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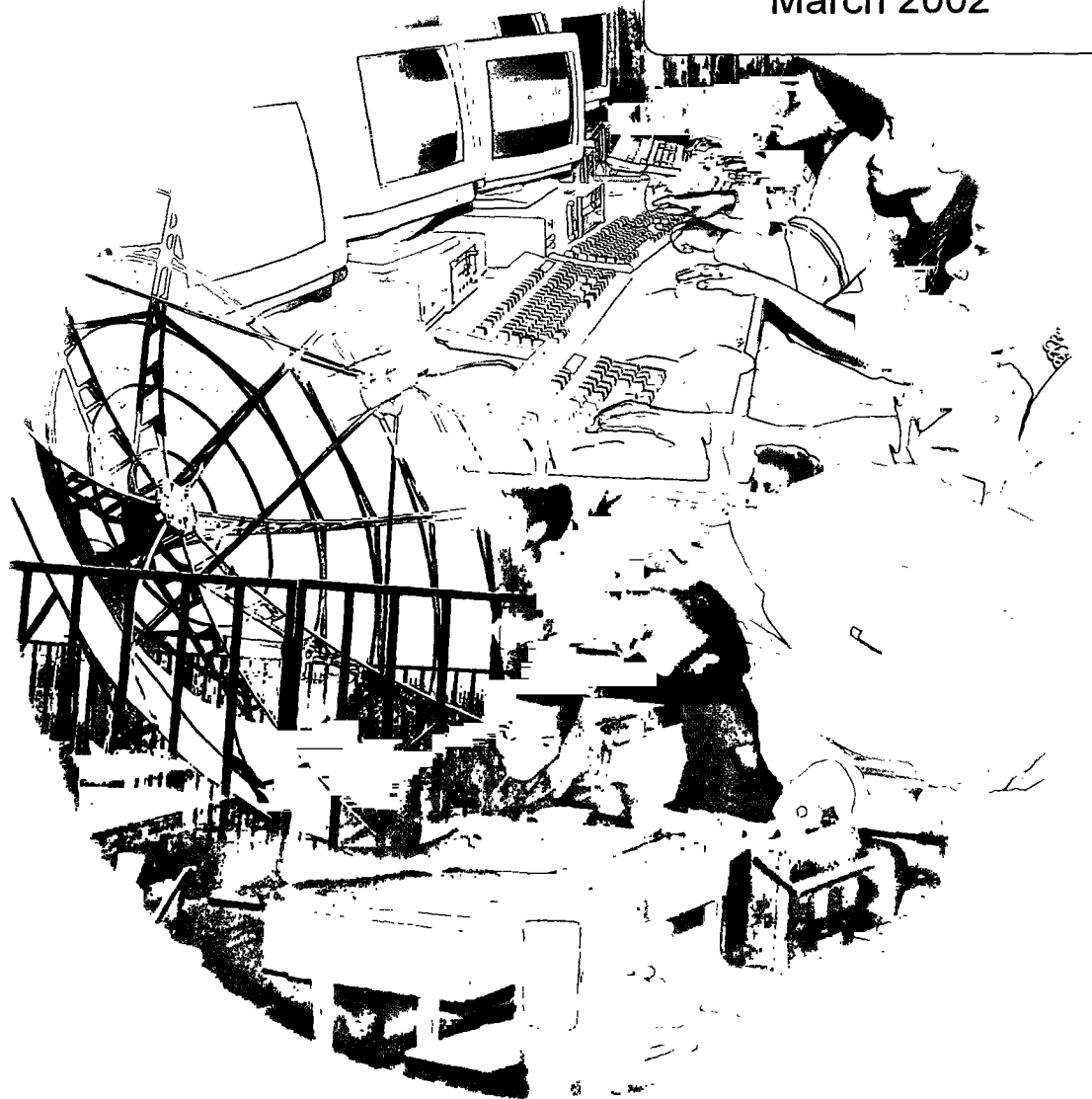
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Enhancing Learning Opportunities in Africa

*Distance Education and Information and
Communication Technologies for Learning*

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Africa Region Human Development
Working Paper Series

Enhancing Learning Opportunities in Africa

*Distance Education and Information and
Communication Technologies for Learning*

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Africa Region
The World Bank

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Foreword

This report is part of a series of initiatives by the World Bank's Africa Region Human Development Department to increase its understanding of how distance education and the new information and communication technologies (ICTs) can support education in Africa. The effort is part of the Bank's overall education sector strategy for Africa, which emphasizes the achievement of universal primary school education and improved access and quality at all other levels.

In focusing on the possibilities offered by distance education and ICTs, the Bank and African countries have two concerns: First, education on the continent must be developed in a way that contributes to Africa's full participation in the knowledge-based economies of the future. Second, traditional modes of delivering education, particularly at post-basic levels, may be more costly than countries can afford. This will entail difficult choices in many countries. It is important that investments in the new paths to education be grounded on a solid basis of knowledge and shared experience. This report provides an inventory of knowledge gained and points to promising areas for future investment.

The report is intended for operational staff of the World Bank and African policymakers, and other

colleagues as they work to identify and design programs that make strategic use of distance education and ICTs to support learning. As the reader will note, although Africa has had considerable experience in this area, much remains to be learned.

The report begins with a synthesis of existing knowledge on the use of distance education and ICTs in Africa. The report focuses on *learning with technology*—the ways in which ICTs can support education systems to carry out their work—rather than *learning about technology*. The study focuses specifically on the learning that takes place (or should take place) within the formal educational system—including primary, secondary, teacher development, and tertiary education. The report identifies several key areas where current knowledge points to a greater likelihood for success in using distance education and ICTs to support Africa's educational goals. It identifies the conditions that must be addressed in making effective use of distance education methods and ICTs. These include supporting infrastructure and issues related to organization and management, program design, and costs and finance. The report recommends actions that the Bank and its partners should take to strengthen their ability to embark upon and support new initiatives.

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Acronyms and abbreviations

ADEA	Association for the Development of Education in Africa	ISP	Internet service provider
APL	Adjustable Program Loan	ITEK	Institute of Teacher Education in Kyambogo
AVU	African Virtual University	LIL	Learning and Innovation Loans
CIFFAD	<i>Consortium international francophone de formation à distance</i>	PANAFTEL	Pan Africa Telecommunications Network
CITS	The Center for Information Technology and Systems of the University of Mauritius	PATU	Pan African Telecommunications Union
COL	Commonwealth of Learning	PTO	African Post and Telecommunications Operators
COMESA	The Common Market for Eastern and Southern Africa	REFER	<i>Réseau électronique francophone pour l'éducation et la recherche</i>
FVU	Francophone Virtual University	RESAFED	<i>Réseau africain pour la Formation à Distance</i>
GDLN	The Global Development Learning Network	SLIDE	Sri Lanka Institute for Distance Education
HDNED	World Bank's Human Development Network—Education	SOPT	Special Orientation of the Primary School Teachers
ICDE	International Council for Distance Education	TTL	Task Team Leader
ICT	Information and communication technologies	UNISA	University of South Africa (formerly University of the Cape of Good Hope)
InfoDev	Information for Development Program	UPE	Universal Primary Education
INRAP	Institute for Research and Pedagogical Support (Guinea)	VITA	Volunteers in Technical Assistance
IRI	Interactive radio instruction	WGDE	Working Group on Distance Education
		WorLD	World Links for Development
		ZINTEC	Zimbabwe Integrated National Teacher Education Course

Executive Summary

Section 1: Introduction

As Sub-Saharan Africa makes the demographic transition needed to participate in the knowledge-based world economy, some of its greatest challenges will be in improving and expanding educational opportunity.

This paper builds on the messages contained in the Africa Region's Sector Assistance Strategy—*A Chance to Learn: Knowledge and Finance for Education in Sub-Saharan Africa*—and examines the contribution that distance education and information and communication technologies (ICTs) have made and can make. The paper concentrates on the contribution to the formal systems of education at primary, secondary, and tertiary levels. Contributions to training, early childhood development, and adult and nonformal education are not addressed; nor does this paper discuss learning about technology, but instead focuses on learning with technology.

African countries, like countries everywhere, are looking to the educational possibilities offered by distance education and ICTs as a way to expand and improve systems. Africa has had a long history in using distance education and technology in education, and today, there are over 140 public and private institutions offering distance education programs in Africa. The interest offered by new technology is reflected in borrowing by African countries. Of the twenty-seven new World Bank education projects that began during the past four fiscal years, some twenty-two of them had technology-

supported components or sub-components. These technology-supported components (which also include non-technology components) represent as much as \$203 million or 25 percent of the value of these projects.

With some exceptions, ICTs have been used mainly in two ways: (i) within alternative systems aimed at extending access—usually called distance education or open learning systems; these systems often use ICTs to replace teachers; (ii) within classrooms or lecture theaters to improve quality; these applications try to enhance the work of the teacher.

Section 2: Experience in Formal Education in Sub-Saharan Africa

Primary education

Distance education systems that extend access to children of primary school age are rare. One likely reason is the inability of younger children to study alone for long periods. While Latin American countries have used radiophonic schools to expand access to primary education for adults, Africa has not.

Radio has been the most widely used technology to improve primary education. Applications involving the interactive radio instruction model (IRI) have been tried or are ongoing in seven African countries, and IRI programs have reached a national scale in Guinea, Lesotho, and South Africa. Evaluations of international IRI applications show that it is effective. However, there is little systematic information about how well programs are doing after ex-

ternal financial assistance ends. Because of the high costs and the large number of learners, television and computers are being used to a limited degree.

Secondary education

Distance education is used in many countries as a means to expand access to secondary education. Despite the low public esteem in some countries for distance education programs at this level, several programs have been operating for more than twenty years. These programs typically rely on a mix of print and audio materials, with occasional use of television. Programs at this level often experience high dropout rates because many younger learners do not function well without face-to-face support.

While the main interest in Africa appears to be in learning to use technology, there is a growing interest in using computers at the secondary level to improve instruction. This involves a variety of applications, mainly utilizing Internet access. One such is the WorLD (World Links for Development) program linking schools in Africa with schools in developed countries. There is also an interest in using computers and Internet access to improve the quality of science courses. Experiments with educational television have not been successful.

Teacher development

Primary teacher development in Africa has a successful history, and there is increasing interest and investment in applications using distance education and ICTs to improve teacher development programs. These applications have provided support to pre-service teachers' courses as well as to teachers in schools. Teacher training courses account for between one-half and three-quarters of the distance education courses offered in Africa. These programs rely on a mixture of technologies, with print materials being the most widely used. Distance secondary teacher development has been confined to degree programs.

The use of computers and the Internet to improve residential teacher development is growing. In addition, teacher resource centers across Africa are

providing teachers access to resources, including computers and the Internet. But, so far there is little information about the cost and effectiveness of these programs.

Tertiary education

Nearly every African country has at least one distance education program at the tertiary level. These programs are meant to increase overall enrollments in tertiary education and to reach students unable to attend on-campus programs because of living too far from facilities or because of working schedules that do not permit them to attend regular classes. The provision occurs through dedicated distance education institutions, through "dual mode" institutions that offer both conventional and distance teaching, and through a growing number of international programs that offer courses through a local partner or directly to students, including a consortium of South African distance education providers and the British Open University. Distance education programs at the tertiary level use a wide range of technologies to reach students.

African institutions are increasingly using computer technology and the Internet. This use is not limited to improving access but also to strengthening teaching, research and professional networks, and to providing access to digital libraries and other sources of information and materials. The Africa Virtual University offers an interesting regional model that combines central course development, mediated through satellite, with local support. Currently AVU is providing enhanced quality in mathematics, science and engineering courses, and is finalizing an action plan.

Strategic areas of application

Given the needs and the demonstrated potential, it appears that a few high priority areas of applications may be worth concentrating on in Africa: enhancing quality in primary education, particularly using IRI; improving access to tertiary education; and teacher development—pre-service and in-service. In addition, improving the quality of second-

ary and tertiary education in science, mathematics, and technology is so critical that countries should experiment with solutions that use ICT, including Internet-based applications. The current evaluation of AVU should provide valuable information for interested countries.

Section 3: Supportive Infrastructure, Institutional Capacity, and Program Design

The conditions that constrain the use of distance education and ICTs on a wide-scale in Africa are (a) the supporting infrastructure, (b) institutional and human resource capacity, and (c) the complexity of program design.

