source code of open source software is accessible to the user. Any qualified

person can see exactly how the software works and can easily make changes to the functionality of it.

The reasons for the growing interest in open source software in the educational context are obvious. As Dr. Kathryn Moyle points out in her paper "Open Source Software and Australian School Education",<sup>4</sup> the use of ICT in schools is an added cost to the traditional infrastructure of buildings, teachers' salaries, books, etc. Therefore, anything that can potentially save money is attractive. Open source is attractive for other reasons as well. Governments and schools are interested in increasing the interoperability between software systems for teaching and learning and administrative purposes. The question of how to achieve interoperability hinges on the nature of the standards upon which the software is based. This is akin to determining the nature of the foundations upon which a house is to be built. Open standards that allow the code for the standard to be seen provide the capacity for interoperability between both open and proprietary software. Open source software provides a concrete way of developing open standards. Rather than making open standards theoretical exercises, open source software provides the practical means for determining these standards.

However, there are pros and cons as Martin Bruggink points out in his paper on "Open Source in Africa: Towards Informed Decision-Making".<sup>5</sup> He provides a comprehensive review of the realities involved in the use of open source software and gives a useful summary of the advantages and disadvantages.

Nevertheless, open source software is becoming increasingly attractive to educational leaders and practitioners. The Australian context described by Kathryn Moyle is illustrative. After a comprehensive review of the current state of open source software use in the country, she concluded that the management of software is emerging as an important part of the work of schools. She reviews a list of the software requirements that schools have, gives her assessment of the pros and cons of open source, and provides a review of the risks involved in using proprietary software.

Obviously the trend toward open source software will be of increasing significance to education leaders and the importance of making informed decisions before adopting it is important. Other sources that discuss this trend include:

- Fredrick Noronha's paper "Liberation Technology for the Lands of Diversity? Free Software in Asia."<sup>6</sup>
- Particular pieces of open source software are discussed at: [www.unesco.org/webworld/portal\\_Software](http://www.unesco.org/webworld/portal_Software).

- [http://fossfa.org/database/all\\_projects.html/](http://fossfa.org/database/all_projects.html/) has a database of people, projects and organizations involved in open source software development.
- The Commonwealth of Learning completed an assessment of open source learning management systems in June 2003. A hard copy is available by sending a request to: (info@col.org).

### *Use of Mobile Technology*

An article in the February 25, 2003 edition of the Guardian begins as follows:

“Imagine all those times in the day when we see groups of young people hunched over mobile phones, thumbs straining repetitively. Now imagine they are not texting friends or passing the time with a game, but are actively engaged in learning. If you are finding this hard to imagine, the researchers running the “m-learning” project are not.”

The aim of **m-Learning**<sup>7</sup> is to develop prototype products and services, which will deliver information and learning experiences via technologies that are inexpensive, portable and accessible to the majority of European Union citizens. The products and services in development are designed to capture the interest of young adults (16 to 24) who are not currently taking part in education or training and to assist them in the development of life long learning objectives. The learning themes focus on subjects of interest to young adults, e.g. football and music, and the modules include activities designed to develop aspects of literacy and numeracy. m-Learning’s target audience includes young adults who are unemployed, under-employed or homeless. The m-learning infrastructure includes a Learning Management System which, when combined with the microportal interface layer under development, will facilitate access to m-learning materials and services from a variety of mobile devices as well as web and TV access. For interfacing with devices with minimum multimedia functionality, and for the benefit of learners with sensory difficulties, m-learning is developing speech-to-text, text-to-speech and SMS facilities. In addition, the following supports are also being developed: an intelligent tutor system to help identify needs and learning preferences, and a tutor agent to help personal learning planning. User trials involving young adults from the target audience will take place in the UK and Italy.

A somewhat similar project began in May, 2003 in the Philippines. Over the life of the project, more than 13,000 pupils in Grades 5 and 6, mostly 10 to 11-year-olds from selected public and private schools, will be able to view educational science videos downloaded to the classroom with the help of mobile phones and satellite communication systems.

**Text2teach**<sup>8</sup> is part of the global Bridgeit programme to deliver digital learning materials to teachers and students in even the most remote schools with the use of mobile and satellite technology. Bridgeit is a global programme developed jointly by Nokia, the international media company Pearson, the International Youth Foundation (IYF), and the United Nations Development Programme (UNDP). The four organizations combined their expertise in technology, content, training, and processes to create an impact on the learning of young people. In the Philippines, text2teach is spearheaded by the Ayala Foundation in cooperation with several partners. The Department of Education and the South East Asia Ministers of Education Organisation (SEAMEO-Innotech) were responsible for lesson development and the training of more than a hundred science teachers, supervisors and school heads. Mobile telephone operator Globe Telecom, PMSI-Dream Broadcasting and the Chikka Asia services, which offers short message service (SMS) on the Internet, provided the hardware, software and technical requirements for the project.

Under text2teach, each school is equipped with a satellite dish, a 29-inch television set with rack, a 40-gigabyte digital video server/recorder to record and store video clips and two to three mobile phones.

The technology is fairly basic. Following a lesson plan that incorporates text2teach lessons, science teachers just have to send an SMS request on mobile phones for specific videos from the more than 100 that Pearson has made available from its KnowledgeBox video library. These are then downloaded via satellite to a Nokia digital recorder connected to the school’s television set.

### *The Emergence of Knowledge Management Systems*

The increasing rate of ICT adoption in education is generating a huge amount of information and knowledge in areas such as technology applications, costs, learning materials, training, and organisational change – all of which people want access to. Fortunately there are a variety of knowledge/information management systems emerging that make the task easier.

1. **Portals** are one of these management systems. They are essentially sites on the Internet that serve as search engines to assist the user in finding the required information from the morass of sources. Nowlin and Bliss<sup>9</sup> have defined a portal as:

“a term, generally synonymous with *gateway*, for a World Wide Web site that is or proposes to be a major starting site for users when they get connected to the Web or that users tend to visit as an anchor site. There are general portals and specialized or niche portals. Some major general portals include Yahoo, Excite, Netscape, Lycos,

CNET, Microsoft Network, and America Online. Examples of niche portals include Garden.com (for gardeners), Fool.com (for investors), and SearchNetworking.com (for network administrators). A number of large access providers offer portals to the Web for their own users. Most portals have adopted the Yahoo style of content categories with a text-intensive, faster loading page that visitors will find easy to use and to return to. Companies with portal sites have attracted much stock market investor interest because portals are viewed as able to command large audiences and numbers of advertising viewers. Typical services offered by portal sites include a directory of Web sites, a facility to search for other sites, news, weather information, e-mail, stock quotes, phone and map information, and sometimes a community forum. Excite is among the first portals to offer users the ability to create a site that is personalized for individual interests.”

Neil Butcher<sup>10</sup> has stated that: “In effect, a portal can contain any service available via the Internet. It is not limited to the World Wide Web, as it can be expanded to include e-mail services, chat rooms, and other Internet applications not dependent on the web.” He describes three types of portals currently available, emphasising that, in many instances, these services are merged in a single portal:

- a. **Networking Portals** are those that provide various individuals (educators, learners, managers and administrators) with a central point from which to access various educational tools and facilities (online and offline).
- b. **Organizational Portals** are those constructed by a specific organization whose core business is to deliver educational material. Generally these types of portals contain search facilities, links to other relevant organizations or institutions, as well as subscription services, projects, publications and information about the organization itself.
- c. **Resource-based Portals** provide access to various educational resources online. A feature of many resource-based portals is that they provide subscription services, thus requiring people to pay before being able to access resources. They may have a focus on generic resources, subject-specific resources such as math, or they may focus on links to other resource sites.

Butcher also provides a comprehensive analysis of the features and tasks required in the construction and maintenance of portals.

An example of a portal that has a different focus, and has direct relevance to this discussion, is the one developed by UNESCO ([www.unesco.org/bangkok/education/ict](http://www.unesco.org/bangkok/education/ict)). This

is a **comprehensive networking portal** that has a focus on ICT use in education in the Asia-Pacific region.

Another is [www.bized.ac.uk/](http://www.bized.ac.uk/), an example of a portal that is both **resource-based and networking**, that provides service for students, teachers and lecturers of **business, economics, accounting, leisure and recreation, and travel and tourism**, with a searchable and browsable catalogue of over 4300 quality checked Internet resources.

The **Digital Dividend Clearinghouse** is an innovative online platform tracking social enterprises that use ICTs to deliver critical tools and services to underserved communities in developing countries. Its twin goals are 1) to serve as a knowledge base for those interested in developing sustainable business models to bridge the global digital divide, and 2) to facilitate networking among those stakeholders. <http://wriws1.digitaldividend.org/wri/app/index.jsp>

2. **AskERIC** (<http://askeric.org/About/>) is a personalized Internet-based service providing education information to teachers, librarians, counsellors, administrators, parents, and anyone interested in education throughout the United States and the world and it contains a database of lesson plans that cover most areas in any curriculum.
3. **Teachers Net** (<http://teachers.net/gazette/AUG03/wong.html>) is another example of a lesson plan and teaching resource database. While this and AskERIC are both US sites, they nonetheless offer a potentially useful resource, and provide an example of how such sites can be constructed.
4. **The Manhattan Virtual Classroom** (<http://manhattan.sf.net>) has been in use at Western New England College since 1997. It includes a variety of discussion groups, live chat, areas to post the syllabus, lectures, and other handouts/notices, a module for organizing online assignments and exams, and a self-contained module for private e-mail. However the point of including it in this illustrative list is that it was developed using open source software and is easy to install on a Linux/FreeBSD server.
5. **Eschoolnet**<sup>11</sup>, a service of Schoolnet Europe, provides another form of knowledge management services that will be described in more detail in a later section of this chapter.
6. **Knowledge Finder** (<http://colfinder.org/public>), a service offered by the Commonwealth of Learning, was launched in July 2002. The Finder, an example of a knowledge management system, is designed to be useful to anyone involved with, or interested in, open anV distance learning, including government policy makers, educators, developers, trainers, researchers and learners. All content comes from online sources in the public

domain, filtered so that only the resources most relevant to educational development, curriculum content and learning are included in the Finder's current index of about one million reports, eBooks, documents and web pages. The type of information available also includes timely and critical development topics such as poverty alleviation, gender equity, food security and health. Open and distance learning (ODL) sites are indexed into regional interest libraries while other development topics are indexed globally. The COL Knowledge Finder is also linked to other key ODL information sources such as the Global Distance Education Network (GDENet, [www.col.org/disted](http://www.col.org/disted)), and national and regional "SchoolNets". Users also have access to advanced tools for storing, cataloguing and disseminating their research.

