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ICT-in-Education Toolkit
for Policy Makers, Planners and Practitioners

Version 2.0

ICTs for Education

A Reference Handbook

Part 3: Resources

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

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

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

Part 1 presents decision makers with a summary of:

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

Part 2 of the handbook:

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

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

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Additional resources are available in the Toolkit Library and in the "Reference Information" sections of certain Tools

1. Background

Resource 1.1 - Revised Bloom's Taxonomy

Benjamin Bloom created the Taxonomy of Educational Objectives in the 1950s as a means of expressing qualitatively different kinds of thinking. Bloom's Taxonomy has since been adapted for classroom use as a planning tool and continues to be one of the most universally applied models across all levels of schooling and in all areas of study.

The Revised Bloom's Taxonomy
During the 1990s, Lorin Anderson (a former student of Benjamin Bloom) led a team of cognitive psychologists in revisiting the taxonomy to examine the relevance of the taxonomy as we enter the 21st century. As a result of the investigation, a number of significant improvements were made to the existing structure.

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

Before turning to examples of how the newly revised Taxonomy may be applied, it would be appropriate at this point to make both the revisions and reasons for the changes explicit. Figure 1.1 below describes both the "old" and the "new" taxonomies:

Figure 1.1 The Original Taxonomy and the Revised Taxonomy

Bloom's Original Taxonomy	Anderson's Revised Taxonomy
Knowledge	Remembering
Comprehension	Understanding
Application	Applying
Analysis	Analyzing
Synthesis	Evaluating
Evaluation	Creating

Some of the more significant changes include changes in terminology, structure, and emphasis, all of which are summarized below.

Changes in Terminology
1. As depicted in the previous table, the names of six major categories were changed from *noun* to *verb* forms. The reasoning behind this is that the taxonomy reflects different forms of thinking and thinking and is an *active* process. Verbs describe actions, not nouns, hence the change.
2. The subcategories of the six major categories were also replaced by verbs, and some subcategories were reorganized.
3. The knowledge category was renamed. Knowledge is an outcome or product of thinking, not a form of thinking per se. Consequently, the word *knowledge* was inappropriate to describe a category of thinking and was replaced with the word *remembering*.
4. Comprehension and synthesis were retitled *understanding* and *creating*, respectively, to better reflect the nature of the thinking defined in each category.

Changes in Structure
1. The one-dimensional form of the original taxonomy becomes a two-dimensional table with the addition of the products of thinking (i.e., various forms of knowledge). Forms of knowledge are listed in the revised taxonomy as factual, conceptual, procedural, and metacognitive.
2. The major categories were ordered in terms of increased complexity. As a result, the order of synthesis (create) and evaluation (evaluate) have been interchanged. This was done in deference to the popularly held notion that if one considers the taxonomy as a hierarchy reflecting increasing complexity, then creative thinking (i.e., *creating* level of the revised taxonomy) is a more complex form of thinking than is critical thinking (i.e., *evaluating* level of the new taxonomy).

Put quite simply, one can be critical without being creative (i.e., judge an idea and justify choices), but creative production often requires critical thinking (i.e., accepting and rejecting ideas on the path to creating a new idea, product, or way of looking at things).

Changes in Emphasis
1. The revision's primary focus is on the taxonomy *in use*. Essentially, this means that the revised taxonomy is a more authentic tool for curriculum planning, instructional delivery, and assessment.
2. The revision is aimed at a broader audience. Bloom's Taxonomy was traditionally viewed as a tool best applied in the earlier years of schooling (i.e., primary and junior primary years). The revised taxonomy is more universal and easily applicable at elementary, secondary, and even tertiary levels.
3. The revision emphasizes explanation and description of subcategories.

For example, subcategories at the *Remembering* level of the taxonomy include:

- **Recognizing/Identifying**—Locating knowledge in memory that is consistent with presented material.
- **Recalling/Retrieving/Naming**—Retrieving relevant knowledge from long-term memory

The table below gives a comprehensive overview of the subcategories, along with some suggested question starters that seek to elicit thinking specific to each level of the taxonomy. Suggested potential activities and student products are also listed.

Category
<u>**REMEMBER**</u> **Recognizing** Locating knowledge in memory that is consistent with presented material. Synonyms: Identifying **Recalling** Retrieving relevant knowledge from long-term memory. Synonyms: Retrieving, Naming
<u>**UNDERSTAND**</u> **Interpreting** Changing from one form of representation to another Synonyms: Paraphrasing, Translating, Representing, Clarifying **Exemplifying** Finding a specific example or illustration of a concept or principle Synonyms: Instantiating, Illustrating **Classifying** Determining that something belongs to a category (e.g., concept or principle) Synonyms: Categorizing, Subsuming **Summarizing** Drawing a logical conclusion from presented information Synonyms: Abstracting, Generalizing **Inferring** Abstracting a general theme or major point Synonyms: Extrapolating. Interpolating, Predicting, Concluding **Comparing** Detecting correspondences between two ideas, objects, etc. Synonyms: Contrasting, Matching, Mapping **Explaining** Constructing a cause-and-effect model of a system Synonyms: Constructing models
<u>**APPLY**</u> **Executing** Applying knowledge (often procedural) to a routine task Synonyms: Carrying out **Implementing** Applying knowledge (often procedural) to a nonroutine task Synonyms: Using

ANALYZE **Differentiating** Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material Synonyms: Discriminating, Selecting, Focusing, Distinguishing **Organizing** Determining how elements fit or function within a structure Synonyms: Outlining, Structuring, Integrating, Finding coherence **Attributing** Determining the point of view, bias, values, or intent underlying presented material Synonyms: Deconstructing
EVALUATE **Checking** Detecting inconsistencies or fallacies within a process or product Determining whether a process or product has internal consistency Synonyms : Testing, Detecting, Monitoring **Critiquing** Detecting the appropriateness of a procedure for a given task or problem Synonyms: Judging
CREATE **Generating** Coming up with alternatives or hypotheses based on criteria Synonyms: Hypothesizing **Planning** Devising a procedure for accomplishing some task. producing Synonyms: Designing **Producing** Inventing a product. Synonyms: Constructing

Reference - The above is excerpted from the following source:

http://rite.ed.qut.edu.au/oz-teachernet/index.php?module=ContentExpress&func=display&ceid=29.

2 The Potential of ICTs: Enhancement of Educational Goals

2.1 Expanding Educational Opportunities and Increasing Efficiency

Resource 2.1.1 - Broadcast Radio Cases

The Case of Botswana[1]

The use of radio as a medium of instruction for distance education started in the 1970s. The program uses what is known as the three-way teaching method of print, radio, and face-to-face instruction to reach students who study by the distance education method, wherever they are in Botswana. Print is the primary medium, and radio and face-to-face methodologies are supplementary. Radio is used in teaching the following subjects:

- Bookkeeping and Commerce
- English
- History
- Human and Social Biology
- Geography
- Mathematics
- Setswana

Students are also counseled through the radio.

The following problems have been experienced in teaching by radio:

- ***Reception***: There are still parts of Botswana where reception is very poor. In such places students do not benefit from the radio lessons.
- ***Access***: Some students do not have access to radios, even though many households have them. Some of those who have radios often run out of batteries, especially in rural areas.
- ***Broadcast schedules***: Some students have complained about the broadcast schedules. Botswana has only one central radio station, so not every program has a time slot suitable for its target audience.

The Case of St. Lucia[2]

An entertainment-education radio soap opera, *Apwe Plezi*, was broadcast and evaluated from February 1996 to September 1998 in St. Lucia. It began a new season in 2000. The program promoted family planning, HIV prevention, and other social development themes. Fifteen-minute episodes were broadcast and rebroadcast most days of the week on Radio St. Lucia.

The characters in the soap opera serve as positive, negative, or transitional behavioral role models, and their fates provide vicarious learning experiences to demonstrate the

[1] Excerpted from: http://www1.worldbank.org/disted/Technology/broadcast/rad-02.html.
[2] Excerpted from: http://www.guttmacher.org/pubs/journals/2614800.html.

consequences of alternative behaviors. Positive characters embody positive values and are rewarded, while negative characters embody negative values and are punished.

The program's effects were assessed through analyses of data from nationally representative pretest and posttest surveys, focus-group discussions, and other qualitative and quantitative sources. Among 1,238 respondents to the posttest survey, 35% had listened to *Apwe Plezi*, with significant effects on several knowledge, attitude, and behavior variables. *Apwe Plezi* increased listeners' awareness of contraceptives, improved their attitudes toward fidelity and family relations, and caused them to adopt family planning methods.

Resource 2.1.2 - Interactive Radio Instruction (IRI)

The Case of the Dominican Republic[3]

In the Dominican Republic, for example, an IRI project, called RADECO, was created for children who had no schools; it has been broadcast for more than 12 years. In early evaluations, children who had just five hours of integrated instruction a week using IRI and 30 minutes of follow-up activities were compared to students who were in regular formal schools for more than twice the amount of time. Results showed that first graders using the RADECO programs responded correctly 51% of the time on posttests, versus 24% of the time for the control group. Second graders using IRI gave 10% more correct answers than did the control group. Overall, even though these students had enormous obstacles, students in both grades who used IRI for an hour a day had comparable results in reading, writing, and language, compared to the control group, and performed significantly better in math.

Based on the early success of the RADECO project, IRI programs are being developed in other areas that face different types of obstacles, such as the failing schools of Haiti, nonformal early childhood development centers in Bolivia and Nepal, and adult learning centers in Honduras.

The Case of Zambia[4]

In Zambia, interactive radio instruction now shows that IRI also can help to increase education access for children who have no schools or teachers and who are increasingly vulnerable due to the effects of HIV/AIDs and poverty. IRI, which is delivering basic education to out-of-school children, especially orphans and other vulnerable children, in community learning centers, is a collaborative effort among communities, churches, nongovernmental organizations (NGOs), the Ministry of Education's Educational Broadcast Services (EBS), the Peace Corps, and the Education Development Center (EDC). EBS develops and broadcasts the programs and develops supplementary materials, such as mentor's guides, and the Ministry of Education trains mentors in its District Resource Centers and provides supervision/monitoring at participating learning centers. Communities, churches, schools (both government and community), and NGOs provide the learning center venues, mentor(s) to facilitate the radio broadcasts, radio receivers, a

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

[4] Excerpted from: Andrea Bosch et al. 2002. "Interactive Radio Instruction: An Update from the Field." In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects*. Paris: UNESCO, and Washington, DC: Academy for Educational Development.

blackboard, and some locally made materials. Communities also mobilize out-of-school children to attend the learning centers each day. EDC has trained EBS writers and producers and assisted EBS to develop a training-of-trainers program for Ministry of Education resource center staff who, in turn, train mentors to run the community-based learning centers.

In 2000 and 2001, EBS produced and aired daily 30-minute lessons for grade 1, following the Zambian curriculum for mathematics and English. Grades 2 and 3 are in the process of lesson development. In addition, each IRI program includes skills in English as a second language, basic mathematical skills, and a five-minute segment covering life skill themes (hygiene, nutrition, social values, etc.) to strengthen the ability of the community to support its children. The programs are designed to be guided by a facilitator rather than a trained teacher, so the content can be delivered easily, and more students can participate. Because the programs promote interactive learning during the broadcast, as do all IRI programs, facilitators are supported in their leadership roles with new content and subject matter.

Resource 2.1.3 - Television

The Case of *Telecurso* in Brazil[5]

With its large territory and low school attendance, Brazil has been experimenting with radio and television education for more than three decades. Two states in the Northeast (Ceará and Maranhão) created secondary schools through television in the 1970s. A bit later, another player—the private enterprise Globo Television Network—stepped onto the stage and completely changed the relationship between secondary schools and television. Being the world's fourth largest network, Globo had ample experience in production, excelling in soap operas that found huge markets in all continents. Twenty years ago, the Roberto Marinho Foundation (FRM), the education branch of Globo, created the first *Telecurso*, adding a number of important innovations, including very expensive production and actors instead of teachers. This program, a major success, aired for more than 15 years.

Telecurso targeted young adults who left primary or secondary schools before graduation. Brazil has always offered open examinations for primary (eight years) and secondary (11 years) certificates (*exame supletivo*) for young adults who are beyond a certain age. Since these were open examinations, students could prepare for them on their own or enroll in preparatory courses. The *Telecurso* took the place of these preparatory courses, allowing students to follow the curricula by watching television. A number of institutions received FRM supervision to create classrooms where, with the aid of an improvised or certified teacher, students could watch the programs/classes and use the complementary written materials.

In the early 1990s, with the rapid transformation and globalization of the Brazilian economy, industrialists were having problems with the appallingly low schooling levels of their workers. In many cases, they sponsored their students to take preparatory courses leading to the government examinations. However, the quality of these courses was, at best, mediocre.

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[5] Excerpted from: Claudio de Moura Castro. November/December 1999. "Brazil's Telecurso 2000: The Flexible Solution for Secondary School Equivalency." ***TechKnowLogia.*** Available at www.TechKnowLogia.org.

The Federation of Industries of the State of São Paulo then struck a deal with FRM to prepare a new *Telecurso* for its workers. In this joint venture, the industrialists contributed US$30 million to produce a new program, and Globo offered to broadcast it without any charges. Globo also donated the equivalent of US$60 million worth of commercial TV time to promote the new program, called ***Telecurso 2000***.

Telecurso 2000, a condensed version of a basic curriculum for distance education, is to be provided through a combination of videotaped classroom sessions and books. Thus, both television sets and videocassette equipment are used. In addition, an optional curriculum is offered that focuses on teaching basic mechanical skills (the vocational course on mechanics).

It is difficult to identify all the users of *Telecurso*. Suffice it to say, however, that 5.2 million accompanying texts were sold or distributed between 1995 and 1999. *Telesalas* (classrooms with television sets) have been created in enterprises, and a support system for those working with students has been established. At present, more than 200,000 students attend classes in factories, schools, churches, offices, prisons, ships, and buses. In addition, an unknown—but probably large—number of people watch television and study on their own. But even more surprising, another large and uncounted crowd watches the programs regularly or occasionally, apparently because it is interesting, light, and fun. A further development is the spontaneous use of the programs in regular schools, something that had already started with the old *Telecurso*. A number of states are now developing explicit programs to incorporate portions of *Telecurso* into regular secondary schools.

The per-student costs are significantly low because of the large number of participants. Assuming a cost of US$30 million for preparing *Telecurso 2000*, if the program were to stop today, figures for book sales indicate that several million students participated in *Telecurso* somewhat seriously. Assuming that three million used the program, this would amount to US$10 per student. This is a very modest per student cost for a set of 1,200 15-minute lectures. Costs per book are around US$4 (the primary school program uses a single book, and the secondary program uses multiple books). Hence, the social cost per student working on his or her own is US$14.

The Case of *Telesecundaria* in Mexico[6]

Telesecundaria was created over three decades ago in response to the needs of rural Mexican communities where a general secondary school (grades 7–9) was not feasible, because of too few students or an ability to attract teachers. The main characteristics of *Telesecundaria* have always been:

- using television to carry most of the teaching load, and
- having one teacher to cover all subjects, rather than the subject matter specialists used in general secondary schools.

This combination permits effective installation and implementation of these schools in sparsely settled rural areas that are usually inhabited by fewer than 2,500 people and have low primary completion and secondary enrollment rates, since just three classrooms and three teachers can cover the complete curriculum.

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[6] Excerpted from: Claudio de Moura Castro, Laurence Wolff, & Norma Garcia. September/October 1999. "Mexico's Telesecundaria—Bringing Education by Television to Rural Areas." *TechKnowLogia*. Available at www.TechKnowLogia.org.

Telesecundaria has experienced a very substantial growth rate since its inception in 1968. Its current enrollment is over a million and is equivalent to 16.6% of total enrollment in grades 7–9.

On average, the *Telesecundaria* schools have three teachers—one for each grade—and 22 students per grade. Students attend school 200 days a year, 30 hours a week. The instructional program, which went through many stages, is now integrated and comprehensive, providing a complete package of distance and in-person support to students and teachers. It puts teachers and students on the screen, brings context and practical uses of the concepts taught, and uses images and available clips extensively to illustrate and help students. It also enables schools to deliver the same secondary school curriculum offered in traditional schools.

At 8 a.m., the teachers in all of the *Telesecundaria* schools in Mexico turn on the TV. The students watch 15 minutes of television, then the set is turned off, and the book, workbook, and teacher take over, following detailed instructions for the remaining 45 minutes. First, the teacher asks whether students have any questions about the concepts they have just seen. Then, they might read aloud, apply what was taught in practical exercises, and participate in a brief evaluation of what has been learned. Finally, the materials taught are reviewed. At 9 a.m., another subject starts, following the same routine.

Evaluation studies show that *Telesecundaria* students start significantly behind other students but catch up completely in math and cut the deficit in language in half. It strongly suggests that the "value added" of learning is higher in *Telesecundaria* than it is in general schools.