Supporting infrastructure

The constraining factors here include (a) broadcasting and receiving hardware required for programs relying on radio and television and (b) other telecommunications and Internet infrastructure. These in turn are affected by telecommunications and broadcast sector policies.

Despite the wide coverage of radio and, increasingly, of television in Africa, educational applications face a number of difficulties. These include the costs of and competition for broadcast slots at appropriate times. The costs of receiving devices, such as radios, televisions, and computers, limits the number of them found in Africa. This makes it harder for students and teachers to follow courses at home, and requires that hardware be supplied to schools. In places without access to the electrical grid, the cost of batteries is a serious obstacle.

Although access to the Internet and telecommunications connections is improving, only a small portion of the African population can now afford telephone or Internet services. The average total cost for about five hours per month of dial-up Internet access (including telephone time) is about US\$60.

Education interventions that use radio, television, and computer/Internet technology will require fa-

vorable policies from the regulatory authorities responsible for broadcasting and telecommunications. More competition in the telecommunications sector will improve access to the Internet. African schools will need subsidized telecommunications charges that benefit schools in other parts of the world.

Institutions, management, and human resources

The viability of distance education, and educational programs using ICTs, depends in large part on effective program management, the performance of institutions, and the availability of skilled human resources. The operation and management of distance education programs, and the use of the newer ICTs, require a range of technical functions and resources that lie outside the educational system and are still in short supply in Africa. Competition for the skilled human resources required is also likely to be strong.

Program design

A lack of attention to program design is constraining the effective use of distance education and ICTs in education. This typically results from overemphasizing issues related to providing hardware and paying less attention to issues linked to specific learning goals or the impact on the wider educational system. This failure to address essential design issues is reflected in programs that make no provisions for motivating and supporting learners and for providing feedback and peer interaction. Many programs have suffered because they have functioned at too great a distance from the curriculum and rewards systems of conventional education. Applications involving the newer ICTs will increasingly face the issue of the alignment of learning objectives with national examinations-sanctioned curriculum objectives. Finally, too little attention seems to be paid to the educational value of content being offered through commercially available software or the Internet.

Section 4: Costs and cost-effectiveness

There are only a few cost studies and even fewer studies of the cost-effectiveness of distance education and ICTs in Africa. A critical point to note in costing ICT use in the classroom is that total costs are significantly greater than hardware costs—the rule of thumb is that hardware makes up 25 percent of the total cost. A second point is that the proportion of fixed to variable costs is higher for programs involving distance education and ICTs than for conventional education. Investments in high quality learning materials and well-designed student supports can result in lower recurrent costs for distance education systems, mainly through a replacement of the amount of face-to-face teaching required. Programs that use broadcast media to improve quality also benefit from economies of scale.

For studies of cost-effectiveness, calculating opportunity cost is important. It costs teachers—and the system supporting them—or other distance learners much less when they can continue to work while learning. A final point to consider in cost-effectiveness calculations is the unit of comparison: per-pupil costs do not measure retention or benefit. Per-graduate costs may be a better measure.

Costs of expanding access

In distance education programs at the secondary and teacher training levels, the use of print materials (and other supporting media) has allowed a reduction in classroom instruction. Some secondary education programs have been shown to operate at one-fifth to one-twentieth the per-student cost of conventional programs. For teacher training, distance education programs have been shown to operate at one-third to two-thirds the per-student cost of conventional programs. A number of studies have also shown reduced costs per graduate.

Similar cost advantages exist at the tertiary level, notably for open universities. Open universities have operated at 13 to 73 percent of the per-student costs of conventional programs. However, because of the higher dropout rates, the cost advantage per graduate has not been as favorable.

At higher levels of education, there are opportunities for cost recovery by shifting costs from the public to students and their families. Students at distance education institutions often assume a higher share of private costs than those at conventional institutions. This has implications for equity.

Costs of improving quality

Programs that use technology to improve educational quality are often an add-on cost, and may be justified where the learning gains can be achieved more economically than using more conventional means. For radio, per-student costs have varied between about US\$3 and \$8, while the use of computers ranged from US\$72 to \$98. Other studies have shown that the use of television is about ten times the cost of radio.

Available discretionary spending at the primary and even at the secondary level in many countries will make it difficult to use computers and Internet technology to improve quality at those levels.

Few comparisons of the cost-effectiveness of ICTs have been published. The few available support the idea that the use of IRI can be cost-effective when compared to textbooks and teacher training.

Section 5: The Way Forward

Policymakers and planners in African countries can do the following to ensure a greater return on investments in distance education and ICTs:

- Prepare national strategies and build capacity for using distance education and technology within the overall country framework for educational reform—and implement these strategies within sector-wide approaches where they exist.
- Build on what has worked, including support for teacher development, improving quality in primary education, and increasing access to tertiary education.
- Invest in innovation, particularly to improve the quality of mathematics, science, and technology teaching at secondary and tertiary levels.
- Analyze costs carefully and support long-term financing through budget allocations and cost sharing at higher levels of education.

- Support the national capacity for program design and implementation.
- Create partnerships within the country with the private sector, groups working in telecommunications reform, other ministries, and NGOs—and outside with other countries—to share knowledge and reduce costs.

The World Bank will continue to support countries' efforts by sharing knowledge and information through websites and special learning events. The Bank will also support international partnerships with agencies such as COL, ICDE, CIFFAD, RESAFAD, REFER, and UNESCO. Finally the Bank will provide technical assistance to develop and cost

country plans—including expertise gained through *WorLD* and *AVU*—and provide financing for both proven and innovative applications.

To accomplish this, the Bank will establish a Regional Advisory Group on distance education and ICTs, and increase the expertise and support in the cost-analysis of ICTs and distance education, as well as the design and management of distance education systems. The Bank will also build staff and client knowledge through learning events, develop toolkits in key areas, and support case studies of cost and cost-effectiveness. And, in partnership with other agencies, the Bank will examine how distance education and technology can support other areas of education and how countries can learn about technology.

1

Introduction

Africa's success in today's information-based world economy will require an accelerated demographic transition to a flexible, educated, and healthy workforce. An analysis presented in the World Bank's *Can Africa Claim the 21st Century?* states that African economies will need to replace reliance on natural resources with skilled labor in order to halt the erosion of its share in world trade and to achieve a reduction in poverty (2001a).

The educational implications of helping African countries make the transition to successful participation in the emerging knowledge-based global economy are considerable. The accessibility and quality of educational opportunities at all levels must be greatly improved. In most countries, participation rates in primary education are expanding too slowly to achieve universal primary education targets for 2015 (World Bank, 2001a). Because of the poor quality of education, children leave school with inadequate skills, and repetition and completion rates are such that many countries must devote as much as 50 percent more resources than needed to produce a primary school graduate (World Bank, 2000a).

At the secondary and tertiary levels, there has been progress in expanding access. Between 1980 and 1995, secondary enrollments have doubled and tertiary enrollments have tripled (World Bank, 2000a). However, the gross enrollment rate of 26 percent for secondary education is only half that for all developing countries. The tertiary enrollment rate of

3.9 percent is far below the 10 percent rate for all developing countries. Acceleration of this progress will be needed to produce the skilled personnel to create new knowledge or acquire, adapt, and apply the information from global systems needed to operate local enterprises and solve local problems.

The World Bank's education sector assistance strategy paper for the Africa Region, *A Chance to Learn: Knowledge and Finance for Education in Sub-Saharan Africa*, calls attention to three persistent challenges: 1) the need to increase access to education by achieving UPE and gradually increasing access at other levels; 2) the need to improve the quality of education; and 3) the need to improve the quality of education and enrollments in math, science, and technology (World Bank, 2000). Increasingly, solutions are sought in distance education and information and communication technologies (ICTs) to spark educational development and reform.

Experiences from the past decade have increased knowledge about how to make effective use of distance education and to integrate ICTs into educational systems. Much of the world has benefited from advances in telecommunications systems and the digital revolution, and many countries have achieved success in combining organizational and pedagogical goals effectively to create innovative educational solutions. Extensive research on distance education and ICTs indicates that many of these applications can be as effective as conventional educational programs and more cost-effective.

However, few of these benefits have been realized within Africa.

Research and analysis on using distance education and ICTs to support education can positively influence new investment in educational planning and educational reform. Africa itself has a rich experience on which to base decisions and create new efforts. Although most African countries have only limited access to computers and digital technologies, many have a history of implementing print-based distance education systems, and varying experience in educational radio. One survey found that over 140 public and private institutions provide tertiary distance education services in Sub-Saharan Africa, with the most frequent use for teacher training (Roberts and Associates, 1998).

Almost all African nations have established some form of distance education as an educational alternative for at least one educational level (Saint, 2000). While programs may require strengthening, the foundations exist. Of the twenty-seven new World Bank education projects that began during the past four fiscal years, twenty-two had technology-supported components or subcomponents. These technology-supported components, which also include non-technology items, are valued at \$203 million, representing 25 percent of the value of these projects. The largest share of the new financial commitments went to support distance education applications. In addition, there were new financial commitments for educational technology applications and for educational management information systems. This level of investment indicates that the importance of distance education and ICTs in education has grown significantly over the years. As African countries seek to widen their participation in the information-based societies of the future, this investment is likely to increase.

This paper examines how more strategic utilization of distance education methods and ICTs can help address the challenges facing education in Africa. It recognizes that, while conditions in many parts of Africa pose serious constraints to the use of educational technology, evidence suggests that well-informed applications of distance education and ICTs are underutilized and can offer valuable pos-

sibilities to improve educational quality and access. The paper also calls attention to experience in particular areas that appear to be cost-effective in responding to educational needs in Africa.

This study is meant to be a strategic guide for Education Task Teams as they work with their African colleagues in the design of educational programs. It is not a detailed historical account or an inventory of experience; instead, it attempts to introduce key experiences that have used distance education and ICTs for educational purposes, and then moves on to an analytical discussion of ways to interpret them and make strategic decisions. The paper tries to identify those general strategies that are likely to have the greatest impact on formal education and still be affordable. When appropriate, relevant experience from other regions is also presented in order to illuminate key issues and options.

The paper also concentrates on how distance education and ICTs can support improvements in the formal education system, including primary, secondary, teacher development, and tertiary education. In particular, it looks at applications that help to increase access and improve quality. It does not, however, cover applications of technologies to other areas of education, such as in technical education and training, adult basic education, nonformal education, or to their use in management (such as in educational information management systems, information storage and retrieval, research, learner support, or communications between and within organizations). Nor does this document examine the important question of *learning about technology* within the curriculum. As countries grapple with the demands of the global economy, they also examine how to equip children and young adults with computer skills and knowledge of the Internet. Although these are important issues and deserve examination and discussion, they are not addressed here. Instead, the emphasis is on exploring how distance education and ICTs have and can be used to enhance learning.

There are five main sections to the study. This section offers an introduction and continues with an examination of applications of distance education and ICTs for two purposes: increasing access, and

improving quality. Section 2 gives an overview of Africa's experience to date with distance education and ICT applications in the formal education system, and highlights a number of promising applications. Section 3 examines three issues that affect the use of technology to support education in Africa: infrastructure, institutional development, and program design. Section 4 presents an analysis of the cost data, and finally, Section 5 suggests a number of actions for African countries as they develop strategies for distance education and ICTs to improve education, and outlines how the World Bank and particularly the Africa Region will help.

Increasing access: Applications that extend systems or create new ones

Applications that primarily extend access fall neatly under the heading of *distance education* or *distance learning* and sometimes under the heading of *open learning*. Distance education has its roots in the tradition of correspondence education and home study, which goes back to the last century. Thus, distance education is a set of practices to plan and implement educational activities when there is a separation between teaching and learning. This separation may result from distance, time, or other barriers. Distance education offers a way to overcome this separation, chiefly through its learning materials, the use of ICTs to provide tutoring, linking learners to the system and each other, and the use of feedback and student support systems. The ICTs used in distance education systems include mail, telephone, face-to-face sessions, radio, television, audio and videocassettes, compact disks, e-mail, and other computer connections, and teleconferencing systems.

Open learning has been described as "primarily a goal, or an educational policy: the provision of learning in a flexible manner, built around the geographical, social and time constraints of individual learners, rather than those of an educational institution" (Bates, 1995:27). According to this view, open learning may contain distance education as well as other forms of flexible learning. Open learning strategies may include provisions for learners not to need certain prerequisites for admission and afford some degree of learner control over what, when, or how something is learned.

