INTER-AMERICAN DEVELOPMENT BANK

REGIONAL POLICY DIALOGUE

EDUCATION AND HUMAN RESOURCES TRAINING NETWORK

SECOND MEETING: SECONDARY EDUCATION

DISTANCE TEACHING STRATEGIES TO REDUCE THE DROPOUT RATE AND IMPROVE LEARNING IN SECONDARY EDUCATION

WORKING PAPER

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Washington, D.C., July 19 y 20, 2001

Note: This document is part of a series of papers commissioned by the IDB for the second meeting of the Education and Human Resources Training Network, that will take place at the IDB headquarters in Washington, D.C. on July 19-20, 2001. This document is under review, therefore it should not be cited as reference. The opinions expressed herein are solely those of the author and do not necessarily reflect the position of the Bank.

(Original document in English)

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Executive Summary

This paper explores the potential for educational planners to incorporate distance education into their strategies for the expansion of secondary education. Many Ministries are facing one of the most challenging problems in education: increasing access at the secondary level while also increasing the success rate (reducing dropouts and failures) for new entrants from the countryside and from poor urban neighborhoods. Distance education appears to offer useful new tools, ranging from the broadcast media to computers and the Internet.

Strategies for the use of distance teaching.

Six strategies for the use of distance teaching are reviewed, with examples of each and a discussion of their implications for secondary education in the Region:

- Supporting and training teachers in teaching techniques for disadvantaged students.
- Delivering remedial instruction in basic reading and math skills for needy students.
- Providing instruction in selected subjects, to increase offerings in both rural and urban schools.
- Delivering a complete curriculum as an alternative secondary education system
    - For school-age learners in rural areas.
    - For out-of-school adults.
- Delivering a complete curriculum as a universal secondary education system for a country.
- Introducing computer technology intensively, as a means of changing the character of teaching and learning.

The two distance teaching services most fully developed in the Region both use the strategy of providing complete, alternative systems of secondary education. .Mexico's Telesecundaria now serves 16% of Mexico's junior secondary population in small rural communities. Brazil's Telecurso program provides a "second chance" for those who have left school to complete their education, through instruction tailored for adults. Both approaches are worthy of serious study for meeting needs within other nations.

Although no full-scale distance teaching systems focus specifically on equalizing secondary opportunity for students in urban schools, many of the strategies could contribute to that end, for example by supporting teachers in new teaching methods, providing remedial instruction, or tailoring courses to serve segmented portions of the student population.

The choices among learning technologies. The broadcast technologies hold the most immediate promise because of their manageable costs, their capacity to integrate with the work of classroom teachers and texts, and their established record. However, the individual interactivity of computers and the Internet is increasingly attractive and should become a component of these distance teaching efforts when feasible and affordable.

Variations due to the size and wealth of countries. The approaches that might be considered will vary with the size of the country, its current economic and human resource capabilities, and of course the judgment of its own educational experts. Smaller and less wealthy countries may be best served by initially focusing on distance learning materials developed elsewhere, with gradual adaptations to local realities. Some larger countries might choose to start afresh, informed by the methods used elsewhere. For the Spanish-speaking nations of the Region, sharing materials, even entire courses, is likely to be highly cost-effective, although politically difficult.

Technological development and new opportunities. As the future unfolds and access to broadband communications grows, new vistas will open. It increasingly will be possible for poor urban and rural schools to access a wide array of educational videos and motion pictures, on demand. Alternative texts may be available in electronic form, updateable easily and designed specifically for s urban or rural students with differing needs. Telecenters are likely to be ubiquitous. Teacher training could take on new forms, with "best practice" examples available to all teachers, and with teachers throughout a nation sharing their own new teaching experiences

The advantage of starting with present technologies. However, it is better to capitalize on what is currently available than to wait for the magic that the future may bring. Constraints of cost and human resources will still be limiting. And in any event, the key tasks for any successful use of distance education are always similar: (1) to closely integrate the contributions of technology, print, teachers, and learners themselves; (2) to ensure that these systems actually have the intended effects on learning, and if not to modify them until they are successful; (3) to create ways to manage these activities on a large scale, probably the greatest challenge of all. Countries that develop that capacity now will be well placed to incorporate every new information and communications technology that will emerge in the future.

Introduction

The Issue: Expanding expectations and limited resources

As primary education targets near achievement in most nations in the hemisphere, Latin American and Caribbean countries are facing a major increase in demand for secondary education places. In the poorer countries there is still unmet demand for grades 7-9.In the more developed nations, this demand is mainly at the upper secondary (grades 10-12). Policy makers are concerned with the logistics of reaching rural areas with quality education, coping with massive increases in the need for secondary teachers and facilities, and reducing the high rate of dropouts after beginning secondary education.

These challenges must be met with limited resources, both human and financial. There are too few qualified teachers. Secondary classrooms are over-crowded in urban areas and non-existent in small villages. Rapid expansion is bringing with it a concern about maintaining quality while at the same time quickly modernizing to meet the needs of the new global economy.

As a result, there is a new openness to examining non-traditional methods of meeting these needs. This paper examines alternatives that involve the use of distance teaching. The new tools of information technology and communications are transforming virtually every institution. They are capable of playing a more central role in education.

This paper examines how some countries are using distance teaching to support secondary education and what possibilities may exist for creative new solutions.

What do we include in the term "distance education"?

Until recently distance education has been considered to consist of a combination of television, radio, print, and/or in person contacts. With the rise of the Internet, computers, CD ROMs, etc., new possibilities are arising for providing education at a distance. For this review, all forms of teaching and learning through the electronic technologies are included.

The examples cited are primarily within school or school-like community settings. For students at this age level, independent learning outside of an organizational setting and without some guidance from a teacher or parent has not been attempted on a large scale.

Key issues in expanding effective secondary education

The context is fairly common across countries :

1. Access must increase. In rural areas, governments cannot afford to provide full-scale secondary schools, with their specialized teachers, for every small community. Boarding schools are costly and often unacceptable to parents. In cities and towns, already-crowded schools must often move to double shifts,

effectively reducing the time spent in schooling. Overcrowded classrooms make teaching difficult and personal attention impractical.

Distance teaching can reach students in the smallest of communities with quality education, supported by teachers who can facilitate their work. In urban schools, it can assist teachers as they deal with large numbers of new students.

2. The quality of education is often bifurcated. Students from economically advantaged families and regions have traditionally met high standards. Those groups newly entering secondary education, especially in nations where it is becoming a universal right, often get a poor education. Their schools are more crowded, with fewer educational resources. If they are in economically heterogeneous schools, expectations for them are lower as teachers try to maintain high standards for the others.

   Traditional teaching methods often do not serve this new student population well. Many students now enter secondary schools with grossly inadequate literacy skills. The "academic" character of traditional teaching, through lectures and texts, poorly serves them. Without special efforts to improve those basic skills and without more wide-ranging instructional methods, relating learning to the experiences of children, high rates of failure and dropout are foreordained.

   Distance teaching can assist in literacy (and numeracy) upgrading (although personal attention is also needed.) It can contribute greatly to transforming the character of teaching and learning. It can do so through bringing new kinds of learning experiences into the classroom and through guiding teachers as they learn new methods.

3. The content of education is evolving. All societies are moving toward a greater emphasis on science, technology, math, and information technology. Skilled teachers are scarce.

   In addition, as the secondary population becomes more diverse, many students will need a combination of core academic skills with skills essential to their immediate post-secondary employment.

   Distance teaching can effectively provide much of the content of science and technology education. It also has the potential to expand the curricular offerings available, to meet the needs of those who will not be proceeding to further levels of education.

4. The objectives of education are slowly changing, with greater emphasis on individual inquiry, collaborative problem solving, and intellectual creativity. While every country is aiming toward these goals, achieving them in the traditional classroom has proved very difficult.

Distance teaching cannot guarantee success in transforming the character of education. But it has the potential to assist every teacher to develop new methods of teaching and learning, by bringing new kinds of learning activities into the classroom and by helping train teachers in these new approaches. Realizing these potentials is obviously not easy within the complexities and traditions of educational systems. Some strategies will work in a particular context, if done in a certain way, while others will fail. But today there is a broad history of successful (and unsuccessful) experiences to guide us. We will examine many of them. That examination hopefully will show that while distance teaching alone cannot solve all of these problems, systems that effectively integrate teachers, texts, and technologies can provide unique and important opportunities that will serve countries well.

What has worked to date: An overview of strategies and projects in the Region and worldwide

Two distance teaching projects in the hemisphere are outstanding examples of ways to provide secondary access to rural or disadvantaged learners: Telesecundaria is a complete junior secondary system serving Mexico's rural villages. Telecurso, in Brazil, is providing out-of-school youths and adults a second-chance opportunity for secondary education. These both will be examined in detail. But these two systems will be described in the context of a number of different distance teaching strategies that have been employed elsewhere.throughout the world.

These strategies are arranged in the order of their comprehensiveness. They begin with support for teachers only, continue on to combinations of student instruction and teacher support in limited subject areas, and go on to full-scale systems using distance education.

In brief, distance teaching can be used to:

1. Support and train teachers in appropriate teaching techniques for disadvantaged students.

Students entering secondary school from disadvantaged communities have special instructional needs , if they are to succeed. Distance teaching can support teachers in adapting their classroom instruction to these new student populations.

2. Deliver remedial instruction in basic reading and math skills for needy students.

Distance teaching has demonstrated a capability to upgrade students in these essential skills, particularly through specialized computer programs,

3. Deliver courses of instruction in selected subjects, to increase offerings in both rural and urban schools.

This approach can give all students access to engaging instruction in subjects such as science, technology, the environment, and foreign languages. It can partially overcome

the problems that schools in poorer regions have in attracting high quality specialized teachers and in providing laboratory equipment. It could also provide alternative courses for students having differing educational needs and capabilities.

4. Deliver a complete curriculum as an alternative secondary education system.

This strategy is exemplified by the two famous Latin American cases:

> Telesecundaria, which has been tailored to serve rural students, who otherwise would not have access to secondary education.
>
> Brazil's Telecurso 2000 program, which gives a "second chance" to those who have left school before completing the secondary cycle..

5. Deliver a complete curriculum as a universal secondary education system for a country.

Earlier projects tried to simultaneously reform and expand educational access by providing instruction for all subjects through television and closely controlled educational inputs, including teacher training. Although this strategy has no current advocates, an examination of these cases illustrates both the advantages and the liabilities of such intensive, centralized use of the technologies.

6. Introduce computer technology intensively and system-wide, as a means of changing the character of teaching and learning.

A few countries are investing on the intensive use of computers, together with a great deal of teacher training, to move toward more problem-solving and inquiry-based forms of teaching and learning. Their objective is to use computers to help change the way teaching proceeds, in order to encourage the development of higher cognitive skills for all students.. Barbados is currently proceeding down this path.

Discussion Of The Six Strategies

The attached Table 1 summarizes certain features of each of these strategies, including the information/communication technologies typically employed, requirements for educationally effective use, examples, risks, and advantages of the strategy.

We now proceed to a discussion of each strategy.

Strategy #1. Support and train teachers in appropriate teaching techniques for disadvantaged students.

Students entering secondary school from disadvantaged communities have unique needs. Whether living in favelas or small towns or decaying urban areas, these students have the greatest need for special educational support. However, these are the very students that teachers are least prepared to assist.

Distance teaching can support teachers in adapting their pedagogical approaches to the needs of these learners. It can train them in upgrading literacy skills, in methods for teaching children with a very wide range of backgrounds and abilities, and in motivating these typically insecure students. Television, CD-ROM's and the Internet all offer promise.

Some examples of teacher-support uses of distance teaching.

Such technological support for teachers has been under-utilized. Yet several examples suggest what would be possible if distance teaching efforts were directed to training teachers in the special needs of disadvantaged students.

> National teacher training with local integration. India has long used its *satellite TV* system for rural teacher training. In an early effort, daily broadcasts demonstrating science teaching methods were beamed to groups of teachers drawn from clusters of nearby villages.[1] A local "master teacher" followed up by leading a day-long discussion of how those approaches might be adapted to local needs. Over one week of school vacation, tens of thousands of teachers were stimulated to explore new ways to teach science content within their own educational contexts. Evaluations documented a very enthusiastic local response, and an appreciation for the effort of the Government in reaching remote areas with first-class training. Impacts on teaching and learning were not assessed.
>
> Pre-service education with classroom experience. Thailand has used its *TV Open University* to try a new approach to teacher training.[2] After a limited period studying at conventional teacher training colleges, students completed their degrees after they began teaching, by taking televised courses and studying for brief periods on-campus. While taking longer for a degree, students brought to their studies their real-life classroom experiences, and their training was more tied to practical issues of teaching, rather than to theory. Evidence suggested that their students performed at a higher level, although comparisons were not rigorous. This approach to teacher training, for example to help fill the needs for additional teachers at the secondary level, may be both less expensive (because of the reduction in pre-service time) and more effective than traditional means.