In terms of cost, *Telesecundaria* schools have proven to be slightly more costly (per student) than conventional schools, mainly because of the cost to develop TV programs. However, a more appropriate comparison would be with the cost of setting up a general secondary school in a rural area. In principle, the cost would be prohibitive, since a school with 60 students would require 12 teachers, for a 5:1 student-teacher ratio, as well as a full laboratory and administrative personnel. This would add up to running costs nearly four times those of *Telesecundaria*. Even after subtracting the unit costs of television programs, schools would still be three times as expensive.

Resource 2.1.4 - Virtual High Schools

Choice 2000[7]

Choice 2000, one of the original charter schools in California, is a completely online and fully accredited secondary school for grades 7–12.

The instructional platform that Choice uses is interactive. Students attend classes daily at set times, and lessons are presented visually and verbally. Students and teachers are able to interact directly in this virtual environment, hearing and answering questions and participating in discussions of what appears on the screen. Students must provide their own computer. The maximum class size is 20 students per class, with an average of 13 students.

[7]Summarized from: http://www.choice2000.org/.

The Alberta Distance Learning Centre[8]

The Alberta Distance Learning Center (ADLC), Canada, provides a distance education program leading to a high school diploma. It uses both asynchronous and synchronous on-line learning methods.

Online students are assigned to in-house Distance Learning Teachers who initiate contact with students to provide regular coaching, monitoring, and tutoring opportunities for each student. Students work from a combination of online and print materials and generally submit their assignments electronically. Expected turnaround time for student work is one to three days. In addition, students receive multiple assessment opportunities beyond regular assignment activities, such as quizzes, a unit test, and possibly a mid-term exam, thereby placing less weight on the final exam and bettering the students' potential for high achievement.

For the predominantly asynchronous courses, students communicate by such Internet media as e-mail, online chat, threaded discussions, audio conferences, and shared whiteboards as well as by telephone, print, and fax machine. For synchronous courses, live classes are conducted over the Internet. The entire class "meets" at a regular time, and students are able to communicate with each other using microphones, drawing tools, and even sharing computer software.

The Open School in British Columbia[9]

The Open School in British Columbia (BC) (Canada)provides asynchronous learning opportunities to high school students in the province. The online courses, using WebCT platform, are developed by a team of teachers, instructional designers, Web developers and education specialists who work together to produce ready-to-use, K-12 courses and resources that meet BC Ministry of Education curriculum guidelines. Unfortunately, however, a review of a sample course shows that it is basically a hyperlinked text. See http://www.openschool.bc.ca/online_login.html.

Virtual School Service in Australia[10]

In Australia, the only full-service virtual school—the Virtual School Service—provides online classes to Queensland's high school students in subject areas that regular high schools have difficulty offering, including economics, mathematics, Japanese, modern history, information processing and technology, and physics. Review sample activities at:
http://education.qld.gov.au/virtualschool/html/students/infohub/study_activities.htm.

PBS—High School Equivalency Online Program[11]

The General Educational Development (GED) Testing Service develops and distributes GED tests, which are designed to provide a "reliable vehicle through which adults can certify that they possess the major and lasting outcomes of a traditional high school education." More than 860,000 adults worldwide take the GED tests each year, and more than 95% of U.S. employers consider GED graduates the same as traditional high school graduates in terms of hiring, salary, and opportunity for advancement.

[8] Summarized from: http://www.adlc.ca/home.
[9] Summarized from: http://www.openschool.bc.ca/.
[10] Summarized from: http://education.qld.gov.au/virtualschool/html/index.htm.
[11] Summarized from: http://litlink.ket.org/wesged.iphtml.

PBS LiteracyLink offers learners a GED Connection package to help individuals prepare for the GED test with:

- 39 video programs, broadcast by public television stations or available as videotapes
- student workbooks covering reading/writing, social studies/science, and math
- interactive online learning modules, with practice tests, online activities and quizzes for each GED lesson.

These integrated multimedia components work together to make studying for the GED easy for busy adults who need to work at their own pace. In addition to the online modules, learners can view the lessons on their local public television stations, record them, and use the videotapes to study at home. Many local adult education programs, community colleges, one-stop career centers, and libraries have GED Connection videos and books available, with classes and teachers to help. Online teachers from several states are also available to coach adult learners in virtual classrooms.

Florida Virtual School[12]

The Florida Virtual School (FLVS) is a statewide, Internet-based, public high school offering a rigorous curriculum online. Enrollment for 2002–03 exceeded 10,000. Courses are free to all Florida students and are available to public, private, and home schooled students, and non-Florida students can enroll in FLVS on a tuition basis. FLVS offered 75 courses during the 2003–04 school year, including honors and 11 Advanced Placement classes. FLVS course grades are accepted for credit and are transferable.

All FLVS courses are delivered over the Internet. To help assure student success with virtual learning, a variety of Web-based, technology-based, and traditional resources is provided. Teachers communicate with students and parents regularly via telephone, e-mail, online chats, instant messaging, and discussion forums. For a course demonstration, visit: http://www.flvs.net/_global_connections/flash_courses/index.htm.

FLVS is currently working to assemble a “Virtual School Sourcebook” designed to offer readers a resource for developing and managing a virtual school learning enterprise. It will highlight FLVS “lessons learned,” along with key issues that should be addressed when undertaking a virtual school initiative. It is also willing to license its courses to other schools and districts.

The Babbage Net School[13]

The Babbage Net School is a private virtual high school offering online, interactive courses in English, math, science, social studies, SAT preparation, foreign language, Advanced Placement, music, and art. These courses are taught by certified teachers in a virtual classroom featuring interactive audio, synchronized Web browsing, and a shared whiteboard. The Babbage Net School also offers in-service courses for teachers.

The classes meet in a “classroom” at a specific time, and only registered students are allowed into a class. The virtual class is extremely similar to classes given in a traditional bricks-and-mortar school building. A certified, experienced teacher is in control of the class and guides the students through each lesson. The students have textbooks, the teacher talks to the class, and students can be “given the floor” so they can also talk to

[12] Summarized from: http://www.flvs.net/.
[13] Summarized from: http://www.babbagenetschool.com/.

the class. Some class material is shown to the students as Web pages using a synchronized Web browser; other material is displayed on a whiteboard that functions as a blackboard does in a traditional classroom. Students can raise their hands to get the teacher's attention, or they can ask questions using text chat. The teacher can have a student answer a question by talking to the class or writing on the whiteboard, making the virtual class fully interactive. Students can also interact asynchronously with the teacher or their classmates by e-mail.

The Virtual High School

The Virtual High School (VHS) is a research-based project administered by a partnership between the Hudson Public School (Massachusetts) and The Concord Consortium. Through the Internet, participating schools can offer new courses without having to increase enrollment to justify the expenses. The project functions as a cooperative; each participating school contributes at least one teacher and a site coordinator to the project, and, in exchange, the school can enroll a preestablished number of students in any VHS courses. A site coordinator helps to recruit the students and teachers, to ensure that the technology is available and functioning, and to provide support to the students. The advantage of the cooperative system is that the major cost of project personnel—is shared among all participants.

Before developing the online course, the teacher must complete a graduate-level course on design and development of network-based material. Each online course may take a year to develop and must be approved by the school principal and VHS central staff. More recently, an Evaluation Board has been formed to define standards of quality for the courses. The courses, mostly one semester long, are taken for credits as core subjects or electives. The courses are mostly interdisciplinary and use student-centered, hands-on instructional strategies that emphasize collaborative learning and inquiry. Students can take the course at home or during school time. The VHS coordinator functions as a tutor. The online courses are housed in a LearningSpace educational environment that enables teachers to deliver lectures, moderate student discussions, conduct assessments, and receive students' work. Students can submit work individually or in groups and can participate in discussions with their peers.

The first semester of the project was hampered by a series of technical problems and a lack of participant experience with the process. For instance, because staff underestimated the server capacity needed to support 350 students online, the courses were offline for a few weeks. As time passed, technical difficulties decreased, the teachers learned how to manage the logistics of online teaching, and students improved their understanding of the responsibility and persistence necessary to participate in distance learning. During the 1997–98 school year, the project had 30 participant schools and offered 30 courses to 700 students. In 1999–2000, the number of schools grew to 87, and the project offered 94 courses to more than 2,500 students. It is estimated that the project will serve more than 6,000 children over the five-year grant period.[14]

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[14] C. Espinoza, T. Dove, A. Zucker, & R.B. Kozma. October 1999. *An Evaluation of the Virtual High school After Two Years of Operation.*: SRI International. Available at http://vhs.concord.org; R. Tinker. 1998. *The Virtual High School: A Scalable Cooperative.* Available at http://vhs.concord.org; K. Yamashiro & A. Zucker. November 1999. *An Expert Panel Review of the Quality of Virtual High School Courses: Final Report.* SRI International. Available at http://vhs.concord.org.

Resource 2.1.5 - Virtual Universities[15]

Peru's Higher Technological Institute

Peru's Higher Technological Institute (TECSUP) is a dual-mode institution that uses both conventional campuses, in Lima and Arequipa, and a virtual campus that was introduced in 1999. As of 2000, more than 1,600 learners were enrolled in a variety of distance education courses, primarily in technical training. According to Wolff and Garcia, learners can access the TECSUP virtual campus through TECSUP conventional campus locations, their workplace, home, or public Internet kiosks. Courses are generally seven weeks and include online content, self-evaluations, and discussions with the instructor and other students.[16] For more information, visit http://www.tecsup.edu.pe.

The African Virtual University

The African Virtual University (AVU) is a single-mode institution that operates without a conventional campus, but uses the facilities of conventional universities in 22 sub-Saharan African universities in 15 countries to provide learners with facilities to access technology delivery systems.[17] Established in 1997, the AVU supports learners across the continent through videotaped instruction and/or live broadcast (via satellite or fiber optic connections), with learners participating in the discussion by e-mail, telephone, or fax. Additional reference materials such as books, journals, and course notes are also available for learners. Courses currently offered by the AVU focus primarily on training and certificate programs, with more than 23,000 learners having completed at least one semester-long course. Though current fees per course are still out of reach of many Africans, they generally are much less than those of competitive programs offered by other international universities. For more information, visit http://www.avu.org.

The University of the Highlands and Islands

Serving a dispersed and rural population in Scotland, the University of the Highlands and Islands (UHI) provides a diverse collage of thematic multidisciplinary learning opportunities for both degree-seeking and nondegree-seeking learners. Like many single-mode institutions, UHI uses local learning centers, 50 in this case, to provide regional support to learners. Using instructional readings, local classroom instruction, informal tutors, videoconferencing, self-paced computerized instruction, and other media, UHI offers courses that, like most professional development training, focus more on "building individual competencies than the transfer of knowledge."[18] Developed in consultation with employers, UHI courses are tailored specifically to the needs of the Highlands and Islands. They cover a range of subjects focusing on the region's principal industries and businesses, including fisheries, land management, forestry, marine ecology, and tourism. For more information, visit http://www.uhi.ac.uk.

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[15] Excerpted from: Ryan Watkins & Michael Corry. 2002. "Virtual Universities: Challenging the Conventions of Education." In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects*. Paris: UNESCO, and Washington, DC: Academy for Educational Development.

[16] L. Wolff & N. Garcia. May/June 2001. "Higher Education and Enterprise Training in Latin America: The Case of the Virtual Campus of Peru's Higher Technological Institute." *TechknowLogia*. Available at www.TechKnowLogia.org.

[17] M. Diagne. January/February 2000. "The African Virtual University: Bridging the Knowledge Gap for Development." *TechKnowLogia*. Available at www.TechKnowLogia.org.

[18] R. Hopper & W. Saint. January/February2000. "New Paradigm or Exceptional Case?" *TechKnowLogia*. Available at www.TechKnowLogia.org.

The Virtual University of the Technological Institute of Monterrey

The Virtual University of the Technological Institute of Monterrey (ITESM), Mexico, is the primary provider of distance education in Mexico and many other areas of Latin America. ITESM is a dual-mode institution that offers mainly master's degree-level programs through its virtual campus.[19] Using primarily satellite technology, ITESM provides courses to more than 1,300 reception sites throughout Mexico and Latin America. In addition, ITESM offers a franchised[20] master's program in educational technology with the University of British Columbia. For more information, visit http://www.itesm.mx.

The University of Phoenix

One of the few private, for-profit universities to offer distance education internationally, the University of Phoenix (UP) operates a variety of small-campus facilities throughout the United States and an online virtual campus. For the majority of learners, the online campus provides a variety of resources to support their classroom sessions.[21] In addition, the UP offers courses conducted completely through the virtual campus as well as nonfranchised international programs to learners around the world through online courses. Currently enrolling more than 80,000 working adult students, the UP's completion rate averages approximately 60% across all programs. For more information, visit http://www.phoenix.edu.

The Open University of Hong Kong

Previously known as the Open Learning Institute of Hong Kong, the Open University of Hong Kong (OUHK) offers a variety of degree and certificate programs in the arts and social sciences, business and administration, education and languages, and science and technology.[22] Currently the university teaches over 100 postgraduate, degree, and subdegree programs to more than 25,000 enrolled learners. The OUHK uses a flexible credit system under which learners earn credits for each course, which accumulate toward a degree. Similar to other open universities—specifically, the United Kingdom Open University—the OUHK provides course-related materials to distance learners through a variety of instructional media, including text, videotape, and some broadcast television. Additionally, learners are required to attend tutoring sessions at local study centers periodically during each course. For more information, visit http://www.ouhk.edu.hk.

Nova Southeastern University

Like the University of Phoenix, Nova Southeastern University (NSU) offers international programs to learners around the world. NSU is private, not-for-profit university that has students at its conventional campus and learners taking courses offered at a distance.

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[19] L. Wolff. January/February 2000. "Mexico: The Virtual University of the Technological Institute of Monterrey." *TechKnowLogia*. Available at www.TechKnowLogia.org.

[20] A franchise is a granted right to use someone else's materials and services in a specific territory.

[21] G. Jackson. January/February 2000. "University of Phoenix: A New Model for Tertiary Education in Developing Countries?" *TechKnowLogia*. Available at www.TechKnowLogia.org.

[22] S. Jurich. January/February 2000. "The Open University of Hong Kong: Quality Assurance in Distance Education." *TechKnowLogia*. Available at www.TechKnowLogia.org.

NSU currently enrolls more than 18,000 learners, and many of its programs provide dual-mode educational opportunities to students who meet in person and online. Providing online programs all the way to the doctorate level, NSU's virtual campus supports online learners with an extensive virtual library. For more information, visit http://www.nova.edu.

The Center for Open Distance Education for Civil Society

The Center for Open Distance Education for Civil Society (CODECS) now offers educational opportunities to learners throughout Romania.[23] In cooperation with the United Kingdom Open University (UKOU), CODECS operates 12 regional centers offering tutorial support for learners using UKOU instructional materials (including videotapes, instructional texts, course software, etc.). Certificates, diplomas, and degrees attained through CODECS-offered courses are recognized internationally through the UKOU. The CODECS model for institutional structure is a primary example of franchised international distance education. For more information, visit http://www.open.ac.uk/collaborate/romania.htm.

2.2 Enhancing Quality of Learning

Resource 2.2.1 - The Value of Tailored Instruction[24]

Technology-Based Instruction

An argument for technology-based instruction may be roughly summarized as the following:

- Tailoring instruction to the needs of individual students remains an instructional imperative. Despite heroic efforts to the contrary, however, today's classroom instruction does not achieve this.
- Tailoring instruction to the needs of individual students requires very low teacher-to-student ratios—specifically the one-to-one ratios found in individual tutoring. Absent dramatic changes in public policy, such individualization remains both an instructional imperative and an economic impracticality.
- Technology-based instruction can make this imperative affordable and feasible.
- Technology-based instruction is more effective than current instructional approaches across many subject matters, because of its intense interactivity and individualization.
- Technology-based instruction is generally less costly than current instructional approaches, especially when many students and/or expensive equipment or instrumentation are involved.
- Technology-based instruction will become increasingly affordable and instructionally more effective.

The Value and Affordability of Tailored Instruction

The argument for technology-based instruction usually begins with an issue that is separate from the use of technology. It concerns the effectiveness of classroom instruction, involving one instructor for 20-30 students, compared to individual tutoring, involving one instructor for each student.

[23] A. Ionescu. January/February 2000. "CODECS Brings the Open University to Romania." *TechKnowLogia*. Available at www.TechknowLogia.org.

[24] Excerpted from: J. D. Fletcher. January–March 2003. "Does This Stuff Work? A Review of Technology Used to Teach." *TechKnowLogia*. Available at www.TechknowLogia.org.