Finally, the term *distributed learning* will become increasingly useful to describe educational experiences in Africa, particularly at the tertiary level. This refers to a mixture of conventional teaching with learning experiences that may be offered on-line or through other open or distance learning methods.

Africa has had considerable experience in the use of distance education and technology to increase access to educational opportunities. In some cases, this has been achieved through extending existing systems; in others, new systems have been created.

Improving access through extending existing systems has been achieved in a variety of ways. For example, secondary education, teacher development, and tertiary education systems have reached new learners through correspondence and self-study programs. Reducing the amount of conventional face-to-face learning has made it possible to reach teachers who are unable to take time away from work for in-service training. It has also helped to extend the enrollments of teacher training programs generally. At the tertiary level, colleges and universities have been able to bring teaching to distant sites or offer courses where there is a shortage of qualified staff or to reach students who cannot leave their work or homes.

In some cases, entirely new systems have been created, often in the form of open secondary schools or universities. Because learning activities usually take place in preexisting community facilities closer to learners' homes and workplaces, this permits expanding access to education without the added costs of building new schools. Another common feature of these applications is their mixture of modalities for teaching and learning, including some reliance on "qualified/certified" teachers, use of texts and printed self-instructional materials, use of community volunteers as monitors or tutors, use of peer learning groups and strategies, and support from radio or television programs. On-line and other computer-mediated learning experiences can be part of the mix in some cases, and these are likely to find wider application in the future at higher levels of education. One important aspect of most of these systems is that learners study in their own time and at their own pace.

Improving quality: Applications that improve learning within systems

In most African countries, improving the quality of education is crucial. Quality improvement can be thought of as having two important dimensions: first, increase the amount of learning in subjects covered by the existing curriculum, generally through better pedagogy and changes in the learning process. Success here can usually be measured through national tests and, in some cases, national performance on international assessments. Second, encourage a variety of educational outcomes that go beyond the traditional examinations-driven emphasis on the memorization of facts. These include outcomes aimed at developing new types of learners and embracing skills referred to variously as the ability to gather and manipulate information, problem solving, higher order thinking, critical or creative thinking, and the skills necessary to interact in knowledge-based economies.

Efforts aimed at improving quality often rely on ICTs to mediate some part of the educational activity. Unlike systems of distance education, *the use of technology is not a response to separation from a teacher*. The teacher usually works together with or alongside the technology, often in the school classroom or college lecture theater. This experience links the traditions of audiovisual education and educational broadcasting with newer areas, such as interactive radio instruction, computer-mediated learning, and on-line learning.

Distance education and ICTs have been introduced into the structure and procedures of existing schools in a variety of ways. At the primary school level, the use of radio has been a low-cost and consistently effective means to improve quality in subjects taught in primary schools. Television and computer-based technology, because of their higher cost per student, are more often found at higher levels. At the secondary level, pilot projects utilizing ICTs have begun in some African countries as a means of improving quality. Tertiary education options are increasingly designed with computers and Internet linkages in mind. For teacher development, most experience has focused on increasing access to training opportunities; however, there are a growing number of applications using technologies that improve quality within residential teachers' colleges.

Future applications are likely to reflect a greater convergence of the two goals: extending access and improving quality. At the tertiary level, for example, investments in ICTs are likely to afford the possibility of improving the quality of the teaching, learning, and research undertaken by "dual mode" universities, while simultaneously offering the means of reaching learners in distant places. At the primary and secondary levels, attempts are being made to extend and merge applications that typically increase quality, such as interactive radio instruction or computer-based learning, so that they also increase access and improve teacher training. These strategies will be important where cost constraints are significant and educational needs are great.

2

Formal Education Experience in Sub-Saharan Africa

Many African countries have had substantial experience, much of it successful, using distance education systems to increase access to education at secondary and tertiary levels, as well as for teacher development. Experience with incorporating ICTs into learning systems is less extensive, has met with mixed results, and faces serious economic pressures. This section reviews the history of using distance education and ICTs in support of educational development and, based on an analysis of that experience, indicates the areas of application most likely to be sustainable and cost-effective.

PRIMARY EDUCATION

With a few exceptions, the goal of improving access to primary education in Africa has been pursued by expanding conventional schools rather than by providing an alternative to schools. In some countries, community schools have been established to provide a lower cost alternative to official schools. Africa does not have the same experience of using distance education methods to provide primary school equivalency programs for out-of-school children (and adults) found in other regions—for example, the radiophonic schools of Latin America (Dodds, 1996).

The use of distance education and ICTs in African primary education has focused on improving the quality of education in schools. These applications provide an in-school alternative to conventional instruction (largely focused on improved teaching

practice and materials) in one or more subjects. Most applications have involved the use of radio as a means to provide teaching in priority subjects, such as mathematics or language skills in the national language of instruction. There have been few applications of television and computer-based learning.

Interactive Radio Instruction and other radio-based interventions

Africa has wide experience in using radio in the classroom. Currently, the most widely used model of radio instruction is Interactive Radio Instruction (IRI). IRI is a model pioneered in Nicaragua in the 1970s to teach mathematics. Since then it has been used to teach a variety of school subjects, including language arts, second language learning, science, and environmental studies. The IRI approach aims at providing direct instruction to students in subjects that are usually not taught well in the curriculum. IRI lessons typically constitute the entire curriculum in a subject at that grade level and are not intended as a supplement to instruction, as is the case with other applications of educational radio. Lessons are usually produced in local languages, except when they are produced to teach a second language.

IRI uses highly structured lessons with pauses to allow students to respond or engage in learning activities. Thus, the “interactive” component of the process refers to interaction between the teacher and learners in the classroom and a simulated interaction with the radio teacher. IRI draws its strength in

Interactive radio instruction in Guinea

Guinea's National Institute for Research and Pedagogical Support (INRAP) initiated the broadest IRI program in Africa in 1998, which trains teachers in the use of IRI and child-centered approaches to teaching. In the 2000–01 academic year, IRI was introduced to grades 1 through 6 in every school in the country. Language, math, and science are taught in French, and early evaluations show that the rate of learning increases at least 6 percent as compared to control groups. Radio broadcasts are supplemented by print materials, posters (in grades 1 through 4), and science kits (in grades 5 and 6). This is the first instance of an IRI program in West Africa going to scale at the national level and is the process of going through a broad array of evaluations (Source: Lynd, personal interview, 2001)

the application of formative evaluation and revision of lessons, based upon how well lessons work with a test group of learners. What distinguishes IRI from other educational applications of radio is that it blends entertainment and education that elicits student responses through engagement with characters, music, singing, dancing, and other verbal and physical responses. Newer applications of IRI tend to incorporate a larger role for teachers during the broadcast of the radio lessons.

IRI has been used in about twenty countries worldwide—most frequently in the Latin American/Caribbean region. IRI has been effective in teaching a variety of school subjects and across a broad population of countries. Studies have shown that annual per student recurrent costs of using IRI (discussed later) to provide instruction in one school subject fall in the range of \$2 to \$3.

IRI activities in Africa include applications to support English teaching in Ethiopia, Kenya, Lesotho, and South Africa, Portuguese in Cape Verde, and French, mathematics, and science in Guinea. Zambia is experimenting with IRI to reach orphans and other disadvantaged children out of school. Annex I provides more detail on these activities. Both Burkina Faso and Zimbabwe use radio broadcasts in primary-grade classrooms, though these do not use the IRI approach. Zimbabwe has only the rem-

nants of a once vital educational radio system. Burkina Faso uses a French-supported program, *Radio Scolaire*.

Evaluations of IRI in Africa and other regions show that it has consistently and significantly improved student achievement. On average, students in IRI classes outperform students in control groups, with an effect size of 0.5 standard deviations (Leigh and Cash, 1999; Tilson et al., 1990, in Lockheed, Middleton and Nettleton, eds.).

Over the last few years, IRI has been reviewed to determine whether applications have been sustained. In essence, of the twenty countries that launched IRI applications between 1974 and 1999, thirteen countries continue to use the IRI applications that were launched, three continue to use IRI but in different applications than those initially launched, and four have abandoned IRI altogether. This would indicate a satisfactory level of institutionalization but a wide variability in how programs are sustained. Unfortunately, there is little information about IRI in terms of costs, effectiveness, broadcasting issues, and teacher acceptance over the long term when external financial assistance has ended.

Similarly, while many studies have focused on costs per-student when programs go to scale, few studies have looked at the issues related to expanding programs to this level. While IRI has yet to be widely used in Africa, applications in Guinea and Lesotho have been taken to a national scale, and IRI English in South Africa is nearly national, as it reaches over 500,000 listeners in seven of the nine provinces. A recent study published by the World Bank and USAID highlighted several issues related to the use of IRI (Dock, 1999):

- Usually, developing IRI programs requires relatively high fixed costs at the outset. In some countries, adapting programs developed elsewhere can significantly reduce these costs. Pilot projects and initial phases of IRI programs have been financed by external funding agencies—most often USAID and more recently, NORAD, UNICEF, and others. Even if external investment covers initial costs, many countries will need help in meeting the recurrent costs of program delivery and maintenance.

- Any large-scale program with several interacting components (in the case of IRI, lesson and script production, broadcast transmission, radio purchase and maintenance, teacher development, and system management) requires confident, knowledgeable leadership and management. Even where present, it can be transitory.
- Large-scale IRI programs also demand wide political support because they divert public funds from other uses. Support takes time to develop and may erode with a change of government.
- Interest and momentum must also be maintained with teachers. If programs are not occasionally revised and teacher enthusiasm reinvigorated, teachers can lose interest in tuning in to broadcasts. New teachers must also be trained and supported in the use of radio lessons. Expectations that programs will never be revised or that familiarizing teachers with the methodology is a one-time event are unrealistic and can damage chances for long-term sustainability.
- The diverse components of radio education must be well integrated into the administrative, budgetary, and professional structures of education and broadcasting institutions. These often change—for example, as a result of decentralization of education systems—which may jeopardize continuity of the program.

Educational television

There are few countries making significant use of television in primary education. Ethiopia, Ghana, Mauritius, Nigeria, South Africa, and Uganda report using television in the classroom to improve the quality of education, but their programs are either on a limited pilot basis or a small scale. Ethiopia and South Africa report that television broadcasting is integrated into the curriculum; in Ghana, Mauritius, Nigeria, and Uganda it is used as a supplement to the curriculum. South Africa broadcasts a weekly program for teachers and a daily program, similar to *Sesame Street*, for young children.

The limited use of television as a medium for education in Africa follows a series of failed international initiatives in the 1960s and 1970s. These included Côte d'Ivoire, Colombia, Niger, El Salvador, India, and American Samoa. The most widely heralded experience took place in Côte d'Ivoire, where television programs reached more than a million and a half students. The program was discontinued because of its high costs, mixed educational results, and lack of support from stakeholders. The costs and lack of success associated with the educational television experience in the 1970s prompted developing countries and donors to look more closely at radio as a medium to assist in improving the quality of primary education.

Educational television in Côte d'Ivoire—ambitious, but costly

One of the region's most ambitious educational television experiments occurred in Côte d'Ivoire during the late 1970s. The project sought to change curriculum content, pedagogy, and the medium of instruction in primary education through a centralized national program. The expectation was that television would serve as a cost-effective tool to reduce disparities between urban and rural education and raise the quality of teaching overall. Although solid evaluation data were never collected, reports show that a higher percentage of television students reached grade 6 than in conventional schools, repetition rates declined from 30 to 10 percent over the life of the project, and students reached higher levels of achievement in spoken French.

The project suffered from a number of problems and was discontinued in 1981. Initially, inadequate consultation with stakeholders prior to the intervention led to resistance by teachers' unions and influential parent groups. An over-reliance on expatriate technical assistance resulted in a failure to develop local capacity. Insufficient cost planning and an overly ambitious timeframe led to cost overruns (Ba, 1999). In short, Côte d'Ivoire's experiment with televisions in primary schools suffered from the same problems as radio programs, but since the costs were higher and the medium drew greater attention, the program was not sustained. Since, there have been no significant interventions in African countries (outside of South Africa) using television for primary schools.

Computers in primary schools

Burkina Faso and Senegal are currently the only countries using computers at this level. The costs and infrastructure issues associated with using computers make it difficult for large-scale use of this technology at the primary school level, particularly in rural areas.