[1] Clifford Block, John Mayo, and Dennis Foote, *Satellite Instructional Television in India*, Journal of Communications, 1976

[2] BRIDGES Report, Harvard University and USAID, 1988

Training in new curricula. Several states in the U.S. (for example South Carolina and Virginia) operate extensive *satellite-based instructional television* systems, particularly to serve rural students. When new teaching methods or new curricular topics are introduced, programs designed for teachers are developed, recently for example programs in information technology.

Teacher certification in one's home island. The University of the West Indies has long used *audio-conferencing* to provide access to both degree and non-degree courses to students throughout the Caribbean, reducing the need for high cost residential study. Among its many offerings have been courses permitting uncertified teachers to receive certification while continuing to teach on their own islands, as well as special courses such as seminars for teachers of the deaf, health education, and others. This remarkably low-cost technology, which now can be supplemented by the Internet, can reach wherever telephone service is available. Because of its reduced need for costly residential study, studies have shown that, for courses such as teacher certification, costs are one-third of traditional means, with similar levels of effectiveness. Like many examples of distance teaching, it shows that success lies not in the particular technology, but instead in the careful crafting of lessons, quality print support, and local organization

The CD-ROM, DVD, and the familiar VCR have brought new training possibilities to teachers, with a great variety of materials to be used or adapted.

> Multi-media training kits. A leading U.S. professional organization, the ASCD[3], provides kits on teaching methodologies combining *videos (often from actual classrooms), and training manuals*. Many of these materials deal with issues in teaching classes of diverse cultural and educational backgrounds.
>
> Linking texts to teacher training modules. Textbook publishers in the U.S. now offer *video materials closely related to their textbooks, sometimes including examples of classroom teaching*. These are particularly useful where new approaches are being promoted. One such example is in teaching lower secondary science in a thematic, exploratory fashion rather than in the traditional "lecture, then laboratory" method. This close integration of student textbook and teacher support materials can be a powerful strategy.

Uses of the Internet to support teaching are steadily emerging, as we discover how to use this amazing medium.

> Creating a community of teachers and learners.. At the primary level, Chile's well-known Enlaces project is linking teachers and students throughout that nation, and providing a common base of information on all

[3] Association for Supervision and Curriculum Development

aspects of education, with active participation from the entire educational community.[4] It provides curricular and teaching materials, web sties, software evaluations, and many other educational resources. By the Year 2000, 90% of Chile's students were in schools connected to the Internet and therefore to Enlaces. The involvement of experts from 30 universities is of special note.

Information resources for teaching. Many countries are creating home pages which can link teachers to information, teaching and curricular guides, and specialized support (for example for teaching disadvantaged students). Thousands of lesson plans produced by individual teachers are freely available. Many sites (largely in English, but rapidly expanding to other languages) have information or products relating to every secondary school subject, as well as for special populations such as the learning-disabled. There are also teacher ratings for hundreds of instructional software programs, and many guides to the use of the information technologies.

Demonstrating teaching methods. In the U.S., a service is emerging that shows brief "streaming video" segments on teaching.[5]

Teachers assisting each other. Many U.S. teachers use e-mail or "listserve forums" to support each other, for example when a teacher in a rural area may find himself the only teacher of a subject, such as chemistry or a foreign language. These professional relationships have become extraordinarily important for some teachers, for both motivation and for sharing teaching ideas.

Degree education on-line. On-line tertiary-level courses of importance to secondary education are gradually emerging. Degrees at the training. levels of bachelors and masters are available totally on-line or with limited in-person attendance. [6] The number of users is growing rapidly (66,000 in 2001 for the largest, the University of Phoenix). Tuition costs are substantial; however, learners can remain at their jobs and at home while earning degrees or certificates. It should be noted that E-mail interaction with faculty is deemed essential by most course providers and is the most costly element of such courses, often requiring more time of teachers than in conventional classes.

[4] www.enlaces.cl

[5] Video on the Internet is limited by long download times. The brevity of video segments limits its usefulness for demonstrating teaching methods. As faster Internet connections become more common, these applications may become quite important.

[6] The University of Phoenix functions only at a distance, while more conventional organizations such as Columbia Teachers College offer courses on-line as an adjunct to their campus-based degree programs.

Discussion of the "teacher support" strategy.

These examples show that any communications technology--from simple telephone conferencing to CD-ROM's to advanced Internet applications--can be used to support teachers in teaching methods, curricular content, and their own professional development.

There has been little effort to evaluate the impact of these various programs on student learning. That absence of evidence is unfortunately characteristic of most investments in teacher training, whether conventional or innovative. Furthermore, the most intensive training efforts are often closely coordinated with the introduction of new teaching materials and methods, complicating any analysis. But logic suggests that training has, for some teachers at least, a payoff in enhanced student learning. For specific skills such as methods for tutoring students in literacy improvement, there is no substitute for specific, intensive training. The issue is how to provide it widely and affordably, and here distance education clearly has a role.

The real challenge to Ministries is to be serious about designing a program of teacher training to improve the learning of disadvantaged children. it. A few occasional training seminars are hardly worth undertaking---they will rarely have major impact and are unlikely to be sustained.

A "serious" effort would have most of the following characteristics: linking professional lessons to very specific issues in teaching and in motivating students; providing time and a convenient facility for teachers to participate (which often is difficult); providing incentives for participation; integrating the distance training into school-level "school improvement programs" so teachers can support each other; linking to pre-service teacher education; and, continually assessing its impact on student learning.

With active participation from teachers, such a system ultimately could generate a wide repertoire of methods for effectively teaching new populations of secondary students.[7]

> *As with other strategies to be discussed, distance teaching provides a new set of opportunities to improve the success of those newly entering lower or senior secondary education. This strategy does so by providing the "missing ingredient" of pedagogical training that is closely linked to the curriculum and to the teaching of disadvantaged students, right at school sites. For rural areas, and for many urban schools, it may do so much more effectively than a sole reliance on already over-stretched systems of school supervision.*

[7] Although not dependent on distance methods, Japan's very successful educational system is characterized by great effort in sharing good teaching practices, from joint planning at the school level to local and national recognition of innovative teaching techniques.

Strategy #2. Deliver remedial instruction in basic reading and math skills.

Literacy development. As noted earlier, extreme deficiencies in literacy skills prevent many students from succeeding as they reach secondary school. Without special efforts to upgrade those skills, at the beginning and perhaps throughout secondary schooling, these children are doomed to failure, to dropping out, or to proceeding through school but learning little.

Upgrading basic reading skills at the secondary school level is difficult through any means. By the time students enter secondary school, they vary so widely in literacy that mass education approaches are likely to be ineffective. Some way to tailor or individualize literacy development is required. Non-technological methods such as tutoring, extra school time, and self-guided instructional reading series have shown promise.[8] The case for most types of distance teaching is more limited, but examples exist that are worth further consideration:

Examples for developing literacy skills

TV and text-based courses tailored for rural populations. Telesecundaria has focused efforts on improving literacy as part of its overall rural junior secondary curriculum, with impressive results, reducing the rural-urban literacy gap by half.[9]. Its methods, discussed later, deserve special attention. They include written materials produced to be readily comprehended by its student population, with examples drawn from Mexico's rural life, and with learning activities liked to learners' home and community environments.

Language arts modules designed around themes and authentic communications. An experimental series (devised in English but that also was available in Spanish), the "Galaxy Classroom" operated in the U.S. at the upper primary level only, but is instructive for possible junior secondary design. The effort was to improve the reading and writing of students in urban and rural schools in areas of deep poverty and with students ranked in the bottom 1/3 in academic performance. Galaxy organized instruction around themes important for poor children, such as dealing with the stress of urban crowding, multiple cultures, privacy and security, family problems, etc. These themes were established by video dramas of children's characters (in a kind of "tele-novela" format). Exploration of those themes was stimulated by the characters in the dramas, children's fiction, and carefully designed learning activities. One other technology was used--the fax machine, which linked all classrooms and the "home" of the TV characters, who asked students to write their

[8] For example, a commercial combination of such methods in the U.S., the "Open Court" system has recently produced dramatic improvement in applications with poor readers in several U.S. cities. At the primary level, a highly structured "mastery learning" system, has been successful at several thousand U.S. schools.

[9] Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999

own opinions and advice. By giving children the chance to write and read "authentic" communications, both writing and reading took on a new, personal reality. Evaluations showed positive results on standardized tests of vocabulary and reading comprehension, together with enthusiastic student and teacher acceptance.[10] Similar approaches could readily be applied to situations faced in other nations.

Computer assisted instruction to build basic literacy skills. The best-established use of learning technologies to upgrade literacy is through computer programs designed for that purpose. Such "integrated learning system"[11] software individualizes practice by continually analyzing each student's achievement level and presenting precisely the lessons each needs to advance to higher levels of reading proficiency. Evidence is extensive for the value of these programs at the primary level[12]. Their usefulness for the more demanding task of upgrading those in secondary schools is less well-documented, but appears to be positive in a number of situations. A trial may start in Trinidad and Tobago in 2001, as an element of that country's adoption of universal access to secondary education..

Numeracy development

A similar deficiency exists in the numeracy skills for many who will be entering secondary education. Mathematical skills are becoming more important as occupations become more technical. Careers in information technology, in particular, require both basic computational skills and the higher order thinking inherent in such subjects as algebra, geometry and statistics. Increasingly all students, even those in vocational tracks, will need secondary level math education

Few countries have put much effort into remedying math deficiencies once students reach the secondary level. Yet the basic math skills are among the easiest to remediate. These basic skills are developed by a great deal of guided practice, until the computational part becomes automatic. That characteristic makes the use of computer programs, "programmed texts", and some forms of broadcast curricula widely successful for improving basic math skills.

For higher order skills, a recent analysis[13] indicates that the use of computers in a more functional way, to help solve problems across a range of subjects, is more productive than structured math programs.

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[10] Clifford Block, Gloria Guth and Susan Austin *Final Report, Galaxy Language Arts Evaluation,* Far West Laboratory, San Francisco, 1993

[11] Integrated Learning System" is the term applied to current versions of "computer-assisted-instruction", one of the oldest forms of computer use.

[12] J.A. Kulik, *Meta-analytic studies of findings in computer-based instruction*. In E.L. Baker and H.F. O'Neill, Technology Assessment in Education and Training, Hillsdale.NJ: Lawrence Erlbaum,1994; also Decker C. Walker, in *Education and Technology, Reflections on Computing in Classrooms*, Fisher, et al Apple Press,1996

[13] Harold Wenglinsky *Does it Compute? The Relation between Ed. Tech. And Student Achievement in Mathematics* Princeton, ETS, 1998 www.ets.org/research

Examples for developing numeracy skills

Programmed texts. Although text-based and thus not thought of as "distance teaching", textbook series based on "mastery learning" are proving successful in upgrading the skills of struggling math students who enter the secondary cycle in the U.S. A series designed originally by the famous educator Benjamin Bloom, published by Saxon Publishers, is enjoying a renaissance in the U.S., as schools face the failure of more conceptual, "new math" approaches for developing basic skills, especially for poor children.

Computer assisted instruction. The same "mastery approach" is used in computer programs designed specifically for math upgrading. Because learning is individualized, students can begin at any level and proceed at a pace consistent with their abilities. Today, these "drill-and-practice" programs have been enriched with more engaging graphics, mathematical games, puzzles and references to real-life applications, and have proved both engaging and successful with students in many countries.