Bloom (1984) combined findings from three empirical studies comparing one-on-one tutoring with one-on-many classroom instruction. It was not surprising that such comparisons showed that the tutored students learned more; however how much more they learned was a surprise. Overall, it amounted to two standard deviations of difference in achievement. This finding means, for example (and roughly), that, with instructional time held fairly constant, one-on-one tutoring raised the performance of mid-level 50th percentile students to that of 98th percentile students. These and similar empirical research findings suggest that differences between one-on-one tutoring and typical classroom instruction are not only likely, but very large.

Why then do we not provide these benefits to all students? The answer is straightforward and obvious. With the exception of a few critical skills, such as aircraft piloting and surgery, we cannot afford it—or choose not to. The primary issue is cost.

Can computer technology help fill the gap between what we need and what we can afford? To answer this question, we should examine what accounts for the success of one-on-one tutoring. Fundamentally, its success appears to be due to two capabilities.

- Tutors and their students can engage in many more interactions per unit of time than is possible in a classroom.
- Tutors can adapt (individualize) their presentations and interactions on demand and in real time to the needs of their students.

Interactive, computer-based technologies can provide both of these capabilities.

Interactivity

With regard to the first tutorial capability (intensity of instructional interaction), Graesser and Person (1994) reported the following:

- Average number of questions by a teacher of a class in a classroom hour: 3
- Average number of questions asked by a tutor and answered by a student during a tutorial hour: 120–145
- Average number of questions asked by any one student during a classroom hour: 0.11
- Average number of questions asked by a student and answered by a tutor during a tutorial hour: 20–30

Is this level of interactivity found in technology-based instruction? One study found that students taking reading and arithmetic instruction were answering 8–10 questions a minute (Fletcher, in press). This level of interactivity extrapolates to 480–600 such questions an hour, if students sustained this level of interaction for 60 minutes. These students worked with the computer-based materials in 12-minute sessions, which extrapolates to 96–144 individually selected and rapidly assessed questions the students received each day for each subject area. This level of interactivity is certainly comparable to what they would receive in one-on-one tutorial instruction. Similar findings have been reported elsewhere.

Individualization

Tutors can and do adjust the content, sequence, and difficulty of instruction to the needs of their students. These adjustments affect pace—the rate or speed with which students proceed through instructional material.

Differences in the speed with which students learn are not surprising, but (as with tutoring) the magnitudes of the differences are. The challenge this diversity presents to classroom instructors is daunting. They typically focus on their slower students and leave the faster students to fend for themselves. It has long been noted that technology-based instruction allows students to proceed as rapidly or as slowly as they need to.

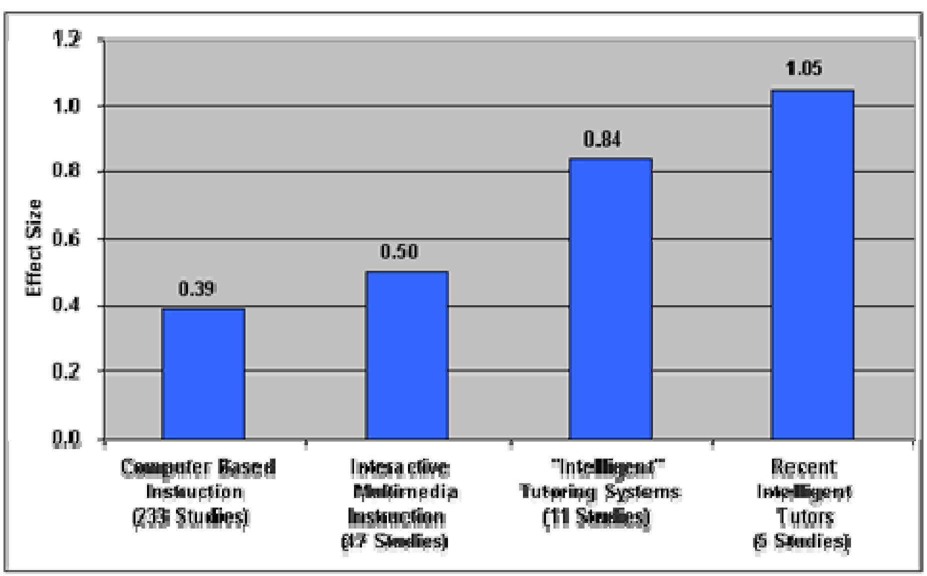
Payoff: Time Savings
One of the most stable findings in comparisons of technology-based instruction and conventional instruction using lecture, text, and experience with equipment concerns instruction time savings. Studies have shown that, overall, it seems reasonable to expect technology-based instruction to reduce the time it takes students to reach a variety of objectives by about 30%.

Payoff: Costs
Obviously, such time savings reduces expenditures for instructional resources, instructors' time, and student pay and allowances, as in the case of industrial training. These cost savings can be substantial.

Instructional Effectiveness
Do these savings in time come at the expense of instructional effectiveness? Research data suggest the opposite. An aggregation of many studies—"meta-analysis" (analysis of analyses)—produced an estimation of effect sizes. Roughly, effect sizes are normalized measures found by subtracting the mean from one collection of results (e.g., a control group) from the mean of another (e.g., an experimental group) and dividing the resulting difference by an estimate of their common standard deviation (Hedges and Olkin, 1985). Because they are normalized, effective sizes can be averaged to give an overall estimate of effect from many separate studies undertaken to investigate the same phenomenon.

Figure 2.2.1 shows effect sizes from several reviews of studies that compared conventional instruction and technology-based instruction.

Figure 2.2.1 Effect Sizes for Studies Comparing Technology-Based Instruction With More Conventional Approaches



“Computer-based instruction” summarizes results from 233 studies that involved straightforward application of computer presentations that used text, graphics, and some animation—as well as some degree of individualized interaction. The effect size of 0.39 standard deviations suggests, roughly, an improvement of 50th percentile students to the performance levels of 65th percentile students.

“Interactive multimedia instruction” involves more elaborate interactions adding more audio, more extensive animation, and video. These added capabilities evidently increase achievement. They show an average effect size of 0.50 standard deviations, which suggests that 50th percentile students improve to the 69th percentile of performance.

“Intelligent tutoring systems” involve a capability that has been developing since the late 1960s (Carbonell, 1970), but has only recently been expanding into general use. In this approach, an attempt is made to directly mimic the one-on-one dialogue that occurs in tutorial interactions. The important component of these systems is that computer presentations and responses are generated in real time, on demand, and as needed or requested by learners. Instructional designers do not need to anticipate and store them in advance.

This approach is computationally more sophisticated and more expensive to produce than is standard computer-based instruction. However, its costs may be justified by the increase in average effect size to 0.84 standard deviations, which suggests, roughly, an improvement from 50th to 80th percentile performance. In five empirical comparisons involving a single intelligent tutoring system, SHERLOCK, Gott, Kane, and Lesgold (1995) found an average effect size of 1.05 standard deviations, which suggests an improvement of the performance of 50th percentile students to the 85 percentile.

The more extensive tailoring of instruction to the needs of individual students that can be obtained with generative, intelligent tutoring systems is expected to increase. Such systems will raise the bar for the ultimate effectiveness of technology-based instruction.

Conclusion

The above research data, along with other findings, suggest a conclusion that has been called the rule of “thirds.” This conclusion states that technology-based instruction will reduce the costs by about a third and *either* increase achievement by about a third *or* decrease time needed to reach instructional objectives by a third.

In sum, the above review suggests the following:

- Technology-based instruction can increase instructional effectiveness.
- Technology-based instruction can reduce time and costs needed for learning.
- Technology-based instruction can make individualization affordable, thereby helping to ensure that all students learn.

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Resource 2.2.2 - Radio and Television Programs[25]

The Case of Ethiopia

Ethiopia has a rich experience in using radio and television to support primary, secondary and nonformal education, spanning more than three decades. The Educational Media Agency (EMA) of the Ministry of Education, which has led this effort, currently manages an extensive broadcasting infrastructure dedicated to supporting education. EMA has large facilities, employs approximately 160 persons, operates 11 transmitters, each with two channels, throughout the country, and runs 12 recording studios at the center and the regions, with more construction planned in the coming years.

Radios, including 500 solar-powered sets, have been distributed to almost all schools nationally, and 800 color televisions have been sent to almost all secondary schools.

The radio and television programs enrich education in the following manner:

- They improve the quality of primary education by producing at the regional level radio programs in local languages for all primary school grades in most subjects.
- They strengthen the teaching of English through development of interactive radio instruction (IRI).
- They improve the quality of secondary education and reduce regional disparities by producing radio and television programs in many secondary school subjects.
- They improve the qualifications of teachers by creating new distance education programs to upgrade underqualified primary school teachers.

The Venezuelan Experience with Interactive Radio for Math[26]

The Interactive Mathematics for Basic Education program is designed to raise the quality of mathematics teaching in the first phase of Basic Education in Venezuela, which corresponds to grades 1–3. The program was developed by the National Center for the Improvement of Science Education, CENAMEC, under the auspices of the Ministry of Education. It was financed at first by the Venezuelan private sector, then by the World Bank during the period of its greatest expansion.

The program was created to help resolve the problem of low levels of quality learning in this subject. Additionally, given that this problem is greatly tied to deficiencies in training and updating math teachers, the program was devised as a system of

[25] Excerpted from: Thomas D. Tilson & Demissew Bekele. May/June 2000. "Ethiopia: Educational Radio and Television. " *TechKnowLogia*. Available at www.TechKnowLogia.org.
[26] For further details, see Nora Ghetea Jaegerman & Victor Vásquez R. May/June 2000. "Interactive Mathematics for Basic Education: The Venezuelan Experience with IRI." *TechKnowLogia*. Available at www.TechKnowLogia.org.

permanent training for teachers using their own resources. To accomplish these objectives, the program offers to each participating classroom a radio, a teacher's guide, a package of complementary materials, the daily transmission of a radio program, *Matemática Divertida* (Entertaining Mathematics), teacher training, and follow-up.

The typical Interactive Mathematics lesson or "encounter" contains three important aspects: preparation, listening to the radio program, and carrying out activities suggested in the guide. During preparation, the teacher organizes the students and ensures that they have the necessary materials ready for the transmission. During the radio program, varied and intensive activities are carried out, monitored by the teacher. To wrap up the "encounter," the teacher conducts evaluation and reinforcement activities, going more in depth as suggested in the guide, in some cases supported by complementary materials the teacher receives.

Comparative studies of the children's learning between an experimental group and a control group indicated the following:

- First trial of first grade. Initially, the students in the experimental group were below the level of the control group students. By the end of the year, the experimental group had reached the control group, achieving learning gains that were significantly greater than those of the control group.
- Measurement of knowledge of children entering fourth grade. A study was done comparing fourth grade students who had studied under the Interactive Mathematics system and others who had followed traditional methods in the Federal District and the states of Lara and Mérida. The experimental group had significantly higher results than the control group.

Cost figures are:

- Development cost per program: US$3,000
- Recurring cost per school year per classroom or section
    - Follow-up and training: US$25
    - Radio transmissions: US$9.37
    - Radios and teacher's guides: US$9.6
    - Complementary materials and batteries: US$9
    - Total recurrent cost per class or section: US$53
- Total recurrent cost per student :US$1.76

The Case of Guinea[27]

The Republic of Guinea provides an example of how a multichannel learning approach and IRI can and do improve instruction on a nationwide scale. To reach the roughly 22,000 primary teachers in need of support and in-service training, a series of materials has been produced, each of which relies primarily on a different "channel" to communicate important concepts and topics to students and teachers. There are 66 IRI programs per grade for every grade from 1 to 6. The children access this learning channel three times a week during their French and math classes. In addition, there are

[27] Excerpted from: Andrea Bosch at al. 2002. "Interactive Radio Instruction: An Update from the Field." In Wadi D. Haddad & Alexandra Draxler (Eds.), *Technologies for Education: Potential, Parameters, and Prospects.* Paris: UNESCO, and Washington, DC: Academy for Educational Development.

materials that rely primarily on "print" to channel information toward the student: student workbooks for children in grades 2–6, and short-story readers for children in grades 1–2. Finally, there is a primarily visual channel: color posters, of which every primary school classroom has a set.

The addition of IRI programs and print materials to the teachers' spoken explanations of French vocabulary and basic math provide the children with a second auditory learning "channel" (the IRI programs); a more stimulating visual "channel" than their own notebooks (the color posters); and a number of kinesthetic "channels" supplied by the activities recommended in the IRI programs, on the backs of the posters, and in the teacher's editions of the workbooks and readers. All of the different materials are specific to the Guinean context and use objects/examples from the students' surroundings, thereby drawing on the learning "channel" to which students are exposed the most: the one that links them to their homes, families, and communities.

Resource 2.2.3 - The Case of IVEN

Science and mathematics are supposed to provide conceptual and technological tools that allow people to describe and explain how the world works with power and precision, and to achieve a richer understanding and appreciation of the world they experience. However, in most cases, school conditions have reduced the wonderful, dynamic, and multidimensional world of science into flat texts, scripted demonstrations, and occasional cookbook experiments. Similarly, the world of mathematical constructs, concepts, and relationships has been transformed into drill and practice of computations and abstract problems.

To address this problem, The Inter American Development Bank financed in 1999, the International Virtual Education Network (IVEN) for the Enhancement of Science and Mathematics Learning, a pilot, collaborative, cross-country project in Latin America. The project was designed by Knowledge Enterprise, Inc., which also acted as the International Coordinating Secretariat through early 2002. Brazil, Peru and Venezuela participated in the program, and Argentina and Colombia did so for a short time. The project is now in its implementation stage.

The backbone of the pilot project is the development of multimedia modules for the whole science and math program for the last two years of secondary schools. This comprehensive undertaking involves setting learning standards; translating standards into teaching/learning activities; producing multimedia curricular materials; staff training; distribution, testing, and refining curricula, educational materials, and pedagogical approaches; assessing learning achievement; and evaluating programs.

IVEN carries out these activities in three phases:

Phase 1. Preparation and Capacity Building

This phase covers preparing the design, training, infrastructure, and tools that set the necessary groundwork for full-scale implementation:

1. Strategy seminars were held with officials and project managers to orient them to the potential of the project and its benefits, prerequisites for success, implementation strategies, and long-term vision.
2. Agreements were finalized among the parties.
3. A design and implementation plan was prepared, including educational and instructional approaches, development of multimedia modules, institutional setup,

specifications for hardware and software, profile of instructional design teams and their training program, and evaluation scheme.

4. Instructional teams were selected and trained. Each discipline had a content team composed of master teachers and science or math education advisers as well as programmers, graphic designers, producers and Web specialists.

Phase 2. Development

This phase involves development and testing of curriculum-related multimedia modules to be applied and tested in experimental schools in the three countries:

1. The most difficult task in the production process was to agree on a common list of modules and a common approach to developing them, because the modules are supposed to be integrated into each country's curriculum without requiring curriculum reform.
   - The first step involved reaching a consensus on the approaches to the teaching of science and mathematics. This was accomplished by highlighting these approaches in the project design, discussing them with the steering committee, and incorporating them into the production teams' training program.
   - The second step was to ask each country to translate its science and math curricula into a logical grid of teaching/learning modules. Each of these modules was to be described in terms of objectives, content, and technological tools. Each country went through this exercise and sent its results to the international coordinating secretariat.
   - The third step was to harmonize the country lists of modules, arrive at a common list, and reach agreement about distribution of production responsibilities among participating countries.
2. Production teams have been developing modules and testing them for implementability and effectiveness.
3. The program of modules will be tested in a limited number of experimental schools.

Phase 3. Application in schools

1. Teachers in the pilot schools will be trained to use the technology and apply it to the above modules.
2. Pilot schools should be equipped with the appropriate technological infrastructure.
3. The developed and tested modules will be distributed to the pilot schools using a Web distributional platform. The modules will then be applied under experimental conditions and revised accordingly.

Phase 4. Scaling Up

The pilot phase will be submitted to a rigorous formative and summative evaluation to test for feasibility, effectiveness, and cost benefit before expanding on a larger scale.

At the end of this pilot phase, the following "products" will have been achieved:

- A fully developed multimedia program covering the total two-year science and mathematics program
- A trained cadre of multimedia production specialists in each participating country
- Personnel trained in the use of science and math learning modules in all of the pilot schools
- A physical infrastructure within schools and across countries

Once this pilot phase is completed successfully and the evaluation results are incorporated into the structure of the Virtual Network, then the Network can be scaled up over time in four directions:

- More secondary schools in the pilot countries
- More countries in Latin America
- Other levels of science and mathematics education
- Other school subjects

Resource 2.2.4 - Simulations

Examples of Web Science Simulations

- "ExploreScience.com" includes a substantial number of simulations about building blocks, mechanics, wave motion, electromagnetism, optics, astronomy, and life sciences. The mechanics simulations include those of two colliding masses, an inclined plane, and freefall. Users can change the variables and actually see the result. There are no instructional guides or lesson plans to go with the simulations (http://www.explorescience.com).