Relevant technologies for primary education in other developing regions

Like Africa, the most effective and enduring use of distance education and use of ICTs at the primary level in regions outside Africa is radio. Since the inception of IRI mathematics in Nicaragua in 1994, IRI has been used to teach math in many countries in the Latin America/Caribbean region: Bolivia, Costa Rica, the Dominican Republic, El Salvador, Guatemala, and Honduras. IRI programs have also been developed in the Dominican Republic to extend access to children in remote areas of the country who would otherwise not have schools, and in Bolivia, Costa Rica, Ecuador Haiti, and Honduras to teach other subjects. These include environmental education, health, basic education for adults, early childhood development, reading, civics, and English. In Asia, IRI has been used in Thailand for math, Nepal for early childhood development programs, and in Indonesia and Nepal to train teachers. IRI was also used in Papua New Guinea to teach science. These efforts are particularly relevant to Africa because the cost of adapting a radio series is more cost-effective than developing one from scratch. While there has been experimentation with computer-assisted instruction in primary schools in Latin America and Asia, efforts have either been confined to middle-income countries or have been small pilot projects.

Summary

Africa has had varied experience in using educational technologies to improve the quality of primary school education. Applications have most frequently relied on print materials and radio. The use of television and other ICTs has been limited. Seven African countries have used Interactive Radio Instruction to improve the quality of education. In one

of these countries, Kenya, the initiative was terminated, and in three others, Ethiopia, Guinea and Zambia, IRI has been introduced within the past few years. IRI has found long-term success in only two African countries, South Africa and Lesotho. There is evidence that IRI can be implemented effectively in Africa, but more information is needed on long-term effects and sustainability.

Issues related to cost, reviewed later in this document, are major determinants of introducing ICTs to improve quality at the primary level. They tend to constrain the potential use of technologies like television and computers, and favor the use of print and radio.

SECONDARY EDUCATION

While the predominant use of technology to support education in African primary schools has been to increase quality, distance education and ICTs in secondary schools have most often been used to increase students' access. There is also an increasing interest in using technology to assist in the development of math, science, and technology skills at the secondary level.

Eleven of the seventeen countries responding to a survey done in 2000 by the World Bank's Human Development Network—Education (HDNED) reported using distance education technologies for secondary school students. Table 1 shows what is currently taking place in these countries.

Distance education using print and radio

Although Table 1 indicates that distance education in some countries might be reaching only a small number of secondary students, Africa's experience here has covered many years. Ethiopia, Malawi, Zimbabwe, and Zambia all have programs that have been operating for over twenty years. Malawi, Zambia, and Zimbabwe established special study or distance education centers for primary school leavers who, supported by facilitators, attend daily to listen to radio programs and study self-instructional printed materials.

Table 1
Distance education for secondary equivalence

Country	Subjects offered	Enrollment (1999–2000)	Technology used
Botswana	All subjects	600 Junior Secondary	Print, radio
Burkina Faso	French, math, physics	n/a	Radio, TV
Ethiopia	8 subjects	8,400	Print, radio, TV
Ghana	English, math, science	n/a	Print, radio, TV
Guinea	French, math, science	300 secondary teachers	Print, radio, audio tapes
Malawi	n/a	80,000	Print, audio tapes
Namibia	All subjects	18,325	Print, radio, audio tapes
Nigeria	All subjects	n/a	Print
Zambia	n/a	11,138 (1990)	Print, radio
Zimbabwe	Academic subjects	25,000	Print

Source: HDNED, The World Bank, 1999.

A review of secondary education programs using distance education in Africa found that programs are plagued by high dropout rates and, in some cases, low achievement levels. The authors concluded, "...the younger the learner, the more likely he or she was to fail. In our judgment, only through extensive face-to-face contacts, careful monitoring, and the addition of study skill courses can we imagine the teenage students we encountered becoming successful distance learners" (Dodds and Mayo, 1992, p.31). Other factors contribute to the lukewarm support for using distance education to improve access to secondary education (Murphy, 1992):

- Distance education does not resemble conventional schooling. Some consider it second-rate, while others find it simply unconventional.
- Distance education programs have often been budgeted and administered outside the mainstream education budget and programs. This gives them an aura of second-best, making them easy to eliminate, in whole or in part, from the budget.
- Because distance education is seen as lowering the cost of education, governments are often unwill-

ing to fund it at a level required for good quality materials and teachers. They do not want to fund distance education centers or activities that make use of face-to-face instruction and other learning experiences.

- The quality of the self-instructional materials is not always high, and the print medium is limited. Its "interactive" quality is rudimentary.
- Younger learners seem to require face-to-face teaching and support; this negatively affects the cost advantages of distance education.

Enhancing quality through computers in secondary schools

Nine countries responding to the HDNED survey reported using computers in secondary schools: Botswana, Burkina Faso, Ghana, Kenya, Mauritius, Senegal, Tanzania, Uganda, and Zimbabwe. Except for Ghana, Mauritius, and Senegal, the number of schools with computers did not exceed twenty, and in most was even lower. Mauritius reported ninety-five schools using computers, and Senegal reported sixty-five.

Applications of computers in secondary schools tend to be supplementary to the curriculum, making use of content developed elsewhere and presented (through packaged software from the Internet) in an international language. As is the case with radio, the costs associated with introducing these supplementary resources are added to other costs per student. The purposes for using computers in secondary schools vary. Some applications aim at helping students "learn about technology." These impart a basic level of computer literacy to familiarize students with technology that will be encountered later in school or on the job, or focus on developing skills in using computer applications, such as word processing and spreadsheets, as tools that have crosscutting use in various school subjects. Other applications aim at "learning with technology"—that is, developing subject-related competence in areas such as science or linking students to other students and sources of information, sometimes through collaborative projects, as a means of developing a wide range of educational and communications skills. In developed countries, the trend is to use computers in ways closely linked to the curriculum and normal classroom activities rather than as separate stand-alone experiences. In Africa and other developing regions, educational applications that favor wider integration of computers into the curriculum will be harder to implement because

these applications require more computers, teacher training, and communications connections in order to be implemented effectively.

However, there are a number of interesting applications of computers in African secondary schools. In 1997, Ghana's Ministry of Education began to supply microcomputer-based science labs to secondary schools in 110 districts. Each of these hub schools serves three or four satellite schools, which share the computers and science labs. Each lab has six computers connected to special probes with software that measures phenomena such as light, heat, and sound. Working with these measurements helps students understand the phenomena under study.

Several projects operating in Africa involve secondary students in using the Internet to share and exchange data, ideas, and communications:

- The WorLD (World Links for Development) program is an independent organization initiated by the World Bank that provides Internet connectivity, content, and training in the use of computer-based technology to more than 140 schools in African countries, including Botswana, Ghana, Mauritania, Mozambique, Senegal, South Africa, and Uganda. The program aims to improve education opportunities for African students, develop technology skills among African youth, and build cultural understanding around the world. Overall, an estimated 40,000 teachers and students are

Expanding access to secondary education in Malawi

The Malawi College of Distance Education was established in the Ministry of Education in 1965. It currently offers courses leading to a Junior Certificate (taken after two years of regular secondary schooling) and a School Certificate in Education (taken after a further two years). Most of those studying for the Junior Certificate examination are young primary school leavers who cannot get into regular secondary schools. All courses are delivered through self-instructional print materials and many students study daily in specially established distance education centers assisted by trained facilitators (often primary school teachers). Government and communities establish distance educa-

tion centers and the government pays teachers' salaries. In 1999 there were 520 centers, more than the number of secondary schools. Budget cuts eventually led to inadequate supplies of materials and training of teachers. Though radio was used at one time to supplement print materials, the national broadcasting company raised rates beyond those that the college could afford. Around 55 percent of students pass their Junior Certificate exams, but pass rates for the Certificate in Education dropped to less than 15 percent in 1997 and 1998. These low rates reflected huge increases in enrollment coupled with the budget cuts and a subsequent inability of the college to sustain high quality (Source: Murphy, 1992).

- participating. The program pairs schools in the developing and industrialized world through collaborative projects that incorporate the principles of project-based learning. The program provides assistance to connect schools and training for educational policy makers, teachers, and students. WorLD is currently experimenting with costs and feasibility of wireless Internet connections for rural schools in Uganda. In 2001, about 100,000 students in eighteen developing countries were linked with students in schools in twenty-five partner countries (Carlson, 2000). WorLD monitors cost data rigorously and is building models for estimating the cost of different levels of provision. While data on learning outcomes are not available, SRI International has carried out detailed evaluations on behalf of WorLD and concludes that providing professional development to enhance teachers' technological and pedagogical skills has been its most important contribution.
- GLOBE is a collaborative on-line network of students, teachers, and scientists from over eighty countries, including at least twelve in Africa, who study the environment. As part of their science classes, students collect local data on environmental issues and submit that data to a central clearinghouse where research scientists analyze and interpret the data from all GLOBE sites around the world. Scientists use the data in their research and provide feedback to the students on the concepts they are studying. Global images based on the student data are displayed on the GLOBE website, enabling students to visualize their environmental observations.
 - A regional initiative to develop science programs for use in African countries is underway. Supported by the World Bank and UNESCO, Knowledge Enterprise, Inc. is leading work in Côte d'Ivoire, Kenya, Mali, Senegal, South Africa, and Zimbabwe to develop learning materials centrally in science and to mediate these through linked systems in each country.

Interest and options for using computers to improve the quality of secondary education in Africa are growing, especially as a tool to introduce diffi-

cult subject matter, such as mathematics, or subjects requiring laboratories, such as science. Since experience in Africa is relatively recent and confined to a few countries, there is not yet a foundation of knowledge to guide decisions about investing in computers. However, innovations in mathematics and science will be particularly important in helping African countries close the knowledge gap and have been prioritized within the donor community.

Relevant technologies for secondary education in other regions

As Africa considers its options for expanding access to secondary education, experience from other countries will be helpful. Following are three examples from Latin America and Asia:

- **Mexico's *Telesecundaria*.** During the 1960s the Mexican government was confronted by a shortage of trained secondary teachers willing to work in remote rural areas and a shortage of schools to accommodate students, particularly in the 200,000 rural communities with populations of less than 2,500 inhabitants. In 1968, Mexico's Ministry of Education began broadcasting educational programs to 6,500 students in seven states centered around Mexico City. Thirty years later, almost 800,000 students in grades seven to nine are enrolled in the national program. Using broadcast satellite, *Telesecundaria* provides a complete package of support to teachers and students in remote rural areas. The program has expanded and improved, despite numerous changes in government and administrations. In 1998, *Telesecundaria* constituted over 15 percent of the overall junior secondary enrollment. Costs are comparable to those of conventional schools in more populated, urban areas.

Communities can initiate a *Telesecundaria* program by providing at least fifteen primary school completers and a place to study. The remaining resources are provided by the national and state-level ministries and include a teacher, a television, a digital signal decoder, a satellite dish, wiring, the instructional program and textbooks, and teacher training. A typical school has three classrooms and three teachers, and an average of nineteen stu-

dents per grade. Instruction is delivered through the television broadcasts, teacher, and texts. In 1993, *Telesecundaria* adopted the national curriculum, which all programs were redesigned to reflect. Students focus on understanding and working to solve problems in areas such as hygiene, pollution, water accessibility, human rights, and productivity (Calderoni, 1998).

- **Brazil's *Telecurso*.** In the early 1990s, with the rapid transformation and globalization of the Brazilian economy, industrialists were having problems with the low schooling levels of their workers. In many cases, they provided sponsorship for their students to take the preparatory courses leading to the government examinations. However, the quality of these courses was, at best, mediocre. In 1995 the Federation of Industries of the State of São Paulo contracted with the education arm of the Globo Television Network, a private enterprise that had been offering the television courses, to prepare a new *Telecurso* for its workers. In this joint venture, the industrialists contributed US\$30 million to produce a new program and Globo offered to broadcast it free of charge. Globo also donated the equivalent of US\$60 million worth of commercial TV time to promote the new program, called *Telecurso 2000*. *Telecurso 2000* provides coursework to 500,000 learners at primary, secondary, and tertiary vocational levels (de Moura Castro, 1999).