"Interactive" radio. These deficiencies in basic math skills, like those of literacy, are best solved by effective primary school instruction. So it might be noted that the well-known approach of "interactive radio" uses daily radio broadcasts to present a programmed, mastery learning curriculum with examples relevant to the student's local culture, utilizing mathematical games, song, and continuing practice to develop the hierarchy of skills needed to master math. Large learning gains at very modest cost have been found in many countries, particularly in Latin America.[14] Venezuela is now reaching over 700,000 students in their classrooms in this way.[15]

TV and text-based courses tailored for rural populations. Using television in a way that is closely integrated with text and teaching activities, Telesecundaria has reportedly raised the math performance of rural children to equal those of urban children, a remarkable development given the fact that entering students lag far behind. [16]

Imaginative computer programming to develop cognitive skills. A wholly different approach to the use of computer programs is to have learners discover and master the underlying logical principles of programming (and scientific thinking) in a way that is appropriate to children. The best known example is the program "Logo" and its successor "MicroWorld", developed by Prof. Seymour Papert at M.I.T. and his followers. Costa Rica has carried out an extraordinary

[14] Andrea Bosch *Interactive Radio Instruction: 23 Years of Improving Educational Quality*, World Bank Distance Learning and Knowledge Initiatives, v.2. No. 1, 1997

[15] Nora Ghetea Jaegerman and Victor Vasquez R. *Interactive Mathematics for Basic Education: The Venezuelan Experience with IRI* at www.techknowlogia.org, May, 2000

[16] Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999

nationwide use of this system reaching into every primary school and some secondary schools for many years. The leaders of that effort cite the excitement of students, even those from impoverished rural areas, the very high level of logical skills developed by some, and the fact that more students, even from rural areas, are now choosing technical careers in part because of this experience.

Computers, math and higher order thinking skills.

A recent U.S. study[17] appears to show that by junior secondary school, computer use focusing on higher order thinking skills has a dramatic positive effect on math understanding. Teachers of course must guide these efforts, but computers can help by simulating mathematical abstractions, applying them to concrete problems, and permitting the manipulation of models, an especially effective technique.

Discussion of the "remedial instruction" strategy

Intensive efforts to upgrade literacy and numeracy are probably essential for many of those newly entering secondary school. However, in order to focus resources on those most needing them, schools will first need to do one or more of the following:

allocate additional time for upgrading those students (during the school day, after school, on weekends, and/or during school holidays):

provide alternative courses, designed for students at lower basic skill levels;

These both involve difficult policy decisions, requiring time, facilities and teacher management, but most of all a recognition that such special efforts are needed and are likely to be effective. Distance teaching can only provide the tools to implement such policies. Sometimes the most difficult aspect is to believe that essentially all students can, in fact, master these skills, if given special attention and the ability to move at their own pace.

For enhancing *literacy* at this level, technology *alone* is not sufficient. Abundant reading materials and some individual help also will be needed . But the use of computers and of the mass media could make very important contributions.

If school time is available for *supplementary additions* to the regular curriculum:

Specialized, high-quality computer programs can help students master the basics of reading comprehension.

[17] Harold Wenglinsky *Does it Compute? The Relation between Ed. Tech. And Student Achievement in Mathematics* Princeton, ETS, 1998 www.ets.org/research

Word processing can assist with the first steps of writing and in developing fluency.

Video and text modules can be designed so that students can enter them at widely differing levels of proficiency, and then move at their own individual paces.

If *differentiated courses can be provided:*

The broadcast media can help structure language arts learning that is tailored to these learners' particular needs, as in Telesecundaria and Galaxy[18]

E-mail access or inter-school fax communications can stimulate interest in reading and in writing

For building basic *mathematics* skills, very effective options exist. Some are sufficiently self-instructional that relatively little teacher supervision is needed.

If school time is available for *supplementary additions* to the regular curriculum:

Individualized practice through computer-aided instruction can improve essential numeracy skills.

If *differentiated courses can be provided:*

The use of television as part of a highly integrated instructional system, as in Telesecundaria, is very likely to be effective.

Programmed texts, which require little or no technological support, are often effective for math learners with limited initial skills.

Single-computer-per-classroom facilities provide many exciting opportunities for mathematical games, simulations, and Internet-based real-world applications of math.

A largely untried approach to remediation is self-instruction in the basic skills . When distance education is used in tertiary education, it is usually through study at home with texts, correspondence, video tapes, and/or television. For younger students, especially those from poorly educated and sometimes single-parent, poor, families, the conditions for successful self-learning are limited. Nevertheless, some technologies can be so motivating and self-guided that for some, they may offer a great new opportunity. The technology of course has to be made available to such students outside of school hours or in an after- school setting supervised by a para-professional. But any such program dramatically reduces a Ministry's cost in terms of school facilities and teachers, and so

[18] They also lend themselves well to "media campaigns" that can show the public, parents and educators that a government is serious about attacking such core problems.

has the potential to be cost-effective. Many students may not persist in such an unstructured situation, but for those who do it can be a life-changing experience. Among the approaches worth examining are the following:

The loan of "personal word processors"[19] (when budgets and security conditions permit), to provide practice in writing and calculating.

The use of audio tape/readable text combinations for mastering early reading skills.[20]

Hand-held electronic devices providing practice on math problems.

Self-instructional, programmed instruction texts in basic mathematics.

There are *other approaches to the problem*, not involving remedial work, which will be described later:

entire courses for all levels of students can be provided in advanced mathematical subjects where teachers may be unavailable, such as algebra, geometry and statistics. (However, there is as yet little evidence that such efforts can successfully reach students at widely varying levels of academic skill.)

systems such as Logo/MicroWorld can be incorporated as well as use of the computer as a tool for mathematical reasoning, to help develop higher-order math skills.

Distance teaching provides many new opportunities to provide secondary students with alternative or compensatory offerings. Educators often are not accustomed to thinking in such a way, since schools are fully occupied in simply offering a common course for all students. As technology is integrated into education, different educational experiences for differing groups of students may become a powerful tool for equalizing educational success.

[19] These are battery-operated computing devices (essentially simple laptops) which cost in the U.S. about $200 each. They contain built-in word processing programs and sometimes a calculator. Some can download easily to computers. They can provide basic practice in writing and revision.

[20] A home version for very young learners, designed for early primary school, is "Hooked on Phonics", a major commercial success in the U.S. Other systems for school use at later ages includes the S.R.A. Reading Lab, a long-time product now in use in a few English-speaking Caribbean schools for upgrading junior secondary students.

Strategy #3. Deliver individual courses of instruction in selected subjects, to increase school offerings.

Both rural and economically disadvantaged urban schools have difficulty retaining good teachers, particularly in such specialized subjects as science, information technology, and foreign language. Here distance teaching, particularly through television, has a long and successful history.

In the United States, for example, several States organized distance teaching systems in the 1970's to meet legal requirements that they equalize educational opportunities for African Americans, who then were concentrated in rural communities in inadequate schools. What began as a "civil rights" program for poor rural children has matured into services available to all schools. Later, as satellite coverage began to encompass the entire U.S., a desire to use that capacity for education led to Federal support for the creation of regional networks and national educational satellite services.

A driving force behind this initiative was to cope with a shortage of science, math and foreign language teachers. Course offerings constantly evolve, to reflect new needs or new educational approaches (such as courses relating to information technology or the use of more "child-centered" and "active learning" teaching methods.)

Noteworthy is that schools are always free to choose the programming they may wish to use. Indeed, for the national systems, school districts need to purchase use of the programs. The idea is that the "educational marketplace" of users will determine those programs and program providers that are useful enough to commit both student time and financial resources toward, and that others will fade away.[21]

Examples of systems providing numerous individual courses

Enhancing educational opportunities for rural children. The State of South Carolina's Educational Television Network broadcasts six thousand instructional television programs each year, more than 200 each day, using 32 satellite channels and low power microwave transmitters for urban areas. The Network re-transmits national programs and produces many itself, correlated with the State's curriculum, teacher guides and textbooks.

Creating systems that respond to regional and national needs for quality science teaching and other important needs. "Star Schools" is a U.S. Federally-funded initiative that has supported the start-up phase of a number of distance teaching services. Its various educational providers now serve over 1.5 million students in the U.S., predominantly in rural and disadvantaged urban schools. Satellite television, with telephone feedback in

[21] The U.S. "Star Schools" system provides support for only a five year initial period, after which the systems much sustain themselves. However, new program and services can be eligible for additional grant support in their developmental phase

some cases, predominates but increasingly Internet applications are being supported, as well as projects involving videodiscs, cable TV, fax, and computers. This program since 1988 has generated many new offerings. It currently is funding, for example, the following offerings:

A service that reaches 140,000 students and 4000 teachers with a “hands-on”, discovery science curriculum for junior secondary school.

A Pacific region system developing science courses made relevant for those in the Pacific Islands, centered on oceanography , volcanic action, and fragile environments.

A collaboration by four U.S. States to develop a multi-media curriculum for geographically scattered Native American populations.

An effort to digitize exemplary video materials in math and science, to permit Internet access to them.

The development of teacher training courses for lower secondary students via the Internet, in subjects such as algebra.

Discussion of the strategy

Several of these U.S. distance teaching services have now survived for over twenty-five years and provide a broad array of subject offerings, some of them complete subjects (mostly in science, math and foreign languages). As intended, the “marketplace” has sustained some while others have disappeared for lack of sufficient demand.

However, these services exist largely at the margin of the U.S. educational system, serving limited numbers of students. Because schools need to purchase programs from the national systems, long-term commitments are difficult. Further, strong U.S. traditions of local educational control tend to create resistance to long-term dependence on such outside programming. Other nations need to consider such factors in relation to their own educational traditions, which often more centralized.

Evaluations of the Star Schools program include the following "lessons learned"[22]:The main early criticism was that Star Schools projects were not doing enough about concerns at the local, school level, where conditions greatly influenced success. Greater attention was recommended to developing more effective, continuous staff development activities.

Ultimately, a number of important successes were reported:

Dozens of courses were offered that otherwise would not have been available.

[22] www.ed.gov/prog_info/StarSchools/eval.html

Teachers reported that undeserved and disadvantaged students, including minority and learning-disabled students, were better served by the distance learning curriculum/programs than by the regular curriculum/programs.

For all students, limited evidence on learning indicated that Star Schools courses were at least as effective as conventional teaching.

Curriculum experts rated Star Schools math and science curricula highly on both content and instructional processes. Teachers were provided with models of exemplary instructional practices.

Many teachers reported changing their approach to teaching, including using more open-ended, collaborative teaching; interdisciplinary team- teaching; and new evaluation methods.

Ninety-six percent (96%) of the science teachers in one project indicated they had little competence in science prior to participation and therefore relied almost exclusively on the textbook. As a result of Star Schools they became more confident in presenting their own lessons.

Links to working scientists and to NASA astronauts in outer space stimulated an intense interest in working on their own science projects by numerous students.

Students in rural Georgia, taught Japanese by a native speaker in Nebraska, won first, second, and third place in a national foreign language competition.

These experiences bring the following to the discussion of the expansion of secondary education in the hemisphere:

> *distance teaching* services, *rather than discrete distance teaching* projects, *are well-equipped to adapt to ever-changing needs, particularly in science and technology education;*
>
> *in nations where schools have some choice in how they deliver curricula, distance teaching has the unique advantage of being able to provide a rich menu of alternatives;*
>
> *a useful role for government is to help create those alternatives through initial support for developing new programs.*

Strategy # 4. Deliver a complete curriculum as an alternative system.

The most ambitious strategy in use in the region is the creation of a fully alternative educational delivery system which is tailored to the specific needs of those learners who otherwise could not obtain schooling. That is the strategy used by Mexico's Telesecundaria, serving rural students, and of Brazil's Telecurso, serving those who have left the school system before graduating. Both of these comprehensive programs have used television plus written materials tightly integrated with each broadcast program.

These important innovations will be examined in some detail, in order (1) to illustrate the principles of effective distance teaching and (2) to explore possible adaptations by other countries.

Examples of alternative secondary systems provided by distance teaching

Providing a complete junior secondary education to small rural communities: Telesecundaria (Mexico, and adaptations in several Central American countries.)[23]

Telesecundaria is probably the most sustained and successful distance education system in the world. Initiated in 1968, Telesecundaria is now a fundamental component of Mexico's educational system, providing junior secondary education (grades 7 to 9.) to about 900,000 students throughout rural Mexico. It serves 17% of Mexico's junior secondary students, and continues to grow.

The problem facing Mexico is common to many countries. Small communities cannot afford a traditional secondary education model that requires a full complement of teachers specialized in language, science, math, social studies, and other secondary subjects. Student populations at each grade level are too small, and teachers are hard to attract to rural towns. In addition, government investments often are concentrated in urban centers. Telesecundaria provides an alternative model that brings education to these villages.

Telesecundaria uses a combination of daily television programming, books, and community-based teachers to serve 14,000 small schools, primarily in villages with fewer than 2,500 people. Satellite distribution, using 6 channels, has supported its expansion since 1992. Over an academic year, over 3,800 programs are broadcast, including subject courses for students, summer school programs and teacher training. Periodically they are revised or replaced with modified content or better pedagogy. Some are used for five or ten years.