- The "Annenberg Teachers' Lab" provides interactive simulations. Although presented as a teacher preparation tool, students can also use the site (http://www.learner.org/teacherslab).

- The following site provides simulations in astronomy: http://instruct1.cit.cornell.edu/courses/astro101/java/simulations.htm.

Other Simulations[28]

The following are examples of math simulations on the Web. Many of these sites require Shockwave, Flash, and, sometimes, other plug-ins.

- The "Mathforum" site (http://mathforum.com/varnelle/index.html) offers early primary education "activities" in basic geometry and measurement. Each activity has stated objectives, a manipulative exercise with materials widely available in schools and homes, a "technology activity" to be conducted with a colorful interactive simulation, and references to children's books that treat the same topic. This is an easy-to-use site for both teachers and students.

- "BBC Online Education" (http://www.bbc.co.uk/education/home/) offers an all-purpose education site. It has many instructional aids, including some simulations, but the site is difficult to navigate. Clicking on "Schools" takes visitors to a page with resources organized by grade level, with links to various subjects. For instance, for the age 4–11 group, click on "MegaMaths,'" then on "World of Tables," then on "Pick a Number," then to any card shown, and then on "Patterns and Hints" to reach a dynamic multiplication table. "Table Tournament" provides a fast-paced multiplication table game with captivating graphics that, for instance, require the users to answer multiplication problems quickly before a rolling bolder crashes into them. "Tell Us Your Top Tips" offers tips on doing multiplication quickly.

[28] Excerpted from: Gregg B. Jackson, & John Jones. March/April 2001. "Web-based Simulations for Science and Math Instruction." *TechKnowLogia*. Available at www.TechKnowLogia.org.

- "ExploreMath.com" (http://www.exploremath.com) offers a series of high school mathematics simulations, most of which show the relationship between equations and their corresponding two-dimensional graphs. Users can modify the equation and see how that affects the graph, or modify the graph and see how that alters the equation. This is one of the few simulations that permit the latter form of interaction. There is also a library of lesson plans that use the simulations.

- University of Minnesota's "Geometry Center" (http://www.geom.umn.edu) offers several interactive simulations of college-level geometry. Generally users specify functions or coordinates, and then see the geometric representation. The simulation includes hyperbolic triangles, Lorenz equations, projective conics, and Teichmuller navigation. These interactive components are in the two-fold link titled, "Interactive Web and Java Applications." There are brief instructions for using the simulations, but no instructional guides or lesson plans. This site also offers downloadable software and other resources for teachers of advanced geometry. Although the site is no longer being maintained, it remains functional.

- The "Visual Calculus" site (http://archives.math.utk.edu/visual.calculus) has an extensive set of visual resources to accompany a two-semester college course in calculus. Some of the resources are Web-based interactive simulations and some are free downloadable simulation software that can be run from individual microcomputers. Ironically, many of the simulations are of the TI-85 and TI-86 graphing calculators. Short tutorials precede the visualizations. The professor who developed this site has also posted the syllabi for the courses he teaches with these Web-based resources, so that other instructors can see how their offerings are integrated with the course.

Resource 2.2.5 - Connecting with the World

Global Learning and Observations to Benefit the Environment[29]

Global Learning and Observations to Benefit the Environment (GLOBE) offers teachers and students, from kindergarten through high school, the opportunity to participate in actual scientific research. The project, open to schools around the world, focuses primarily on mapping and understanding patterns and changes in three major areas: atmosphere/climate, hydrology/water chemistry, and land cover/biology. The project, launched on Earth Day 1994, is administered by an interagency partnership that includes some of the most renowned scientific organizations in the United States: the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF).

GLOBE has three main objectives: to improve mathematics and science education, to raise environmental awareness, and to contribute to a worldwide scientific database about Earth. To attain these objectives, GLOBE scientists help teachers and students develop meaningful science projects, such as measuring pH in the water or analyzing temperature readings to observe changing patterns. GLOBE projects can be implemented in different ways: as part of a science class, a separate class, a club, a lunch group, or any other creative venue. In grades K–3, GLOBE teachers work with fewer than 10 children per project. Groups for older children can be much larger.

[29] Excerpted from: Editorial staff. March/April 2001. "Learning by Doing Science: Two Internet-Based Cases." *TechKnowLogia*. Available at www.TechKnowLogia.org.

A four-year evaluation of GLOBE found that participating students perform better than do their peers in activities that require an understanding of science, including the ability to interpret data and apply science concepts. They also showed a greater appreciation of science. In addition, the project instills in the students pride in their work, which is taken seriously by scientists and community members.

Currently, about 9,500 schools in more than 90 countries participate in GLOBE, and participation continues to grow, although only a small percentage of these schools contribute data to the central database. Recent training of new GLOBE teachers in Katmandu, Nepal, drew more than 80 teachers from seven Asian countries and New Zealand. Information on GLOBE, including evaluations of the project, can be found at http://www.globe.gov.

The JASON Project[30]

The JASON Project was created to encourage scientists and students to collaborate on research expeditions using advanced communications technologies. Prominent scientist, explorer, and educator Dr. Robert D. Ballard and his visionary project have bridged the scientific and education communities by making scientific research an exciting adventure for students and teachers in the classroom, through a series of real expeditions in which scientists, teachers, and students participate.

Teachers begin the JASON Project by participating in professional development workshops, which model new methods of teaching science content using JASON's suite of multimedia tools. They guide students into the expedition by discussing novels and conducting classroom activities about the geography, history, and culture of the expedition site. Through readings, videos, and Internet chat sessions, students make personal contact with host researchers and observe how they work. Then, through a series of inquiry-based exercises—including local field studies, gathering and analyzing data, designing experiments, and building models—students emulate the field research conducted at the expedition site and conduct their own investigations. During JASON XII, for example, students have created geographic information system (GIS) maps of lava flows, classified fish species located in Hawaii's deep reefs, participated in ecological restoration projects, transformed classrooms into lava tubes, and compared aquatic data from their local site with data from sites around the country.

Throughout the year, teachers and students use several online tools, such as workshops, message boards, simulations, and contests, to facilitate year-long interactivity between scientists and the global community. One highlight of the JASON expedition is a live, two-week satellite broadcast in late winter. During the broadcast, a small group of researchers, teachers, and students (known as Argonauts) shares its discoveries from the expedition field site with classrooms all over the globe

To learn more about the JASON Project, visit www.jasonproject.org.

[30] Excerpted from: Bram Duchovnay. March/April 2001. "The Jason Project: The Search for the Golden Fleece." *TechKnowLogia*. Available at www.TechKnowLogia.org.

Resource 2.2.6 - MIT Clubhouses[31]

Computer Clubhouses are very different from most telecenters and community technology centers in that they seek not simply to teach basic skills, but to help young people learn to express themselves and gain confidence in themselves as learners. If young people are interested in video games, they don't come to the Clubhouse to *play* games; they come to *create* their own games. They don't *download* videos from the Web; they *create* their own videos. In the process, youth learn the heuristics of being a good designer: how to conceptualize a project, use the materials available, persist and find alternatives when things go wrong, collaborate with others, and view a project through the eyes of others. In short, they learn how to manage a complex project from start to finish.

The Computer Clubhouse approach strikes a balance between structure and freedom in the learning process. As Clubhouse youth work on projects based on their own interests, they receive a great deal of support from other members of the Clubhouse community (e.g., staff members, volunteer mentors, and other Clubhouse youth). There is a large collection of sample projects on the walls, shelves, and hard drives of the Clubhouses; these provide Clubhouse youth with a sense of the possible and multiple entry points through which they can start.

Consider Mike Lee, who spent time at the original Computer Clubhouse in Boston, Massachusetts. Mike first came to the Clubhouse after he had dropped out of high school. His true passion was drawing, and he filled up notebook after notebook with sketches of cartoon characters. At the Clubhouse, Mike developed a new method for his artwork. First, he drew black-and-white sketches by hand. Then, he scanned the sketches into the computer and used the computer to color them in. His work often involved comic-book images of himself and his friends.

Over time, Mike learned to use more advanced computer techniques in his artwork. He also began working with others at the Clubhouse on collaborative projects. Together, they created an online art gallery. Once a week, they met with a local artist who agreed to mentor the project. After a year, their online art show was accepted for exhibition at Siggraph, the world's premiere computer graphics conference.

As Mike worked with others at the Clubhouse, he began to experiment with new artistic techniques. He added more computer effects and began working on digital collages combining photographs and graphics, while maintaining his distinctive style. Over time, Mike explored how he might use his artwork as a form of social commentary and political expression.

As he worked at the Clubhouse, Mike Lee clearly learned a lot about computers and graphic design. But he also began to develop his own ideas about teaching and learning. "At the Clubhouse, I was free to do what I wanted, learn what I wanted," says Mike. "Whatever I did was just for me. If I had taken computer courses [in school], there would have been all those assignments. Here I could be totally creative." Mike remembers—and appreciates—how the staff members treated him when he first came to the Clubhouse. They asked him to design the sign for the entrance and looked to him as a resource. They never thought of him as a "high school dropout," but as an artist.

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[31] Excerpted from: Mitchel Resnick. 2002. "Rethinking Learning in the Digital Age." In *The Global Information Technology Report 2001–2002: Readiness for the Networked World (GITR).* Cambridge, MA: Center for International Development at Harvard University. Available at http://www.cid.harvard.edu/cr/pdf/gitrr2002_ch03.pdf.

2.3 Enriching Quality of Teaching

Resource 2.3.1 - Multimedia Training and Support

The Case of Shoma—South Africa[32]

The MIH Group, the holding company for MultiChoice, M-Net, and M-Web, has developed a unique model of delivering educational and training programs for the professional development of South African educators. This delivery model uses the power of technology to leverage the delivery of appropriate educational programs prepared in conjunction with the country's national and provincial education departments. The programs are relayed from the M-Group's Broadcast Center in Randburg, via satellite, to a video server linked to a television set and to a network server, which, in turn, serves 24 workstations.

Shoma was designed, in part, to accommodate the greatest number of teachers possible during after-school hours, generally between 1:00 to 4:30 p.m.. To do this, Shoma's model consists of three "rooms," each lasting a specific amount of time within a 2½ -hour period.

Broadcast Room. This room is equipped with a television monitor, a video server and satellite dish. Here, teachers watch a video, which lasts about 10–12 minutes and is focused on a particular theme. All videos involve a combination of explanation by one or more experts, interwoven with classroom demonstrations. Each video ends with a probing question that teachers are to discuss for about 20 minutes, with guidance by one or more provincial department curricular specialists who have been trained by Shoma to facilitate the lessons.

Computer Room. In the second room, teachers engage in computer-based learning designed to reinforce the content shown in the video. Teachers work individually for approximately 45 minutes on the computers, reading text, watching digitized video and audio clips, answering questions, and completing exercises.

Lesson Development Room. The most important room in the process, this is where teachers have the opportunity to practice the theory learned in the broadcast and computer rooms. In this room, teachers work together to develop their own lesson plans for the following week, based on what they learned during the broadcast and computer-based learning.

Integral to the Shoma training methodology is the use of facilitators to mediate the learning process in all three tiers. Facilitators are drawn from the ranks of curriculum developers whose responsibility it is to provide support to educators on curriculum issues.

Currently Shoma is working in 14 centers in eight of the nation's nine provinces (with the exception of Western Cape). Although the number of professional development

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[32] Excerpted from: Joanne Capper. October–December 2002. "SHOMA: A Multimedia Approach to South Africa's Teacher Development." *TechKnowLogia*. Available at www.TechKnowLogia.org; Claire Brown, Violet Sithole, & Robert Hofmeyr. May/June 2000. "South Africa: Teacher Training in the Sky." *TechKnowLogia*. Available at www.TechKnowLogia.org.

sessions varies across centers, most host three to four sessions a day, four days a week, serving approximately 320 teachers per year—over 5,000 across all centers in 2001 and approximately 13,500 since 1998.

The Case of Aula Mentor[33]

The "Aula Mentor"[34] ("Aula" means classroom), created by National Center for Education Information and Communication of the New Technologies Program of the Ministry of Education in Spain, uses the Internet to bring together educators throughout the country and beyond. It offers a range of courses and options for self-paced, self-study through tele-tutoring. A total of 61 courses are offered, each of which lasts an average of four months.

Every student trainee has his or her own online "mentor" who is responsible for keeping the student trainee on track and monitoring and evaluating progress made on all course work. Recruited, trained, and selected by the (Spanish) Ministry of Education, the mentors are the key component of the program; they are responsible for ensuring that learning objectives are met online. Through daily e-mail with each one of their students, mentors provide "one-on-one coaching" and individualized attention to students, and they facilitate "chats," tele-conferences, and/or tele-debates between students. All student inquiries are answered within 24 hours. In addition, mentors are responsible for updating course materials and evaluating student performance as well.

Online delivery has placed a premium on high-quality teaching and learning materials. Recognizing this need, the (Spanish) Ministry of Education put together an interdisciplinary team of experts (in content, pedagogy, program design, and implementation) specifically charged with elaborating materials for online delivery and others to support content delivered online, such as CD-ROMs and study guides. These materials are intentionally sequenced and balanced among theory and practical applications, complementary activities and activities designed to reinforce key curricular concepts, and self-, peer, and mentor evaluation. All materials are available online (in a secure location so that they can be accessed by students only) and in "hard" (e.g., CD-ROM, paper) formats.

Outside of Spain, as of December 2002, Nicaragua is the only country where the Aula Mentor program has been introduced as a seven-month long pilot experiment.

Resource 2.3.2 - Videos for Teacher Training[35]

By turning the information into images that can be replayed whenever necessary, the technology gives learners more control over the information and empowers trainees to set their own pace in the learning process. This flexibility has been used with positive results in teacher training and development programs (Hatfield & Bitter, 1994; Lambdin, Duffy, & Moore, 1997; Mousley & Sullivan, 1996). These programs use video clips to provide prospective teachers with exemplary models of instructional methods, classroom management, innovative techniques, and concept and symbol developments.

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[33] Excerpted from: Aimee Verdisco. October-December 2002. "The Aula Mentor Program: Making Connections and Building Capacities across Continents." *TechKnowLogia*. Available at www.TechKnowLogia.org.
[34] www.mentor.mec.es.
[35] Excerpted from: Sonia Jurich. September/October 1999. "The Impact of Video Technology in Education: From Here to Where?" *TechKnowLogia*. Available at www.TechKnowLogia.org.

The videos include clips of actual instructors at work, interviews with students and instructors about their classroom experiences, analyses of the styles and techniques presented and their rationale, and any other information that helps the trainees to develop an analytical approach to teaching. The technique exposes trainees to a variety of model teaching experiences to which they can refer whenever necessary. The videotaped lessons also help them become familiar with the classroom experience in a controlled, anxiety-free situation, before they start their field placements. Trainees also may be videotaped during their field experience and can analyze the tape with their supervisors. By reviewing the tapes, trainees can compare the exemplary models with their own teaching to better understand their weaknesses and strengths and make necessary improvements.

Another advantage of video technology is its ***preserving power***. Maheshwari and Raina (1998) used an interactive television system (ITV) to train primary school teachers in a joint effort between Indira Gandhi Open University and the Indian Space Research Organisation. This program combines two-way video and audio interaction broadcast via satellite, prerecorded videotape instruction, and face-to-face interaction with facilitators at the remote sites. Through the technology, a larger number of teachers, including those in remote areas, were able to receive instruction directly from the experts. This direct line of communication avoided the loss of information that commonly occurs in the alternative option considered for the project—the cascade model, whereby training flows down through levels of less experienced trainers until it reaches the target group; in the process, complex information tends to be lost.

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Mousley, J. & Sullivan, P. (1996). *Interactive multimedia as a resource for preparing teachers for problem based mathematics instruction*. Paper presented at the annual meeting of the American Educational Research Association, New York.

Resource 2.3.3 - Selected Internet Resources for Teachers

There are thousands of Websites for educators. Searching the Web using search engines such as Google produces an extensive list of sites. The list below focuses only on those Websites that are intended to assist a wide range of teachers in their day-to-day classroom work. They have been selected to illustrate the variety of supports that teachers can access via the Web. Some items were compiled for *TechknowLogia*.[36]

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

The Best on the Web for Teachers

http://teachers.teach-nology.com/
This Website, which is like a teacher's library, is a compilation of Websites and online materials offering lesson plans, curriculum materials, teaching ideas, educational games, tutorials, teacher tools, workbooks, and worksheet makers. It also has a message board.

Sites for Teachers

http://www.sitesforteachers.com/
A compilation of Websites with resources for teachers

Scholastic

http://teacher.scholastic.com/
Offers lessons and interactive activities for specific grade levels

AOL@School

http://www.aolatschool.com/
This site compiles Web materials for teachers and administrators, including subjects and standards, lesson plans, special needs and counseling, classroom tools and tips, and research and reference.