Telecurso 2000 is a condensed version of the government's curriculum, which is provided through a combination of videotaped classroom sessions and books. The curriculum is designed by a collaboration of industry representatives and educational experts and responds to employers' needs for skills. Telecasts are filmed entirely in workplaces and are supported by print materials widely available in newsstands. Learners can view the television programs at home or in a "telesala," which is a special room staffed with specially trained personnel and located in workplaces, community centers, churches, buses, ships, and even prisons.

- **National Open School of India.** The Open School was established in 1989 to offer an alternative educational opportunity for those who cannot attend

schools. Its principal programs offer secondary and senior secondary courses leading to grades ten and twelve certification. Between 1990 and 1995 the Open School enrolled more than a quarter of a million students in these courses. Although the main source of learning for students is printed self-instructional materials, the Open School also provides contact classes at study centers, where students have access to video and audio programs. These are intended to supplement the printed materials and provide the student with an opportunity to meet other students and discuss problems with counselors.

Both Brazil and Mexico have found ways to make use of television to extend access to secondary schools. They provide examples of educational use of television that contrast with the less successful applications of the 1960s and 1970s. Both countries, however, have large populations of potential secondary school students, which permit economies of scale that would not be possible in many African countries. Similarly, the cost of the *Telesecundaria* program (see below) would substantially increase the average public expenditure on secondary school education in Sub-Saharan Africa.

Both *Telesecundaria* and *Telecurso* have become models for similar programs in other countries. *Telesecundaria* is being broadcast over the same satellite that serves Mexico to neighboring Central American countries, including Honduras, where it is delivered through videocassettes to schools in a program called *Telebásica*. Russia and South Africa are adopting *Telecurso*.

Summary

Africa has considerable experience using distance education to improve access to secondary education. This has involved a mix of teaching/learning modalities, with printed materials as the main modality. Many programs have been sustained for long periods, but for various reasons have not been widely accepted or expanded to reach the growing number of young people who leave primary school and are unable to find places in conventional secondary schools. Most programs have not been able

to make use of new policies, organizational arrangements, and combinations of technologies and other practices that could make distance education more cost-effective for learners not enrolled in regular schools. The reasons for this may be that distance education systems for secondary education have been separate from the formal education system, and the possibility that students of this age are not self-motivated or ready for self-instruction.

So far, experience introducing computers and Internet connectivity in national systems of secondary education in Africa for the purpose of increasing quality has been limited to pilot programs and has many of the same cost challenges experienced at the primary level (explored later). Consequently, not enough is known about costs and effectiveness associated with different kinds of applications, and requirements to bring pilot projects to large-scale use. However, as programs like WorLD continue to build data on costs, and as information about learning outcomes becomes more available, this can be expected to change.

TEACHER DEVELOPMENT

The effectiveness, relevance, and costs of on-campus pre-service teacher education have been persistent issues. Cost analyses of pre-service programs in Africa during the 1980s showed them costing about nine to ten times more per student than programs of secondary education (Perraton, 1993). The wide perception of ineffectiveness of conventional programs of teacher development and the relatively high level of public expenditures going into these programs have provided a strong rationale for seeking alternatives that would make more effective use of distance education and ICTs as part of the teacher development effort. In addition, as countries like Malawi and Uganda have massively expanded access to primary schools, there has been an urgent need to get teachers into classrooms, and conventional methods either took too long or produced too few teachers.

Partly because of these and other pressures, distance education to provide certification for teachers has a long and successful tradition in Africa. From the work in Botswana in the late 1960s (Francistown

Uganda: an emergency response to teacher supply

Uganda's primary education system was devastated by the Amin and Obote years. While schools continued to function, teachers were in short supply, and about 56 percent of the primary teachers were untrained. Following the NRM takeover, a number of upgrading courses at-a-distance helped upgrade the qualifications of teachers in the classroom. For example, the Mubende Integrated Teacher Education Program (MITEP) aimed to upgrade teachers' qualifications in the Mubende district of Uganda and used twenty-two printed self-instructional booklets, tutor-marked assignments, five residential courses—each of about two weeks duration—group meetings every two weeks, and teaching supervision. Nine hundred teachers enrolled and about 700 completed the course three years later. Other districts had similar courses. In 1994, the government established the Teacher Development and Management System (TDMS), comprising a network of of eighteen core primary teachers' colleges, each supporting about twenty coordinating centers, staffed by tutors, and each coordinating center in turn responsible for about twenty to twenty-five

schools. This national system is used for a wide variety of purposes: management training and support to headteachers, district education officials, school community organs; pre-service training for teachers; inservice upgrading for practicing teachers through vocational courses and distance education; on-going inservice training to bring new methods, texts, and learning materials to teachers in school. The upgrading course builds on the work of MITEP and uses the outreach tutors to support coordinating center tutors, who in turn support and supervise the underqualified teachers and the teachers' colleges to provide residential courses. In the period from 1996, over 10,000 teachers have been upgraded. The UPE policy has led to a massive expansion of pupil numbers and a consequent deterioration in the pupil to teacher ratio. The supply of qualified teachers is not meeting the demand. Currently, there are plans to post about 20,000 "O" and "A" level graduates to schools to reduce the ratio. The TDMS model will be utilized to provide upgrading.

Table 2
Teacher development programs and use of educational technologies

Country	Institution	Pre-service	In-service	Technologies
Benin	Participation in CIFFAD program		Yes	Print, satellite
Côte d'Ivoire	WorLD program		Yes	Computers, satellite
Ghana	Winneba College of Education; University of Cape Coast World Links program	Yes	Yes	Print, audio cassettes; satellite (through the AVU)
Kenya	University of Nairobi, Institute of Education/ Ministry of Education	Degree	Yes	Print, audio and video cassettes, face-to-face teaching
Malawi	MASTEP	Special program		Print, audio and video cassettes, face-to-face
Mozambique	Teacher Improvement Institute		Yes	Print, face-to-face instruction
Namibia	Centre for External Studies University of Namibia	Yes		Print, computers, Internet, video, audio
Nigeria	NTI; COSIT; a number of other universities	NCE, B.Ed	PGCE	Print, radio, audio
Senegal	WorLD program		Yes	Computers, satellite
South Africa	Several universities and colleges of Education	Yes	Yes	Print, computers, Internet, video, audio
Tanzania	Open University of Tanzania	Yes	Yes	Print, audio and video cassettes, face-to-face
Uganda	NITEP; MITEP; TDMS Makerere University	Special programs B.Ed	Yes	Print, audio and video cassettes, face-to-face
Zambia	University of Zambia	B.Ed		Print, face-to-face instruction
Zimbabwe	Zimbabwe Open University	B.Ed	ZINTEC	Print, radio, telephone, face-to-face

Source: Irele, Modupe. 1999. "Distance Education and Teacher Training in Sub-Saharan Africa." Background paper. World Bank.

College) to upgrade unqualified teachers, through the work in Tanzania in the 1970s and in Zimbabwe in the early 1980s (Zimbabwe Integrated National Teacher Education Course—ZINTEC) to prepare teachers *ab initio*, to current efforts in Zambia, Malawi, Uganda, and Nigeria, distance education

has proved to be a successful mode of providing professional development for teachers throughout their careers. Teacher-training courses account for three-quarters of all distance education courses in francophone Africa and about half of all distance education courses in anglophone Africa (Robinson, 1996).

While countries that responded to the HDNED survey indicated that their distance education teacher development programs now make use of a range of technologies (Table 2), most of these programs have involved printed self-instructional materials to cover the bulk of the curriculum, residential courses in teacher colleges, supplemented by occasional radio programs and classroom supervision. Teachers continue to teach, sometimes under supervision of colleagues or other professionals, study the printed materials in the evenings and at weekends, listen to radio or audio programs when they can, sometimes attend weekend courses with colleagues, and attend residential courses during school holidays.

Zambia is currently utilizing a “one-plus-one” course for all primary teacher preparation. One year of residential courses is followed by one year of studying self-instructional printed and audio materials while teaching under supervision in schools. The course concludes with a further six-week residential course. This approach is expected to have a number of advantages. First, it will double the annual number of graduates from Zambian colleges—a critical factor in a country with HIV/AIDS infection rates of 20 percent. Second, it will provide teachers with experience teaching in “real” schools and, incidentally, expose their teacher college supervisors to these schools as well. A third benefit is expected to be a greater number of qualified teachers serving in rural schools.

As Table 3 shows, countries are beginning to experiment with ICTs within conventional teachers’ colleges and teacher resource centers. Six countries responding to the HDNED survey reported using computers, and several indicated plans to extend the use of computers in their programs.

- In South Africa, the Shoma Education Foundation’s teacher development program uses a combination of satellite TV, computers linked to the Internet, and collaborative lesson planning to reach under-qualified teachers in remote rural and urban areas of the country for in-service training. Launched in 1998, Shoma is supported, in part, by a private holding company for a satellite cable TV provider, plus an Internet service provider and

a satellite signal distributor. Shoma relays programs from a broadcast center, via satellite, to a video server linked to a television set, and to a computer network server, which in turn serves twenty-four workstations throughout the country. Each workstation belongs to a lesson development center, where teachers work together to develop their own lesson plans for the following week. Thus, thousands of teachers have access to the new technology, including those in remote locations. The initial capital outlay required to install the technological infrastructure was high. Familiarizing teachers with how to make good use of the technology also required considerable time and resources (Brown, 2000).

- Uganda has recently begun to introduce computers to teacher training colleges in order to make the curriculum and supplementary materials available to teachers and students. At present, the curriculum is being entered into the computer at the Institute of Teacher Education in Kyambogo (ITEK). However, most of the forty-five colleges do not yet have access to the Internet, so computerized materials are delivered by CD-ROM. The Uganda project (Connect-Ed) is one of five “computer-mediated professional development programs” supported by USAID. The other project in Africa is in Namibia (Fontaine, 2000).
- Creating Learning Networks for African Teachers is a UNESCO-supported project intended to equip a maximum of four teacher-education colleges in each of twenty African countries with a computer and full access to the Internet in order to develop local, national, and regional networks. The project, in its pilot stage in Zimbabwe, will also fund curriculum development of teacher education in mathematics and science, and the creation of twenty national educational websites (Perraton and Creed, 2000).
- In some places, computers are being used to manage administrative tasks and to help teachers plan lessons and prepare materials. In Ethiopia, for example, the Kotebe College of Teacher Education in Addis Ababa has a computer center equipped with about ten computers. It is in the process of equipping all nine departments with one new

Table 3
Computer use in teacher colleges and resource centers

Country	Colleges	Resource centers	Plans to add more
Botswana	n/a	Computers and email	n/a
Ethiopia	All 6 colleges		Yes
Guinea	Over 200 computers in 4 colleges	On average 1 computer in each center	Yes, to other centers
Mauritius	55 computers at Mauritius Institute of Education	30 at the National Tech. Resource Center	Yes (20 to MIE)
Nigeria	20 federal colleges; 20 of 38 state colleges	National centers	n/a
Tanzania	600 for 22 colleges	None	n/a
Uganda	10 at 1 college		Yes, to more colleges
Zimbabwe	n/a	20	n/a

Source: HDNED, The World Bank, 1999.

computer for administration, lesson planning, teaching material preparation, and research. One problem encountered is that, since computer use is not part of the curriculum, there is little incentive for some teachers or students to use the available computers. Other teacher training colleges have computers for teachers and administrative staff. Most computers are not yet networked, either to each other or to the Internet (Tilson, 2000).

Some observers suggest that methods like small group tutorials have been more effective than technology for supporting teacher development (Nielsen and Tatto, 1993; Dodds, 1988). How technology is used, particularly when combined with other methods, is likely to be an important design issue for technology-assisted teacher development initiatives in Africa.

Relevant technologies for teacher development from other regions

The challenge in Africa is to build better systems of teacher development that use distance education and ICTs to improve specific areas of teacher development and to increase peer interaction. These can be built upon the already existing systems of teacher development as they link teachers to new possibilities. While there are some good examples from other regions, particularly in television and the Internet, Africa is an important pioneer in this area.

Print-based teacher development

Utilizing a model not unlike many of those in Africa, the Sri Lanka Institute for Distance Education offers at-a-distance teacher development courses to untrained teachers. These teachers study printed self-instructional materials then receive supervised teaching and follow up. In addition, teachers are

supported through face-to-face sessions in regional centers and through study circles with other student-teachers. The Sri Lankan teachers are supported over a period of three to five years. Alternative conventional courses take two years of full-time study in a teachers college.