### Analysis

The rate of change in the nature of ICT infrastructure, combined with the stunning rate of global adoption, makes the development of policy frameworks very challenging. Historically and theoretically, the purpose of policy in educational environments has been to guide the adoption process; however, what we observe now is that innovation typically begins in the absence of any guiding policy, and policymakers find themselves in the position of scrambling to regain the leadership role. And they find that the policy development processes of the past, those based on careful, time consuming analysis, are a luxury that can no longer be afforded because the pace of change is so rapid. Policy makers need access to planning tools that enable them to assess needs, evaluate ICT infrastructure options, and make decisions within short timeframes. And they need to be able to continually evaluate the effects of policy and make adjustments as needed. Efforts to develop tools and training to assist policy makers to meet this challenge need to be "ramped up".

## Trends in Content Development – Learning Objects and Repositories

The background for this trend is well stated on the website of the Centre for Educational Technology:<sup>12</sup>

*"Learning Technologies have been evolving over the last two or three decades, and have gone through many phases and approaches, including early mainframe based programmed learning systems, microcomputer software packages written in native programming languages for specific machines, bulletin boards, CBT systems, authoring systems, and more recently after the internet explosion, web-based systems and Learning Management Systems. For much of this time, learning software development has*

*often been the result of individual ideas and initiative, and little regard has been paid to ensuring that learning software can survive the rapid change in technology. Those who wrote high quality learning materials for BBC micros now find them trapped on floppy disks that cannot be read by modern PCs, and even if they could, the software on them would not run.*

*Further, unlike the well elaborated ways we have for categorising and describing text that libraries have evolved, no such system exists for computer based learning materials. This has made the learning content world somewhat chaotic, and many excellent materials are underused for one or both of the above reasons."*

The need then is for standardised systems that can catalogue, store and retrieve content in ways that enable users to access and organize it for their particular purposes as well as sharing it institutionally, nationally, and internationally. There is a great deal of effort being expended around the world on the development of such systems – ones that will standardize the development of resources (learning objects), catalogue them (metadata) and store them (repositories).

A recent paper<sup>13</sup> from the Australian National Training Authority provides an excellent overview of Learning Object Repositories. While the paper acknowledges the lack of a generally accepted specific definition of a **learning object**, it suggests that one think about it as you would any educational resource. Learning objects are digital assets that can be as diverse as a chapter in a book, a piece of text, a video or audio clip, or visuals on an overhead transparency or PowerPoint slide. And they can be used in a variety of teaching settings, by course designers, managers, trainers, content writers and learners. The only constraint is that the asset meet the required level of educational integrity.

The educational integrity of learning objects means that they can be identified, tracked, referenced, used and reused for a variety of learning purposes. Learning objects are developed to function as discrete entities or to be linked in order to relate to explicit concepts or learning outcomes. Content requirements are determined through communication with educators across the target audience and then the learning object is developed by independent contractors.

Another way of thinking about learning objects comes from the Wisconsin Online Resource Center.<sup>14</sup> They define learning objects as:

- A new way of thinking about learning content. Traditionally, content comes in several hour chunks. Learning objects are much *smaller units of learning*, typically ranging from 2 minutes to 15 minutes.

- ➔ *Self-contained* – each learning object can be taken independently.
- ➔ *Reusable* – a single learning object may be used in multiple contexts for multiple purposes.
- ➔ *Capable of being aggregated* – learning objects can be grouped into larger collections of content, including traditional course structures.
- ➔ *Tagged with metadata* – every learning object has descriptive information allowing it to be easily found by a search.

As the authors of the Australian paper state, the smaller a learning object is, the higher the level of reusability, but the lower the level of instructional value. While this is true, if a learning object becomes too small, there is a danger that it may become meaningless with little chance for reuse. Conversely, the larger the learning object the greater the instructional content and context, but there will be fewer opportunities for its reuse.

**Metadata** is structured data that is used to “tag” information to learning objects that enable users to locate the information they are searching for. It is essentially descriptors for the learning object much like the card catalogue system of a library. Typically the metadata tagging would include information about the subject content (e.g., math, science, etc.), the form of the object (such as a video clip, piece of text, slides, etc.), and the learners for whom it would be appropriate.

**Repositories**, the “libraries” where learning object databases are stored, differ from standard web materials in that they provide teachers, students and parents with information that is structured and organized to facilitate the finding and use of learning materials regardless of their source location. The Australian paper points out that:

“Most learning object repositories are stand alone. That is, these repositories function a lot like portals in that they contain a web-based user interface, a search mechanism, and a means of retrieving a learning object. Within this stand-alone architecture, there is the potential for two major models or repository. The most common suggests a centralised model in which the learning object metadata is located on a single server or website. This website or portal then provides the interface with which to search the repository. This model is typical of the small intra-organisational repository. The alternative model is based on a distributed system, in which the learning object metadata is contained in a number of connected servers or websites. Distributed learning object repositories typically employ a peer-to-peer architecture in which a variety of repositories may be searched from a single portal”.

While the initial leadership for learning object repositories has tended to come from the university sector, the interest and activity in the schools sector is increasing rapidly. For example, the Australian and New Zealand Governments have created an organization to develop a pool of educationally sound and quality assured content specifically for Australian and New Zealand schools. This initiative will support teachers in enhancing student learning, thereby greatly improving educational outcomes for students.

EdNA Online<sup>15</sup> is a repository that holds information in a range of formats: learning materials, networks, authorities, policy, industry information, traineeships, packages, support services, training providers and research. The EdNA VET Online project aims to develop the vocational education and training (VET) component, and, during 2003, EDNA will work collaboratively with the Australian Flexible Learning Framework (AFLF) to develop content guidelines and metadata standards to facilitate interoperability.

The eduSource project ([www.edusource.ca/english/what\\_eng.html](http://www.edusource.ca/english/what_eng.html)) is focused on the creation of a network of linked and interoperable learning object repositories across Canada. The initial part of this project will be an inventory of ongoing development of the tools, systems, protocols and practices. Consequent to this initial exercise the project will look at defining the components of an interoperable framework, the web services that will tie them all together, and the protocols necessary to allow institutions to enter into that framework.

The Campus Alberta Repository of Educational Objects (CAREO) (<http://careo.netera.ca>) in Canada is a searchable, web-based collection of teaching material for educators. The CAREO project defines learning objects as including: simulations, tutorials, drill and practice modules, content databases, multi-media exercises. It also goes beyond the area of curriculum development to include administrative objects such as calendars and quiz programmes, research-related items such as discussion papers and research results, and also content creation tools such as map makers, database tools, graphics and animation tools. CAREO is a project supported by Alberta Learning and the Canadian Advanced Network for Research, Industry and Education (CANARIE) that has as its primary goal the creation of a searchable, web-based collection of multidisciplinary teaching materials for educators across the province and beyond.

Educational Software Components of Tomorrow (ESCOT-[www.escot.org/](http://www.escot.org/)) is a test bed project for the integration of innovative technology in middle school mathematics. The project investigates replicable practices that produce predictably high quality digital learning resources (learning objects).

There are a great many repositories that are focused on content development in the realm of higher education. One of the most well known is the Merlot project

([www.merlot.org/Home.po](http://www.merlot.org/Home.po)). Merlot is a free and open resource designed primarily for faculty and students of higher education. Links to online learning materials are collected here along with annotations such as peer reviews and assignments.

The Wisconsin Online Resource Center mentioned previously provides a comprehensive listing of repository sites, including Merlot, as well as a bibliography on learning objects.

Work on the development of international standards for building educational content repositories is well underway. The most well know project is The IMS Global Learning Consortium that develops and promotes the adoption of open technical specifications for interoperable learning technology. Several IMS specifications have become worldwide de facto standards for delivering learning products and services. IMS specifications and related publications are made available to the public at no charge from [www.imsglobal.org](http://www.imsglobal.org). No fee is required to implement the specifications.

### ***Analysis***

As the work on learning repositories progresses, so must the development of international standards to ensure that there is interoperability among them. One of these standards development projects is the *ISO/IEC JTC 1/SC 36 project* on information technology for learning, education and training that is administered under the American National Standards Institute (ANSI). Its scope is: standardization in the field of information technologies for learning, education and training to support individuals, groups or organizations, and to enable interoperability and reusability of resources and tools.

The development of learning object repositories that are widely accessible and sharable is perhaps the most significant trend of all because of the potential it holds for reducing one of the largest single costs in the use of ICT in education – namely the cost of developing content. It is often said that “it is not the technology that’s difficult – it is developing appropriate content”. This development offers not only the economy and flexibility that comes with reusability, but also, for the first time, allows content to be developed independently from the form of its delivery. It offers benefits across the spectrum of learning venues – from the remote learner in some form of distance education, to the teacher and learners face-to-face in a classroom.

The potential is also there for much greater collaboration among educators in the developing world to develop content repositories that reflect both culture and content – while still being able to chose from databases internationally. The challenge will be to provide the training and core infrastructure needed to take advantage of it.

## **Trends in ICT applications in primary and secondary education**

Three trends that are being enabled by the increasing rates of ICT adoption are: the growing use of distance education models; the growth of organizations that facilitate collaboration and sharing across schools and school systems; and the pedagogical changes occurring as a result of ICT applications. The first of these often uses the label Open School ; the second is typically called Schoolnets; and the third refers to the variety of ways that teachers are using ICTs to enhance teaching and learning processes in their classrooms.

### ***The Growth of Open Schools***

The models that have evolved in the primary and secondary education sectors as a result of the use of distance education methodologies often use the label “Open School”. It is somewhat ironic that the development of distance education models, which began in many parts of the world for the purpose of increasing access to primary and secondary education, has been so dominated by the higher education sector for the past quarter century. That, however, is changing. “Open schools” are emerging to provide:

- Education opportunities in dispersed locations where conventional schools are not viable;
- A choice to students (and their parents) of what they want to learn;
- A safety net to school drop-outs so they do not lapse into illiteracy;
- An education to those who cannot attend conventional schools for a variety of social and economic reasons, as well as to those who missed out and are now “over age”.

These developments are making important contributions to the achievement of EFA goals.

A report published by COL in 2000<sup>16</sup> described the ways in which this trend is being facilitated by the ever-increasing use of ICT in education:

- The Internet and worldwide web are enabling access to new and enlarged sources of information and knowledge that offer teachers and students opportunities for self-development as well as benefits from incorporation into classroom environments.



- Other Internet-related feedback mechanisms are providing greater opportunity to reduce the isolation and time delay associated with distance education.
- The extraordinary pace of software development is enriching teaching and learning with enhanced graphics, interaction, animation and visualization.
- Lower telecommunications bandwidth costs and the emergence of enhanced cable, wireless and satellite systems are facilitating greater opportunities for basic access, video-conferencing, on-line interactive learning, and real time interaction between the learner and the providing institution or teacher.
- Community access schemes are making it easier for lower income people and rural people to receive the benefits of distance education.