[23] The IDB and World Bank have produced two very useful reports on Telesecundaria, on which this description is largely based: Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999 and Jose Calderoni *Telesecundaria: Using TV to Bring Education to Rural Mexico* World Bank Distance Learning and Knowledge Initiatives v.3.,No. 2, 1998

Each community must take the first step in seeking Telesecundaria educational services, by providing a place to study and at least 15 primary school completers. The Ministry of Education then provides teachers, facilities, a television, a satellite dish and de-coder, the instructional program and textbooks.

The typical school has three classrooms, a science lab and a library. There are but three teachers, one for each grade. Each teacher covers all subjects, with subject-specific instruction provided through television and associated learning materials. Telesecundaria schools average 22 students per grade. They follow the same overall curriculum as students in conventional schools.

Learning in a Telesecundaria school. It would be a mistake to think of this as purely television-based. Instead, it is a tightly structured *system* of instruction consisting of the following:

1. Television broadcasts each day, 15 minutes for each subject. Programs are broadcast twice each day, from 8:00AM to 2:00PM and from 2:00PM to 8:00PM, to serve a second shift.
2. Teacher-led learning activities for another 45 minutes for every subject, informed by a teacher's guide with lesson-specific learning objectives, instructional strategies, and explanations.
3. A specially-developed student text which amplifies the concepts in each televised lesson.
4. A student workbook with individual and group learning activities. These books are made available at a very low cost (U.S. $.35 each) (refundable at the end of the school year), to ensure their regular use by all students.

As Telesecundaria has matured, didactic lectures are being replaced with more locally relevant "active learning" approaches. For example, a biology program might show students in natural settings and in their communities, observing, recording, drawing pictures, classifying and then discussing their findings in small groups.

Those who serve as community teachers are sometimes certified teachers, but most are not. They initially receive only one-week of intensive training prior to entering the classroom. As a result, continued in-service teacher training is essential. It is provided through televised programs broadcast during the afternoons and on Saturdays, as well as some face-to-face training seminars. These training programs are not theoretical; instead, they concentrate on day-to-day methods for teaching the Telesecundaria curriculum. Teachers watch a series of specially produced TV programs and then, in a group, work through teacher guides containing learning activities and curricular content.

Mexico reportedly intends to adapt Telesecundaria for use in some urban schools, a development that is worth watching.

Evaluations of Telesecundaria's effectiveness. Telesecundaria students appear to do well. Although definitive data is not yet available from a recent Ministry of Education study, the following facts are available from an IDB study[24] based in part on those results.

> Telesecundaria students begin significantly behind other students in both math and language but by the end of the three year junior secondary cycle they have caught up completely in math and have cut the deficit in half in language. Almost universally, in other educational systems students who begin the secondary cycle with such deficient skills simply fall further behind. But with this alternative system, these students are overcoming these deficiencies, a remarkable outcome.
>
> The IDB study estimates that 79% of students who enter at the 7th grade complete 9th grade, the same percentage as those entering Mexico's conventional lower-secondary schools. (Students entering traditional vocational schools show only a 56% completion rate.) The comparability of examinations in Telesecundaria and conventional schools is not clear, however.
>
> The only troubling fact is that only 21% of Telesecundaria graduates proceed to the senior secondary level, compared to more than 85% nationally. Studies have not yet shown the reasons, nor have tracer studies followed the performance of those graduates who do enter senior secondary. However, lack of rural access to senior high schools and economic factors certainly contribute to the gap.

What investments support these educational results? In Telesecundaria (as in other such systems) a team of teachers, instructional experts, and subject specialists work together with television and print specialists. As a result, development of each 15-minute module requires twenty days and costs US $30,000 to $50,000.[25] There are over a hundred televised programs for each subject: e.g., 181 in mathematics for students in grade 7, 105 in biology. *It is this major investment in instructional design and continuous improvement that is a key to this success.*

The serious use of distance education changes the investment pattern in education. Because of the economies of scale in distributing instruction to large numbers of students, far greater investment can be put into perfecting the pedagogy underlying the television programs, print materials, and teacher training than in traditional systems.

Utilizing Telesecundaria programs in other nations. In a landmark of international collaboration, Mexico's Ministry of Education, its domestic satellite authority, and several Central American nations agreed in 1996 to use Mexico's Solidaridad Satellite for international utilization of Telesecundaria. Mexico is making available an invaluable store of 3600 fifteen-minute television programs and associated texts and teacher guides, which can be supplemented by national programming. Panama began broadcasting Telesecundaria programs in 1995 and Costa Rica in 1997. El Salvador is taping the programs in order to broadcast them to their own small rural communities. In El Salvador, additional economies are expected by combining the Telesecundaria facilities

[24] Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999

[25] Each program is used for five-to-ten years before being revised.

with community learning centers serving adults in other ways, including the introduction of computers.

This experimental adoption of Telesecundaria programs by other nations bears very careful observation.

On the positive side:

> Adoption of such well-designed programs is a very low-cost strategy with potentially high educational payoffs. For nations too small to make major investments in new productions, it is especially valuable, but its applicability may be much broader. It is difficult to conceive of a more cost-effective approach.
>
> The provision of secondary education to underserved populations can begin with unprecedented speed, with educational services delivered within a year or two after a decision to proceed has been made.

On the other hand, some important issues might conceivably arise:

> A wholesale use of another country's instructional system may raise issues of differences in language use, in local references, and more broadly in national culture and ways of thinking. Education "made elsewhere" is challenging for national educators to accept as a long-term solution. [26] Indeed, today there are no multi-national curricula or programs at any level of education that reach large numbers of students. . Whether the new technologies and global integration will change those attitudes remains to be seen.
>
> The lack of institutional experience, compared to Mexico's development of its capacity over thirty years, may require sustained collaboration with the Mexican experts. It is rare that simply delivering packaged programs is enough. The elements of local support, training, and feedback are critical and need to be developed within each country's own situation.

This array of possible concerns is *not* intended to discourage consideration of this very attractive strategy, but instead to suggest adaptations that might take account of these potential issues.

If the characteristics of learners and educational objectives are similar enough to those of rural Mexico, as in many parts of rural Latin America, this might be a very attractive way to start a distance education service for under-served groups, while gradually adding national content and unique cultural characteristics.

Discussion of the implications of Telesecundaria.

[26] In the Internet realm, thousands of schools and classrooms have created their own web sites, but access to those sites by those in other schools is rare.

Mexico now has *the only educational system in the world where a significant portion of its secondary student population is served through distance teaching*. The results of Telesecundaria show that well-designed distance education can increase secondary access, keep retention rates high, and achieve education of quality. It is doing so in the absence of specialized teachers in rural communities. Particularly i*f its intended adoption by some urban schools proves effective, a very different model for education at the junior secondary level might emerge.* Instead of teachers who are primarily trained in their subject specialties, classroom teacher training could place greater emphasis on pedagogical methods and individualized tutoring when needed. The recruitment of non-certified professionals, while understandably distressing to many educators, could provide at least temporary relief for the teacher gap that always exists as systems increase universal access to higher levels.[27]

> *Mexico is showing that the expansion of secondary education can be done economically, and need not be characterized by the failure or drop out of many who enter. By tailoring education to fit the backgrounds of these learners, and by providing it in their own communities, a high level of success and satisfaction can be achieved.*
>
> *The willingness of Mexico to share its well-developed educational materials with its neighbors offers them an opportunity to rapidly expand secondary education to their own rural communities. While issues of cultural and national differences will undoubtedly arise, there is no other alternative that can as quickly begin to offer secondary educational services to underserved communities.*

Providing an alternative route to junior secondary certification for young adults who did not continue beyond primary school. Telecurso 2000 (Brazil)

One of the hemisphere's most ambitious educational efforts is Brazil's Telecurso 2000 program, serving Brazilians who have not been able to complete their formal education. Since its initiation in 1995, Telecurso 2000 has provided primary, secondary and vocational education by television and texts to groups of learners gathered in "telessalas," where they are assisted by trained educators. Participants are then able to sit examinations for primary (eight years) and secondary (eleven years) certificates.

The numbers served by Telecurso 2000 have grown rapidly. By 1999, more than 200,000 students were attending classes at factories, schools, churches, offices, prisons, ships and buses, and many more individuals watch individual courses at home. Six hundred telessalas had been established, in six regions of Brazil, with an ultimate target of 4000. An astounding 5.2 million accompanying texts were sold between 1995 and

[27] Even without the aid of technology, many urban schools in the U.S. are now turning to the use of uncertified teachers, who take brief vacation training courses. New York City recruits 1600 such new teachers per year, and the State of California has a similar program.

1999. An IDB study estimates that perhaps 3 million people had studied through Telecurso in its first five years.[28]

Importantly, an additional 200,000 students are now found in regular schools where Telecurso is the predominant mode of delivery. This is an unplanned use, driven by demand from individual schools, and is a tribute to the perceived quality and relevance of the courses.

The overall design of Telecurso 2000 is like other integrated distance education programs, with TV lessons supported by specially written text and, when available, teachers or tutors. However, the character of the programs could hardly be more different from conventional instruction. There are no tele-lectures. Instead, programs are set in situations familiar to the average Brazilian adult learner, such as factories, homes, offices, businesses, and streets. Commercial television actors are used, together with the pace, style and humor that has made Brazilian telenovelas among the most watched programs in the world.[29]

The wide and flexible availability of the courses is important for this population of adult, working students. The tele-courses are broadcast on Globo TV, Brazil's largest television network in the early morning, and then re-broadcast on Brazil's public and educational channels throughout the day. Many learners tape the programs for convenient viewing, often in the telessalas, where personal support is available. An important component is the availability of print materials at newsstands.

Costs. Brazil devoted $30 million to development and initial production of the programs and supportive materials. The leading Brazilian TV network has donated transmission time and has promoted Telecurso through TV advertising valued at $60 million. Because of the large numbers of learners involved, an IDB study estimates that total costs may be as low as $10 per student for the TV lessons and $4 for the text for each course. As more and more use the courses, those costs shrink further. However, when teachers are added for the telessalas or in regular schools, the estimated cost of about $400 is comparable to conventional education.(The bulk of educational system costs are always in teacher salaries.) The massive amount of donated time makes a generalization of these costs to other countries inappropriate.

Effectiveness. Studies are underway to try to assess the system's effectiveness. While undoubtedly informative, assessment of this kind of alternative educational system requires a somewhat different way of thinking about outcomes, since there are no alternatives for satisfactory comparison. The number who ultimately reach secondary certification through this route will of course be very important to know. But many others will have taken some courses, which may be to their benefit even if not ultimately leading to certification. Some will not succeed in the certification examinations and others will drop out. Other systems that operate outside the formal structures of education

[28] Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999

[29] Based on a guess that as many as 3 million have viewed the programs.

often report dropout rates (i.e. not completing required courses of instruction) of 70% or even more.[30]. There are many reasons: difficulty in spending the needed time over a period of years; finding the work more difficult than expected; dealing with competing demands of work and family.

On the other hand, Telecurso has done everything right to reduce that propensity to drop out: providing inter-personal support through the telessalas; locating telessalas in institutions and organizations that encourage both convenience and institutional support; continuing the "social marketing" of Telecurso through advertising, conferring a positive social status on participation; and most importantly making the style of learning fit the life experiences of its students.

In short, if the numbers now choosing to dedicate time and effort to Telecurso study are maintained or grow, there is little question that a very important educational service is being provided. Its ultimate impact on the completion of secondary education in Brazil remains to be determined. Further research hopefully might illuminate further the relative roles of the telessala instructors and the televised lessons, whether, It would be useful to understand better the degree to which the actual contact with telessala teachers makes a difference for learners and whether costs could be reduced, for example by using lower-cost facilitators or only occasional face-to-face meetings.

Discussion

Telecurso 2000 may be very important to the future of distance education and of education in general. As with other examples, it is showing that really well designed distance teaching can serve large numbers in a process that breaks through the constraints of attending conventional schools and conventional teaching practices.

It also shows how rapidly and widely education of quality can be delivered. Only two or three years from its inception, it was able to reach tens of thousands of learners, a marked contrast to the glacial pace of change typical of more conventional means.

There are other features characteristic of Telecurso that call for serious attention by educational planners:

> The use of radically different pedagogical contexts, centered on real-life experiences, not lectures.
> Embedding learning in modes such as story, humor and personal experience, which cognitive research tells us are powerful aids to learning and to applying knowledge.
> Using the multiplicity of today's media channels to make learning accessible at times that suit the learner, rather than the educational organization.