Approximately 5,000 teachers were studying with SLIDE in 1993. An evaluation in 1990 comparing this approach with the more conventional approach (Tatto et al, 1991) found that this mode was more cost-effective than the two conventional alternatives by a factor of between 4.5 and 6 times.

Radio for teacher development

The first attempt to create an IRI project specifically for teacher development took place in the 1980s in Nepal's Radio Education Teacher Training Project (although the interactive nature of this effort was questionable, and logistical and institutional difficulties eventually shut down the project). Teachers completed at a rate of 83 percent but only passed at a 54 percent rate, suggesting either a poorly designed training program or a poorly designed examination. (Perraton and Potashnik, 1997). Recently, IRI for recurrent teacher development is being piloted again in Nepal, this time with a specific emphasis on overcoming the theory/practice divide that plagues in-service and pre-service teacher development generally and on teaching specific subject matter—fifth grade English as a foreign language and third grade math. All India Radio has used instructional radio to develop teachers in English language skills. Radio is also used in the Dominican Republic and Honduras to develop teachers.

Television, video, and computers

Television has also been used widely to develop teachers, especially in Asia. China's Television University System (TVU), established in the 1960s, develops science teachers and other professionals. Closed during the Cultural Revolution, it reopened in 1979. The government also launched an educational television channel and an in-service teacher-training program to televise instructional packages from Beijing to other parts of the country via satellite (Perraton and Potashnik, 1997). Observers have

noted, however, that in remote areas of the country, teachers rarely use the television programs. Only about 15 percent of teachers had a television and VCR at home, and they lived quite a distance from the study centers where this equipment was available. China's Television University is now being challenged by the Internet. This year, the education ministry has approved twenty higher-learning institutions to develop and deliver on-line courses, which are expected to reduce the demand for televised programs (Capper, 2000).

Computer-based programs would seem to pose the same problems of inaccessibility as do television broadcasts. India's National Council of Educational Research and Training operates a program that provides short-term training to nearly two million primary school teachers. Special Orientation of the Primary School Teachers (SOPT) trains teachers through two-way video and one-way audio, uplinking instructional programs from studios of the Indira Gandhi National Open University. The seven-day development program consists of both content and pedagogy (Perraton and Potashnik, 1997).

As in Africa, computer use for teacher development in other parts of the developing world is in a pilot stage. USAID's LearnLink project is also piloting computer-mediated teacher development networks in Brazil, Morocco, and Guatemala. Because the activities are relatively new, longitudinal data on results and impact are not yet available. However, summaries of these activities demonstrate the kinds of applications that can be designed for pre- and in-service teacher development in particular, and provide broad and ongoing professional development opportunities for teachers in general (Fontaine, 2000).

Summary

There is considerable experience in using distance education to develop teachers in Africa, whether in-service or pre-service. Although print materials are the primary means for providing education to teachers at a distance, they have been supplemented by audio and video delivered through broadcasts or on cassettes. All courses offer face-to-face instruction, usually on weekends and in residential courses

over school holidays. Many of these programs have been successful, particularly those offered to meet an emergency demand, such as in Malawi, Tanzania, Uganda and Zimbabwe; however, very few have been maintained. Variations of the current national experiment in Zambia, combining both residential and distance modalities, may offer a solution to the problem of providing teachers with appropriate experience while training, and lead to more teachers choosing to stay in rural schools.

There seems to be growing interest in using computers as a platform to provide training and to improve the access of teachers to educational resources and to other teachers on an on-going basis. Many computer- and Internet-based initiatives in teacher development are just beginning, and there is little information yet on costs and benefits. However, the experience to date and the cost analyses presented later in this document suggest that reducing face-to-face teacher development through distance education and ICTs offers a valuable means of reprogramming constrained educational budgets.

The main caution for distance education and ICT for teacher development programs is one of effectiveness. Too many examples of mediocre teacher development programs using distance education exist—examples where teachers are read a text over radio without any real explanation or effort to make it meaningful or pedagogically sound. Teachers need to be engaged and motivated so that they will complete a course, pass the exam, and understand how to apply the knowledge. For teacher development, the deliberate use of all levels of technology make sense to some degree, borrowing from applications of computer use as developed for tertiary education and applications of radio instruction as developed for primary education.

TERTIARY EDUCATION

Distance education at the post-secondary level has a long history in Africa, going back to 1873 with the founding of the University of the Cape of Good Hope in South Africa, now called UNISA. UNISA, one of the world's eleven mega-universities, enrolls 130,000 students in degree programs and graduates

10,000 students per year. Botswana, Tanzania, and Zimbabwe have also established new higher education institutions wholly dedicated to distance education. The Zimbabwe Open University already enrolls nearly 10,000 students in nine programs and recently launched a master's degree in education for in-service teachers. Namibia and Ghana have formally declared dual-mode instruction (both residential and distance courses) to be national policy.

The use of distance education and ICTs to expand access to tertiary education in Africa has two objectives: increasing enrollments and increasing the opportunities for students unable to take part in campus-based programs because they live far from existing facilities, or because their work schedules prevent them from attending regular classes. While significant, enrollments in most of Africa's open universities remain relatively small in comparison to many other countries, many of which enroll over 100,000 students per year in degree programs. Countries seeking to expand the reach of their systems will need to assess potential investments in expansion relative to the investment in ICTs required to connect to international networks of knowledge and professional exchange. The increasing on-line availability of educational courses and materials and digital library resources is likely to open new avenues for teaching and learning.

The provision of tertiary distance education in Africa is taking place through a variety of institutional arrangements—each with relative advantages and disadvantages. These include the following: “single mode” institutions entirely dedicated to providing distance education; “dual-mode” institutions that offer both conventional and distance teaching; “franchised” international programs that offer courses from an external provider through a local institution; and “direct unfranchised” international programs made available to individual students by an international university or commercial provider through electronic connections (Saint, 2000).

Although Table 4 suggests that a mix of technologies is used for distance education at the tertiary level, the core medium of instruction in Africa has been print, with other technologies supporting the system.

Computers at universities

African universities are making significant investments in computer technologies to strengthen ongoing functions, to extend their programs to distant centers, and to link with resources and programs offered internationally. When computers are networked or connected to the Internet, they offer a variety of other functions. Some examples include:

- The University of Dar es Salaam has established a university-wide data communication network, connecting all twenty-six academic buildings on the main campus with eight km. of fiber-optic cable, as well as two regional campuses with a 2-Mbps wireless link. Full Internet connectivity is provided to the colleges via a satellite link at the main campus. A virtual distance learning system is being established, using the fiber-optic and wireless backbone and Internet infrastructure. Plans are to ensure that all university graduates will be computer literate within two years. Many aspects of the administrative system have been computerized. Though the current (2000) computer: student ratio is 1:60, it is expected to fall to 1:10 very soon. Computers are installed in every residence hall.
- The Center for Information Technology and Systems of the University of Mauritius is a provider of computer-based network services and management information systems. The CITS provides access to computing facilities to students, staff, and administrators. It maintains and upgrades the hardware and software equipment and supports end users. Staff promote the use of state-of-the-art technology in instructional support, and they support basic information technology modules through the distance education delivery system via videoconferencing facilities.
- Botswana, Cameroon, and Zambia are using a university-based Internet system to support interactive regional study centers for distance learners.

Relevant experience for tertiary education from other regions

Worldwide, various applications of distance education have assisted the massification and privatization of higher education, and may be rel-

evant to the development of new systems in Africa. The Monterrey Virtual University, for example, represents the new high-tech breed of open universities. It is part of the Monterrey Institute of Technology and comprises thirty campus-based universities plus the virtual university. The Virtual University serves about 50,000 graduate and undergraduate, degree and non-degree students from ten Latin American countries. It uses satellite links, videoconferencing, the Internet, and other technology. Technology is used to import and export courses to and from other universities in Latin America, referred to as "edu-trade." Major clients of the Monterrey Virtual University include corporations, who recognize the need to retrain workers frequently in order to be competitive in the new global economy. This model is growing in other universities and institutes where connectivity and language skills become the precursor to participation.

African countries may also benefit from considering the experience of some of the international "mega-universities." A mega-university is an institution based on an open university model but which reaches out to a very large number of students. Table 5 presents a list of mega-universities that enroll thousands of active students at one time in degree-level courses. The list shows that, for the most part, universities in Asia enroll the largest percent of tertiary students in their countries.

Mega-universities and open universities do not require that students live within national borders. Turkey's Anadolu University has many students living in Germany and other European or Asian countries. The University of the South Pacific serves students spread over 30 million km², and most of them do some or all of their studies at a distance. Of the 79,000 international students in Australian universities, nearly 16,000 were at offshore campuses, mostly Malaysia and Singapore. In 1998, the Open University (UK) had 25,000 international students living in 94 different countries (Jurich 2000). Interestingly, UNISA numbers among its graduates African Heads of State Nelson Mandela, Robert Mugabe, Samora Machel, and Samuel Njovu. (Only the first of these is South African, and he, of course, was living offshore when he studied with UNISA!)

Table 4
Distance education technology use at higher education institutions

Country	Institution	Courses offered	Technology used
Botswana	Center of Continuing Education	Certificate in Adult Education; Masters in Education Planning	Print (audio and video being considered)
Côte d'Ivoire	FVU	Economic Development Computer Science (grad. level) Environmental Science	Satellite, CD-ROM, video, print
	ENS	Mathematics	Print
Ethiopia	Addis Ababa University	Masters in Education, Curriculum Studies and Education Planning	Print (will add audio)
	UKOU	MBA	
	African Virtual University (AVU)	Computer Engineering, Computer Science, Electrical Engineering	Satellite broadcasts, Internet, fax, phone, print
	Civil Service College/ World Bank Learning Network	23 courses	V-Sat, 11 networked computers
Ghana	African Virtual University	Computer science, science, English, French	Satellite broadcasts, Internet, fax, phone, print
	University of Science & Technology	B.Sc., Building Technology	Print
Guinea	Superior Institute of Education	School administration	Computers, print
	FVU	Computer Science (grad. level) Economic Development Environmental Science	Satellite, CD-ROM, video, print
	Agency of Technical and Cultural Cooperation	Vocational skills	Radio, TV, print
	National Direction of Technical and Professional Training Gamal Abdel Nassar University of Conakry	School Administration Public Health, Human Rights	Computers, print Computers, Internet, print
Mauritius	University of Mauritius	IT, Communication Skills, Management, Economics, Math, Law, Statistics	Print, Internet, computers, audio, video, tapes
Namibia	Center for External Studies	Nursing, African Languages, School Library, Science	Print, some audio tapes, radio
	University of Namibia		Print, radio
Nigeria	University of Abuja	Law, Administration, History, Accounting, Economics, Political, Science, Sociology, Geography, English	Print, audio/video tapes, digital radios
	Most other universities	Part-time and "sandwich" programs	

Country	Institution	Courses offered	Technology used
Senegal	African Virtual University	Engineering, Sciences	Satellite broadcasts, Internet, print
	FVU	Computer Science, Economic Development, Environmental Science	Satellite, CD-ROM, video, print
Swaziland	Institute of Distance Education	B.A. in Education, Humanities, Diploma in Commerce, Law, Certificate, French	Print, radio, video and audio tapes, TV
	Emlaladini Development Center	Certificate and Diploma in Adult Education	Print, radio
Tanzania	Open University of Tanzania	Multiple degrees	Print, radio
	Institute of Adult Education	8 subjects	Print, radio, audio tapes
Uganda	Makarere University	B.A., Commerce	Print, audio tapes
Zimbabwe	Zimbabwe Open University	B.A., Education; B.S., Agriculture Diploma in Education, MBA	Radio, television

Source: HDNED, The World Bank, 1999.

Summary

New educational technologies can change the entire institutional structure of tertiary education. Examples of open universities, mega-universities, and virtual universities, as well as conventional univer-

sities, have been provided. Unlike policy-makers and practitioners at primary and secondary levels, most of those at universities and technical institutes will soon be forced to make significant changes in their institutions. These changes will be imposed through the demands of the knowledge economy,

The Africa Virtual University

This technology-based distance education network began in 1997 as a pilot project in the Africa Region of the World Bank. Since then it has been established as an independent, non-profit organization headquartered in Nairobi, Kenya.