However, it is not just the newer digital technologies that are enabling this trend. The older ICTs such as radio and television have been, and continue to be, used widely because they have greater outreach, and are often cheaper than other technologies. And, as we shall see later, they are increasingly being used in combination with newer ICTs. The following examples will serve to illustrate how ICTs are being applied to make elementary and secondary education more accessible on a mass scale in different parts of the world:

1. **India's National Open School (NOS)** ([www.nos.org](http://www.nos.org)) is the largest Open School in the world in terms of enrolment, programmes and courses offered and the geographical areas under its operations. It operates through a network of 10 regional centres and more than 1400 study centres spread all over India. It also has study centres in the Middle-East, Nepal and Canada. NOS offers Secondary and Senior Secondary courses, as well as various vocational and life enrichment courses, through an open and distance learning mode. More recently it also ventured into Open Basic and Elementary Education. At the Elementary Education Level and Adult Education sector, it has MOUs with more than 200 agencies that in turn have their own centres through which the NOS courses are offered. During the 2001-2002 admission year 213,660 students were admitted in the academic and vocational stream making the cumulative enrolment more than 725,000. During that year 329,136 students appeared in the NOS examinations and, of these, 25% were certified. Approximately 35% of NOS learners are female.

NOS is a prime example of a distance teaching institution that is continually evolving in its use of ICT. It began, as have most such institutions, using print based materials that were distributed to learners through the post and regional centres. Today, it is equipped with the latest hardware and software. There is a Local Area Network

with a centralised database system using Windows NT as the basic operating system and a Pentium III-based NT Server. All the Regional Centres of NOS have been provided with Internet access and an e-mail facility for transfer of data and smooth connectivity with headquarters in Delhi. In order to provide better and more efficient services, all major areas of applications have been computerized. For example, learners can now register entirely on-line.

NOS has also established a partnership network of over 100 institutions, mostly in the private sector, to run its IT courses. These centres serve as training centres for NOS and in turn get the benefit of well-planned, well-structured courses, supported by self-study instructional and audio-video material.

NOS also offers a wide range of vocational courses that are independent and modular and lead to various certificates in Agriculture, Secretarial Practice, Technology, etc.

CD versions of all course materials have been produced and made available to students as priced publications. The course materials have also been placed onto the NOS website ([www.nos.org](http://www.nos.org)). Other current and planned uses for this website include:

- Direct Interaction with the students: once registration of a particular student is done on-line, each individual student account will be provided with a user-ID and password and a free e-mail account.
- Tutorials: there will be a separate section for tutorials as part of the course itself. At the end of this section, on-line testing will be provided.
- Assignments: students will be required to submit assignments via the Internet. They will be evaluated and feedback provided immediately.
- On Demand Examinations: this is a revolutionary concept in the context of Indian education, but an important step to take from the standpoint of adding more flexibility to the distance learning process. Pilots are underway and systems are being put in place.

NOS has also taken a lead role in establishing an electronic forum using the Internet. The forum, "Indian Open Schooling Network (IOSN)", enables member Internet-based schools (approximately 30) to communicate, share content, problem solve and generally enhance the teaching-learning process. IOSN has linkages with the Commonwealth Electronic Network for Schools and Education (CENSE), thereby expanding contacts within the international community.

2. **Mexico's Telesecundaria** was created over three decades ago in response to the needs of rural Mexican communities where a general secondary school (grades 7 to 9) was not feasible because the number of students was low and attracting teachers was difficult. Telesecundaria's primary feature is the use of television to enable one teacher to be responsible for all subjects, rather than having several subject matter specialists as is the case in general secondary schools. Enrolments are currently over 900,000 and expected to grow. Neighbouring countries are beginning to use it as well. Much of the following information on the Telesecundaria is derived from a paper by Castro, Wolff and Garc'a:<sup>17</sup>

The pedagogical model is not distance education in any pure sense. It is not a conventional classroom model either. The programmes are aired from 8:00 a.m. to 2:00 p.m. and repeated from 2:00 p.m. to 8:00 p.m. for a second shift of students. Each subject is allocated 60 minutes in the school day. The students watch 15 minutes of television and at the end of the TV session, the set is turned off and the book, workbook and teacher take over, following detailed instructions on what to do in the remaining 45 minutes. At the end of the 60 minutes another subject begins following the same routine. Teachers follow a guide that contains instructional strategies and learning objectives. The guide also assists teachers in overcoming some of the limitations they may encounter due to unavailability of teaching materials or learning tools, and it provides strategies for adapting the lesson to local contexts and individual student needs. Telesecundaria teachers and supervisors also receive in-service training through televised programmes that are broadcast during the afternoons or on Saturdays.

Each Telesecundaria school has at least three television sets, a decoder to decompress EDUSAT's digital signal, and a 1.9 minimum meter external satellite dish. About 10% of Telesecundaria schools use solar power. A majority (85%) of the Telesecundaria schools are located in purpose-built buildings constructed by the government, and have 3 to 9 classrooms, restrooms, a library, a science laboratory, playground, and often a piece of land for farming. The remaining 15% are often poor, ill-equipped facilities.

Telesecundaria is both effective and cost efficient. Flow rates (a measure of dropouts) are slightly better than those of general secondary schools, and significantly better than technical schools – in spite of the fact that this is a school catering to the poor, predominantly located in rural areas, where one would expect high dropout rates. The explanation offered by Telesecundaria officials is that this is because: there is strong involvement of local communities; the use of a single teacher (instead of one teacher per discipline) means the teacher is closer to students; and, the high quality of the programmes. Almost

75% of the students who enter at grade 7 successfully complete grade 9.

In terms of costs, the authors show that it would be three times more expensive to operate a conventional secondary school in the areas where Telesecundaria schools operate. In short, these schools are an example of one of the very few programmes in which the poor receive a better-conceived and better-managed programme than urban middle and upper socio-economic classes.

That said, however, Telesecundaria is not perfect. Theft of TV sets occurs at some schools, sometimes antennas malfunction, and sometimes the books do not get out to rural areas in time. It is also recognized that the Telesecundaria model is very rigid because of TV scheduling. Experiments are underway with an Internet based system that would allow teachers and students to view programmes at different times and to view programme repeats. More than likely, the long-run future of Telesecundaria will be web-based to give it more flexibility.

3. **The New Zealand Correspondence School** ([www.correspondence.school.nz/](http://www.correspondence.school.nz/)) was started by the Ministry of Education in the early part of the 20<sup>th</sup> century for the purpose of enabling access to primary and secondary education through the use of print materials distributed via the post. Today it is New Zealand's largest school serving over 31,000 students, nationally and internationally, with a wide range of programmes of study that lead to a variety of qualifications, including the National Certificates in: Educational Achievement, University Bursary (2003 only), Employment Skills, Computing, and Business and Computing. One may also choose to build a personal record of learning or simply take a subject for interest.

According to the 2002 report from the CEO, the School embarked on a journey in 2000 that will enable it to reposition itself within New Zealand education.

The new vision calls for a new pedagogy that is "learner centred-digitally minded". The pedagogy is based on research conducted through the school's two-year "eSection" pilot, which explored best teaching practice in an online environment. Systematic provision of intensive professional development for teachers is now a priority to ensure that they, and in turn their students, will gain maximum benefit from technology and from the new pedagogy. As part of implementing the vision, thirteen ICT projects were continued or completed in 2002. These ranged from the further development of the ICT infrastructure to the digitisation of resources and the development of new software. Work was also started on the development of a new Learning Management System, which is a key ICT project. Changes to

pedagogy, operational processes, and student preferences are driving the design of the new system, which, when complete, will enable teachers to personalise a programme of learning for each student and to tailor learning resources to each student's needs and interests.

The New Zealand Correspondence School was chosen as one of the current models that illustrate the trend towards "open schools" as part of national education systems, not because it is new, but because it is an organization that is essentially "re-inventing" itself in order to incorporate emerging ICTs into its operations. The process of this "re-invention" is described in the following comments taken from the 2002 Annual Report ([www.correspondence.school.nz/about/publications/2002annual\\_report.pdf](http://www.correspondence.school.nz/about/publications/2002annual_report.pdf)):

**Then.** Until relatively recently the practice within face-to-face classrooms could be characterised as teachers working on their own in a rectangular classroom with a group of 20+ students for fixed periods of time. Much of the theory and practice that has been developed about what happens in classrooms is based on these assumptions. Similarly, in the field of distance education there has been an emphasis on bridging the geographical separation of teacher and student, based on the notion of a guided didactic conversation being embedded within print-based materials. Each of these areas of education has developed quite separately, with their own bodies of knowledge, skills and experience, and their own theories and practices. The one thing that they did have in common was a focus on teaching, emphasizing instructional processes and asking, "How can we teach better?"

**Now.** We are witnessing a fundamental shift in the culture of pedagogic practice in our schools and distance education settings. As primarily face-to-face institutions strive to embrace ICT and attempt to address the demands of learner choice and autonomy, many classroom teachers are adopting practices that may previously have been considered the domain of distance educators, for example, establishing individualized learning programmes on school intranets. Similarly, as distance education providers adopt a range of online technologies as an alternative means of providing instruction, they too face the challenge of adopting what may have been regarded as face-to-face practices, for example, teaching via video conferencing. This is the era of eLearning where a gray area is forming between two previously discreet areas of educational endeavour, as each uses ICT as a means of meeting learner needs instead of emphasising the role of teaching.

**Next.** It may be only a relatively short time before we move to the next phase, where we see an almost complete merging of the two paradigms, and where a student's learning experience will not be dependent on attendance

at a particular school or institution, or enrolment with a particular provider. Instead, a combination of online technologies will make it possible for students to complete a 'portfolio' of subjects through a range of institutions. In this scenario the role of schools, teachers and students will all change and the emphasis on the "e" in eLearning will no longer be necessary. Instead, the focus will be again on the whole sphere of education, addressing the issues of both teaching and learning, as well as taking into account the context of that learning.

Alternative Secondary Education is the core activity of the Namibian College for Open Learning (NAMCOL). ([www.saide.org.za/worldbank/countries/namibia/namcol.htm](http://www.saide.org.za/worldbank/countries/namibia/namcol.htm)) It began after independence when the government in Namibia was faced with the problem of providing secondary education for large numbers of learners who could not be accommodated in the formal school sector. More specifically, the objectives of NAMCOL are: upgrading the educational level of adults and out-of-school youths through programmes of open learning; establishment and maintenance of tutorial centres for those Namibians who are unable to engage in conventional school-based education; and provision of counselling services to those seeking admission into programmes of open learning.

The College currently offers courses at two levels: the Junior Secondary Certificate (Grade 10) and the International General Certificate of Secondary Education (Grade 12). In addition, NAMCOL offers the Certificate in Education for Development (CED), which is designed to meet the professional development needs of adult educators, extension agents and community development workers. This course is offered in collaboration with the University of South Africa (UNISA) Adult Basic Education and Training Institute. All courses are offered in English, with the exception of the indigenous language courses.

The College has used radio mainly for information campaigns. However, an instructional radio programme is now being developed in partnership with the Namibian Broadcasting Corporation which will be incorporated into the Business Management Course for Grade Ten.