All of this, notably, has come about outside of Brazil's traditional educational system. Initial funding of the program development came from an association of manufacturers; a

[30] For example, India's "Open School", a correspondence high school with media assistance has a graduation pass rate of 25%, with many others not proceeding as far as the examination..

television network provides free time; and an educational foundation creates the programs and manages the system.

What is clear is that few if any alternatives to achieving educational certification exist for those who avail themselves of education through Telecurso.

> *For the motivated young adult in Brazil, Telecurso provides an avenue to economic and social mobility that all countries might consider emulating.*
>
> *The greatest challenge for others may be to find ways to create such significant innovations within their own national institutional contexts. It is not now a question of* what *to do nor even of* how*, educationally, to do it. But there is a major question of whether governmental organizations and/or private sector partners in other countries can find ways to give birth to such efforts.*

Strategy #5. Deliver a complete curriculum as a universal secondary education system for a country.

In the 1960's and early 1970's, several countries tried to simultaneously reform and expand educational access by providing instruction for all subjects through television and related materials. These are worth a brief note, since elements of those strategies may still be applied today, modified by experience and by new opportunities.

Examples

Expand junior secondary access rapidly while introducing a modern curriculum and more dynamic teaching. (El Salvador ITV, 1970's)

Strategy: Use daily television lessons as the core and catalyst of a comprehensive reform, without substantially increasing teaching staffs or facilities.

Educational Results: Rapid expansion of access by moving to double sessions; entirely new curricula introduced; apparent learning gains.

Ultimate outcome: Not continued by the country; teacher dissatisfaction with their constrained roles possibly one of the reasons, together with civil unrest.

In this ambitious effort, the intention was to fuel economic growth by very rapidly expanding junior secondary education while "modernizing" its character to better fit the needs of a technological world. It was to do so without increasing greatly the numbers of secondary school teachers and schools, through shifting to double sessions and using television.

The result was one of the most tightly integrated of all distance teaching systems. A totally changed curriculum was delivered through daily television lessons in every

subject; an effort was made to reduce didactic instruction in favor of approaches such as demonstrations of scientific experiments; intensive teacher re-training was focused on helping teachers support the new curriculum; and new student text materials and teacher's guides were keyed to each daily lesson.

As a result, access to junior secondary education was rapidly doubled while still maintaining--even improving---educational quality. Independent evaluations showed gains in intellectual skills, together with very positive student attitudes and initially positive teacher attitudes.

Importantly, however, the system was not sustained. The occurrence of civil war itself would have prevented the steady growth and improvement of the system that has been a characteristic of Mexico's Telesecundaria. However, other factors certainly contributed: continued resistance among many educational leaders to what seemed to be an approach that had been imposed upon them by reformers and foreign assistance and carried out largely without them by a team of specialists; a slowly growing dissatisfaction by some teachers (although not all) at the highly structured system and its heavy reliance on TV, which diminished their own autonomy; and a concern that teachers had to work longer and in some ways harder without economic benefits. It was an early lesson that the institutionalization of radical change requires as much attention as its technical design.

Expand enrollment rapidly while introducing a modern curriculum and more dynamic teaching. (Ivory Coast, 1970's)

Strategy: Establish a reformed system through television and integrated materials.

Educational Results: Rapid expansion of access by moving to double sessions; new curricula and very dynamic teaching methods introduced; no adequate tests of learning.

Ultimate outcome: Not continued by the country; dissatisfaction with donor domination; failure to write French well (as a result of inadequate practice) cited as key reason for discontinuation.

Like El Salvador, this program facilitated a rapid doubling of enrollment. Similar in its integrated nature to El Salvador, the Ivory Coast ITV system stressed imaginative instructional programming using drama, graphics, and other methods to introduce a child-centered, activity-based educational approach. It, too, was not sustained.

The Ivory Coast reform did so with a teaching force that had been extremely traditional and in fact authoritarian in classroom discipline and practice. . The drastic change in process and objectives (stressing thinking skills more than rote memorization of facts, enjoyment of the learning process instead of fear of failure) probably contributed to its lack of institutionalization. Heavy donor influence also was seen as a problem. The program was summarily terminated after a few years, with the Government citing parental complaints that children leaving the system were not writing French at expected

levels. Previously, much of education was centered on copying dictation or chalkboard work in French.

Similar models were also developed and operated for some in two states of Brazil and sustained for longer periods but never became a fundamental component of the educational systems in those states. .

Radio based junior secondary schools. (Republic of Korea, Colombia)

Problem that was addressed: Expand junior secondary access, especially to rural areas and those wising to catch up.

Strategy: Establish an alternative junior secondary system through radio and associated texts.

Educational Results: Initial large-scale use, gradually declining over time.

Ultimate outcome: Colombia's program continues but with very limited use; greater national attention being given to computers, the Internet and television. .

Several countries, including the Republic of Korea and Colombia developed radio schools in the 1960's and 1970's as one way to expand access to junior secondary education. As with TV, they were integrated with specially developed texts. These clearly filled gaps, making a major educational difference for some students. However, the growth of television and the information technologies has pushed aside interest in radio. The connection with dispersed learners and local facilitators has gradually declined, along with budgets. That is unfortunate, because radio can play a very effective role for many subjects, with excellent programs developed and distributed at low cost.

Discussion of Strategy # 5

These experiences have shown that carefully developed distance teaching systems operating within the "regular" school system can achieve multiple objectives: rapid expansion of access, curricular reform, and pedagogic improvement. These multiple outcomes can be achieved quite rapidly as well, In El Salvador classrooms were using the reformed system two years after initiation of the project. The implications for serving the new populations waiting to enter secondary schools today would seem to be great.

However, the distressing reality is that none of these systems was institutionalized and sustained. .Wholesale change means wholesale disruption for those within a country's educational system. It also means that groups outside the normal organizational structure, with expertise in instructional technology, need to be given considerable authority over teaching processes and instructional materials. Genuine concerns by experienced educators tend to fall on deaf ears by those intent on pushing through dramatic reform.

In addition, teaching and learning activities in the systems just described were very different from traditional classrooms. They all incorporated to some degree, as Telecurso and Telesecundaria do today, the use of drama, visual learning, explorations of the local environment, and student-driven learning processes, all very different from the lecture method that is traditional. While educators are still arguing, more than ever, for the increased use of such methods, technology's ability to actually bring such reforms into every classroom is highly visible. When it does so, it does not "look" like the disciplined teaching methods of the past and may be rejected by parents (as in the Ivory Coast), teachers, or educational decision makers. Such non-traditional methods may be perceived as acceptable for those outside of the educational mainstream, such as children from the countryside or adults.

Given these complex forces, going to a nation's very idea of what "education" should be and the role of qualified teachers, lessons need to be drawn with some humility. Nevertheless, the following may be worth considering:

Somehow *educational leaders, school administrators and teachers need to feel some genuine "ownership"* of the changed system, through participation in initial design and through contributing to its steady improvement. Telesecundaria's vacation-period feedback and training sessions are a good model for feedback. .

Individual teachers and schools may need to be given greater autonomy in how they choose to incorporate distance teaching components into the daily work of classrooms. That approach could lead to a great dilution of the quality of the intervention. One variant, used in the aforementioned Galaxy program in the U.S., is to provide a choice of a "menu" of suggested classroom teaching activities and of resources such as reading materials. That strategy worked well, and exemplified the authentic partnership between the knowledge of the classroom teacher and that provided through distance teaching..

These technology-delivered interventions may have to be used in a more selective way, for example for subjects where many teachers may acknowledge a special need, as in science or in literacy upgrading. The never-ending daily schedule of broadcasts in every subject simply may not be acceptable to those for whom teaching is seen as a profession, rather than participation on a production line.

> *The wholesale introduction of a system where distance teaching carries much of the instructional load theoretically could be an effective way to rapidly expand access while achieving success for all students. The centralized character of this approach permits new teaching methods and materials, which can be crafted to reach students with a wide range of skills.*
>
> *However, the way to accomplish this in a manner that is embraced by decision-makers, teachers and parents has not yet been discovered. The blending of a classroom teacher's skills and motivation with distance teaching's multi-faceted instructional capacities is a delicate one. The introduction of new educational methods to the very traditional practices of education can be seen as a risk.*

For the moment, use of distance teaching for selected courses may be the only acceptable and prudent route for most countries.

Strategy #6. Introduce computer technology intensively and system-wide, as a means of changing the character of teaching and learning.

This is a very new strategy, exemplified by efforts in Singapore and now Barbados. These countries are counting on the intensive use of computers, together with a great deal of teacher training, to transform the character of learning to one based more on inquiry, problem-solving, and mastery of the new intellectual tools provided by the information technologies. A brief examination of the current effort in Barbados will illustrate the magnitude of this effort to conjoin the new technologies and new ways of learning and thinking.

Example

Creating a population with universal mastery of the skills and knowledge needed for success in the new global economy. Edutech 2000 (Barbados)

In 1997, Barbados began planning a reform of its system which would make intensive use of computers. It now is completing the first year of implementing a phased introduction of the new system, in its first 15 schools. The project is designed to achieve multiple objectives: moving away from solely didactic methods of education to more "child-centered" and inquiry-based methods; creating a society with universal "computer literacy" of a high level; and developing a teaching force that can carry these innovations well into the future.

The means chosen is to introduce computers intensively at both primary and secondary levels, together with extensive training and professional development opportunities for teachers.

This is not a strategy specifically focused on reducing dropouts or increasing the success of low-performing students. Instead, it posits that all students will be raised to new levels of performance. However, access to computers in every school will provide opportunities to use a wide variety of specialized software, including software designed to upgrade the literacy and numeracy skills of lagging students. Furthermore, the assumption is that the new teaching methods will engage more effectively the minds of all learners.

Computer availability is intensive: a target ratio of five students per computer at the primary level and ten per computer at secondary. With this ratio, each student could average more than one hour per day of individual use of a computer at the primary level and 30-to-40 minutes per day at secondary. These "computer-contact-hours" will actually be higher, however, since for many activities pairs of students will work together

and in other cases teachers may lead whole classes with the aid of a single computer, plus other multi-media devices. Therefore, especially at the primary level, computer use could well play a daily role in almost every subject.

Most important, however, is the intensity of teacher re-training. Before the project is phased into each school, two teachers are released to spend an entire school year working with software, to integrate its potential into their teaching of the Barbadian curriculum. They then return to lead that school's efforts. Over a period of a few years every teacher is expected to have 360 hours of training in the use of computers within the system.

This training is designed to develop fluency with computers and with common productivity software such as word processing, spreadsheets and data bases, including their application to teaching. It then proceeds to a deeper understanding of pedagogical methods such as project-based and cooperative learning, and how computers and the Internet can be used to support a change from strictly didactic methods to these more "constructivist" approaches. The use of the Internet is also emphasized, including the ability to design lessons tailored to Barbados' culture, geography, and economic life. In these ways, computer use and new ways of thinking about teaching and learning are being fully intertwined.

It is too early to assess the educational impact of this very ambitious effort. However, it certainly will result in a very high level of familiarity with the use of computers throughout Barbados' student population, which itself may be a force for change.

Discussion of the computer-as-catalyst-for reform strategy.
What is most impressive about this approach is that the introduction of computers has been designed to produce fundamental change in the educational process. It thus bears a similarity to Strategy # 5 above, which used television both as the core of instruction and as a catalyst for change in instructional methods. However, teachers and schools are far more central to the process in Barbados. Teachers' own pedagogical methods are viewed as the essential agents of change, with software as a tool to support those methods. In many respects, teachers are being afforded substantial autonomy.

Edutech 2000 will provide important lessons as it evolves over the next several years. Much is being asked of teachers as they develop and master a very different philosophy of teaching and learning, and as they work on the elusive process of fully integrating computer use into the daily work of a classroom. Perhaps the great question is whether a mastery of "higher cognitive processes" will emerge, and if so whether that will apply to the entire range of student backgrounds and abilities. School systems trying to do so through traditional means alone have largely failed, and particularly with disadvantaged students.[31]

[31] In the U.S. and U.K., these failures have led to a massive return to a "back-to-basics" approach by educational policy makers within the past five years. For example, adoption of "whole language" approaches to reading have been associated with major declines in literacy achievement.

Barbados is engaged in a bold national experiment. If Edutech 2000 can, in fact, generate a mastery of higher cognitive skills as well as more basic skills in students of all ability levels, education ultimately could be greatly influenced in many countries.