AVU's goal has been to use ICTs in SSA to provide increased access to quality higher education in areas critical to economic development. Thirty AVU Learning Centers have been established in tertiary institutions in seventeen anglophone, francophone, and lusophone countries across Africa. So far, AVU has delivered over 3,000 hours of instructional programs, and registered approximately 24,000 students in semester-long programs. In addition to courses, AVU offers a digital library with full-text journals and a catalogue of subject-related Web links.

During the pilot phase the AVU teaching-learning model was comprised of a mixture of videotaped and live lectures delivered by one-way video, 2-way audio digital satellite broadcast, and e-mail interaction between students and instructors. These were supple-

mented by textbooks, course notes, and support in the classroom by local facilitators. Although a formal evaluation has yet to be done, reports from the pilot phase indicate satisfactory academic results and a low drop-out rate—approximately 15 percent.

Following a recent strategic review, AVU will no longer aspire to be a university in itself. Rather, AVU will help expand access by delivering accredited distance learning diploma and degree programs from other institutions and by building the capacity of its partner universities to develop and deliver their own ICT-enhanced distance learning programs. AVU hopes to serve as a technical resource and catalyst for ICT investments in African higher education. AVU will assist partner institutions to gain access to high-speed Internet connectivity and with other technology improvements. AVU also plans to develop a Web-based Portal for the African educational community to share information and find new distance learning products and to expand the scope and scale of its existing digital library.

Table 5
Enrollment at mega-universities

Institution	Institution's Enrollment*	% of total tertiary students
China TV University system	>500,000	n/a
Anadolu University, Turkey	>500,000	38*
Universitas Terbuka, Indonesia	>300,000	18
South Korea National Open University	>200,000	13
Indira Gandhi National Open University, India	>200,000	11
Open University, Thailand	>200,000	41*
Open University, United Kingdom	>100,000	8
Fédération Interuniversitaire de l'Enseignement à Distance, France	>100,000	2
Payame Noor University (Iran)	>100,000	n/a
University of South Africa	>100,000	n/a
Universidad Nacional de Educación a Distancia (Spain)	>100,000	n/a

Sources: Daniel (1996); Dhanarajan (1994) as compiled in Saint (2000). *Jurich (2000).

with countries competing for skilled people and the increasing pressure for places. They must decide upon strategic uses of new educational technologies. These might range from a conservative adoption of computer uses, satellite broadcasts, and/or Internet use into existing curricula, to a radical transformation of the institution into an open university, at which all courses are offered through ICTs. An open university model would change the basis of revenues from on-campus to off-campus students. The issue will shift from cost-effectiveness (comparing the costs of different combinations of courses and media to achieve defined learning objectives) to larger economic issues and alternatives.

A growing number of distance learning strategies are being researched worldwide, with a growing knowledge of how to integrate on-line learning with face-to-face instruction for adults. The concern is how to make the most out of what the technologies

offer. Early conclusions suggest that on-line activities (downloading and sharing documents, interacting in discussions, and the creation of projects) might create opportunities for diverse teaching and learning styles. Students who prefer more reflection before responding can still engage in interchange. However, these strategies are best used in coordination with activities, such as face-to-face instruction, where real-time interaction and feedback can take place, rather than on their own (Kleimann, 2001).

There is considerable activity underway in Africa to build upon its capacity to provide distance education as a means of addressing demand for tertiary education. Distance education programs are being offered through a variety of organizational arrangements. These offer distance education through an extension of the programs at conventional universities, open universities, or through external providers. Distance education programs are using a vari-

ety of technologies. Most programs continue to rely heavily on print materials, but there is more use of ICTs to support the teaching/learning, research, and other functions of tertiary-level institutions.

The organizational arrangements and technologies to establish or extend systems of distance education at the tertiary level will be determined by the conditions in Africa in regard to infrastructure and institutional capacity, as well as cost and finance issues.

APPLICATIONS WITH THE GREATEST POTENTIAL

Of the applications studied—in Africa and other regions—some can clearly be implemented in African countries at the scale necessary to be affordable and sustainable. These applications offer the least risk for decision-makers and warrant further investigation to judge whether they are appropriate for a particular African country. It is also important to determine if existing conventional systems can be strengthened and expanded so that issues of access and quality can be addressed.

However, although some programs have shown potential, others have not been effective. And there are areas of education that would benefit from further research and piloting to determine how distance education or ICTs can make a contribution.

Quality in primary education

At the primary level, successful applications have largely focused on improving quality, with interactive radio instruction as an application with the greatest success to date. It has proved to be implementable and able to go to scale. Six projects across different regions of Sub-Saharan Africa have been successfully piloted: three have gone to scale (Guinea, Lesotho, South Africa), two are in the pilot stage (Ethiopia and Zambia), and one was not sustained beyond the pilot (Kenya). These efforts are important both because they demonstrate that quality in primary education can be improved with the introduction of particular methods, and because they offer examples for other African nations.

There is room to broaden IRI methods to include other educational goals. While only one country, Zambia, so far has experimented with increasing access, the potential exists for innovation and exploration in this area. The knowledge of IRI at the primary level is also valuable for planners.

Access to tertiary education

The growing capacity of computer-based distance learning tools, such as the Internet and computer-based courses, holds more promise at the tertiary level, where more students may have the ability to be self-learners and the expenditure per student increases. Experience of expanding access at the tertiary level in Africa has largely relied on correspondence, with varying degrees of quality. The burgeoning potential of computer-based solutions offers some examples of how to strengthen known systems or how to add new alternative methods to reach out to more students.

Many of the decisions at this level concern the design of distance education systems and how they link up to the existing infrastructure and educational systems. The evidence suggests that distance education and ICTs can profoundly affect the reach and quality of tertiary education in Africa.

Teacher development

The use of distance education for teacher certification has a long and relatively successful history in Africa. The relative cost-effectiveness of systems, their potential to get more teachers into classrooms quickly, and the new teacher development paradigm that highlights the importance of learning while teaching should ensure that countries consider these methods. In this regard, Zambia's experience with its "one plus one" system will interest many other countries. However, many of the applications have made familiar mistakes and not concentrated on the quality of instruction for teachers and the amount of interaction and feedback they require. Further experimentation is needed to determine how distance education systems can be strengthened with the strategic (and economic) introduction of diverse technologies.

Strengthening existing systems of distance education and ICTs for in-service education of certified teachers can reduce costs and improve the quality of instruction in primary and secondary education. This can be done by introducing new applications that integrate different types of technologies, incorporate greater attention to pedagogy, and apply the conservative use of high-tech solutions, such as linkages through computer connectivity.

Mathematics, science and technology in secondary and tertiary education

The experience using distance education and ICTs for secondary education has not been conclusive. Although several efforts have been made to use distance education modalities to increase access to secondary education—and some have functioned well—none stands out as a model for replication. While there is evidence to suggest that investing in programs to increase access could be more cost effective than conventional educational approaches—and the study center system in Malawi offers an interesting model to reach primary school leavers—there is no evidence to suggest that such programs can be brought to national scale.

There is, however, the potential at the secondary level to increase quality. The instruction of mathematics, science, and technology poses special chal-

lenges in Africa because teachers are often unfamiliar with these subjects and not prepared to engage students. Skills in technology are foreign to most teachers, as is well documented, and access to computers is challenging at best. Increasing attention to how these subjects are taught and how to familiarize secondary students with technology may have a substantial payoff. Experimentation in this area is beginning to take place, but is still in a pilot stage in most areas. While there are no firm models yet, an investment in innovation and experimentation can help revitalize secondary education in under-served subjects.

In tertiary education, as in secondary, it is becoming more difficult to retain high quality instructors in technology and in mathematics and science. The Africa Virtual University is experimenting with modes of centralizing the development of instruction modules and courses, and distributing these centrally developed materials across a large number of campuses. While the distribution costs remain significant, they can be expected to fall and the per-student cost on campus is likely to be smaller than the conventional alternative. The costs and cost-effectiveness of the first phase of AVU are being examined, and the results, together with the expertise acquired in implementing the first phase, are likely to interest many African countries.

3

Supportive Infrastructure, Institutional Capacity and Program Design

African countries must address a number of issues in order to exploit the benefits of technology in education. These include the supportive infrastructure required to enable the use of technology, the human resources needed to implement applications involving technology, and the design of the distance education or ICT initiative itself. In many cases, successful programs can be launched by building on the infrastructure that exists and by linking and extending current systems of teaching and learning through strengthening institutional capacity. The success of the effort does not rely on the technology alone, but on the quality of the application to promote learning and educational reform. This section explores issues related to these three areas: supporting infrastructure, institutional capacity, and program design.

Supportive infrastructure

The use of distance education and ICTs in education requires a mixture of infrastructure to support systems operations. The infrastructure required varies depending on the technology used by the delivery system, and will range from systems that are largely in place, such as the postal system and radio broadcast systems, to telecommunications systems that may be undergoing change. The issues for educational use include not only the physical resources present in the country but also the policies and regulations governing their use and the capacity to maintain and support infrastructure.

Broadcasting and receiving hardware

Applications that rely on radio or television require facilities for recording and broadcasting programs. They also must provide users access to receivers and maintain the receivers. In addition, it is often necessary to broadcast on more than one station in order to achieve national coverage. Broadcasts that have been free of charge to the education sector in the past may now face charges for airtime. There is often competition for available studio time or appropriate broadcast slots. These difficulties are compounded when there is double-shifting of classes or special schedules meant to accommodate work-related or seasonal demands on students.

Recording and broadcasting issues differ across African nations and will be easier to overcome in some countries than in others. More broadcasting possibilities are coming through a proliferation of satellites or transmission facilities in other countries. National broadcasting authorities in Africa can now purchase broadcast slots on satellites such as the Worldspace AfricaStar™ satellite. Three beams of this satellite cover all of Africa with digital radio signals (reception requires special receivers). In addition to AM and FM radio time, it is now possible to purchase airtime commercially for shortwave transmissions, which are broadcast from several international sites outside of Africa.

While not ubiquitous, the relative prevalence of radios per capita across Africa gives radio a comparative advantage over many technologies; how-

Table 6
Education technologies available per 1000 persons

Region/country	Radios (1996)	Televisions (1997)	Personal computers (1997)
Africa	54 (Angola) 238 (Ghana) 256 (Malawi) 316 (South Africa)	5 (Ethiopia) 26 (Uganda) 64 (Ivory Coast)	>1 (Burkina Faso) 9 (Zimbabwe) 42 (South Africa)
Asia	195 (China) 432 (Malaysia)	124 (Cambodia) 69 (India)	4 (Pakistan) 399 (Singapore)
LAC	283 (Nicaragua) 610 (Uruguay)	294 (Ecuador) 323 (Jamaica)	3 (Guatemala) 54 (Chile)
ECA	404 (Lithuania)	469 (Czech Republic)	348 (Switzerland)
North America	1,078 (Canada)	847 (USA)	407 (USA)

Source: World Bank (2000).

ever, the number of radio and television receivers available is still substantially below that in the rest of the world. This makes it harder for people living in rural areas to purchase receivers and have them repaired. It also has implications for strategies that count on students or teachers to follow courses while at home. In many cases, learners will have to be provided with receivers, or assistance in obtaining them. In some cases, a bigger obstacle to providing access to radios, televisions, or even computers is supplying the electrical current to run the devices—much of Africa does not have access to an electrical power grid. This presents schools or individual users with significant recurrent costs: in some countries the cost of a year's supply of batteries may equal the purchase price of the radio.

An increasing number of technological possibilities to reduce recurrent costs associated with poor infrastructure exist. The "windup" radio now being used widely in Africa obviates the need for batteries. However, some countries using windup radios indicate a high rate of breakage of the windup mechanism. Solutions prevalent in the informal sector, such as car batteries powering televisions, may also provide answers. The power requirements for devices such as CD players, televisions, and computers are higher than for radio. There are a num-

ber of solar recharging options for batteries now available for receiving devices; but none is widely used because of the cost and complexity of operating them in schools and homes.

These data are important to consider for another reason. Applications of distance education and ICTs have varying ratios of use per student and therefore varying needs in terms of the amount of hardware required. For example, a radio program designed to be used with a group of forty students (1:40) will not have the same requirements as a radio program designed to be used one-on-one in the home (1:1). Similarly, a computer application used for teacher connectivity may have a 1:1 ratio, but has a reduced hardware requirement given the smaller number of teachers.