### *The Emergence of SchoolNets*

A recent study by the Commonwealth of Learning<sup>18</sup> defines Schoolnets as follows:

"Schoolnets can be defined as groupings of schools that use ICTs to support the education process, or agencies that facilitate and develop the use of ICTs in the education context. The word "school" refers to the participants, namely the schools in the primary and secondary education space. Schools generally consist of the teachers, students, families and the broader community,

all of who can benefit from the introduction of schoolnets. The word “net,” a shortened form of “network,” refers to the purpose of the initiatives. Most importantly, it is the network of people within the community of practitioners that collaborate for the purpose of enhancing teaching and learning. Secondly, it is the network or platform of ICT infrastructure that allows people to communicate, collaborate and share within restricted or larger groupings. Thirdly, it refers to the emphasis on the Internet and related technologies that enable the world at large to be accessible to the individual, no matter where in the world he or she may be. By definition, schoolnets encourage teaching and learning through a collaborative approach to the education process. Complementing this is the belief that the use of ICTs promotes a more individualised learning experience, with a broad range of educational resources and experiences available to both the teacher and learner, and that the use of ICTs throughout the world supports the trend towards outcomes-based and learner-focused education.

These movements have typically been organized within school districts, or within geographic or socio-economic boundaries and include the establishment of national and regional Schoolnets to promote and facilitate the use of ICTs in the education sector, in both the developed and developing world. Although the overarching theme among Schoolnets is similar, they range in their focus from policy formulation and advocacy, information dissemination, deployment and installation of technology, teacher training and facilitation of collaborative student projects.”

The report also provides examples of these various types of schoolnet organizations:

1. SchoolNet Canada ([www.schoolnet.ca](http://www.schoolnet.ca)) is an initiative led by Industry Canada in partnership with provincial and territorial governments, the education community and private sector. SchoolNet Canada carries out many initiatives to encourage the use of ICT in the classroom, including SchoolNet GrassRoots, SchoolNet’s Network of Innovative Schools, First Nation’s SchoolNet, LibraryNet and SchoolNet’s Youth Employment Initiative. SchoolNet’s services allow students, teachers and parents to learn about the world of ICTs and how they can be used to enhance education. Over the past two years it has also focused on creating e-learning content.
2. European SchoolNet ([www.eun.org](http://www.eun.org) or [www.eschoolnet.org](http://www.eschoolnet.org)) is an international partnership of 26 Ministries of Education developing learning for schools, teachers and pupils across Europe and beyond. It provides insight into the use of ICT in Europe for policy-makers and education professionals. The organization acts as a gateway to national and regional school networks and international partnerships for more than 20 European Ministries of Education, thus helping to develop learning for schools, teachers and pupils across Europe, and supporting school networks in individual European Union (EU) countries. It is primarily driven by individual governments and the EU, and is focused on the teaching and learning experience using ICTs.
3. SchoolNet South Africa ([www.school.za](http://www.school.za)) is a non-profit, independent organization with an emphasis on promoting the use of ICT for teaching and learning in South Africa, particularly in historically disadvantaged schools. The organization initially worked on many aspects of school networking including policy and advocacy, infrastructure provision, teacher development and content provision. As the use of ICTs in South African schools has proliferated, the organization has refocused to ensure that the educational value of ICTs is realised, largely through teacher development, conferencing and workshops.
4. Western Cape Schools Network ([www.wcape.school.za](http://www.wcape.school.za)) was established in 1994 and, together with other provincially based school networks in South Africa, assisted in the development of SchoolNet SA. It is largely a volunteer-based organization with a small staff and has extended its functions over time. It is soon to be merged into SchoolNet SA. The Western Cape office of SchoolNet SA will continue to manage the help desk and some other educational services on behalf of SchoolNet SA for the entire country, in addition to providing other services.
5. SchoolNet Africa ([www.schoolnet africa.net](http://www.schoolnet africa.net)) emerged out of a need to promote and support the development of schoolnets throughout the African continent. The organization has been created as a support mechanism for national schoolnets, and thus works primarily in the areas of policy direction, information dissemination and support, and resource mobilisation while participating in various continent-wide initiatives.
6. World Links for Development ([www.worldbank.org/worldlinks](http://www.worldbank.org/worldlinks)) started as an initiative of the World Bank Institute and has grown to become a separate non-profit entity. World Links is focused on the promotion of ICTs in the developing world, and as of October 2001, was active within 15 countries, reaching approximately 650 schools. It works in collaboration with Ministries of Education and supports the development of national schoolnets. Although involved in various aspects of ICT in education, it has had a particular focus on teacher development. The organization is currently developing a fee-for-service contracting component that will enable it to share its knowledge and expertise more broadly and will also assist in sustaining the organization.
7. SchoolNet India ([www.schoolnetindia.com](http://www.schoolnetindia.com)) was incorporated by Infrastructure Leasing & Financial Services Limited (of India) as part of a broader initiative

to meet the need for sustainable models of social infrastructure, specifically in the sectors of education and health. SchoolNet India is committed to enhancing the quality and delivery of education across the spectrum of schools and curricula in the country. Its focus is on the use of technology in the development of teaching materials as well as the learning process in the classroom. The areas of content include technology, curriculum subjects, teacher training and support services. It is operational in over 18 locations across India. In order to facilitate support for their programmes in less advantaged schools (over 750,000 schools), it has established the SchoolNet Foundation, which attracts financial and in-kind support from individuals, corporations and donor agencies. The SchoolNet India model is a standard corporation that performs the operations with the assistance of a special purpose charitable vehicle.

8. Pilippinas Schoolnet ([www.world-links.org/english/html/philippines.html](http://www.world-links.org/english/html/philippines.html)) is a partnership involving the Department of Education, the private sector, NGOs and local universities. Thirty geographically dispersed public high schools have been selected to participate in a pilot programme to animate ICT applications. Hardware, software, connectivity and basic computer literacy training are being provided by the Department of Education, NGOs and a variety of corporate donors.
9. The development of the Schoolnet in Thailand ([www.nectec.or.th/it-projects/](http://www.nectec.or.th/it-projects/)) in 1995 allowed schools all over Thailand to have dial-up access to the Internet. This goal was furthered in 1998 as a result of a Golden Jubilee initiative, which allowed schools to access the Internet without the need for a long distance phone call to Bangkok. This has enabled schools to use the Internet to access the libraries, classrooms and laboratories in the country. By April of 1999 there were more than 850 schools using SchoolNet services, with more than 200 schools running their own websites. More recently, a project has been initiated aimed at providing massive educational content in the Thai language on the web.
10. Another development is the ASEAN SchoolNet ([www.unesco.org/bangkok/education/ict/unesco\\_projects/JFIT/ICT\\_Brochure.pdf](http://www.unesco.org/bangkok/education/ict/unesco_projects/JFIT/ICT_Brochure.pdf)), a UNESCO-led project co-funded by the Japanese Funds-In-Trust and the ASEAN Foundation to strengthen ICT use in schools. The project is designed to explore and demonstrate ICT applications; test innovative models; and improve connectivity and access to resources.

## Changing Practice in the Classroom

Change in education involves much more than the provision of technological appliances. Not only do teachers need to develop the competencies for using the tools and developing instructional materials for them, but also the educational systems they are part of need to change in order to provide

an environment that encourages and supports ICT-integrated pedagogy. Roy Singh<sup>19</sup> makes this point very well in a paper on 21st century education in the Asia-Pacific region. He describes challenges facing educational systems and makes the point that these need to have the capacity to nurture both individual and institutional creativity. The following case examples, reports and analyses describe various ways teachers are integrating ICT applications into their classrooms, and provide some insight into the processes they follow in making decisions to adopt particular ICT tools.

1. Lawrence Ssenkubuge, an information technology resource teacher at a school in Uganda, was faced with an overwhelming response to his efforts to get teachers and students to use the school computers.<sup>20</sup> He had to make changes to his classroom practices in order to accommodate the huge increase in the demand for training on the use of computers and how they could be used in teaching. His solution was to develop a system of peer-to-peer learning whereby some of the trained students became the trainer for other students and teachers. They set up a student-managed computer club as the forum for conducting training and maintaining the equipment – something, he states, that the students undertook with much enthusiasm. Ssenkubuge goes on to describe how he and his students, in collaboration with a neighboring school, created an award winning website on “wetlands” that became part of a world-wide project.
2. A comprehensive source of information regarding integration of ICTs in classrooms around the world is the report on the Second Information Technology in Education Module 2 (SITES M2), edited by Robert Kozma.<sup>21</sup> The qualitative study he describes was conducted by a team of international education experts in 28 countries studying 174 case studies of innovative pedagogical practices that used ICTs. In general, the findings of SITES M2 support those of an earlier study which found that: teachers and students are using ICTs as part of larger changes in the roles and activities of the classroom; teachers are engaged in advising and guiding students; students do collaborate with other students to search for information, design or create products, and publish or present their results; teachers do acquire new ICT and pedagogical skills, subject knowledge and collaborative skills.

The following examples, taken from an abstract<sup>22</sup> of the study, are illustrative of how ICTs are being integrated into classrooms:

- ➔ *Primary school children in a small rural school in Catalonia, Spain took digital photographs of their church and town square and digital recordings of their grandparents telling folktales and singing nearly forgotten folksongs. They collaborated with*

*students in nearby villages to build a website on the history of their region.*

- *Lower secondary school students in Norway used the e-mail to collaborate with students in the US as they followed two women who crossed Antarctica on cross-country skis. The students communicated with the women and with weather and research stations in the area to learn about the Antarctic continent.*
- *A technology-intensive upper secondary school in the US was redesigned from the ground up around technology and project-based learning. The school was organized like a high-tech start-up business in that students were given real world projects consisting of complex tasks with long-range due dates for which they had individual and shared responsibility.*
- *First and second grade students in Chile used low-cost Nintendo Gameboys to improve their reading and mathematics skills. The self-regulated educational games were developed by university engineers, psychologists, and educators in support of the country's curriculum objectives.*
- *A physics teacher in the Philippines wanted to enhance the development of her students' critical thinking skills through hands-on investigation, in-depth verification, exploration, and discovery of scientific concepts and processes. Teams of students used computers and probe ware to conduct experiments and solve a hypothetical murder case.*

3. England's contribution to the SITES M2 study was carried out by the National Foundation for Educational Research. The results were reported by Harris and Kington<sup>23</sup> as follows:

*The introduction of the innovative practices in these schools placed additional demands on teachers as they had to:*

- *develop their own ICT skills.*
- *be willing to change their existing practices.*
- *support students as their roles and activities changed.*
- *monitor the implementation of the activities they introduced, and identify possible solutions to any problems that arose.*

*In addition, students' roles and activities also changed as they:*

- *had greater independence and responsibility for their own work.*

- *worked towards targets/deadlines.*
- *were more reflective about their work.*

*Several factors were important in contributing to the successful implementation of the innovations introduced within the schools:*

- *previous involvement in innovations (both involving ICT and unrelated to ICT).*
- *support at senior management level, not only for implementing new practices, but also for addressing financial implications when appropriate.*
- *the involvement of several members of staff: the prevailing culture within the schools was one of collaboration and mutual support.*
- *willingness to take risks, accepting that some ventures would succeed but others would not.*

4. The lack of broadband connectivity in many parts of the world is a major constraint to the use of the web in classroom instruction; however, that is changing and it is useful to look at the ways the web can be used to facilitate learning. A recent paper<sup>24</sup> from TeleEducation New Brunswick provides a framework for this. Four examples are presented to illustrate increasing integration of web use:

- *A website is developed as an information "container" to supplement classroom education with text (course notes, assignments, pointers to external websites), and other types of media (graphics, video clips etc.).*

Currently this is by far the most common use of the web in the classroom supporting the presentation of information. The functions of learner guidance, practice and feedback, and student assessment are left to classroom interactions between the student and the teacher.