Barbados small size and relative prosperity make possible its large investment in technology and training, and may limit the applicability of this strategy. At the very least,, others would do well to emulate the intensive commitment to having teachers master not just the technology, but also its use in implementing new methods of teaching and learning. This approach will produce a corps of teachers well equipped to lead effective use of the technologies well into the future.

Strategies that have not been successful.

Countries should be cautioned about approaches in the use of distance teaching that have not been very successful, at least on a large scale.

An ineffective strategy: Using instructional technologies as modest "supplements" to selected parts of the curriculum.

The tradition in some developed countries has been to focus distance teaching on a few concepts and then broadcast well-crafted supplementary programs centered on them, perhaps once every week or two. This was the practice from any years in the U.K., in relation to B.B.C. programs. A number of developing countries in Latin America, the Caribbean, and Africa originally set up their educational broadcasting units following a similar model, first for radio and then for television. Today, most of those efforts are moribund.

While the logic of this targeted approach is appealing and costs are manageable, the strategy fell victim to three fatal flaws. Because of their supplementary nature, schools did not place enough emphasis on them to engender broad utilization. The varying pace of covering curricula among schools often caused the broadcast lessons to be inappropriately timed. And, the educational input was so brief that educational impact could not be assessed, making it difficult to justify continued investment. .

An often ineffective strategy: Providing computer access to schools with minimal software and training.

This is the situation found in many developing countries and in numerous schools in the industrialized world. Some educational planners have thought that this "hands-off" approach would engender maximum creativity and a natural evolution to computer applications that proved widely effective.

Studies have shown little if any effect on education. Often computers stand idle. Even when used, often by particularly creative teachers, it is usually difficult to find any significant impact or expansion of their use.[32] . .

There are exceptions. When one or two teachers at a school, or an enterprising principle, use a modest initial computer investment to gradually build up significant uses, computer use can diffuse throughout that school over a period of several years, with each teacher finding particular ways to support their efforts. These individual stories are quite inspiring, but uncommon enough that this overall "strategy" is suspect.

Starting with a serious educational purpose and then expanding to a variety of other uses, some created locally, seems to be a safer use of these scarce resources.

What opportunities are opening up in the near future?

New opportunities constantly arise for distance teaching, typically following this sequence:

1. A new technological capacity is developed that may have educational significance.
2. A few pioneering organizations or school systems begin to use it in an exploratory way.
3. (Rarely) a large scale adoption brings it into the mainstream of education, in the process discovering how to scale up to a large-scale program with real educational impact. .

We can see on the near-term horizon developments at each of these levels and will briefly note them. However, it is seldom a rapid step from introduction of a new technology to its educationally significant use. Often, such applications never occur.

1. Opportunities arising from emerging technological capacities.

1.a. Broadband Internet access is gradually bringing "streaming video and audio" to the Internet. For education the future implications may be enormous, for the Internet will no longer be limited to text and graphics; instead it will add back some of the human, emotional aspects of communication that great teachers have always utilized. In addition, the entire body of material on video will become accessible for teacher training and for instruction. One result is that it will become easier to develop and distribute specialized course material for those requiring it.

Until this year, the use of broadband required Internet reception through fiber optic cable or high capacity telephone lines, or digital satellite. For many schools, those are not on the near-term horizon. However, Broadband Internet services by satellite has just become a reality. A new technology providing stand-alone two-way Internet

[32] Fisher, et al *Education and Technology, Reflections on Computing in Classrooms*, Apple Press,1996

communications from any site came into commercial use in mid-2001.Small VSAT[33] satellite terminals at schools, homes or businesses will have the capability of receiving the Internet at speeds about 10 times higher than normal modems. In addition, a Ministry could transmit simultaneously the same information to all sites. Colombia announced in March, 2001 an agreement to provide such a service to 1400 rural schools.[34] . If this new technology proves as effective and affordable as it appears to be, it will provide a breakthrough in Internet access for rural schools.

1.b. Digital radio and Internet downloads by satellite, direct to receivers. Another service is about to come into operation in Latin America in 2001, direct reception of satellite radio.[35] With a single up-link any country or group of countries can provide multiple, high-quality radio broadcasts directly to home or school receivers which cost about $200 each. The primary purpose of the service is for re-broadcasts of national radio services, news, information and entertainment. However, in Africa a the provider has contributed the use of several radio channels for education and development information such as healt5h, agriculture, environment and woman's issues.

A new capability of the same system is the capacity to receive downloads of World Wide Web content directly to a PC, through a $100 PC card and associated small antenna. While two-way interaction is not possible, Ministries could therefore download material in this fashion, on a regular basis.

1.c. Electronic books. "E- books" offer books stored on hand-held readers, down-loaded through the Internet. Legibility and battery life are improving. If a viable commercial market develops, which remains uncertain, educational uses will emerge.

1.d. Increasing computer capacity and declining costs. High costs for computers are a major constraint to having computers contribute to secondary education. Unlike TV, most applications to education require individual or paired student use, requiring massive equipment investment in order to provide enough student access. Any major reduction, through general consumer trends or through specialized educational production, would be of great importance. .

Brazil has embarked on an effort to reduce such costs through a computer designed for the educational market. Past attempts to develop specialized lower-cost computers, ranging from the BBC Acorn to the "network computer" have failed to find a large enough market to compete successfully with the general-purpose PC, where mass marketing continually drives down costs. However, Brazil's large internal market might change this equation.

[33]" VSAT": Very Small Aperture Terminals, small satellite reception/transmission dishes.
[34] Providers are Gilat Communications Latin American and StarBand Latin America. (www.gilatflorida.com). DirecPC and other companies are also beginning such services in various places.
[35] The provider is WorldSpace. (www.worldspace.com)

2. Opportunities arising from exploratory and pilot applications.

2.a. On-line alternatives to traditional secondary education. On-line "virtual high schools" are emerging. In the U.S., these systems are primarily serving families who choose to educate their children at home. Some small rural school districts also are pooling their intellectual resources through this means. However, all of these systems are still very small in the numbers being served.

All operate through daily on-line lessons that can be used at any time, associated texts, ample opportunities for on-line tutoring, and on-line testing. Typically they provide for on-line discussions among enrolled students and for collaboration on group projects. Enrollment fees are substantial and students require substantial time on the Internet each day.

These systems are likely to remain viable because of the special "home-schooling" market in the U.S. Their use within schools themselves will be important to observe, since on-line education provides one opportunity to provide special courses for students who need differentiated instruction. As broadband capacity increases the importance of such on-line learning will increase, although limited by computer and Internet costs..

2.b. CD-ROM based alternatives to traditional secondary education. One U.S. company offers a complete primary and secondary education through a combination of 22 CD-ROMs and texts, some of them programmed texts, again for "home-schoolers." The current enrollment is said to be 35,000.[36] It is designed for only a few minutes a day of parental(or teacher) supervision. Costs are only $200 for the entire course. Unfortunately, its quality is unsubstantiated. Its structure, however, is important to consider: a comprehensive set of CD-ROMs permit individualization and self-pacing, supposedly without very much skilled supervision.

2.c. Multi-media science and mathematics programs: (I.V.E.N.) The International Virtual Education Network for the Enhancement of Science and Mathematics Learning is a collaborative project of Brazil, Colombia, and Venezuela, facilitated by the I.D.B. and a start-up grant form UNESCO. This important pilot effort is designed to produce science and math courses for the last two years of secondary school which make full use of the current potential of information technology.

Over the next three-to-four years, a collaborative group of electronic content developers will be producing programs for either Internet or DVD use. Fifty pilot schools in each of the collaborating countries will utilize the science and math modules after extensive teacher training. An evaluation will assess its effectiveness and its potential for wide applicability.

IVEN is noteworthy for several features: the multi-national collaboration of outstanding educational technology experts; its intention to center on genuinely "hands-on, minds-

[36] www.robinsoncurriculum,com

on, and reality-on" science teaching, long sought but seldom achieved through conventional means; and its hope to be applicable to current curricular objectives while conducting an "instructional reform." If its objectives are achieved, two things will have been accomplished: (1) an important instructional tool will be available in the critical area of science and math teaching, where expert teachers and facilities are scarce; and (2) an institutional foundation will have been established to capitalize on the many other emerging possibilities of the future. Meanwhile, IVEN will be generating ma y lessons and methodologies useful for all.

3. Opportunities arising from larger-scale adoptions of distance learning.

3.a. Potential expansion and further assessment of Mexico's Telesecundaria.
Mexico has planned for some time to extend its successful system to senior secondary levels on a pilot basis and to introduce use of the Internet. These, together with use by neighboring countries, provide a rich opportunity for drawing lessons of wide applicability.

Discussion: future opportunities and present realities

It is exciting to look to the future. The history of educational technology has been to look to each coming development with unlimited enthusiasm, as technologies have moved from radio to television to computers to CD ROMs, and now to the Internet and beyond. However, history has shown that for most of the world's learners, education has in the end been little affected, and schools have gone on as usual.

The prudent course would seem to be to examine the rich technological resources already available and see how they can be incorporated into educational practice to serve education. Future technologies can always be incorporated by educational organizations that have mastered the integration of a current technology into the fabric of the educational process.

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Cost Considerations

This paper will touch on cost issues in only a general way. A number of existing IDB and World Bank Case Studies provide excellent reviews of costing methods as applied to particular cases.[37] They would serve as good guides to a country's initial costing.

The cost structure of distance teaching systems differs somewhat from traditional education systems. Annex #1 notes the major cost categories in distance education systems-- start-up costs at both the Ministerial and school level, and recurrent costs. It also cites cost estimates for broadcast-based systems such as Telesecundaria and for computer-mediated systems such as Barbados Edutech 2000.

Table 2 summarizes relative costs as they vary with the primary technology used, as well as variations in management demands their use imposes on Ministries.[38]

General observations on costs

1. The medium used for distance teaching has a major impact on the overall cost, the unit costs and the cost structure for distance teaching.

Distance teaching systems involving television broadcasting involve *substantial centralized costs* for startup, transmission, administration, and continued program and staff development. However, once developed *they can serve large populations of students and can be used for many years*. Thus, broadcast systems are very sensitive to economies of scale. For large student populations, as in Mexico's Telesecundaria, they tend to be quite economical. Total costs of about $500 per student per year are roughly comparable to urban schools, with the largest percentage being for teacher salaries. The television component is only $50 of that total, with start-up costs adding $63 annually. However, for very small student populations (either in small countries or for segments of student populations), costs per student are relatively high.

Because of the high cost of initial program development, *adapting materials is likely to be more cost-effective for countries with small populations or for specialized groups.*

Distance teaching systems using radio have *much lower centralized costs*, although economies of scale still apply. Quality radio production costs about 1/10$^{th\ of}$ TV production, and both transmission and reception costs are much lower. Therefore, greater investment can be put into instructional development, books and teacher training. Adaptations of successful approaches, such as Interactive Radio, reduce costs further,

[37] Claudio de Moura Castro, Laurence Wolff and Norma García *Mexico's Telesecundaria: A Cost-Effective Program* IDB Education Unit, Dec., 1999

[38] These generalizations are based on a variety of studies over a number of years as well as the author's personal experience with each of these kinds of systems.

while ensuring a local character through local productions. The total cost per subject has been estimated to be in the range of an additional $3 to $8 dollars per student per year.[39]

The costs of computer based distance teaching systems are largely concentrated at each school site, and thus are largely *insensitive to economies of scale*. Computers, electricity, supplies, facilities, computer programs and Internet facilities need to be replicated at each school. In addition, effective computer use requires substantial, ongoing teacher training as well as the addition of school staff with specialized training in educational management of computer facilities. Informal estimates of total costs per student per year range from an added $200 in Barbados' intensive use to $37 in Costa Rica's less intensive applications. These are not, however, comprehensive instructional systems, so cost comparisons are not fully appropriate.

2. Teacher salaries remain the largest single budgetary item for most distance teaching systems, just as in traditional systems.

Some countries using distance teaching have reduced the budgetary cost of teacher salaries and facilities by *changing to double shifts with the same teaching force*, although this may not be a viable long-term strategy because of the increased teacher workload.

Others have used *lesser-trained, lower-paid teachers*, as in Telesecundaria. At least as an interim policy in the early stages of expanding secondary education, this may be a viable strategy, given the scarcity of trained secondary teachers in most nations. It is a policy that *may apply equally to urban schools as to rural schools.*

There are no "teacherless" distance teaching systems which use the technologies. On-line "virtual high schools" simply substitute on-line teachers for on-site teachers, who handle "virtual classes" of about the same size as regular classrooms. The same is true for correspondence education, although demands on distance tutors are fewer.