National Geographic

http://www.nationalgeographic.com/xpeditions/atlas/
Free downloadable maps

MarcoPolo Education Foundation

www.mped.org/teacher/standards.aspx

MarcoPolo provides more than 20,000 resources and 3,600 lesson plans, free of charge, to K-12 teachers and students.

Gateway to Educational Materials (GEM)

http://thegateway.org

This U.S. government-sponsored site is a portal to lesson plans and teacher guides available on various federal, state, university, nonprofit, and commercial Internet sites. Users can search by general subjects (such as "science"), specific subjects (such as "biology"), and various key words. Search results provide a brief abstract of the materials. Users can also click on a more detailed description, including the grade level of material, the type of pedagogy used, national curriculum standards that the material may address, the source, and the cost (most are free, but some entail a fee.) There are also links to the Websites where the materials can be found.

Science Learning Network

http://www.sln.org

A consortium of 12 science museums around the globe is producing high-quality, inquiry-based K-6 science learning modules that are available through this site. The topics tend to be related to current events or otherwise of interest of students. Some of the modules can be used interactively only on the Web; others can be used in classrooms.

Eisenhower Clearinghouse for Mathematics and Science Education

http://www.enc.org

This U.S.-government sponsored organization identifies effective math and science curriculum materials, creating high-quality professional development materials for teachers of math and science and disseminating those resources to teachers, parents, and students. Users can search materials by subject, grade level, and cost. The online description of each resource includes the instructional philosophy, intended audience, evaluative information (for some of the sites), publisher, and a link to publisher's Website.

TESL: Lessons

http://www.aitech.ac.jp/~iteslj/links/TESL/Lessons

Resources for Students and Teachers of French as a Second Language

http://www.uottawa.ca/~weinberg/french.html

These sites link to lesson plans, exercises, and other resources for teaching languages to non-native speakers.

PBS Teacher Source

http://www.pbs.org/teachersource

The U.S. public radio and television system operates this site, which offers lesson plans and teacher's guides to accompany some of its television programs. The programs seek to engage students, and the lessons and activities are intended to extend their learning. Many of the TV programs are available on videocassette, and a few are rebroadcast a few years after they first appear.

British Columbia Ministry of Education: Special Education On-Line Documents

http://www.bced.gov.bc.ca/specialed/docs.htm

This government-operated site provides a wide range of resources for teachers with special-needs students. It includes government policies for such students, a review of special education provisions in this province of Canada, and resource guides for teachers on each of several kinds of special need students (blind, hearing-impaired, gifted, etc.).

Teachers.Net

http://www.teachers.net

This site offers a broad array of services for teachers, including live "chats" with prominent authors of education-related books, chat boards for teachers to exchange ideas, job announcements, and lesson plans and publications. There are affiliated Websites in the United Kingdom, Australia, and Canada.

Teachers Helping Teachers

http://www.pacificnet.net/~mandel

This is mostly a self-help site for teachers. where they can post questions asking for guidance from other teachers and share lesson plans and classroom management strategies. More than two million people have visited the homepage of this site since it was established in 1995.

Ask Dr. Math

http://forum.swarthmore.edu/dr.math/dr-math.html
This site uses hundreds of volunteer college math majors to answer questions from high school mathematics teachers and their students. The questions and answers are archived in a searchable database.

TEAMS Electronic Classrooms

http://teams.lacoe.edu/documentation/classrooms/classrooms.html
Part of the Los Angeles Department of Education (LACOE), this site offers resources for elementary school teachers, including lesson plans, guided activities for teachers, student interactive activities, parent resources, and varied information. Teachers can also join TEAMS to publish their own projects.

2.4 Facilitating Skill Formation

Resource 2.4.1 - Simulations for Skill Formation[37]

Flight Simulator

The first significant use of simulations was to train airplane pilots. The flight trainer, invented by Edwin Link in 1929, was first used to teach pilots instrument flying. But as simulators became more sophisticated and computers were introduced, they became a tool to teach pilots how to handle emergency and life-threatening situations. Yet, turning off a turbine or disabling a rudder control in a jetliner to test pilot reaction is not a good idea. Modern flight simulators are multimillion-dollar machines, often not much cheaper than real airplanes. But nobody thinks of costs when deciding whether to use them. The reason to use simulation is that it permits reproduction of conditions that, if reproduced in real flight, would be very dangerous. Thus, simulators give pilots a chance to learn the proper way to react under safer conditions.

Simulation of CNC Machines

Another common family of simulations is those that reproduce the operation of numerically controlled machine tools (known as CNC machines). Apprentices get to know a conventional lathe by handling it under controlled conditions, by machining simple parts initially, always being careful to keep the tool far away from the faceplate. Accidents happen, however; an extra turn of the lever and the tool may hit the turning plate. But a broken bit and a scratched faceplate in a learning lathe are not much of a loss. Yet, CNC lathes—which are programmed like a computer—cost several times more and are more prone to serious accidents. A wrong line of code may zoom the turret toward the faceplate, provoking a horrendous collision and causing serious losses. Students are said to be traumatized by the crash, and administrations have to write off the losses.

[37] Excerpted from: Claudio Castro. July/August 2000. “Skills Training: Where Simulations Are at Home.” *TechKnowLogia*. Available at www.TechKnowLogia.org.

Therefore, the obvious first idea was to couple the CNC to a simulator that traced on paper the trajectory of the cutting tool. The resulting drawing would immediately reveal any eventual mistake. Only after the simulation shows the program to be devoid of gross mistakes can an individual use the real machine. With computers becoming more common, a monitor has replaced the paper plotter. The obvious follow-up development is software that simulates the entire process, dispensing with the real-life lathe altogether. This obviously applies to milling machines and the whole gamut of CNC-controlled machine tools.

Today, computer simulations of CNC machines are very common, sophisticated, and inexpensive. When used properly, they can speed up the training and lower the costs significantly, because trainees can learn much from them and require a lot less supervision. Whether they dispense altogether with firsthand contact with real-life CNC machines is controversial, but our sole concern here is that we remember that the challenges of moving from a manual lathe to a CNC version lie with the programmers, not those who train on the machine, which, once programmed, requires little human input. That being the case, it makes little difference whether the programming is for a machine simulated with the monitor or a real-life machine.

Simulations for Troubleshooting

Another very common family of simulations occurs in electric and electronic circuits. Vocational schools frequently use panels on which components are installed, reproducing the typical electric wiring, for example, of an automobile. After students understand the circuitry, the teacher may introduce faults into the circuit, either by disconnecting wires or inserting malfunctioning components. Students have to troubleshoot the defective circuit and find the faults. Obviously, this is much more convenient and faster than working in real automobiles, where access to components and wiring is far more time-consuming. In more modern versions, defects can be introduced electronically, by means of central controls in the hands of the instructors. There are also simulations of defects in real-life automobiles or tractors that have been wired to a computer that simulates the faults.

Simulations for Manual Dexterity

A more unusual form of simulations are those that teach manual dexterity without incurring the costs of consumables. For instance, arc welding requires a steady hand to keep the electrode at a constant distance from the parts being welded. At the same time that the hand has to move at constant speed, it has to adjust for the distance, as the electrode shortens. This operation requires hundreds of hours of practice, burning expensive electrodes, but there are contraptions that simulate a welding machine and permit significant savings in consumables.

The Electronic Bench

Perhaps the most impressive developments are coming from the use of computers to simulate electrical and electronic circuitry. One can use a mouse to pick up electronic components in a virtual storeroom and connect them in any way desired. A virtual battery or power supply is then connected, energizing the circuit. The electronic bench displays the properties of a real system, from turning on a light bulb to far more complex roles. Then, using a virtual multimeter or oscilloscope, students can make any measurement in this circuit as if it were a real one. The best known software of this type, the electronic bench can enable trainees to assemble an infinite variety of virtual circuits quickly and watch them work. This avoids damage to real-world components, and allows much greater speed of assembly, even compared to panels where no soldering is required.

Software to Simulate Hardware

The ultimate in digital electronic simulations, students can build a computer that works just like as it does in real life. The parts are picked up with the mouse and connected, creating digital circuits, starting from flip-flop gates and/or switches and moving up to more complex microprocessors. In other words, one can assemble and operate a computer on the screen of a computer using software that simulates the hardware. Ultimately, this is no different from a major thrust in real computer design, that is, using software to simulate or, as said in the industry, to emulate hardware.

Resource 2.4.2 - The Francis Tuttle Vocational School[38]

The Francis Tuttle School, established in 1979, was named after the founder of the VoTech system of Oklahoma (USA). Currently, more than 30,000 students are taking at least one short-term course from a wide variety of offerings, including more than 200 short-term courses and more than 30 daytime education programs.[39]

Multidimensional Nature of Skills
The speed with which technology changes has increased so much in the last few years that experience is becoming an almost irrelevant asset when it comes to hiring employees. Firms can no longer require many years of experience, because in most cases equipment and the processes have not been around that long. What matters then is the ability of a worker to think through the overall manufacturing system involved in the fabrication process. Workers who can work with their hands only are becoming a relic of the past in an increasing number of occupations. Francis Tuttle prepares its student for critical thinking while teaching them lifelong skills. In fact, one of the hallmarks of its primary program in technology is the multidimensional nature of the skills taught. The orientation of the courses is justified by two main findings: first, some firms offer higher wages to workers with multiple skills, and in periods of crisis firms do not lay off these types of workers, and, second, there is an immense market for maintaining complex equipment.

The school programs are developed in very close collaboration with industry to offer students courses that enable them to hold high-demand jobs. More than 300 business representatives look at the school's curricula and course content as participants in the various program advisory committees.

Technology for Training
Each instructional program at Francis Tuttle is fully equipped with industry standard equipment valued at more than US$10.9 million. The school's services and programs include a teaching factory, advanced technology programs, and VAN SAT, an engineering and electronic commerce center provider. In addition, the main campus has an 11-meter satellite teleport for distance learning, the largest in Oklahoma, which allows students to surf on the Internet during real-time, interactive 12 LIVE classes as

[38] Excerpted from: Claudio de Moura Castro. July/August 2000. "What, No Lectures? The Francis Tuttle Vocational School." *TechKnowLogia*. Available at www.TechKnowLogia.org.
[39] http://www.francistuttle.com/.

part of their daily activities or to take specialized classes taught at other locations. 12 LIVE is the first cooperative network able to connect a mixture of city and rural schools to a vocational center, a community college, and a university. Furthermore, each classroom has remote-controlled cameras, television monitors, microphones, and speakers, and the teachers' workstation includes an image document camera, a VHS player, a computer loaded with software and tied to a laser printer, Internet access, and a fax machine.

The overall objective of all the training is the operation and maintenance of the new generation of machines and technology equipment. The school builds on the belief that the ability of enterprises to generate new technologies has far outstripped the ability of servicepersons to maintain them. As a result, these maintenance requirements will create more jobs in the next several years than the country is able to train individuals to fill. There is a scarcity of maintenance technicians who can understand the mechanics, electronics, and pneumatics of such machines. One interesting example mentioned at Francis Tuttle is the new generation of pagers transmitting through satellites. The technology and satellites are available, but there are very few technicians who have the breadth of skills and the specific knowledge to repair them.

No Lectures

All of the courses offered are competency-based, which, by itself, indicates the commitment of this institution to offer serious training geared to the needs of industry, since competency-based training clearly shows the links between training and expected performance. This approach avoids conventional lectures, as is the case at Francis Tuttle, where all live lectures have been eliminated. Videotaped lectures, written materials, and computers are used instead. Teachers are not replaced, however, so the valuable interaction between them and students is fully preserved. The experience of this school suggests that not all students operate well with this system, and there are attempts to help those who have initial difficulties with computers and VCRs. However, only a few consider this method to be inadequate and, curiously, they are not necessarily the weakest students academically. The school uses one-to-one tutoring in the difficult cases, the price to pay for an otherwise interesting innovation.

By eliminating lectures and using competency-based training materials, this system allows each student to move at his or her own pace. Students can join the course at any time and leave when they finish their modules. They use Learning Activity Packets (LAPs) to advance and are required to take performance tests to demonstrate mastery of one LAP before moving on to the next. This system allows fast-moving students to advance quickly and slow students to master the contents fully, taking as long as they need. LAPs are used because they are an excellent tool for delivering competency-based instruction. Some estimates based on similar programs elsewhere indicate that efficiency increases can be quite substantial, depending on how they are defined. On the downside, the fixed investment to operate this method is consistently higher, the logistical problems much more pressing, and the administrative and technical overhead somewhat higher. But these are all minor problems. Overall, the method seems to be a step ahead, which, unfortunately, has not been adopted by many schools.

A Modular Program

Perhaps the most interesting aspect of the series of courses offered Tuttle offers is the modular nature of the curriculum and the vast common core of subjects. There are only five basic processes: mechanics, electricity, thermal, fluid, and Optics, all of which encompass 13 major concepts (such as force, energy, and so on), and all of the manufacturing processes are based on combinations of these. To become a technician, one needs an integrated view of all of them.

Students devote about 30% of their time to classroom theory work and spend the remaining time on applications and hands-on activities. In addition, given the weakness of high schools in math and science, and the importance of this type of knowledge in the various high demand occupations, remedial courses are offered to those who need them. All students spend about 60% of their time taking common core modules and the remaining time in specialization. Since these basic processes change very little over time, 60% of most courses is common for all specializations and does not need frequent updating. In electronics programs, for instance, 80% of the materials are the same in all of the courses offered. Therefore, the fixed investment of developing a systems approach based on five processes can be justified.

Can It Be Replicated?
The Francis Tuttle School remains committed to continuous quality improvement, and word about its intriguing achievements has spread worldwide. Tour groups from approximately 50 countries, including Australia, Brazil, China, Great Britain, Pakistan, Russia, and Saudi Arabia, have visited the school.

Resource 2.4.3 - Interactive Media Training[40]

Interactive software is out there, and it's not just for children. One of the most useful applications for multimedia (videos and CD-ROMs) is skill enhancement and training. Below is a sample of such products.

Technical Training

Automation Studio (www.ttaweb.com) is a technical and interactive CD package that trains individuals in circuit design and automation technology. The software package is designed so users are able to outline, simulate, and animate their own circuits while using various methods of electrical controls, including hydraulics and pneumatics. Appropriate for engineers, teachers, and students alike, *Automation Studio* is available in English, Spanish, French, Italian, Japanese, and Portuguese.

Aircraft Systems Review (www.nolly.com/asrv.html) can be used to train pilots on unfamiliar aircraft and enables those in the aviation field to refresh their knowledge. The videos incorporate one-on-one instruction with visual explanations and procedures, viewed from a pilot's perspective. These videos are also "generic" in the sense that they can be used universally without regard to individual trainees' airline affiliations.

TPC Training Systems (www.tpctraining.com), which offer an extensive video and interactive CD library specializing in machine and mechanical training, have provided training to more than three million employees. The training videos cover such topics as reading blueprints, schematics, and symbols; electronics and digital electronics education; and engine mechanics, hydraulics, and even heavy machinery use. The training CDs cover process instrumentation, mechanics maintenance, and air conditioning/refrigeration systems.

[40] Excerpts from J. Lewis (July/August 2000). "Enhancing Vocational Skills: Interactive Media Training." *TechKnowLogia*. Available at www.TechKnowLogia org.

Medical Training

TUTOR Series (www.labmed.washington.edu/tutor/products) is a set of interactive CDs produced by the University of Washington and covering several different aspects of evaluating medical data and training individuals in interpreting multiple results. *ElectrophoresisTUTOR*, for example, is an interactive computer program that teaches electrophoresis interpretations of proteins in various body fluids. With its illustrations, charts, and tables, the software is useful for instructing beginning students or evaluating competency levels. *PhlebotomyTUTOR* simply trains individuals in the appropriate techniques for taking blood from a patient.

PedsLink (www.pedslink.com), a resource for pediatric health care, produces a series of training videos geared to home health clinicians and nurses who provide care for infants and children with various illnesses. Videos, such as *Home Phototherapy for Infants*, take the care provider step-by-step through treatment methods and assessments and use specific procedural demonstrations.

General Skill Training

Glencoe Online (www.glencoe.com) is a source of several tools, one of which is *The Job Interview* CD-ROM, an interactive guide that trains job seekers in all aspects of the interviewing process. The CD also provides information on commonly asked interview questions and gives advice on how one should respond to them. It uses video clips depicting job interview scenarios, narration, tips, and questions to reinforce concepts that are vital to a successful interview.