- *A website is created to supplement classroom education similar to the previous example, but a news group and e-mail discussion list is established for the instructor to communicate asynchronously (not in real time) with students to help guide their understanding of content and exercises. The instructor has also developed an on-line student assessment application that allows students to take some tests on-line and submit them electronically to the instructor.*

In this example, the instructor has shifted more of the functions of effective instruction to Internet support including elements of learner guidance and learner

assessment. The primary delivery vehicle is still the classroom, however.

- ➔ *An instructor with the support of an instructional designer and media developers prepares a series of Internet-based self-instructional tutorials or modules which present important concepts using simple simulations and video clips, provides interactive sequences of examples and non-examples to guide students through tough concepts, includes practice questions with computer generated corrective feedback, and finally presents on-line tests on the module concepts which are tracked and reported back to the instructor via an Internet application.*

Here most instructional functions have been shifted to the Internet environment. The modules are entirely self-instructional and no collaborative Internet tools like e-mail have been included. This approach is derived from the tradition of self-instructional, individualized computer-based training (CBT). Classroom sessions may still take place for other non-modularized segments of the course.

- ➔ *An instructor, with the support of an instructional designer and media developer, prepares an Internet-based “distance education” course for remote students or those who wish to study independently. Information is presented primarily using WWW pages, embedded media files like graphics, simple animations, video and sound clips, and a supporting textbook. Collaborative tools like e-mail, discussion lists, live chat and a shared work space are used for learner guidance, dialogue, and practice activities. The instructor also embeds a few multi-media self-instructional tutorials with computer generated practice and feedback as exercises within some course units. Finally, all testing and student assessment is completed using various Internet tools. An Internet application is used to track student activity and assessment.*

In this example, the Internet was again used to support all instructional functions; however, the entire course is delivered “virtually” via the Internet. This approach is based on a classroom model that fosters collaborative approaches to learning among students. The electronic environment attempts to mirror and enhance that model in a space that is totally virtual.

## Analysis

A conclusion drawn from examination of these trends in the application of ICTs in schools is the fact that they are highly interrelated. For example, the use of ICTs to improve access to education requires that mechanisms be established to train teachers, develop materials and share experiences. Changes to pedagogical practice in classrooms require that teachers have access to infrastructure and are given the

opportunity to develop the expertise to use the machines and software tools. The trends also demonstrate the variety of strategies that educational policy makers, administrators and teachers are pursuing in order to improve access to learning opportunities, enhance the quality of the learning experience for students, and, at the same time, make the most efficient use of limited resources. They also illustrate a number of other features about the adoption of ICTs into the schools and school systems. These include:

1. The adoption of ICTs that continues to enable the growth of “open school” institutions is not a “one-off” process. It is an on-going process incorporating new technologies as they are perceived to add value to those already deployed. Furthermore, the adoption process is facilitated when it is possible to try new initiatives on a small scale and then make decisions regarding larger scale adoption on the basis of evidence that doing so will add value to current practice. The development of “readiness indicators” that help decision makers understand the circumstances under which a given technology innovation will add value and be sustainable will be of growing importance.
2. The examples of the National Open School in India and Telesecundaria in Mexico, both highly successful in terms of fulfilling their respective mandates, begs the question of the conditions that need to be met in order for these models to be replicated elsewhere. Clearly, one is that there be a national need for delivery systems capable of reaching mass numbers – as there was in India and Mexico. Also, there were successful precedents for the models that emerged in each of the countries. In the case of India there was the highly successful Indira Gandhi National Open University; Mexico had a national television network and experience in using it for education purposes; and the Namibian College of Open Learning had experience using radio. It would seem, therefore, that adoption occurs more readily when there are existing models that can be used to help educators “imagine what could be”, and when there is some level of existing infrastructure to use as a “launch pad”.
3. The increasing use of ICTs creates needs that are systemic in nature. For example, teachers want to share experience and learn from that of others. Collaboration becomes an obvious way of achieving economies both in the technologies and development of learning materials. And partnerships, consortia and joint ventures become useful ways to share risk and costs. The growth of SchoolNets is, in part, a response to these needs – one that has become a truly global phenomenon in both developed and developing countries. The interesting point is that it is the increasing adoption of ICTs that creates the needs and facilitates the solution strategies!
4. The growing array of partnership arrangements deserves a special focus. The examples demonstrate a growing

comfort with partnerships, not only among institutions and different levels of government, but more importantly with the private sector. The role the private sector plays in the provision of infrastructure and software makes such partnerships an inevitable component of the adoption process.

5. There are several additional conclusions that can be reached about the impact of ICT use on classroom practices. First, the evidence clearly indicates that ICT use requires a change in pedagogical practice. Teachers need training, ongoing support, and a work environment that supports change if they are to make appropriate adaptations. Secondly, the evidence suggests that changing classroom practice is an evolutionary process involving small increments of change rather than large ones. Teachers need to be able to see how a change in practice will enable them to improve on the way they currently do their job. Using peers as a way of coaching and supporting change in schools appears to be effective.

## Trends in ICT applications in non-formal education

Non-formal education (NFE) is an integral part of a lifelong learning concept that allows young people and adults to acquire and maintain the skills and abilities needed to adapt to a continuously changing environment. Much, perhaps most, of non-formal learning is organized by the individual learner and occurs through self study outside the formal educational system. The content of this type of NFE is as eclectic as the needs and interests of the learners, reflecting the diversity of their demographic and socio-economic circumstances. And there is no doubt that as more individuals have access to the web, and as the amount of information on the web continues to grow, individual self study will increase.

There is a very substantial portion of NFE that is organized by some type of “provider”. One part of this activity is reflected in what is frequently termed the “continuing education market” by both public and private institutions and organizations. Here one finds formally organized courses and workshops on almost every subject imaginable. The use of ICTs to provide access to this type of learning activity is increasing; however, some research has shown that one of the powerful motivators that drives participation in these programmes is the social contact. Therefore, one would not expect the use of ICTs to replace face-to-face contact.

Another part of this “organized” NFE activity are the programmes that are more targeted to both content and learner groups. Whereas the “continuing education” activity described above is typically market responsive and sustained by fees, this type of activity is usually sponsored and designed to achieve particular ends such as professional

up-grading, religious education, corporate in-house training, literacy development, or community development more generally. The use of ICT in this sector of NFE has historically been much higher than in the other sectors. The use of radio and television has been, and continues to be, quite extensive. And the use of the newer digital technologies is increasing rapidly – often in a “mix and match” fashion as described previously. The use of the web tends to be the medium of choice in corporate training initiatives.

This latter sector of NFE activity (organized) is the one that is of particular interest to this study because it is here that we find NFE programmes focusing on issues related to poverty reduction and capacity building in the developing nations of the world. It is in this type of NFE activity that we see donor organizations, non-governmental organizations (NGOs), governments, and increasingly the private sector, focusing their efforts on increasing literacy levels and enhancing the capacities of developing nations to improve socio-economic conditions. And it is also in this sector of NFE that we find a concerted effort to up-grade the skills of specialised workers such as teachers and health care personnel. For purposes of examining the use of ICTs in this branch of NFE activity, the examples are grouped into three categories: literacy programmes, specialised up-grading and community development – by far the most eclectic grouping of activities!

### *Applications in Literacy*

Literacy programmes have historically involved face-to-face interactions between and among learners and tutors. Other than radio, ICT has not had much applicability because of the lack of resources and infrastructure in the communities where literacy programmes have typically been offered. However, as the following examples indicate, that is starting to change:

1. **The Tata Group.** “40 hours is all it takes to teach an Indian to read” is a claim being made on the basis of the results from an initiative<sup>25</sup> of the Tata Group in India. The initiative is a computer-based functional literacy (CBFL) programme that used a “new-age solution” to an age-old problem, and one that has the potential to lift India’s literacy rate in record time.

The programme uses animated graphics and a voiceover to explain how individual alphabets combine to give structure and meaning to various words. It was designed from education material developed by the National Literacy Mission and uses puppets as the motif in the teaching process. The lessons are tailored to fit different languages and even dialects, to focus on reading, and are based on theories of cognition, language and communication. With the emphasis on learning words rather than alphabets, the project stimulates thought



processes. The objective is to teach the reading of words in as short a time as possible.

The initial experiment for the CBFL programme was conducted in Beeramguda village in the Medak district of Andhra Pradesh in February 2000. This was followed by an extended trial run in 80 centres spread across the districts of Medak, Guntur, Vijayawada and Visakhapatnam. The initial experiment and trial run highlighted the following advantages of the project:

- ➔ Acceleration in the pace of ‘learning to read’ (it takes about one-third of the time that writing-oriented methods require).
- ➔ Flexibility in adjusting to individual learning rates.
- ➔ Lower dropout rates in comparison with other adult literacy programmes.
- ➔ Trained teachers or large-scale infrastructure not required.
- ➔ Programs can run on low-end computers (these are the kind of machines that many organizations can afford to give away).
- ➔ Enhanced existing adult-literacy programmes.
- ➔ Multimedia format ensured that the pronunciation of the words/letters is taught accurately through the system, rather than being left to individual teachers. This is particularly useful for languages like Tamil, where the same letter can be pronounced differently depending on the context.

2. **The Commonwealth of Learning.** Another example is a project that has just recently been completed by the Commonwealth of Learning.<sup>26</sup> The purpose of the project was to explore ways in which literacy programmes might be enhanced through the use of appropriate technologies. The project outcomes were defined and approved as follows:

- ➔ Enhanced knowledge of what constitutes appropriate and sustainable use of ICTs in literacy education.
- ➔ Development of a cadre of tutors who are knowledgeable in terms of using ICT in literacy education and are aware of media-based instructional resources on a global basis.
- ➔ Significantly improved knowledge and skills in reading, numeracy and the use of ICT appliances for learners who participated in the project.

- ➔ Objective data regarding the role of ICT-based community learning centres (CLC) in the education delivery model for the country.
- ➔ Development of materials for training literacy workers.
- ➔ Development of literacy teaching materials.

The issues associated with providing access for literacy workers and learners to technology appliances such as computers, audio and video equipment, as well as on-line connectivity, had to be resolved in order for the project to proceed. Therefore, the delivery model selected was that of a “technology-based community learning centre” that would give learners access to the technological appliances as well as a place to gather and interact with others. As a result, these centres were at the core of the implementation of the project. An important aspect of the project evaluation was an assessment of their effectiveness in enabling literacy workers to develop instructional materials and deliver literacy training programmes. The use of these centres for other purposes by members of the community was encouraged as a way of increasing both sustainability and relevance in the community.