Students could be asked to learn largely on their own, perhaps with occasional tutoring. Access to secondary education would thereby be provided to the highly motivated, at very low cost. Experience suggests, however, that relatively few young people will succeed in this unstructured and unsupervised situation.

Further thought is warranted on creative ways to provide educational opportunities while minimizing costs for teachers or tutors and for school facilities.

3. Typically, distance teaching *adds to the unit cost* of secondary education, unless one of the lower-cost teacher utilization strategies can be used.

Compared to alternative ways to reach dispersed student populations, however, *it may be far less costly than building traditionally-staffed schools for small numbers* of students *or creating boarding schools* in nearby towns.

[39] Douglas Adkins, *Cost and Finance*, in Dock and Helwig, *Interactive Radio Instruction: Impact, sustainability and future directions* World Bank Distance Learning and Knowledge Initiatives, 1998

4. The use of distance teaching has the potential to substantially *increase the cost-effectiveness* of secondary education.

It may contribute to cost effectiveness most directly by making it possible for students with lower academic proficiency to finish school instead of dropping out, and to really benefit from their new educational opportunities.

5. Its use could produce *direct budgetary savings for a country, if one result is substantially reduced grade repetition.*

That fact argues for the *economic credibility of concentrating special attention where failure and repetition rates are highest*: that is, on those in rural areas and those with lower academic proficiencies.

It also supports *increased investments in improving basic skills during primary education*, particularly in literacy and numeracy. Grade repetition is highest in most countries the earliest years of school. Distance teaching methods have an encouraging record of enhancing basic skills[40] in the early grades and some, such as interactive radio, are very low in cost.

[40] See *Interactive Radio Instruction: Impact, sustainability and future directions* World Bank Distance Learning and Knowledge Initiatives, 1998 and J.A. Kulik, *Meta-analytic studies of findings in computer-based instruction*. In E.L. Baker and H.F. O'Neill, Technology Assessment in Education and Training, Hillsdale.NJ: Lawrence Erlbaum,1994

Recommendations

National decision makers will apply their own expertise in determining how distance teaching might in fact, play a role in the expansion and improvement of secondary education. A broad menu of possibilities exists.

At this point a few suggestions will be put forward. Please note that it is always assumed that the technology will be integrated with appropriate--but varying--levels of teacher guidance and print support.

These suggestions are organized around four aspects of expanding access to secondary education:

- in rural areas.
- in urban junior secondary schools.
- at the senior secondary level.
- for those no longer in school (primarily adults).

Application #1. Enhancing access and reducing dropouts in urban junior secondary schools.

The crowded conditions and mix of students from widely varying educational backgrounds and skills makes the task in urban schools very complex.

There are three broad approaches suggested:

- providing *additional instruction* for those who enter with lower basic skill levels;

- providing those students with *coursework different from others* (that is, differentiating instruction based on student proficiencies);

- *changing overall instruction* to attempt to teach everyone more effectively.

In fact, all three strategies might need to be utilized. In each strategy, distance teaching may prove invaluable, given the fact that teachers and schools are already stretched to their limits.

Providing specialized additional instruction for those who enter with inadequate basic skills

When additional time can be allocated for upgrading (during the school day, on vacations, and after school), distance teaching can help through:

Training teachers in literacy and tutoring skills

Integrating CAI and word processing into a comprehensive literacy improvement program (with tutoring, self-guided readers, and libraries of readable materials.)

Individualizing practice in math through Computer Assisted Instruction (CAI).

Providing alternative courses for students at lower levels of proficiency.

When differentiated courses can be provided within the same school, distance teaching may make it possible to provide alternative coursework, reflecting differences in initial levels of understanding and in learning rates.

Distance teaching can help through:

Well-crafted broadcast courses in math and language skills (as in Telecurso, the Galaxy program, and Star Schools projects), with integrated teacher support.

The use of CAI and word processing, when affordable, to sharpen individual skills.

When available, the use of Internet projects to promote the use of language and math skills and to generate interest.

Changing overall instruction to teach everyone more effectively

The most comprehensive approach is to revamp a nation's junior secondary education, with distance education as the “spark” for new teaching methods and new content. It has *not* yet been shown that such changes will benefit students at all levels of proficiency. However, distance teaching has important contributions to make in that regard, by:

Providing a greater variety of learning modalities to reach diverse learners; e.g., graphics, video, simulations, dramatizations, real-life scientific work, virtual "trips" to the rain forest or seabed, etc.

Structuring teaching to bring more inquiry-based methods into classrooms, such as project-based learning, “discovery” science, and other less didactic forms of learning.

Guiding teachers in how to deal with more diverse students in their classrooms.

The strategy of imposing complete new systems through daily, media-driven instruction has not proved viable over the long term.

Therefore, *one approach to consider* might be to:

Gradually build a series of core distance teaching courses, in critical subject areas.

In their development, ensure intensive pilot testing, ascertaining the combination of media, method, text and teacher involvement needed to effectively teach students at varying ability levels, as well as the approaches welcomed by teachers or facilitators.

Use the media significantly for instruction, but not on a daily basis, permitting a greater choice of learning activities by classroom teachers.

Invite individual schools to begin with a focus on one or two core subjects, and to expand use only when demanded.

Emphasize training and the feedback provided by teachers, as well as their capacity to support each other.

A much more modest approach is to determine certain key learning activities where video or computer assistance may be uniquely valuable, and to then work carefully with curriculum experts in the subject areas, as well as teachers, to design classroom activities around them. By packaging these as modules of media, print, perhaps computer-based activities, and teacher guidance, a gradual and targeted introduction of distance teaching might be feasible. While logical and manageable in scale, this is a largely untested approach.

For most countries, television (or videotape) remains the current choice for providing the core of such instruction. In addition, even limited computer and Internet exposure may be powerful. For example, in science the ability of the individual (or small-group) learner to seek out scientific information, manipulate variables, see their chemical, geological or physical outcomes, and contribute unique data (as in a growing global environmental database) can have the student *doing* science instead of solely *studying* science. These experiences may be particularly satisfying for those who have, until then, not thrived in education's more conceptual and didactic atmosphere.

Application #2. Expanding junior secondary access to rural areas

Countries can either try to extend their present national school systems, for example through boarding schools in larger communities or through the addition of secondary grades to primary schools, or they can design an alternative or modified system for rural students.

A full-scale alternative system.

The Telesecundaria approach, creating a truly alternative system for rural communities, appears to be a strategy worthy of emulation *when feasible*. Education is provided locally, tailored to local experiences, delivered with the aid of facilitators, and supported by distance teaching and distance training for teachers. The evidence indicates it is quite successful, if based on the kind of high quality instructional effort characteristic of Telesecundaria.

Some countries, particularly *smaller nations,* might be well-advised to start with the Telesecundaria materials themselves (assuming they are Spanish speaking). National adaptations of supportive text materials would involve only a modest cost, and gradual adaptations of the video materials could be undertaken.

Larger countries might develop their own materials. Even they would do well to study Telesecundaria's materials and adapt any that might be useful, particularly in alleviating math and literacy deficiencies. There also are many video-based materials in English, Spanish and Portuguese from other sources.

By initially adopting some Telesecundaria materials, countries could save several years in establishing such a rural education service.

Embellishments to a Telesecundaria-type system, when feasible, might usefully include the following:

- E-mail or full Internet access, to connect to a wider community;
- radio-based instruction for some courses, to permit localization and reduce cost;
- limited use of computers to upgrade literacy and numeracy skills;
- low-cost "personal computing devices" to provide learners with word processing experience;
- complementary efforts at literacy enhancement--increasing instructional time, self-guided reading materials, and tutoring .

If a full-scale alternative system is not feasible or desirable

It will be difficult for many countries to take such a step. The idea of a "second-tier" system may be politically unacceptable, and the rural teaching force might object to such a highly structured instructional approach

If so, several suggestions follow:

Provide some key courses on a dual basis

The offering of a few key courses which vary in their examples and approaches depending on whether they are rural or urban-focused may prove attractive, especially if schools are given a choice. Such courses use TV, radio and/or video for core instruction in:

- Literacy
- Math
- Science and technology
- Problem-solving and inquiry-based learning

In doing so, teaching control may be placed more fully into the hands of teachers, with technology helping to structure teaching and learning to be more effective

- the "Galaxy" project used only one video every two weeks, but provided a structure through related teachers' guides and print materials, with teachers given a choice among alternative learning activities.

Use distance training to support staff in new instructional techniques

Provide at least minimal access to computers and the Internet for motivation, for literacy/numeracy upgrading, and for inquiry.

Application #3. Enhancing educational access and quality at the senior secondary level.

The shortage of qualified teachers, particularly in the sciences, advanced mathematics, information science, and technology is often a crippling constraint. Even when courses are available, places are often reserved for the best students, even though today all learners need technical and scientific education.

At this level, the expanded use of distance teaching may be the most viable solution for providing widespread quality education in these technical fields.

The strategy described above for creating quality video-based courses at the junior secondary level is equally applicable. A few full courses already exist in the sciences, either on-line or on video. However, countries may intend to create their own, either individually or in a consortium of nations, as in the I.V.E.N. project. Again, the vast collection of video, CD ROMs and computer programs offers a rich source of raw material.

At the senior secondary level today, *computer applications are of greater importance than at lower levels.* Simulations can transform the abstractions of algebra, geometry, and physics into concrete processes. Student manipulation of variables may effectively substitute for laboratory time. The Internet can be an unending source of inquiry and problem-based learning. The use of data bases and spreadsheets can teach these practical skills in the context of gathering and analyzing information. .

While the task of creating effective courses for diverse student populations is formidable at the senior secondary level, the payoff for the national future of many countries is equally high.

Application # 4. Providing opportunity for learners no longer in school

Many countries face the same issues that have prompted Brazil to create Telecurso. In fact, a number already are using distance education at a modest level to provide secondary school equivalency opportunities.

The advantage of distance learning is that it can reach learners in their homes, workplaces, community centers, churches, or learning centers. The task is to design learning activities that seem relevant to more adult learners and to keep them motivated.

Without detailing the variety of options, it can simply be noted that Telecurso provides a model of well-designed adult distance teaching. It provides convenient access, interpersonal support when needed, print support, engaging and instructionally sound programs, and the "social marketing" that keeps attention to the program and provides it status. Anyone planning a new effort would do well to seek counsel from its planners.

Concluding Comments

Distance teaching offers many tools to help expand secondary education to all citizens and to improve the success of all.

But if distance teaching is to have an impact on national educational objectives, it will need to move from the margin of educational planning much closer to the center, becoming as significant as efforts in curriculum, supervision, infrastructure and professional development. The information and communications technologies are "here-to-stay"--they should be put to the best possible use.

Table 1: Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Technologies Now	Technol-ogies Tomorrow	Non-technological requirements	Examples of programs	Risks	Advantages
1. *Support and train teachers* in appropriate teaching techniques for disadvantaged students. Training in: Methods for improving reading and math in students with lower skill levels. Teaching classes of students with very wide ranges of academic proficiency.	TV, Videos, DVD, audio-conferencing, computer conferencing, Internet discussion groups. Uses of distance teaching: illustrations of classroom teaching methods; discussions of problems and solutions with other teachers and/or experts; support in following special curricula or texts.	Broad-band Internet video	Integration of teaching examples with the specific kinds of instruction used for this purpose: e.g., structured reading materials, programmed math texts, readable text and library books, tutoring. Feedback from teachers. Organization of school-level support groups of teachers.	Few, if any, sustained, large-scale efforts for these educational targets. More general in-service distance learning for vast numbers of teachers in India (satellite TV and local discussion groups); formal teacher training through campus education and several years of on-site distance teaching in Thailand (highly successful); successful writing support groups in regions of the U.S.; Enlaces program in Chile.	Teachers may not take the time to participate, unless the distance training becomes a part of the school schedule or credit is earned. Instructional materials (special texts, books, etc.) may not be reliably available at some schools. The instructional methods advocated may not be effective in the diversity of local settings.	Distance methods can reach many more teachers, more often and with more expertise, than traditional supervision systems alone. Ultimately it may create a "community" of teachers supporting each other in developing more effective methods.