BrainwareMedia (www.Brainware-tm.com) offers several videos and CDs for business and managerial training, but it can be useful to everyone. *The Art of Communication* is an interactive CD-ROM that helps individuals to improve their communication skills. It features advice; interactive role-playing using common, everyday situations; and self-assessment exercises, and is ideal for training in giving presentations, public speaking, or just communicating with people in general

Resource 2.4.4 - Applications of E-Training

AXA—The French Solution[41]

The growth of e-training in France has been slow, compared to that in the United States. While e-training accounts for 60% of the expenses of corporate training in the United States, in France it accounts for only 11%. Surveys of French companies indicate that face-to-face is still the preferred training model, and that many human resources employees are not clear about e-learning's potential as a training tool.[42] AXA is among the exceptions.

AXA, a multinational insurance group with close to 100,000 employees in 25 countries, provides training to this large and scattered workforce, which was becoming increasingly complex and expensive. AXA's Human Resources Department in France decided to use its intranet connection to develop a distance learning program that could ensure fast distribution to a large audience. A modular structure was adopted to

[41] The descriptions of e-training applications in AXA, Carrefour, and Cisco are taken from: S. Jurich. May/June 2001. "Corporate Universities: Three Examples from across the World." *TechKnowLogia*. Available at www.TechKnowLogia.org.

[42] S. Ghys. *E-learning, les enterprises françaises restent à convaincr*e. In Jurich, op cit.

facilitate frequent but cost-effective updates of the content material. The company entered into a partnership with IBM for the technical aspects of the training and had a number of partners for production of educational material.

Before starting the project, in 1997, AXA’s Human Resources Department organized a five-day retreat to ensure the managers’ support for the program. Then, the department met with the employees to discuss the new training and orient them on how to use the intranet for training purposes. Only after ensuring that managers and employees were ready to accept and use distance learning strategies did the department begin to introduce e-training gradually into the employees’ traditional training schedule. Training programs take between 40 and 400 hours per employee, depending on the topic. Employees can go through the training individually or with the help of volunteer tutors who are content area experts working with the distance education experts. They can be reached by e-mail, telephone, or face-to-face contact. Piloted in one of the French branches, e-training is now available to AXA’s employees worldwide.

The pilot stage provided good results and some important lessons for companies considering developing their own training:

- Developing training materials for multinational workforces is a major challenge, since learning preferences vary across countries. For instance, English speakers preferred lessons that began with anecdotes and moved from the particular to the general, while the French preferred to look at the general before going into the particular.
- It is important to have a place reserved for training and someone to encourage and prod trainees; few individuals have the self-discipline to search for training independently.
- Supervisors’ support is essential for the success of any training project.

Carrefour—A Brazilian Experience

Carrefour is likely the largest wholesale chain in Brazil, with almost 50,000 employees. Founded in France in 1963, the chain has a long tradition of employee training. In the late 1980s, Carrefour founded one of the world’s first “corporate universities,” the Institute Marcel Fournier, and used videoconferencing for employee training. Currently, the chain has three “corporate universities,” one of which is in São Paulo, Brazil: the Instituto de Formação Carrefour (Carrefour Institute for Professional Development).

The reasons Carrefour moved into e-training are similar to AXA’s. As the chain spread throughout the country, the distance between stores and training centers escalated costs. E-training was the strategy of choice because it (1) provides economies with traveling costs, (2) reduces the amount of time employees are away from work, and (3) avoids the complex logistics of planning and implementing training for large numbers of individuals coming from many different places. In addition, it is easier and less expensive to update e-learning material than it is to produce printed material. The company also perceived a need to maintain a technological lead. According to the Institute’s Training Director, “The majority of large businesses in the world are investing in online training...and some are well advanced in this area. We could not be left behind.”

Carrefour universities offer a variety of training, not only to employees, but also to clients and vendors. The Brazilian Institute provides 114 courses in different areas that include informatics, marketing, management, etc. The programs have different platforms, including multimedia, video, DVD, television broadcast via satellite, and intranet, and they vary in length from four hours to 15 days. Some courses are mandatory, while others are elective, and participation depends on the interests of the employees and their supervisors. Courses can also be provided on-site, and the Institute has many training rooms in addition to a large auditorium with simultaneous translation capabilities. At first, the Institute served only employees, but training programs for clients and vendors were programmed to begin in late 2002. Plans for expansion also include courses on the Internet and a mix of online and face-to-face strategies. In less than one year, the Institute trained about 3,000 employees.

Cisco Learning Network

Cisco Systems is one of the largest network companies in the world, with annual revenues of over US$20 billion. Headquartered in the United States, the company has 225 sales and support offices in 75 countries. For years, its training programs were managed independently at each different unit, resulting in redundant and inconsistent programming. To streamline, expedite, and improve the quality of the training programs, the company developed the Cisco Learning Network (CLN).

CLN training is developed using multimedia technologies and stored in a centralized database. Employees select either a full curriculum or individual modules and take an assessment test, the results of which guide the adaptation of the module to respond to each employee’s specific needs. Employees are evaluated at different intervals to gauge the effectiveness of the program, and results are stored in a personal training file in the Human Resources database.

The programs can be provided in two ways: (1) in scheduled delivery, at a fixed time and place, or (2) on-demand, for individuals who have particular needs. Scheduled delivery uses three platforms: multicasts (videos that are sent over the network to desktops), virtual classrooms, and remote laboratories. On-demand training uses Web-based on-demand content, CD-ROMs, and remote labs. Laboratories, used to supplement complex topics, include simulations that provide virtual access to equipment and techniques too costly to be available for every learner. It was observed that CLN courses reduced the time sales employees spent away from their customers by up to 40%.

Cisco’s training expertise has outgrown the corporation, and the company is now a major developer of training solutions. The Cisco Networking Academy Program prepares high school and college students to design, build, and maintain computer networks in more than 6,000 academies spread throughout the 50 American states. The academies reflect partnerships between the company and private or government organizations, including public schools. Cisco also provides online seminars and Career Certification programs; the latter has grown from 6,000 students per year to 100,000 and is offered online or through more than 130 sites and 750 certified instructors worldwide. Some of the courses are offered by Cisco Learning Partners, organizations authorized to deliver Cisco-developed learning content. According to Cisco management, in the current economy, the key to gaining a competitive advantage is the ability to disseminate information, education, and training rapidly.

Lucent Technologies[43]

Lucent Technologies is a spin-off of Bell Telephone Laboratories, which has been at the center of major innovations in communications technology for more than a century. Launched in 1996, Lucent has focused on research, production, and services in optical, data, and wireless networking; optic-electronics; communications semiconductors; communications software; and Web-based enterprise solutions and professional network design and consulting services.

The Global Learning Solutions (GLS) Learning Architecture, developed by Lucent Technologies' New Enterprise Networks Group, combines the Internet, voice network, and small-dish digital video technology to expand the outreach power of traditional training without losing the human interaction aspect. It uses independent, self-directed learning events (asynchronous strategy) with a virtual classroom in which the instructor and most of the learners are at locations distant from each other (synchronous strategy). A typical course operates much like a college class. Learners meet for one to two hours for the live, facilitated part of the course and work on their own until current assignments, exercises, and readings are complete. Often, subsequent live sessions are scheduled with the instructor to follow up on assignments and discuss new material. The extent to which this happens depends on the instructional design. During these interactive sessions, students can present results to the class, have questions answered, pose new questions, participate in group discussions, and receive their next assignment. Between sessions, learners still have access to the instructor and to other learners through chat rooms, threaded news groups, e-mail, and instructor Web "office hours."

Using the GLS Learning Architecture, Lucent has developed a training approach to reach a large workforce dispersed across the world. Its training branch, LucentVision Interactive (LVI), was launched in 1999 initially to train more than 9,000 direct and indirect sales personnel. LVI was able to deliver more than150 hours of training a month with similar or better results than those obtained by traditional, face-to-face strategies, while reducing the number of contact hours by 35%. LVI is now expanding into a "Sales and Marketing University" with an audience of more than 22,000 direct and indirect sales, technical sales support, marketing, and product marketing personnel. A total of US$3.4 million in capital investment and US$2 million in expense budget have been allocated to expand uplink portals in three U.S. cities and Singapore, with another 120 downlinks worldwide.

Corporate Universities[44]

Many companies have developed their own universities to provide training in the core competencies necessary to conduct their business and compete in the marketplace.

Early in the 20th century, General Motors had already developed its own educational division: the General Motors Engineering and Management Institute (GMI). Other companies soon followed. In 1961, the American fast-food chain, McDonald's, opened "Hamburger University." As the more traditional education and training division, the university sought to instill corporate values and teach basic business skills. However, it

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[43] This description is taken from: R. L. Vigil. July/August 2000. "Getting the Most out of Online Training: Integrating the Missing Ingredients." *TechKnowLogia*. Available at http://www.techknowlogia.org.

[44] This section includes excerpts from J. Y. Jones. May/June 2001. "Business, Corporate Universities and E-Learning." *TechKnowLogia*. Available at www.TechKnowLogia.org.

instituted a major innovation—a concern with involving all those connected with the fast-food chain, either directly (McDonald's employees) or indirectly (franchise owners and their employees). Hamburger University, now with branches in the United Kingdom, Germany, Japan, and Australia, started a trend that continues to grow.

While the traditional means for delivering a corporate education has been the classroom, many companies are embracing the Internet as a medium of instruction because it offers many advantages over face-to-face teaching. A Web-based system of instruction allows centralized coordination but dispersed learning, can be adapted to each individual's learning needs, can provide numerous resources without taking up space on a computer's hard drive, and is more convenient to incorporate into the workday than is traditional classroom instruction.[45] It also usually cuts costs, often dramatically, because personnel might otherwise have to travel to another city for the instruction.

It is not only big companies that can benefit from corporate universities. Verifone, with about 2,500 employees in regional offices in the Americas, Africa, Asia, and Australia, operates its own university. Verifone University created its curriculum using in-house experts when possible and contractors when necessary. It made all course information available on each employee's computer or at office-based learning centers, and is moving toward making all education available on company Websites. Verifone encourages employees to take charge of their own education, going so far as to provide subsidies for employees' home computer purchases.

Two professional associations may be of assistance to those establishing corporate universities: the American Society for Training and Development, a professional association of corporate education officers and consultants, and the European Consortium for the Learning Organisation, a network of business and academic professionals that collaborates on learning. The journal, *Corporate University Review* is available online at http://www.trainingworks.org/pdf/corpuniversities.pdf. Several Websites now index e-learning firms, such as L-Guide; the Clearinghouse for Training, Education, and Development; and EdSurf. For-profit firms also have sprung up to consult and provide services in this new field. These include the Corporate University Xchange, The Corporate University, The Virtual Corporate University Extension, Woohoo Inc., and McGraw-Hill.

2.5 Sustaining Lifelong Learning

Resource 2.5.1 - Open Universities

The following are examples of the lifelong education programs provided by open universities. The information is taken from Sir John Daniel's *Mega Universities & Knowledge Media* and Keith Harry's *Higher Education through Open and Distance Learning*, unless otherwise indicated.[46]

[45] N. Chase. 1998. "Lessons from the Corporate University." *Quality Magazine*. Available at http://www.qualitymag.com.
[46] J. S. Daniel. 1999. *Mega-Universities & Knowledge Media*. London: Kogan Page Limited; K. Harry. 1999. *Higher Education through Open and Distance Learning.* London: Routledge; summarized by: Robert Savukinas & Gregg Jackson. September/October 200. "Open Universities: A Revolution in Lifelong Learning." *TechKnowLogia*. Available at www.TechKnowLogia.org.

China TV University

China TV University is the largest university in the world, with a total enrollment of 850,000 in 1994. The system includes a central unit that develops and produces course materials, 44 provincial units that also develop and produce such materials, 1,550 Education Centers at the county or company level, and 30,000 tutorial groups. The Education Centers have pressured the system to provide more job training, courses of local interest, and continuing education. Although China TV University serves mostly urban residents, there are plans to broadcast some of its programs more widely, and 20 million farmers reportedly have already received "intermediate education of a practical interest" through an associated unit. (For more information about China TV University, visit http://www.crtvu.edu.cn.)

Indira Gandhi National Open University

India has the second-largest higher education system in the world. By 1980, 20 Indian universities offered correspondence courses, but most were considered to be of low quality. Indira Gandhi University was established to provide high-quality distance education and coordinate standards for tertiary distance education throughout India. From the beginning, it was planned that only one-third of the students would be in degree programs, and the rest would be in shorter programs directly related to employment. Programs of study include computer education, nursing, agriculture, food and nutrition, creative writing, and child care. The university has been able to secure only 90 minutes of nationally broadcast television each week and no radio coverage, so instruction is mostly by printed material and required periodic attendance in 229 study centers located primarily in urban areas. Despite those constraints, and competition from seven other state open universities, Indira Gandhi University had 162,540 registered students 1998. In the late 1990s, the university began establishing high-capacity telecommunications links with 16 regional centers and, later, some of the study centers. Satellite communications systems are also in use now. (For more information about Indira Gandhi University, visit http://www.ignou.org/index.htm.)

Sukhothai Thammanthirat Open University

Sukhothai Thammanthirat Open University (Thailand), committed to lifelong education, expansion of educational opportunities for secondary school graduates, and personnel development, provides academic degree programs, short training programs, and individual courses. About 300,000 students are enrolled in the nondegree programs, and three-fourths of the students are from rural areas. The university combines printed materials with 1,100 30-minute television broadcasts annually and 150 20-minute radio programs each week. It also makes extensive use of physical facilities scattered throughout the country and operates 87 Regional and Provincial Study Centers for orientation of new students, tutorials, and examinations. It has Special Study Centers in government agencies, such as hospitals, regional agricultural offices, and government offices, which have laboratory and other facilities needed for study. It also has 80 Corners located in provincial libraries that provide library and education media support for students. Telephone communication between students and instructors is common, and the university hopes to expand its services with cable television and satellite television broadcasts, accompanied by two-way audio links. (For more information about Sukhothai Thammanthirat Open University, visit www.stou.ac.th/eng.)

Universidad Nacional Abierta

Universidad Nacional Abierta, Venezuela's answer to the rising social demand for higher education and the scarcity of study opportunities for adults, focuses on providing high-quality education and serving working individuals. It also attempts to spur innovation in individualized and self-directed learning. The programs are organized into five sections: Introductory Courses, General Studies, Professional Studies, Postgraduate Studies, and Continuing Education. The goal of the continuing education section is to elevate the level of knowledge of the general population in specific disciplines of science, technology, and culture. Instruction is by printed correspondence materials, audiovisual media, and face-to-face instruction at 21 regional study centers. (For more information about Universidad Nacional Abierta, visit www.una.edu.ve.)

University of South Africa

The University of South Africa has been open to all races since before and throughout the apartheid era. In 1995, it had 130,000 students, 47% of whom were black and 40% white. More than 80% are employed, and the average age is 31. Almost a third of the students are schoolteachers. Applicants who have not completed high school are admitted conditionally and are restricted in the number of courses they can take during their first year. There are more than 2,000 course modules; most are developed by individual instructors, but teams are developing some courses. Instruction is primarily by texts and printed study guides, sometimes supplemented by audiocassettes and some radio broadcasts. Instructors and students communicate by mail and telephone. The limited number of face-to-face tutorials, staffed by part-timers, are being expanded. The University of South Africa's most famous graduate is Nelson Mandela, who studied while jailed (www.unisa.ac.za).

Resource 2.5.2 - China's University of the Third Age[47]

With the increase in the elderly population and the compulsory retirement system of the last two decades, China has been facing a big challenge in meeting the learning needs of the elderly. Various forms of education and learning programs have been developed for seniors all over the country, and the University of the Third Age (UTA) has been the country's most successful program in promoting lifelong learning. However, existing UTAs can hardly meet the increasing demand, so use of new technology, such as remote teaching and the Internet, has been explored to make learning accessible to more elderly.

The Development of UTAs in China

The first UTA in China was established in Shangdong Province in 1983. Since then, the UTA concept has been accepted widely, and UTAs have spread throughout the country. Statistics show that the number of UTAs in China had reached 16,676 by the end of 1999, and more than 1.38 million seniors were studying at them.

The programs for lifelong learning, especially the development of UTAs, have been supported and encouraged by the Chinese government. The Law of the People's Republic of China on Protection of the Legal Rights and Interests of the Elderly, passed by the Chinese National People's Congress in 1996, stipulates that the elderly have the

[47] Xiao Caiwei. September/October 2000. "China: Lifelong Learning and the Use of New Technology." *TechKnowLogia*. Available at www.TechKnowLogia.org.

right to continuing education, and the state must develop education of the elderly and encourage the establishment and operation of various kinds of UTAs. In 1994, 10 of the ministries of the Chinese central government jointly worked out the National Seven-Year Development Plan of the Work on Aging, which mobilizes and requires local governments to devise a development plan to educate the elderly.

To promote the development of UTAs in China, the China Association of Universities for the Aged (CAUA), a network organization, was established in 1988. It now has 207 member UTAs, publishes a magazine on lifelong learning, which provides guidance to Chinese UTAs, and has set up a research group on the development of textbooks for UTAs.