Each centre was equipped with two or three computers, a printer, TV, VCR, digital camera, handycam and an audiocassette recorder. Internet connectivity was to be provided along with regional language software where available. Staff were selected and trained to operate and support the equipment and tutors were taught how to use the technology to design and produce instructional material locally.

Following the completion of the project, workshops were held in each of the countries to disseminate information gleaned from the project. The evaluation report, written and carried out by an independent team, is available from COL.

3. **The Solomon Islands.** A project in the Solomon Islands<sup>27</sup> is another illustration of the application of ICT in developing literacy skills, but in the context of a more specific national development goal. The need was to find ways to provide services more equitably to remote communities and to enable a greater degree of information exchange among citizens. Obviously, both access to infrastructure and the literacy skills to use it are necessary prerequisites.

The purpose of the project was to explore the feasibility of using an existing communications network (Pfnnet) to provide educational opportunities to remote communities. The courses selected were Pre-tertiary English and English for all academic purposes. They were provided by the University of the South Pacific

(USP). A Pfnet Internet gateway base station was established in the rural community of Sasamungga, Choiseul along with a solar powered computer centre at the community school. Part of the evaluation of the project was to assess impact of this on the wider community – particularly the impact on vulnerable groups such as women and young people. In doing so, it was hoped that this study would provide useful baseline data for further expansion of Pfnet to all rural areas of the country, and provide a prototype example of how it can be used for distance learning.

Participants rated the project as very successful. The achievement of the distance learners was high, village leaders came to realize the importance of good leadership in their communities, and, staff and administrators at Sasamunga Community High and Primary School now have access to computers.

### *Action Aid*

The International Education Unit of ActionAid<sup>28</sup> has set up three pilot projects in Burundi, India and Uganda to introduce ICTs through existent Reflect structures. The central assumptions of the project are:

- It is the process by which technology and its management are chosen - not the choice of technology itself - which has the greatest impact on the lives and livelihoods of poor and marginalized people and on the sustainability of the technology.
- Existing Reflect structures and methods are an ideal bridge to provide poor people with access to ICTs in accordance with their needs and objectives as they define them.
- Communities already possess the knowledge that is most valuable to them and their development, but need additional information in order to make meaningful choices, particularly when making links with processes and actors beyond their local level.

The overall objective of the project is to strengthen the capacity of poor people to communicate by providing ICTs they themselves have chosen as valuable and appropriate for their specific context. Clearly this involves building the capacity of those people to make that choice. In particular, the project aims to:

- Develop a pro-poor model for ICTs in development.
- Draw and disseminate lessons from the experiences of integrating ICTs into Reflect programmes and processes.

In all three pilot communities, facilitators will assist members of the communities to identify and analyse their

information gaps and communication needs. The facilitators will then act as intermediaries, introducing Reflect circles to ICTs and describing their potential uses. Where other ICT initiatives exist within easy distance, groups can make contact with them and find out about their experiences.

On the basis of this participatory process, groups will come to a point where they will be able to choose the equipment they would like to have, where it should be, and how it should be managed, sustained and monitored. According to these requirements, a communication centre will be planned and set up in each pilot location.

### *Applications in Specialised Up-Grading of Education*

The need to enable a variety of workers to up-grade and maintain their skill level and competencies is of utmost importance all over the world, particularly in developing countries where the need for competent teachers, health care workers and policy makers is especially acute. The use of various combinations of ICT is becoming an important strategy for addressing this challenge.

1. **The Global Development Learning Network (GDLN)** ([www.gdln.org/about.html](http://www.gdln.org/about.html)) is a worldwide partnership of distance learning centres and other public, private, and non-governmental organizations committed to development learning and development dialogue for lasting poverty reduction. Offering a unique combination of distance learning technologies and methods, GDLN facilitates timely and cost-effective knowledge sharing, consultation, coordination, and training. Through GDLN, individuals, groups, and organizations design and deliver courses, seminars, and other activities that cover the full range of development issues. GDLN Centres around the world have facilities for videoconferencing, web-based learning, and face-to-face interaction as well as offering logistical support and facilitation services. These provide cost-effective, fast, and high-impact alternatives to traditional meetings and courses, enabling people around the world to connect with each other without having to travel.
2. The **Distance Learning Project of the World Bank in Sri Lanka**<sup>29</sup> is an example of a project designed to strengthen the environment for policy reforms and to build capacity in the public and private sectors. Distance learning will be used to disseminate the latest technical information and cross-country experience in support of market reforms. Senior public and private sector decision-makers will access interactive multi-media and Internet-based training programmes developed by the World Bank Institute, major universities, private corporations, and technical organizations around the world. This exposure to global knowledge will enhance the capacity of Sri Lankan decision-makers to conceptualise and implement reforms. Better policies

will, in turn, lead to improved governance, poverty reduction, and economic growth. The activities include: the establishment of video conferencing capacity; access to distance learning course materials; financing of operating costs over the first 4 years of operation; technical assistance for staff training; a market survey; development of a business plan; a marketing campaign and periodic evaluation of centre operation/management effectiveness; and the purchasing, installing, and maintaining of distance learning technology.

3. The **e-learning for life** initiative<sup>30</sup> is a partnership involving the Coca-Cola Company, the United Nations Development Programme (UNDP) and the Ministry of Education in Malaysia. It provides Internet access, educational software and ICT training for students, teachers and local community members in peri-urban and rural areas. The project supports the Malaysian government's vision of building a knowledge-based economy and the Ministry of Education's drive to bridge the digital divide by bringing Internet access and e-learning resources to Malaysian classrooms and communities.

Six ICT "hubs," equipped with state-of-the-art infrastructure, multimedia resources and software, have been set up in secondary schools across Peninsular Malaysia. Under the leadership of the Ministry of Education, the ICT "hub" schools are integrating computer lab-based training into existing curricula. A core group of teachers and students are being trained so they can then transfer their ICT skills to others in the hub area.

4. **Healthworks**<sup>31</sup> is a new radio program series for health professionals who want to improve living conditions in their communities. It consists of thirteen (13) programmes of information and ideas to help health and social development workers. The Healthworks episodes plus theme music and promo are available to radio stations for download from OneWorld Radio. The series is accompanied by a workbook with spaces for responding to learning activities in the Healthworks programmes. Listeners who complete the workbook can receive a Certificate of Participation. Radio stations interested in re-broadcasting Healthworks, can download an Info Pack and a script for a sample Healthworks programme.
5. The **Aravind Eye Hospital** in India is helping to eradicate blindness by using Internet-connected kiosks to provide video consultations and diagnosis, as well as providing extensive education and training to local healthcare providers ([www.digitaldividend.org/pubs/pubs\\_04\\_overview.htm](http://www.digitaldividend.org/pubs/pubs_04_overview.htm)).
6. **TelMedPak** ([www.telmedpak.com](http://www.telmedpak.com)) is a team of health professionals in Pakistan working to: create awareness

of the educational and reference opportunities available on the Internet amongst health professionals and medical students; facilitate electronic access to medical information for the public; facilitate the use of information technology at medical colleges and institutions in Pakistan; and explore modalities for provision of telemedicine to the rural areas of Pakistan.

7. **MEdRC EduTech** ([www.medrcedutech.com/](http://www.medrcedutech.com/)) is an Indian company that has core competencies in learning technologies, multimedia programming, television production and development of interactive software. MEdRC has developed a unique process through which media can be distributed through personal computers at networked e-Learning Centres and emerging channels such as broadband Internet, interactive TV and mobile technologies. MedRC's mission is to:

- Provide the opportunity for medical teachers to deliver education using digital channels.
- Forge collaborative relationships to promote lifelong learning in medical and health education, particularly in the form of continuing professional development at all levels.
- Innovate and imaginatively utilize emerging technologies to make learning interactive, flexible and exciting.
- Set up a network of 200 e-Learning centres, one each at every medical college location in India - on a build, own and operate model.

8. **Teachers Without Borders**<sup>32</sup> is a website that connects a global community of teachers with each other in order to share ideas, work collaboratively, and make change. One of its services is a programme that leads to a Certificate of Teaching Mastery. The programme is a professional development course of study that focuses on preparing teachers for the 21st century.
9. China is trying to improve the quality and technical competence of primary school teachers through a project<sup>33</sup> that will use two ICT approaches: the **electronic classroom** model, already in use elsewhere in China, and **online learning resources for self-study**. There will be a learning centre in three counties of each province, linked to a common network, with multi-media classrooms at each site. For primary schools in central townships, satellite technology will provide digital data, including text, video, audio and graphics, which they can download and store. Teachers in the townships will use these materials for their own learning, which will include how to make use of ICT in their classrooms. The project will also test models for financing distance teacher education and produce policy recommendations on cost-efficiency and cost-recovery strategies.

Community use of the ICT infrastructure can be a source of income to offset costs, including fee-for-service ICT and agricultural training, cyber weather services, and dial-up Internet.

10. **Straight Talk** ([www.straight-talk.or.ug](http://www.straight-talk.or.ug)) and **SchoolNet Uganda** ([www.schoolnetuganda.sc.ug](http://www.schoolnetuganda.sc.ug)) have collaborated to launch an online counseling service that provides training for teacher and student-peer counsellors. The objectives of the project include: demonstrating the integration of ICTs in HIV/AIDS prevention and caring services; expanding and diversifying opportunities for access to Adolescent Sexual Reproductive Health (ASRH); information and services for young people in and out of school; and promoting the creation of HIV/AIDS information and educational communication initiatives by and for young people, to enhance behaviour change.

11. **The Virtual Colombo Plan**<sup>34</sup> was launched by the Australian Government and the World Bank in August 2001. Its major focus is to improve education and access to knowledge in developing countries through distance education and to support policy development using ICTs. It is designed to:

- Enhance the quality of basic teacher education and school management in Papua New Guinea, Indonesia and a number of other developing countries.
- Expand physical infrastructure to improve access to and the cost-effectiveness of ICTs for distance learning and knowledge dissemination. This will be achieved by providing support for the World Bank's Global Development Learning Network in selected countries in Asia and the Pacific.
- Use courses and material developed by Australian universities to improve the capacity of the African Virtual University to deliver quality, relevant courses that address Africa's development needs.
- Deliver ICT-based training through some 200 virtual scholarships.
- Develop activities in basic education, public policy, and higher education, in consultation with Australian universities and other key institutions.

### *Applications in Community Development*

The range of examples that could be used to illustrate this trend is almost limitless. Those that follow will demonstrate the range of contexts in which ICTs are being applied.

1. **The Asian Women's Exchange** ([www.panasia.org.sg/grants/awards/99221a.htm](http://www.panasia.org.sg/grants/awards/99221a.htm)) is an Internet-based women's information service and network in Asia. It is an initiative

geared towards developing cooperative approaches and partnerships in increasing access and exploring applications of ICTs for women's empowerment. This network aims to help expand existing regional networks in the women's movement, promote electronic resource sharing and build a regional information service that will support various women's advocacies, specifically those that are critical for the women in the region.