Table 1 (Cont.): Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Technologies Now	Technologies Tomorrow	Non-technological requirements	Examples of programs	Risks	Advantages
2. Deliver *remedial instruction* in basic reading and math skills for needy students	Computer Assisted Instruction (CAI) CAI with the addition of Internet tutors Word processing	(Possibly) low cost specialized computers or hand-held. devices for math and language practice..	Training of lab facilitators to aid students and teachers in using the ILS programs. (However, the more sophisticated programs are almost stand-alone, so training is not extensive.) Reinforcement of lessons by classroom teachers increases learning outcomes.	Various "Integrated Learning System" programs are being used in thousands of schools in the UK, US, Canada. Pilot trials in Jamaica, Barbados, Grenada. Current trials beginning in Guyana. Spanish versions of some programs exist.	Cost can be high, for programs and for required computer time. Students may be allocated insufficient time to master the reading and math; 20-30 individual hours yearly needed for major gains. New skills may not be reinforced enough in regular teaching. Basic skill programs seen as overly structured by some creative educators. Local tailoring is limited.	Provides individually tailored practice needed for these basic skills. Substantial success in diverse settings, even for students with very low skills. Required teacher support is limited and thus feasible for almost any school. Large-scale implementation can be rapid, since both the programs and training methods for lab facilitators are well developed. Programs have been based on extensive research on student learning, and continue to evolve.

Table 1 (Cont.): Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Tech-nologies Now	Tech-nologies Tomorrow	Non-techno-logical require-ments	Examples of programs	Risks	Advantages
3. Deliver *individual courses*, to increase school offerings For example: courses in the sciences, environment, applied technology, geometry, foreign languages, info tech. *or* courses using new methods--project-based learning; linkages to industry; links to experts worldwide.	Combi-nations of TV and special text material. Combi-nation of CD ROMs and text. On-line Internet delivered courses, with online tutors.	Broad-band Internet video Elec-tronic books	Specially developed print materials for students and teachers (although close integration with existing texts are possible.) Teacher orientation and on-site support, especially for new methods (such as project-based learning. . .	U.S. "Star Schools" systems provide courses by satellite TV, sometimes with telephone feedback or the Internet. State-run systems for rural and poor urban students in South Carolina, Virginia, elsewhere. "Galaxy Science" uses video with fax feedback to bring inquiry science (for upper primary) into rural and poor urban schools. I.D.B. "I.V.E.N." Pilot Project will bring sophisticated science and math courses to upper secondary classes in Brazil, Colombia, and Venezuela through DVD, Internet, text. "Independent-study" courses such as Saxon Math combine CD ROMs and programmed texts, need little teacher intervention.	Investments in equipment (TV, computers, etc.) may not seem justified if used for only a single course. Developing first-class programs is costly; numerous users are required to justify the investment. Teacher training and support can be complex if schools are widespread and diverse in character.	Can be designed to engage students from a very wide range of abilities, through good instructional design and use of multi-media. Could also be tailored to needs of disadvantaged students, with examples from their rural or urban environments. Can support teachers in using new teaching and learning methods by providing a course structure, instructional materials and distance instruction as a packaged system.. Can make up for lack of labs, specialized teachers, other resources in poor regions.

Table 1 (Cont.): Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Technologies Now	Technol-ogies Tomorrow	Non-Technological Requirements	Examples of programs	Risks	Advantages
4. Deliver a complete curriculum as an* alternative *educational system For example: For rural students, tailored to their environment and to limited teaching resources For adults who have not completed secondary cycle. (Has not been attempted for disadvantaged urban students)	TV Supplementable by computers and the Internet in some schools DVD a possible distribution alternative Radio can be effectively used for some subjects.	Broad-band Internet video	A classroom facilitator seems essential for each class. Books and teacher training, closely integrated with each lesson. Occasional on-site monitoring, to ensure that TV programs, books are in fact available and are being used appropriately.	Telesecundaria (Mexico). A large rural population is being provided access to junior secondary education, with effectiveness and economy. Use of Telesecundaria in some Central American countries. Telecurso (Brazil): Large numbers of adults are being given a second chance at secondary education while they continue working..	In delivery, lack of print materials and potential for technological breakdowns are risks in rural settings. To develop a system initially, a major investment of time and talent is needed, as well as good feedback and adaptation. When used elsewhere, local dialects, music and culture are different. Adaptations are possible but complex and costly.	Can serve students even in small communities, where too few students per grade would make conventional education cost-ineffective. Can tailor programs to the lower reading and math proficiencies of entering students.

Table 1 (Cont.): Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Technologies Now	Technol-ogies Tomorrow	Non-Technological Requirements	Examples of Programs	Risks	Advantages
5. Deliver a complete curriculum as a universal secondary system for a country To bring a reformed curriculum and new teaching methods to all students.	TV, radio (Could be supplemented by computers and the Internet in some schools.) DVD is a possible distribution alternative. .	Broad-band Internet video Electronic books	Requires close, day-to-day integration of teacher activities, distance teaching components, and print materials. Requires major teacher retraining in the new curriculum and in new teaching methods, to be fully successful.	TV-centered reform and expansion of junior secondary systems in El Salvador (1970's), Ivory Coast (1970's.)	Some teachers resent their more restricted roles and "assembly-line" approach when every subject starts with a TV lesson every day. . Traditional educational leaders can feel excluded when the core of all instruction is produced y the distance-teaching specialists Total dependence on technological reliability is somewhat risky. . Media-rich teaching may seem too unconventional.	Can produce improvements in student learning rapidly and on a national scale. Can assure delivery of a new curriculum in every classroom. Economy of scale permits heavy investment in the design of quality programs One of the few ways to ensure that technology, texts and teachers are truly integrated and mutually reinforcing.

Table 1 (Cont.): Strategies for Reducing Dropout and Improving Learning in Secondary Education

Strategy	Technologies Now	Technol-ogies Tomorrow	Non-technological requirements	Examples of programs	Risks	Advantages
6. Introduce computer technology intensively and system-wide, to change the character of teaching and learning. To produce major change in teaching methods and curricula for all, while developing universal expertise in information technologies.	Computers and the Internet[o]	Broad-band Internet video Electronic books	Intensive training of teachers in "child-centered" teaching and in the use of computers to support such.. Related reforms in supervision, pre-service training, and assessment. .	Barbados Edutech 2000 program Singapore	Cost and administrative demands for providing and maintaining large numbers of computers (e.g., 5/1 ratio at primary, 10/1 or better at secondary), as well as Internet use, are great.. Results of intensive teacher re-training in new methods not yet known. In other situations, computer use by some teachers often has been insufficient to justify the cost. Not yet known if both higher cognitive skills and basic literacy/numeracy skills will be adequately developed . Not yet known if attainment of disadvantaged students will be markedly increased. Large technology investments can concern teachers that they compete with salaries. (Countries cited have not had a problem.)	Visionary goals and seriousness of the effort can engage public support and can increase educational funding. Wide access to computers may increase motivation for both parents and children. Resulting national sophistication in the information technologies will be an asset for economic development. If higher cognitive skills are successfully developed, it will demonstrate a path many countries may wish to follow.

Table 2: Relative Cost and Administrative Requirements Of Various Technologies for Typical Distance Teaching Applications

PRIMARY LEARNING TECHNOLOGY (Assumes integration with teacher training and print support)	TYPICAL "DELIVERY" COST PER STUDENT	CAPACITY TO DELIVER "CORE" INSTRUCTION TO SUBSTANTIAL NUMBERS ♦	TEACHER TRAINING REQUIRE-MENTS	CONTINUING MINISTRY SUPPORT REQUIRE-MENTS	TIME TO BEGIN MAKING MAJOR IMPACT♣
Radio	Low	Some subjects	Moderate	Low	1-2 years
TV	Moderate	All subjects	Moderate	Moderate	2-3 years
CD ROMS, DVD's, Videos	Depends on use	No (except for use by small numbers of students at home)	Low to high (depends on use)	Moderate (for selection, distribution and maintenance)	---
Computer Labs (and Software)	High	Core for basic skills only (e.g., math); perhaps for foreign languages and information technology	High, but for a small number of lab teachers	High	1 year
Several computers in each classroom (and software)	High	No	High, to insure full integration by all teachers	Very high	Several years (many teachers must master integration)
Single computer per classroom (and software)	Moderate	No	High, to insure full integration by all teachers	Very high	Several years (many teachers must master integration)
Internet	Low to high (depends on use)	No (except for intensive on-line courses by small numbers of students at home)	Low for limited use; high for significant integration	Moderate	Several years

♦ Assumes integration with teacher training and print support.

♣ Estimated minimum time from project inception to delivery of distance teaching to substantial numbers of students. Radio and TV are sensitive to economies of scale; this assumes student populations of several hundred thousand.

Illustrative Cost Components in Distance Education

Major Cost Components in a Distance Education System

1. Start-up costs required for developing the distance teaching system
    - Overall design of the instructional system, its delivery components and its management
    - Instructional development of: programs, text materials, teacher training materials, feedback and
    - assessment methods
    - Media production (TV, radio, computer programs, CD ROMs, Web pages)
    - Orientation or recruitment of users
    - Conduct of initial teacher training
    - Initial small pilot trials and subsequent system revisions

2. Start up costs required at each school or learning center
    - School facilities (building or re-modeling, electrical supplies, telephone linkages, security, air conditioning, etc.)
    - Technologies (TV or radio receivers, computers and peripherals, satellite antennas, VCRs, etc.)

3. Recurrent costs for the central management of the distance teaching system
    - Delivery costs of the distance learning g program by TV, radio, CD ROMs, etc.
    - Print materials for students and teachers
    - Maintenance
    - Continuous teacher training and support
    - Collection of assessment and feedback information
    - Periodic program revision and development of new programs
    - Administration

4. Recurrent costs at each school or learning center
    - Teacher or facilitator salaries
    - Local training costs (materials, per diem, etc.)
    - Computer programs
    - Communications (telephone, Internet
    - Consumables (paper, printer cartridges, etc.)
    - Maintenance, insurance of equipment
    - Security
    - Electricity
    - Replacement of equipment (every 5-to-7 years)

Some Examples Of Distance Teaching Costs With TV And With Computers

Telesecundaria illustrates the different cost structure that can characterize distance teaching.[41]

Annual per student costs for Telesecundaria are near those of Mexico's conventional junior secondary schools ($527 vs. $477 per student). However, annualized costs for the initial investment are much higher for Telesecundaria ($113 vs. $21), while recurrent costs are lower ($413 vs. $456.) As the number of schools grows, per student costs for Telesecundaria will decline further while those for conventional schools should remain about the same. Costs of providing conventional secondary school staffs have been estimated to be three times as high. A school of 60 students would require 12 teachers, for a 5:1 student teacher ratio. An annex provides more detailed information from this interesting analysis.

One implication of the cost structure for broadcast-based distance education strategies is clear. Countries need to set aside very substantial special funding to initiate such systems. Those nations that may have the legacies of educational broadcasting units set up some years ago cannot expect them to make a significant difference with their small annual budgets and small staffs.

Computer-based strategies are likely to be higher in cost, given the need for substantial individual computer time and teacher training.

It is difficult to generalize based upon prior cases, because of the very different ways that computers have been used. However, a few cases will illustrate the general magnitude of these costs.

Barbados' program gives some sense of the scale of investment in a really serious effort to use computers as an engine of reform and improvement. An IDB Project Summary indicates projected funding of $69 million for hardware (8,000 to 10,000 computers), software and networking, plus a substantial sum (perhaps $5 million) for remodeling schools to accommodate computer facilities. Another $4.9 million is dedicated to training 4000 educators. Therefore, for Barbados' school-age population of about 50,000, it appears that about $1,600 per student will be spent in start-up costs. In addition, computer equipment will need to be replaced, perhaps at five-year intervals, at a cost of perhaps $10 million each time. Recurrent operating costs will include maintenance, consumables, administration, supervision, and assessment as well as costs for electricity and the Internet. From this very informal analysis, one can speculate that over a ten-year period this intensive incorporation of computers might add $200 to $250 per student annually to Barbados' usual educational expenditures.

At a more limited level of use, an article on Costa Rica's[42] secondary use of computers estimates an annual cost of only $37 per student ($22 in annualized capital costs, $6 for a

[41] These estimates are from Wolff, et al., based largely on Calderoni, which provides a full and useful cost analysis.

lab coordinator's salary, and $10 for training, maintenance and security.) However, this configuration provides only two hours per week per student on the computer, with fairly limited software.

Other cost analyses, of Enlaces and of a Jamaican computer project, have costs falling between Costa Rica and Barbados, but in applications with quite different objectives.

[42] Wolff, L. "Are Computers in School Cost Effective?", TechKnowLogia, Nov./Dec. 1999