Most of the UTAs are established, financed, and operated by the government, but some are set up by the private sector. For instance, of the 207 members of CAUA, 26 were established by the private sector. Some of the privately operated UTAs also receive financial assistance from the government. Normally, a UTA is different and separate from an ordinary university: it has its own classrooms, and the courses offered are designed with the interests and demands of the senior students in mind. Popular courses include calligraphy, painting, literature, cooking, gardening, health care, music, dancing, and computers. In rural areas, the courses primarily teach technology needed in agriculture.

The Use of New Technology

In 1998, a TV UTA was opened in Zhe Jiang Province through the joint efforts of the Committee on Aging, the Personnel Department, the Trade Union, the Financial Department, the Labor Department, and the Administrative Department on Radio and TV of Zhe Jiang Province. Zhe Jiang TV UTA has more than 10 courses, in such disciplines as medicine, health care, calligraphy, painting, literature, history, psychology, and science and technology. In addition, courses may be added or adjusted according to the interests and demands of the elderly. The TV UTA program is offered from 8:30 to 9:20 a.m. every Friday in two classes of 25 minutes each. The same TV UTA program is rebroadcast every Saturday. The examination is conducted in the form of a written test or by discussion among the students. Students receive diplomas after they have completed eight courses. Zhe Jiang TV UTA has branches in 22 cities and counties in the province where the elderly can register.

With the development of the Internet, Shanghai TV UTA opened an online UTA in 1999 in cooperation with the Shanghai TV Station. Although it is the only online UTA in China, and most elderly people do not have access to the Internet, it represents the new development trend. This new technology is expected to make lifelong learning more easily accessible to the elderly. (For more on Shanghai online UTA, visit www.ol.com.cn or www.shtvu.edu.cn.)

2.6 Improving Policy Planning and Management

Resource 2.6.1 - Sample List of EMIS Software[48]

Sample List of EMIS Software				
Name and Contact	**Area**	**Sample Functions**	**Country of Origin**	**Comments**
Education Management Systems www.ems-isis.com	Integrated School & District Software	Finance, School Lunches, Student Records,	USA	Small, medium-size schools & districts
Class Act Software Info@classactsoftware.com	Integrated School Software	Student Records, Teacher Pay, Finances, Class Attendance	USA	Small, medium-size schools
TASS—Alpha School System www.alphabus.com.au/tass/tass.html	Integrated School Software	Student Records, Teacher Pay, Finances, Class Attendance, Student Accounts	Australia	Used primarily in Australia, variable school sizes
Powerschool www.Powerschool.com	School Student Software	Student Records, Class Attendance, Parent Contact	USA	Supports instructional activity best
ABT Campus www.abtcampus.com	Integrated School Software	Student Records, Class Attendance, Business Management	USA	Extensive use of the Web for interfaces
Rediker Software www.rediker.com	Integrated School Software	Student Records, Class Attendance, Counseling Records, Business Management	USA/Europe	Worldwide application, oriented to educators' needs
SchoolPro www.schoolpro.com	Integrated School Software	Student Admissions, Records, Billing, Business Management, Payroll, Facilities Management	USA	
IBM—Solutions for Schools www.ibm.com/solutions/	School Software, Selected District Software	Various	USA/ Worldwide	Various semicustom solutions
Computer Associates www.ca.com/products	District, Regional, National,	Finance/Accounting, Human Resources, Inventory	USA/ European	Requires Systems Integrator to

[48] Kurt Moses & Vivian Toro. January/February 2001. "Education Management Information Systems (EMIS): Available Software and Guidelines for Selection." *TechKnowLogia*. Available at www.TechKnowLogia.org.

	Single-Function Software			link large systems
MSA Inc. www.msa.com	National, Provincial, Single - Function Software	Human Resources, Inventory, Textbook Management	USA/ Worldwide	Requires Systems Integrator to link large systems
PeopleSoft, Inc. www.peoplesoft.com	National, Provincial Semi-Integrated Software	Human Resources, Financial, Student Records	USA/ Europe	Requires Systems Integrator to install
ED*ASSIST www.aed.org./edassist	National, Provincial, Regional, District Integrated Software	Information reporting on Students, Human Resources, Financial Summaries, Facilities, Textbooks	USA	Planning- & management-oriented EMIS; links to existing school system
SCT Solutions www.sctcorp.com	National , School Integrated Software; also Higher Education	Students, Human Resources, Finances, Inventory, Class Scheduling	USA/ Europe	Higher Education-oriented; large user base
Campus America www.campus.com	School Integrated Software—Higher Education	Student Records, Human Resources, Finances, Inventory, Class Attendance, Store Management	USA	Higher education-oriented; medium-size institutions

Resource 2.6.2 - Examples of Structured Simulations[49]

Structured simulations use algorithms to simulate how a system operates, and users' choices and possible outputs are specified in advance. The following four models exemplify of this kind of simulation:

APEX (Assessing Policies for Educational Excellence)[50]

The underlying model shows the effects of decisions about class size, teacher training, and other inputs on enrollments, costs, and school quality. The simulation was developed initially to assist the opposition to the apartheid government of South Africa to anticipate the consequences of government-proposed education reforms. After the transition to a democratic government, APEX was used extensively to educate citizen groups on what reasonably could be expected from various policy reforms.

[49] Excerpted from: Noel F. McGinn. January/February 2001. "Computer Simulations and Policy Analysis." *TechKnowLogia*. Available at www.TechKnowLogia.org.
[50] F. H. Healey. 1984. "Policy Support in South Africa: An Emerging Paradigm." *The Forum for Advancing Basic Education and Literacy*, *3*(4).

EPICS[51]

This model runs as a table game in which the players' decisions are scored by an underlying computer model that calculates the impact of allocations on educational indicators, such as enrollment, class size, gender equity, and internal efficiency, as well as indicators of economic growth, public health, and population growth. Players represent the staff of a ministry of education charged with resource allocation through the annual budget. Normally, the simulation takes players through five rounds of annual budgets. External "events" that occur in several rounds require players to reconsider the strategies they are developing.

REDUC (Latin American Network of Centers of Educational Research)[52]

REDUC has produced six policy analysis simulations, which combine structured and unstructured elements. Players assume roles within a government agency and must negotiate with other actors to determine allocation of scarce resources. An underlying mathematical model generates system responses to these allocations, which then stimulate further negotiations. (See "Using Technology to Manage Education Information" in *TechKnowLogia* for more information on REDUC.)[53]

DECIDE[54]

DECIDE is a computer-based simulation to be used by teams that discuss where to locate decision making to solve the problem presented by the computer. The sequences of situations that follow correspond to the school calendar and are responsive to the participants' choices. Each new situation provides text evaluating the previous choice in terms of whether it solves the initial problem or generates new ones. The participants' progress is "scored" in reference to whether they are able to keep up with the school calendar.

2.7 Advancing Community Linkages

Resource 2.7.1 - Radio Receivers

Radios that use electricity are the most common and probably the least troublesome because they can be used day or night without fear that the batteries will run out. The problem is that, for many, electricity is simply not available. Transistor radios may use batteries, but they too can be relatively expensive and not readily available. Wind-up solar-powered crank radios may be the answer to these problems and more.

The crank radio (see the photos below) is solar-powered and self-powered; it needs no batteries or electricity to work. It winds up, and one full crank can last an hour. The

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[51] Claire Brown, Haroona Jatoi, & Christina Rawley. 1998. *Education Policy Simulation (EPICS): A Decision-Making Model to Improve Access to Schooling* (Rev. ed.). Creative Associates International and Harvard Institute for International Development; Jeanne Moulton. 1998. *Uganda's Primary Education System: A Model of Sustainable Reform*. Washington, DC: Academy for Educational Development.

[52] *Heuristica* educativa. 1998. Santiago: UNESCO/OREALC.

[53] http://www.techknowlogia.org/TKL_active_pages2/CurrentArticles/t-right.asp?IssueNumber=9&FileType=HTML&ArticleID=228.

[54] T. Welsh & N. McGinn. 1999. *DECIDE: A Simulation of Relocating Decision Making in Education Systems* (Version 4) [CD]. Washington DC: Academy for Educational Development.

crank motion creates tension in a clock-like spring that powers the generator in the radio, which, in turn, provides electricity. The solar panel stores the energy for the radio, and, in direct sunlight, the radio switches to solar power automatically.

Crank Radio

Crank Solar radio

Resource 2.7.2 - Digital Radio

A geo-stationary satellite, AfriStar™, of the WorldSpace system orbits over Africa. Comprised of three beams, AfriStar™ covers every inch of the African continent, the Middle East, and parts of Southern Europe. It broadcasts to portable digital receivers equipped with satellite dishes the size of teacup saucers (see the photo at right). The audience hears crystal clear, CD-quality sound without static or interference. The receivers run on batteries or electricity and have been adapted to use solar power. They can pick up the satellite's signal at any location in Africa and the Middle East, no matter how remote or isolated. When connected to a computer using a special adapter, they operate as a modem for transmission of Web-based multimedia data from the satellite to the computer.

Resource 2.7.3 - Suitcase Radio Station

The Commonwealth of Learning has sponsored the development of a portable FM radio system. The station configurations range in price from US$3,000 to US$5,000, including all elements: antenna, transmitter, console, mixer, microphones, and CD and tape decks The stations can be powered by 12V DC or 120/240 AC.

Figure 2.7.3.1 shows a station in its watertight carrying case. On the console (from left) is the gooseneck microphone, below it is the mixer, at the top right are two tape decks, and below them are two CD decks. The transmitter and power supply, not pictured, are housed under the console. The console is removed from the carrying case when in operation.

Apac, Uganda's northern region, wanted to install the portable station. A feasibility study, however, revealed several limitations with the electrical infrastructure, which was not reliable—a result of load sharing throughout the country (Apac could not receive power for several days). The power was also not usable for electronic equipment because of the dramatic power fluctuations. Therefore, it was decided that, to maintain a reliable broadcasting schedule and develop the station as a center point to community activities by different groups, Radio Apac would operated entirely by solar power. This frees the project from the constraints of the electrical situation and the tariffs associated with it. In consultation with a solar distributor in Kampala, a configuration was determined to allow the station to stay operational during the 18-hour broadcast day. Eight solar panels and seven deep cycle batteries were installed at the station, which now provide lighting and all of the station's power requirements for daily broadcasting (Figure 2.7.3.2). The life span of solar installations is more than a decade and entails low maintenance costs.

Figure 2.7.3.1

Figure 2.7.3.2

Source of figures and text excerpts: David Walker. March 2000. "FM Radio Stations: Broadcasting in the Sun." ***TechKnowLogia***. Available at www.TechKnowLogia.org

Resource 2.7.4 - Community Telecenters[55]

The community telecenters follow different organizational models:

- the ***adoption model***, in which an NGO serves as the host organization, managing the center and integrating it, to one degree or another, into the organization's core business;
- the ***municipal model***, in which a government agency opens a center, often disseminating information, decentralizing services, and encouraging civic participation as well as providing public ICT access; and
- the ***private-sector/commercial model***, in which entrepreneurs launch for-profit centers with "social good" services offered as well.

Examples of these models follow.

[55] Excerpted from: Mary Fontaine. 2002. Community Telecenters: Enabling Lifelong Learning. In Wadi D. Haddad & Alexandra Draxler (Eds.) *Technologies for Education: Potential, Parameters, and Prospects*. Paris: UNESCO, and Washington, DC: Academy for Educational Development.

Three Adoptions in Ghana

In Ghana, each of three NGOs in different parts of the country has established and assumed responsibility for operating a telecenter. Their stories illustrate lessons for public access efforts, including the importance of reaching out creatively to people and groups unfamiliar with ICT, achieving a balance between social service and commercial interests, and providing ICT training programs to build a firm client base.

Before opening their doors, Ghana's telecenters wisely undertook a comprehensive outreach program to familiarize future clients with the possibilities, potential, and relevance of ICT. For example, special days (or weeks) were set aside for women, youth, entrepreneurs, medical practitioners, local officials, and other groups to visit them. Invitations were distributed widely, and when the groups arrived, they received an orientation program designed specifically for them. Local celebrities, tribal leaders, and dignitaries from a variety of fields addressed the groups and cut the ribbons, and local radio and television stations covered the events. Each group left with a specially developed "take-away," such as a floppy diskette containing information relevant to its work, which helped to make tangible the virtual world to which they were introduced. Following these events was the launch of a seminar program inviting people back to explore topics of special interest, such as "The Computer as a Tool for Medicine."

One of the NGOs operating a telecenter in Ghana faced a dilemma between its desire to serve its constituents—the poor—and its need to generate revenue from clients able to pay. In part, it was a moral issue for the telecenter. While its contractual obligations included achieving financial sustainability, the clients it was dedicated to serving did not have sufficient funds to pay the fees necessary for the telecenter to cover its costs. By the end of the project, the NGO had managed to achieve a balance in three ways: first, by developing a sliding fee scale whereby higher-income groups subsidized lower-income groups; second, by building a popular training program for individuals and groups that generated substantial revenue; and, third, by bringing in large blocks of income through outside contracts. For example, through a British Council-sponsored program, the telecenter was paid to provide computer training to groups of secondary school students. In this way, the telecenter could bring in sufficient revenue without having to rely exclusively on individual fees from low-income users to support its operations.

One of the greatest strengths of the LearnLink-launched telecenters in Ghana is their focus on training. From a modest beginning, the telecenters became a significant skill-building force nationwide, supplementing and extending learning opportunities beyond those available in either public and private educational institutes, and providing more practical, hands-on training than some technical universities. In just two years, the training program not only provided more than 10,000 individuals—students, teachers, businesspeople, and even staff from the national telecom—with useful ICT skills, but it also contributed to the financial sustainability of the telecenters, which have relied on client fees to operate since external funding ended. Moreover, when the centers first opened, clients required assistance for even the most basic functions. Due to effective marketing of the training program, 77% of telecenter users registered for training classes. As clients developed their own skills, staff were freed to attend to other functions.

A Municipal Model in Asunción, Paraguay

The vision was good: the Municipality of Asunción would provide less-advantaged communities in the city with the benefits of ICT for civic development purposes. People no longer would have to travel downtown and stand in long lines to register to vote, obtain licenses, or access databases of government information. Instead, they could do it all at neighborhood-based municipal centers. The telecenters would help devolve official functions to the neighborhood level, the public would be better informed and more engaged in democratic processes, and citizens in poor communities would have access to improved communication facilities and opportunities for civic education and lifelong learning. According to Sergio Aranda, LearnLink resident advisor, “it became clear that…this project needed to be looked at in terms of social demand. It needed to be tied into the daily lives of the residents.”

Considering every person and group in town a potential partner, the local director of the municipal telecenter activity forged alliances with the potential to contribute greatly to its own long-term sustainability:

- In return for displaying marketing materials in the telecenters, the local Internet service provider gave the telecenters free Internet connectivity.
- In exchange for free e-mails, Peace Corps volunteers provided free administrative assistance.
- For use of the IT equipment, Catholic University instructors trained telecenter staff in facilitation skills.
- College students designed Web pages for the municipality in exchange for discounted online time at the telecenters.
- Police and prison officials, who used the telecenters to learn computer skills, provided security.
- The mayor, an enthusiastic supporter, participated in teleconferences with local residents, attended telecenter launch celebrations, and found scarce municipal funds to help cover maintenance costs.

Informal contributions were elicited, too, with enthusiasm. Just for the chance to have a telecenter in its neighborhood, a local association of bricklayers, masons, and carpenters built the center, literally and voluntarily, from the ground up.

A Commercial Model: PC3s in Bulgaria

Nearly half of all Bulgarians live in small towns not yet reached by the economic progress underway in urban areas. The farther a community is from one of Bulgaria’s five largest cities, the greater is the gap in economic development.

This holds true as well for access to ICT. While multiple Internet service providers (ISPs) compete with one another in urban centers, few operate in small towns and rural areas. Where Internet access is available, average prices for service are almost twice as high as in the cities.

In Bulgaria’s cities, ICT is helping to drive development by:

- stimulating economic competitiveness;
- catalyzing spin-off businesses;
- creating a platform for e-commerce;
- increasing employment;
- increasing education and training opportunities;

- improving communication; and
- facilitating provision of government and social services for city dwellers.

Lacking infrastructure and access to ICT, small towns and rural areas are in danger of falling even further behind. To meet IT access needs in these areas, a Public Computer and Communication Center (PC3) program is underway to create viable telecenter businesses that combine for-profit and public good services with a sound business plan.

Essential elements of the business plan include:
- launching PC3s with local entrepreneurs;
- distributing prepaid computer access cards, redeemable for PC3 services, to groups throughout Bulgaria to stimulate use and reduce risk for operators;
- developing local language resources on social and economic development for clients;
- providing hardware, technical assistance, training, and Internet connectivity subsidies to operators;
- promoting spin-off businesses, such as the sale of peripherals, desktop publishing, and equipment repair; and
- providing local businesses with e-commerce assistance.