2. **Catalysing Access to ICTs** is a three-year project in Africa<sup>35</sup> to enable poor people to gain maximum benefit from the opportunities offered by ICT. It is hoped it will also act as a strong catalyst for reform. It will provide a package of strategic activities to improve affordable access to the full range of ICTs, from Internet to community radio.

3. The **Learning Center Program** in Vietnam ([www2.coca-cola.com/citizenship/education\\_asia\\_digital\\_divid.html](http://www2.coca-cola.com/citizenship/education_asia_digital_divid.html)) is part of a pan-Asian programme in which the Coca Cola Company is partnering with governments, multilateral organizations, non-government organizations and educators to help and empower a new generation of teachers and students through the innovative and locally relevant use of ICTs. The goal is to help communities throughout the region bridge the growing "digital divide" between ICT "haves" and ICT "have-nots".

4. **Deepalaya schools** ([www.digitalopportunity.org/article/view/64866/1](http://www.digitalopportunity.org/article/view/64866/1)) have started 337 educational centres and 7 formal schools that offer education from Kindergarten to 12th grade. Computer lessons are a compulsory part of the curriculum from 6th to 12th grade; however, after 8th grade the children also learn how to use DOS and Windows operating systems, MS Office, the Internet, and e-mail. Apart from the computer lessons that are in the students' timetable, there is also a vocational training programme on computer hardware and software for school drop-outs or students that have passed grade 10 or 12.

5. Pedagogical techniques that allow communities to become owners of the technology as they learn to use ICTs were demonstrated in the **Lighthouse Project** in Thailand ([www.panasia.org.sg/news/rnd\\_st/ict\\_rnd06s.htm](http://www.panasia.org.sg/news/rnd_st/ict_rnd06s.htm)). The goals of this pilot project were to help villagers master technology, cultivate a sense of ownership in the use of technology, and foster cultural pride. Additionally, the project intended to create a learner-centred constructivist educational experience using desktop publishing software. A community computer centre was constructed and equipped and training was provided. Many of the goals of the project were accomplished, as villagers became owners of the technology they learned to use, and became information-producers rather than information-receivers.

- 6. The Gobi Women's Project**, launched in 1996, provides non-formal distance education to some 15,000 nomadic women. ([www.unesco.org/education/educnews/96\\_12\\_12/gobi.htm](http://www.unesco.org/education/educnews/96_12_12/gobi.htm)) The aim is to provide useful instruction on health, commercial skills, family planning, traditional crafts and environmental issues. The project has re-equipped four radio stations (one in the capital and three in the Gobi) to produce three weekly series reinforcing the books' lessons. While the Ulaanbaator station takes the lead in introducing new subjects, the regional stations take a local look at the curriculum. Radio producers, teachers and communicators have been trained by the project, which has also provided some 30 jeeps. An achievement of the project is that women are becoming self-sufficient: they can now make clothes for their children and families.
7. One of the most intensive applications of ICTs anywhere in the world can be found in the Pondicherry region of south India. The **M.S. Swaminathan Foundation** ([www.mssrf.org/](http://www.mssrf.org/)) has provided leadership in an experiment in electronic knowledge delivery to the poor. Ten villages near Pondicherry have been connected by a hybrid wired and wireless network - consisting of PCs, telephones, VHF duplex radio devices and e-mail connectivity through dial-up telephone lines - that facilitates both voice and data transfer. This has enabled the villagers to get information that they need and can use to improve their agricultural and fishing practices. The vision for the project is based on the holistic philosophy of Swaminathan, which emphasizes an integrated pro-poor, pro-women, pro-nature orientation to development and community ownership of technological tools and encourages collective action for the spread of technology. The process involves local volunteers gathering information and feeding it into an intranet that people access through nodes in different villages in their local language. Most of the operators and volunteers providing primary information are women, thus giving them status and influence. All centres evolved to meet the information demands made by the community. More recently, the project has been replicated in other regions of southern India and has incorporated literacy training into the activities.

### *Analysis*

The three categories of NFE show quite different patterns of ICT use. For example, while literacy programmes have not historically incorporated much use of ICT, mostly because of the environments of the learners, one gets the sense that this is changing rapidly. The Tata project demonstrates that large numbers of literacy learners can learn quickly with relatively low cost infrastructure requirements. The Commonwealth of Learning project demonstrated that ICTs can be used very effectively by tutors to develop locally relevant teaching materials. The Solomon Islands example is encouraging so far as the use

of distance education is concerned. And the Action Aid initiative, similar in many ways to the model developed by the M.S. Swaminathan Foundation, promises, with its "bottom up" development model, to make a unique addition to the growing experience of ICT use in literacy education programmes.

However, unlike the adoption of ICT in primary and secondary education, ICT use in literacy has not yet captured the imagination and commitment of policy makers needed to move adoption to a mass level. A more comprehensive review of the use of ICT in literacy education needs to be undertaken that compiles a body of evidence, describes policy options, and defines mechanisms for sharing resources, materials and experience in the same way that SchoolNets are doing in formal primary and secondary education.

The use of ICT to facilitate skills up-grading for professionals and para-professionals is well underway – often because of the advocacy and initiative of the workers themselves. Access to these types of programmes is typically through the use of distance education models that are enhanced by ICT applications. Of particular note is the increasing use of ICT - supported distance education strategies for up-grading the skills of teachers.

As indicated earlier, the number of examples using ICT in education for development – community education - is huge. It is in this sector that we see the most use of older broadcast technologies as well as the most creative examples of ways they can be combined with the use of e-mail and the Internet. The Swaminathan example also demonstrates how we can develop both community "ownership" and the direction in which ICT use should be heading – an important point from a sustainability perspective!

The examples of ICT use in NFE have been selected only to illustrate some of the many applications that are underway around the world. Many more are identified on a website developed by UNESCO Bangkok which is undoubtedly the most comprehensive source of information on ICT applications in non-formal education in the Asia Pacific region. The website can be found at: [www.unesco.org/bangkok/education/ict/teaching\\_learning/nonformal\\_edu/projects.htm](http://www.unesco.org/bangkok/education/ict/teaching_learning/nonformal_edu/projects.htm).

## Trends in research and evaluation

The amount of research and evaluation regarding ICT applications in education is limited. And the majority of what has been done has occurred in the higher education sector. Most of what has been written about ICT in education has been either of a visionary nature describing what "might be" or advocating increased use. However, this situation is

changing as use of ICT in the other sectors of education increases. As the rate of ICT use increases, there are more projects to evaluate. The following studies and reports of project evaluations illustrate this growing emphasis on the gathering and documentation of evidence concerning the use of ICT in education:

1. At all levels there are questions as to whether, in the rush to embrace e-learning, enough research is being done into the benefits for students and staff in different disciplines. For example, **Oxford University's Learning Technologies Group**<sup>36</sup> has questioned whether the choice of technology will shape the way subjects are taught or researched. It said that in trying to make a "tool-kit" for all, staff might be deterred from experimenting by imposing the teaching methods of one discipline onto another. Their view is that there has been an absence of debate about how information technology can be used effectively to complement face-to-face teaching.
2. The **Flexible Learning Framework in Australia** has just completed a project called "*Access & Equity in Online Learning*".<sup>37</sup> The purpose of the project was to establish the needs of learners in the following groups: those with literacy needs, indigenous learners and learners with disability. Three additional groups were subsequently added: women e-learners, rural and remote rural e-learners and isolated metropolitan e-learners. The project produced guidelines, literature reviews and research reports, 17 of which are listed on their website.
3. Another contribution to the body of evidence about ICT applications is the work that the **UNESCO office in Bangkok** is conducting on performance indicators regarding the use of ICTs in education.<sup>38</sup> This work is part of the "ICT in Education in Asia and the Pacific Programme", an international undertaking funded by the Japanese Funds-in-Trust.
4. A project of the **Flexible Learning Framework in Australia** (<http://learnscope.flexiblelearning.net.au/LearnScope/golearn.asp?Category=11&DocumentId=4379>) attempted to enhance the learning outcomes of students by using ICTs to provide direct instruction. This involved a trial of real time teaching via the Internet, using Microsoft Netmeeting. The conclusion was that real time teaching via the Internet appears to enhance the cognitive functioning of children in the five-to-eight-year age groups and demonstrated that teaching via the Internet using a direct instruction model with children in the five-to-eight-year age groups is a pedagogically sound and cost effective way to support young learners.
5. A research project<sup>39</sup> carried out by the **Institute of Education, University of London** from April 2000 to March 2001 provided some data regarding the use of ICT in literacy. The study report focused on the following points:

- The use of ICT to provide effective learning for people with literacy and numeracy needs.
- The use of ICT in helping people with literacy and numeracy needs to achieve satisfactory learning outcomes in non-basic skills learning.

The study concluded that the use of ICT did have beneficial effects. A full description of the results is provided on the website.

6. A study<sup>40</sup> by **SchoolNet Canada** to assess the impact of its "Grassroots Programme" provides some insights into the adoption of ICT by teachers. The study report provides an overview of innovation and a background to some of the challenges associated with large-scale innovation in the Canadian K-12 school system. It describes the factors contributing to the success of the programme and also the challenges that are faced.
7. Another **SchoolNet Canada** report<sup>41</sup> from 1998 titled "The Emerging Contribution of Online Resources and Tools to Classroom Learning and Teaching" concluded that the use of technology in the classroom has already been demonstrated to have a significant impact on teaching and learning. It concluded that the way new technology is adopted is related to 1) the users' interest in improving on what they now do well, and 2) the users' interest in doing things that are different from the ones they are used to doing. It also identified several trends with respect to the K/12-13 sector:
  - Trend 1: Higher levels of control by learners are called for as classrooms are getting more online.
  - Trend 2: Learning situations become more realistic and authentic as classrooms are getting online.
  - Trend 3: Online resources boost student interest and motivation in the classroom through a greater diversity of learning goals, projects, and outcomes.
  - Trend 4: The successful online classroom combines information technology with appropriate pedagogy.
  - Trend 5: The classroom is extended to online learning communities with the potential to support or even challenge the locally established curriculum.
  - Trend 6: The education of educators is broadened to include just-in-time and/or collaborative learning.
  - Trend 7: Educators use online technology as a driving element of an educational reform.

The report goes on to describe a number of gaps in current knowledge about online use of technology in the classroom such as:

- More information is needed on the nature and extent of teachers' experience with information technologies, how teachers view these resources, how they understand their impact on society as a whole, and how they alter their instructional practices in order to use them effectively.
- The content of what will be taught using online resources is becoming more diverse and shifting towards more construction and input by the learner. More information is required on whether this more dynamic content conflicts with traditional curriculum content and goals.
- As the presence and use of information technologies becomes increasingly widespread, schools and universities will need to develop performance indicators to monitor the use and outcomes of the technologies, and to demonstrate accountability to funding sources and the public.

8. A recent study<sup>42</sup> in the **UK** identified a range of factors that teachers need to take into account when using ICTs. These include:

- Clear identification of how ICT will be used to improve pupils' attainment and meet specific objectives within subjects of the curriculum.
- Ensuring that pupils have adequate ICT skills to achieve those subject specific objectives.
- A planned match of pedagogy with the identified purpose of ICT activities and learning outcomes.
- Finding appropriate starting points for development for particular teachers in accordance with their teaching styles and approaches.
- Adequate access to, and intensity of use of, the necessary equipment by pupils and teachers.
- Effective technical back-up and support to overcome any difficulties encountered.

9. The British Educational Communications and Technology Agency (BECTA) is an organization set up to support the transformation of education through the integration of ICT into learning and teaching, educational institutions and systems. It provides a variety of services, one of which is an educational research portal<sup>43</sup> that contains links to other websites, documents and sources of information in the field of ICT research and educational research generally. Study reports are listed in categories such as "ICT and Effective Pedagogy"; "ICT and School Improvement"; and "Management Information Systems".

An example, one of the many reports contained in the "ICT and Pedagogy" section of this portal, is a study focusing on how teachers make effective choices about when, when not, and how to use ICT in teaching literacy and numeracy in primary schools.

## Analysis

These examples of research and evaluation, while providing some very useful evidence, also underscore the point that there is still a paucity of "hard data" on which to base policy and investment decisions. As was pointed out in the opening paragraphs of this chapter, the adoption of ICT in education is still in its early stages. However, it has seemingly reached a "take-off" point which increases the pressure on educational leaders to be, and be seen to be, doing something about the adoption of ICTs. Networks that facilitate sharing experience and information among policy makers and institutional leaders seem to be lacking. Initiatives that would address this need would make a significant contribution as the more formal research activities proceed.

## Summary

The adoption of ICTs into the practice of education is not something that began with the emergence of the new digital technologies. It has been on going for decades in very successful programmes that have utilised radio, television and print. What is new are the many ways that these "older technologies" are being combined with the use of e-mail and the Internet, particularly in the arena of non-formal education.

ICT infrastructure is evolving in other ways as well. The use of wireless technologies, often referred to as "m-learning", is a relatively new trend that may help overcome the lack of ICT infrastructure in remote communities. Open source system software holds some promise for cost saving, and more importantly, for the development of standards that facilitate interoperability among systems. And, with the burgeoning amount of information, it is not surprising that management systems are being developed to allow for efficient cataloguing, searching and retrieval of information. One of the more important trends is the rapidly expanding development of online learning object content repositories. The ability to be able to reuse content in different contexts and deliver it in different formats for learners at different levels of the system is promising, and will lead to greater convergence between the historically separate worlds of the distance educator and the classroom teacher. But it is in an early stage of development and there are issues that need to be resolved.

A trend that will surely grow is the use of distance learning models to create mass access to primary and secondary education. The very successful examples of the National Open School in India and Telesecundaria in Mexico

demonstrate how the goals of increasing access and enhancing the quality of curriculum content can be achieved. However, the increased use of ICT in schools has created new needs for both teachers and school systems. For example, the benefits of sharing information and teaching materials becomes more obvious. Teachers need to acquire new skills. And managers want to collaborate to share costs. In response, we are seeing the emergence of new organizational models called schoolnets with mandates to address these and other needs.

While the “tried and true” older technologies continue to play an important role in non-formal education, the use of newer ICTs is proving useful here as well. There are emerging applications in literacy training and certainly in continuing professional education. In the community development area the applications demonstrate appropriate use as well as showing models of local control and relevance to community needs.

The final comment is about evidence. Is this increased use of ICT in education contributing to the goals of more access to learning opportunities; enhanced quality of content and pedagogy; and greater efficiencies? While there remains a paucity of data to answer these questions, it is clear that the emphasis on research and evaluation is increasing. And a notable feature of this increasing effort is a shift from the arguments of being “for” or “against” ICTs, to questions related to the conditions that need to be met in order to ensure that adoption adds value to current practice.

### NOTES

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- 7 M-Learning is a 3-year pan-European research and development programme supported by the European Commission’s Information Society Technologies Programme and is coordinated by the Learning and Skills Development Agency. [www.m-learning.org/background.html](http://www.m-learning.org/background.html)
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- 11 Eschoolnet offers a wide range of services including eLearning news, online training, European curriculum resources and school practice ideas. One can meet European teachers, trainers and students through collaborative school projects or learning communities. [http://eunbrux02.eun.org/eun.org2/eun/en/index\\_eschoolnet.html](http://eunbrux02.eun.org/eun.org2/eun/en/index_eschoolnet.html).
- 12 The Centre for Educational Technology Interoperability Standards (CETIS) is an organization that represents higher and further education institutions on international learning technology standards initiatives. in the United Kingdom. ([www.cetis.ac.uk/static/standards.html](http://www.cetis.ac.uk/static/standards.html)):
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- 22 SITESM2 abstract [http://sitesm2.org/sitesm2\\_studyabstract.pdf](http://sitesm2.org/sitesm2_studyabstract.pdf)
- 23 Harris, S. and Kington, A. “Innovative Classroom Practices in England: Implications for Schools”. National Foundation for Educational Research 2002. [www.nfer.ac.uk/research/down\\_pub.asp](http://www.nfer.ac.uk/research/down_pub.asp)
- 24 TeleEducation NB. “New Media Survey”. 2002. <http://teleeducation.nb.ca/content/web-guides/english/NewMediaSurvey/intro.htm>
- 25 The Tata Group is a large corporation in India that has long had a commitment to community development. A full description of the computer-based functional literacy programme can be found at [www.tataliteracy.com/how\\_it\\_works.htm#](http://www.tataliteracy.com/how_it_works.htm#)
- 26 The project was implemented at three sites in Zambia and seven sites in India from July 1999 to December 31, 2002. Support was provided by the Department for International Development of the government of the UK. [www.col.org/literacy](http://www.col.org/literacy)
- 27 The “Radio Sagarmatha” project was a distance learning research initiative of the People First Network, partner organization to the Rural Development Division of the Ministry of Rural Development of the provincial government in the Solomon Islands. The project was carried out from June to September, 2002. [www.panasia.org.sg/grants/awards/0201a1s006rtp2.htm](http://www.panasia.org.sg/grants/awards/0201a1s006rtp2.htm)
- 28 The project is led by Action Aid ([www.actionaid.org/](http://www.actionaid.org/)), one of the largest development organizations in the UK. A description of the project can be found at <http://217.206.205.24/Initiatives/ict/project/project.htm>
- 29 A description of this pilot project can be found at [www4.worldbank.org/sprojects/Project.asp?pid=P069784](http://www4.worldbank.org/sprojects/Project.asp?pid=P069784)
- 30 The project focuses on the innovative and enjoyable use of Information and Communication Technology (ICT) for youth



- learning and community development. It has been underway since March 2002. [www2.coca-cola.com/citizenship/education\\_malaysia\\_elearning.html](http://www2.coca-cola.com/citizenship/education_malaysia_elearning.html)
- 31 The programme was produced by Health Communication Resources in Australia ([www.h-c-r.org](http://www.h-c-r.org)) A description is at [http://radio.oneworld.net/index.php?fuseaction=audio.view&audio\\_id=339](http://radio.oneworld.net/index.php?fuseaction=audio.view&audio_id=339)
- 32 The programme is geared to those teachers who seek additional education. Students who enroll in the Certificate of Teaching Mastery are placed in a **global cohort**, interact with a teacher mentor, and have access to a **professional technical support** team. Graduates of the programme become **local mentors**. [www.teacherswithoutborders.org/html/certificate\\_of\\_mastery.html#description](http://www.teacherswithoutborders.org/html/certificate_of_mastery.html#description)
- 33 The project is designed to help meet the increasing demand for better-qualified teachers and to provide opportunities for teachers to continue their professional development. (<http://learningchannel.oneworld.net/external/?url=http%3A%2F%2Fwww.undp.org%2Fdpa%2Ffrontpagearchive%2F2002%2Fnovember%2F26nov02%2Findex.html>)
- 34 See the following website for detailed information on the Virtual Colombo Plan Initiative: [www.ausaid.gov.au/hottopics/topic.cfm?Id=326\\_3216\\_5474\\_6437\\_2910](http://www.ausaid.gov.au/hottopics/topic.cfm?Id=326_3216_5474_6437_2910)
- 35 This programme is described at [www.catia.ws/](http://www.catia.ws/). It is focused on addressing the need for ICTs to support social and economic development issues. It will be working to help build capacity across Africa to achieve sustainable change. The components of the programme are:
- Low-cost satellite Internet access widely available across Africa (Component 1a)
  - Robust African Internet backbone with exchange points at the core and strong African ISP Associations (Component 1b)
  - Well-informed, lively and inclusive policy debates across Africa, shaping the local policy environment (Component 1c)
  - Positive policy environments for radio broadcasting across Africa (led by Panos Institute) (Component 1d)
- An African-led network of institutions, actively strengthening the African expertise involved in setting ICT related policy (Component 1e)
  - Increased capacity for African developing countries to participate in international ICT decision making (Component 1f)
  - Low-cost computers and open source software being developed and tailored to the African market (Component 2a)
  - Stronger network of community radio, FM and public service radio stations across Africa, offering good pro-poor radio programmes (led by Amarc) (Component 2b)
  - A thriving African-based Open Knowledge Network, catalysing the creation and exchange of local content (led by OneWorld) (Component 2c)
- 36 For a more complete description of this report see [www.oucs.ox.ac.uk](http://www.oucs.ox.ac.uk).
- 37 The project, which began in 2000, focused on issues for e-learners around the Digital Divide. It developed recommendations and guidelines for six learner groups as well as guidelines, literature reviews and research reports that are available at <http://flexiblelearning.net.au/accessequity/research/research.htm>
- 38 For a description of this work see [www.unescobkk.org/ips/ebooks/documents/ICTedu/index.htm](http://www.unescobkk.org/ips/ebooks/documents/ICTedu/index.htm)
- 39 The venues for the project were FE colleges, community colleges, outreach centres, learning shops, a prison and a refugee organization. The results from the study are available at: [www.ufildt.co.uk/press/papers/literacyguide.pdf](http://www.ufildt.co.uk/press/papers/literacyguide.pdf)
- 40 The report is provided at: [www.schoolnet.ca/grassroots/e/resources/toolkit/Dibbon/index.asp](http://www.schoolnet.ca/grassroots/e/resources/toolkit/Dibbon/index.asp). The GrassRoots Programme is aimed at encouraging teachers to move beyond traditional ways of teaching to incorporating more innovative approaches to teaching and learning in their day-to-day work.
- 41 The report is available at [www.schoolnet.ca/accueil/e/resources/metadata/newurl\\_technology\\_support\\_13842\\_e.html](http://www.schoolnet.ca/accueil/e/resources/metadata/newurl_technology_support_13842_e.html)
- 42 [www.leeds.ac.uk/educol/documents/00001369.htm#Summary](http://www.leeds.ac.uk/educol/documents/00001369.htm#Summary)
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