Resource 2.7.5 - Telecenters: Selected Resources

UNESCO Guide to Community Multimedia Centers: How to Get Started and Keep Going

http://portal.unesco.org/ci/en/ev.php-URL_ID=15709&URL_DO=DO_TOPIC&URL_SECTION=201.html

UNESCO Portal for Telecenters

http://portal.unesco.org/ci/en/ev.php-URL_ID=1263&URL_DO=DO_TOPIC&URL_SECTION=201.html
This site presents information on projects and tools.

International Community Telecenter Resources

http://portal.unesco.org/ci/en/ev.php-URL_ID=3870&URL_DO=DO_TOPIC&URL_SECTION=201.html
The UNESCO site seeks to facilitate development of community telecenters worldwide by providing information, experiences, and resources related to practical telecenter implementation and management.

Assessing Community Telecentres: Guidelines for Researchers

http://www.idrc.ca/acb/showdetl.cfm?&DID=6&Product_ID=520&CATID=15
This IDRC report (free online version) covers a telecenter evaluation plan, indicators in telecenter studies, issues in sampling and surveying, matching research methods to data needs, and data analysis and reporting.

IDRC Telecentre Research

http://www.idrc.ca/pan/telecentres.html

This site serves as a meeting place for people interested in telecenter practice and research. Information on IDRC's telecenter initiatives is included, along with links to resources produced by others working in the field.

Ten Steps for Establishing Multipurpose Community Telecenters

http://www.unescobkk.org/ips/ebooks/documents/tensteps/index.htm
"Ten Steps" is a new UNESCO publication to assist communities in establishing, operating, and managing sustainable Multipurpose Community Telecenters (MCTs). The publication comprises 10 booklets, each of which presents a step toward establishing a sustainable MCT in simple and easy-to-understand terms.

CTCNet Community Technology Center Start-Up Manual

http://www.ctcnet.org/resources/toc.htm
CTCNet serves as a support mechanism for Community Technology Centers (CTCs) by providing electronic and in-person links for its affiliated programs. This manual covers timeline and process, mapping community resources, determining program focus, staffing, software selection and criteria, space, hardware, security, scheduling, outreach, self-assessment, budgeting and funding, and preparing a business plan.

Gender Analysis of Telecenter Evaluation Methodology

http://www.apcwomen.org/resources/research/telecentre-gender.html
This document addresses how gender can be integrated meaningfully into telecenter evaluation methodologies. It is animated by African experiences and examples, particularly South African experiences and examples.

3 From Potential to Effectiveness

3.1 Infrastructure

Resource 3.1.1 - Electric and Solar

Many communities do not have reliable electric source to power radios, televisions, and computers. Some, like the one discussed below, are experimenting with solar energy to run their hardware.
Small-scale electricity generator sets – commonly known as gensets – are among the most technologically and commercially mature options for distributed energy generation. Generator sets have relatively low capital costs but high running costs due to the need to purchase fuel and provide regular maintenance. If routine maintenance tasks are not carried out regularly, the genset may break down before its time.

For generator sets with a capacity of less than 3 kW, gasoline and diesel are popular fuels. Genset engines may also use other fuels, such as propane, kerosene, biogas, biofuels or fossil/biofuel mixtures.

Source of excerpt and for further information:
http://www.dot-com-alliance.org/POWERING_ICT/

To learn more about energy options go to:
http://www.dot-com-alliance.org/POWERING_ICT/pub/Energy_Options.htm

Honduras Solar Village[56]

San Ramón, a Honduran village of about 840 people located in the hills above Choluteca, is proof positive of the power of new technologies to leapfrog over traditional barriers to development. San Ramón has become the world's first solar-powered community hooked up to the Internet.

Although located a mere 24 kilometers from a main thoroughfare, the journey up to San Ramón requires a good 45 minutes in a 4 x 4 all-terrain vehicle—and a strong stomach. There is no road to speak of. Rather, a path of stones, ravines, and otherwise tough conditions leads slowly upward. This lack of accessibility, coupled with the relatively few inhabitants and high unit costs, has made the government less than anxious to extend the electric distribution network from Choluteca to San Ramón.

San Ramón started exploring the potential of alternative energy sources, and, in February 1999, solar panels were installed strategically throughout the village. The energy generated through the solar panels powers a variety of community services, including:

- five streetlights;
- six classrooms, each of which has its own electrical outlets for a TV/VHS, computer, or other pieces of equipment;
- a community center, with outlets for fans, computers, TVs, etc., as well;

[56] Excerpted from: Aimee Verdisco et al. May/June 2001. "Honduras: Solar Energy Bridges the Digital Divide." *TechKnowLogia*. Available at www.TechknowLogia.org.

- an innovative classroom equipped with 11 computers, a TV, video and tape recorders, digital cameras, scanners, printers, etc.;
- a health clinic, with a heating and cooling system for water and storage of medicines and vaccines; and
- lighting in the village's church.

In October 2000, San Ramón went global, becoming wired to the Internet through each of the 11 computers in its innovative classroom.

Two additional solar villages are currently under preparation: Las Trojas (with a population of just over 190) and La Montaña (population of 240),

Resource 3.1.2 - Wind Power - Spirit Lakes Community Schools

In 1991, Spirit Lake Community Schools in Spirit Lake, Iowa, began studying the use of wind as a renewable energy source. With the support of the Iowa Department of Natural Resources, the school district used the first year of the project to measure the wind speed on the proposed site and analyze its electrical costs. In addition, the team familiarized itself with wind turbine manufacturing and the federal and state rules and regulations regarding energy production and use. With a federal grant and a low-interest loan, the district bought its first turbine to supply electrical energy for the elementary school. An agreement with the local utility company specified that, during peak demand and/or low winds, the district must purchase electricity from the company, and during excess production, the company must purchase electricity from the district. The turbine began producing electricity in 1993, and nine months later it had produced 1,570,000 KW hours of energy, providing all of the electricity for the schools and a reimbursement from the utility company. In 1998, the school made the last payment on the loan for the turbine, and the savings are now going to the school's instructional program. The turbine has also been used as an educational tool and has attracted many schools and visitors to study renewable sources of energy. A second turbine has been installed, and, in 2007, when both turbines are paid for, the district expects to have about US$120,000 in tax-free income from the project to improve education in the area. For additional information, visit http://www.spirit-lake.k12.ia.us/~apeck/bg/building.htm.

Resource 3.1.3 - Pedal Power - Bijli Bike

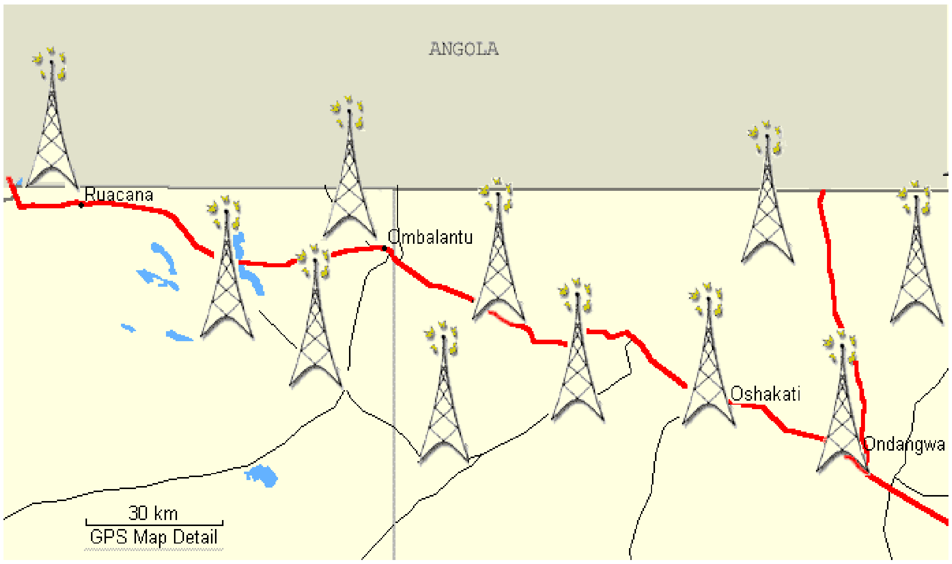
The Association for India's Development (AID) has developed a Pedal Power Generator or Bijli Bike that converts human power to electricity. A student pedaling for 15 minutes can light up two to three classrooms using 11 18 watts CFL lamps for one hour. An initial prototype that could generate 70 watts was first tested in the Domkhedi village, in the tribal belt of Maharshtra, where there is no electricity grid. A new, perfected design is available by mail order from Rashron Ltd. More than 30 generators have been distributed to groups in several states, including Jharkhand, Madhya Pradesh, Gujarat, and others. AID is also collaborating with other groups to bring alternate energy through pedal and wind to Indian villages. For additional information, visit http://www.aidindia.org/hq/projects/illus/pedal2.htm.

Resource 3.1.4 - Connectivity

Turning computers into powerful communication tools requires access to the Internet; however, getting a school online, particularly one in a remote area, is not a straightforward task. In many areas, the communication infrastructure is either nonexistent or too expensive to use. Some forms of terrestrial wireless and satellite technologies are being introduced that do not require installation of wire line networks and are ideal for remote and isolated areas. Below are two examples.

SchoolNet Namibia: A Wireless Solution[57]

Almost two-thirds of Namibian schools still do not have a telephone, but that will no longer keep them from accessing the Internet. Construction has begun on an ambitiously novel project to provide Internet service without wires or telephone lines.



When completed, SchoolNet Namibia, which provides Internet service to Namibia's learners, will be able to hook up hundreds of schools via a narrow-band radio network that will cover most of the densely populated north as well as certain urban pockets. This network will cover almost 900 schools and 54,000 square kilometers. Three Windhoek-area schools have already begun surfing wirelessly.

The system works much in the way as cellular networks. First, a series of strategically placed towers brings a signal to a given area. Devices called subscriber units located on school grounds then pick up the broadcast signal to send and receive data on preordained frequencies. Bridging technology, which allows signals to hop from tower to tower, carries the packets back and forth to SchoolNet servers physically connected to **the Internet**

VSAT in Uganda[58]

Small satellite earth stations operating with geosynchronous satellites can be used for interactive voice and data as well as for broadcast reception For example, banks in remote areas of Brazil are linked via ***very small aperture terminals*** (VSATs), and the National Stock Exchange in India links brokers with rooftop VSATs. VSATs for television

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[57] www.schoolnet.na

[58] Excerpted from: Anthony Bloome. January–March 2002. "Uganda: Wireless School Internet Connectivity." *TechKnowLogia*. Available at www.TechknowLogia.org.

reception (known as TVRO (televisions receive only) deliver broadcasting signals to viewers in many developing regions, particularly in Asia and Latin America.

Uganda is implementing a World Links pilot project in the use of VSATs. Fourteen secondary schools and one National Teacher's College have been outfitted with VSATs for high-speed Internet connectivity. The VSAT system uses a national network of 2.4-meter dishes operating in the C-Band. (Due to climatic conditions, C-Band [3–6 GHz] is less susceptible to interference from heavy rains because its wavelength is much bigger than the size of a raindrop.) The system is full duplex (two-way), so no public switched telephone network (PSTN), microwave links, or optical fibers are needed for a return link. The link is asymmetric—that is, more bandwidth will come to the schools than go from the schools.

The "download" bandwidth, 256 Kbps shared among the network of participating sites, guarantees each site a minimum of 23 Kbps to operate simultaneously. Any school will be able to "burst" or obtain higher bandwidth (from the total amount available) if other schools are not using it. The "upload" bandwidth is a dedicated 32 Kbps per site during the pilot phase. While this bandwidth currently is not sufficient for videoconferencing or -streaming, schools can purchase more bandwidth if there is sufficient demand for additional capabilities.

Ten of the 15 participating sites will have stand-alone VSATs (i.e., antenna, wireless units, routing equipment), a server, and at least 10 PCs on a local area network (LAN). An 11th site has an onward connection to four other schools via a point-to-multipoint Spread Spectrum wireless link through Ethernet bridge equipment. With a wireless Ethernet connection, the four "remote" sites require very little maintenance and their bandwidth use can be tracked and controlled by the VSAT "hub" site with appropriate monitoring software.

The cost of satellite connectivity is about US$400 a month per site. Each new school or institution added to the network as a "hub" or "remote" site will share some of the connectivity costs, which will lower the overall operating costs for each of the schools involved.

3.2 Hardware

Resource 3.2.1 - Computers: Low-Cost Alternative

Although the price of computers is going down, they are still prohibitive for many developing countries if computers are to be made available across the school system in enough numbers to serve the countries' educational objectives. There have been some humble efforts in countries such as Brazil and India to address this issue and to produce a less costly computer with a longer operational life.

In India, a small company, Media Video Limited, is providing low-end computers priced between US$30 and US$65. Another new low-cost product is the Simputer (**S**imple **I**nexpensive **M**ultilingual **P**eople's Comp**uter**), which uses a touch screen interface, but allows for an external keyboard through a USB interface for those who require data entry capability. It is built around Intel's StrongARM CPU and is based on the Linux operating system, with 16MB of flash memory, a monochrome liquid crystal display (LCD), and a touch-panel for pen-based computing. Users do not have to be literate; the device reads out text and supports Hindi, Kannada, and English.

Brazil's version of the Simputer is the Volkscomputer. Very similar in configuration to the Simputer, the Volkscomputer will have a 500-megahertz processor, 64 megabytes of main memory, and 16 MB more on a flash chip that substitutes for a hard drive. Thesystem has a 56 kbps modem and the software is Linux-based and, therefore, is free. Because the machine is modular, schools can link a series up to a regular PC that acts as a server. Volkscomputer was created by the Federal University of Minas Gerais as a result of a commission last year from the Brazilian federal government. Although the Volkscomputer is still in the prototype stage, Brazil hopes to sell it to individuals on an installment plan for as little as US$15 a month. In addition, installing the Volkscomputer in schools will give Internet access to seven million students.

To create affordable PCs, Intel is stripping out the extras. The Affordable PC, an Intel-designed PC for this market, is a desktop that cannot be upgraded. It comes with 128MB or 256MB of memory, a 40GB drive, optical drive and two USB slots. Memory can't be added and some of the other options on typical western PCs are gone. Intel is also developing Classmate PC - a sub-US$400 notebook for schools in developing countries. It will come with about 1GB of flash memeory instead of a hard drive so as to withstand accidents. For further information go to:
http://news.com.com/Intels+bridge+for+the+digital+divide/2100-1005_3-6084250.html

Another attempt is the US$100 laptop designed by the MIT Media Lab. The "machine will be a Linux-based, with a dual-mode display—both a full-color, transmissive DVD mode, and a second display option that is black and white reflective and sunlight-readable at 3× the resolution. The laptop will have a 500MHz processor and 128MB of DRAM, with 500MB of Flash memory; it will not have a hard disk, but it will have four USB ports. The laptops will have wireless broadband that, among other things, allows them to work as a mesh network; each laptop will be able to talk to its nearest neighbors, creating an ad hoc local area network. The laptops will use innovative power (including wind-up) and will be able to do most everything except store huge amounts of data." The designers expect is to have units ready for shipment by early 2007. For more information go to:
http://www.laptop.org/faq.en_US.html

Resource 3.2.2 - Recycling

While organizations, schools, and families struggle to obtain computers and enter the digital revolution, ever more of them are being discarded solely because a newer version is available. International, regional, and local efforts are underway to collect discarded computers, clean them, and distribute them to schools.

There is a glitch, however, with this potentially happy-ending situation. Most computers that are being discarded no longer have software installed, and/or they cannot support newer software. The use of older software limits these recycled computers' usefulness. Therefore, some recycling organizations only accept donations of more recent models, such as Pentium 75 or higher. This requirement excludes a significant number of computers that are now being replaced, particularly those from the late 1980s, including the 386 and 486 series.[59]

[59] See Sonia Jurich. May/June 2000. "Recycling Computers: A Simple Solution for a Complex Problem." *TechKnowLogia*. Available at www.TechknowLogia.org.

Some organizations are trying to address the problem by providing software packages that can be run on any computer, from a 286 to the newest Pentiums. NewDeal software, sold by Breadbox,[60] restores the core functionality of old computers. It contains a complete suite of integrated software applications, including design and Internet applications, and it has a point-and-click interface, like Windows, but with two major differences: first, it runs on computers with as little as 640K RAM and 20 MB of free Hard Disk space, and, second, it retails for less than US$100.

Below are links to some organizations that are providing recycled computers to developing countries:

- World Computer Exchange (US based)
- Computer Aid International (UK based)
- TecsChange (US based)
- Digital Partnership (UK based)
- Digital Links (UK based)
- Computers for Africa

[60] http://www.breadbox.com/geocats.asp.