Other telecommunications and Internet infrastructure

Distance education and the use of ICTs to support education are increasingly making use of telecommunications connections that go beyond broadcast radio and television. These involve linking computers through a variety of connections including telephone lines, fiber optic cables, and satellites. Currently, only a very small portion of the African population can afford telephone or Internet services (see Annex 2). The average total cost of using a local dial-

up Internet account for five hours a month in Africa is about \$60. This includes usage fees and telephone time, but not telephone line rental. Internet Service Provider (ISP) charges vary greatly, between \$10 and \$100 a month, reflecting different levels of maturity of the markets, the presence or absence of competition, varying tariff policies, and different national policies on access to international telecommunications bandwidth (Fillip, 2000). There are many possibilities emerging that promise connectivity, including a cable around Africa and satellites (see Annex 3); however, none of these options currently offer solutions that are available to most people beyond urban centers.

Telecommunications and broadcast sector policies

Education interventions that use radio and television need favorable policies in the government sector that regulates broadcasting, even in countries where the communications system has been decentralized. Those that use computers and other digital technologies often rely on different government authorities—usually those responsible for telephones. (Though the technical components of broadcasting and telecommunications are becoming indistinguishable, they are usually regulated by at least two governing agencies.) Because digital technologies are relatively new, there has been more experience with relationships between educators and broadcast regulators. Unfortunately, they have not always been productive. Ministries of information have balked at sharing the cost of transmission to schools by sharing production facilities and/or reducing transmission fees.

As radio and television signals—as well as computer communications—become digitized, telecommunications policies become more important. The key to Internet access is affordable telephone access (copper wire, cable, or fiber optic), and the key to telephone access is a competitive telecommunications infrastructure. Telecoms privatization in Africa is accelerating, although less than half of the continent's countries have begun to privatize their national telecom operator. While privatization is expected to lower the cost of telephone access, government regulators can require service providers,

public or private, to subsidize the cost or reduce tariffs for education institutions. These costs can make an application prohibitive.

Telecommunications policies can also affect equity issues. These players have a strong voice in whether to invest first in satellite and other technologies that serve rural areas or to concentrate on urban networks. These issues affect the shape that a distance education or ICT initiative can take, and opportunities will differ by country.

Institutions, management, and human resources

All countries face a serious constraint in their ability to activate and manage the institutional and human capacity required to operate systems effectively. This constraint is present whether strategies seek to establish new institutions, create distance education programs or technology support units within existing ones, or revitalize distance education programs that currently operate.

Distance educators have debated whether distance education can be described in terms of applying the principles and techniques of industrial production to education, including such things as planning, division of labor, mass production, automation, standardization, and quality control (Peters, 1983; Moore and Kearsley, 1996). Whether the characterization of distance education in industrial terms is accurate or not, the debate does point out that the functions of distance education or ICT support units are not identical to those of conventional educational departments, programs, or teaching units. Management functions of distance education programs vary according to their organizational structures and media use. For example, single-mode distance education institutions will be managed differently from dual-mode institutions. Also, managing programs that involve a combination of printed materials, face-to-face instruction, and broadcasts requires more complex organizational structures than those focussing on print alone.

Distance education systems and programs using ICTs demand specialized skills that are rarely found within the formal educational system. Learning systems involve developing and operating a variety of specialized sub-systems: course development, for-

mative evaluation, tutoring, student support, broadcasting, materials production (print, radio, television, Internet) and distribution, operation of remote sites or local and regional study centers, and so on. Managers of distance education systems must manage all of these different inputs and ensure that the student receives each element of support that he or she needs to study. Similarly, managing distance education programs often involves crucial decisions related to the costs of creating courses, selecting technology for course delivery, and determining "break even" points for course enrollments. These involve costing and planning skills rarely required of administrators of conventional education programs.

Part of the problem comes from a failure to understand the differences in the teaching/learning process when students learn at a distance and/or with technology. Consequently, there is a tendency to recycle course materials, lecture notes, and educational broadcasts that have been produced for conventional programs and that do not necessarily reflect good practice in distance learning. Similarly, there is a failure to prepare instructors to operate as part of a distance learning system rather than in a more conventional instructional role.

As discussed in Section 2, many long-standing distance education programs have operated at the margins of educational development and reform in Africa. Weak mandates for distance education have resulted in insufficient resources for institutions to grow and diversify. Limited resources in turn constrain the development of technical expertise and the expansion of the pool of talent.

Many African distance education programs have been successful in attracting skilled people to lead and direct programs. The scarcity of technical resources appears most frequently at levels involving the day-to-day management functions related to such things as course and materials development and student support. The development of capacity at this level is often constrained by strategies that seek to meet rapid enrollment or program development targets at the expense of on-the-job training. Moreover, providing technical assistance for developing distance education institutions and other

technology support units is often programmed in a "one off" fashion. This fails to take into account the capacity development required to address staff turnover or train new staff as systems expand.

Civil service and education sector policies are often inimical to the kind of human resource utilization conducive to the effective and efficient staffing of distance education or technology support units. Policies often require redeployment of personnel from other parts of the system. This results in staffing programs with people with teaching or supervisory experience relevant to operating conventional programs but unrelated to the technical requirements for good distance education practice. Limited resources often mean that personnel deployed to distance education programs do not receive adequate training to perform new functions.

The specialized functions of distance education and use of educational technology are often addressed through strategies that draw upon expertise across educational organizations or from outside the educational sector. Policies or institutional habits that do not permit use of part-time personnel or outsourcing of certain functions can be inefficient. As African educational institutions, particularly those at the tertiary level, make wider use of ICTs, the complexities of management will increase. The use of ICTs will suggest ways for universities to restructure the teaching/learning process and the use of facilities. This will involve such things as re-considering teaching loads, student/teacher ratios, classroom and library utilization, and using content produced in other countries. African universities, like those in other countries, will increasingly face issues of ownership and distribution of knowledge produced by individual faculty members and through university participation in networked research consortia. Anticipating and managing a restructuring of programs and facilities will be essential in order to prevent ICTs from becoming an expensive overlay to university programs, while failing to provide cost-effective avenues to improve quality and access.

If investments in distance education and ICTs to support education are to show good returns, more flexible institutional arrangements and more inten-

sive human capacity development, especially in the area of program management, will be needed as part of the overall development effort.

Program design

A preoccupation with hardware can result in too little attention given to program design and its compatibility with educational goals. And using low-cost applications as a way to expand access can sometimes eclipse effectiveness. This can result in systems that function, but do not encourage changes in achievement. Both of these scenarios are common in the use of educational technologies worldwide and contribute to the controversy that surrounds how to use distance education and ICTs effectively.

One rule of thumb in introducing educational technologies is to emphasize the role of distance education and ICTs in supporting educational reform. While this seems obvious, the reiteration of this rule can be important when faced with technological applications that may be highly effective but pose difficult challenges to implementation, affordability, or sustainability—or, alternatively, that may seem affordable but offer little real pedagogical value. This approach means that program design lays out *how* technology is used, i.e., to what organizational and pedagogical end, rather than *if* technology is used. It also suggests that the details of the program design make a significant difference in how a distance education program will function.

A secondary focus of program design on learning outcomes ensures that, foremost, learning is achievable. It brings forward issues that can plague programs of distance education, but are sometimes left unresolved, such as motivating students, face-to-face contact, peer interaction, feedback, accreditation, and instructional design. The following points highlight essential aspects of program design, with an emphasis on potential problems.

Alignment and compatibility

As ministries of education and their nongovernmental and international partners have attempted to adopt innovations that improve access to schooling and quality of education, it has become clear that

administrators, teachers, parents, and communities resist interventions that do not look like traditional schools. Alternatives that ask students or teachers to behave differently or that introduce new practices are often treated with enough skepticism and resistance to lead to their demise. For example, students cannot be expected to be self-motivated or self-instructing—especially in primary and secondary schools. Thus, aligning the design and implementation of educational interventions with the traditional and formal school systems has value. Distance education and ICTs are then seen as extensions and enhancements to the formal systems, even when created to resolve specific educational obstacles.

In particular, the curriculum offered by distance education should be consistent with the national curricula for primary and secondary, or that of the higher education institution in which it is being used. This is especially important at lower levels of the system because parents want their children to earn the qualifications to continue to higher levels. In tertiary education, dual-mode universities that deliver both conventional and distance methods of learning are considered an effective way of preserving educational quality (Saint, 2000).

Distance education often requires flexibility in school schedules, standards in teacher qualifications and credentials, and other matters. Thus, aligning a distance education intervention with the national curriculum and standards is a two-way street; it may force the ministry to reshape the curriculum to accommodate new modes of delivery and get access to new resources. Experience in Brazil, for example, has shown tolerance within the education sector for abridgements of the curriculum to fit into video formats. While this may not be appropriate now for countries in Africa, increasingly available newer digital technologies for radio and computers ensure that revisions in the curriculum in all types of programming are possible, if they are factored into a long-term plan. When goals are outside the existing national curriculum, such as building the skills needed to communicate in the new digital economy, attention can focus on how to bring the national curriculum closer to the reform effort.

Content

On the content side, considerable faith is placed in the educational value of commercially available software and information and materials currently available on the Internet. How effective this will be for students in Africa remains to be seen. In the past, there has been frequent reliance on putting printed materials in the hands of students and then assuming that they are being “taught.” More attention needs to be paid to using technologies in ways that go beyond exposure to information.

This can be achieved by developing the course design and educational programming capacity of national organizations and through efforts to ensure wider and more effective adaptation of materials used in other countries. While it increases development costs, formative evaluation can make adaptations of radio or computer programs more realistic and can help ensure that students are able to build on previous knowledge.

A modular approach

When distance education and ICTs are designed and produced in modules, rather than as a total system, there is more flexibility for revision, adaptation, cost-sharing, and concentration on issues of quality (both in programs that prioritize extensions of access and increases in quality). Various programs thought to be effective in both primary education and in tertiary education use this approach (Saint, 2000; Bosch, 1997). Experimentation with regional approaches to improve math and science for secondary education in Latin America and computer-based programs also used this approach, and were able to distribute the costs of producing and testing programs among different countries according to modules (WorldLinks, 2000).

Instructional design and timely feedback

Distance education programs that rely on self-motivation and self-instruction, particularly at the lower levels risk that students will drop out or not learn. In all technologies, including text, a lack of attention to making materials attractive and to making the learning process interactive and engaging results in poorer quality. A radio or computer pro-

gram using a narrator or having the learner read a text will not have the same affect as one based on experimentation and a variety of presentation methods.

Some believe that the high dropout rates are related to not giving students feedback on their performance and a lack of access to other support resources (Moore and Kearsley, 1997). Better feedback systems and local resources can counteract high dropout rates and improve quality. Isolated students lose interest.

Partnerships and teamwork

Considering institutional partnerships to accomplish goals is important to program design, particularly in the global economies of telecommunications, the Internet and hardware. Partnerships in the development and implementation of distance education and ICT programs can also broaden the expertise available and the application that results. In this case, partnerships include collaboration among groups of people with different skills, such as instructional designers, evaluators, content specialists, and radio/TV/computer producers. Including these perspectives into design will improve effectiveness.

Adaptations

Obvious difficulties arise when the conditions for creating a technological application are different from the conditions of the ones that succeeded. For example, when there are especially small populations groups because of language or course desired, it may not be possible to attain low per student costs and still attend to issues of effectiveness. In some cases, adaptations of programs that are already tested are available.

Summary

Africa is starting from a disadvantage in technological infrastructure and telecommunications systems. However, many of the changes taking place globally will positively affect Africa’s opportunities. The expansion of digital technologies offers Africa the possibility of increasing its infrastructure on a broader, regional level. Satellites, cables, and Internet services will make it possible to connect to the rest of the world and to others in the region, as long as people

have receiving devices. Decisions about how to link up and expand access depend on the hardware on the ground, both in terms of current telecommunications systems, receiving devices among learners, and the cost of adding the missing pieces.

However, distance education and ICTs depend only in part on the technological infrastructure, and an overemphasis on the infrastructure may distract from educational issues about how programs are developed, implemented, and sustained. While they may affect the opportunities available, issues related to telecommunications are likely to be resolved out-

side the education sector. Building on, linking up, and extending educational systems based on what exists, both in terms of delivery and reception of educational resources, can improve the chances that a program will be implemented and sustained.

Issues of institutional development, human resources, management, and program design benefit from careful planning. Finding methods of increasing effectiveness involves attention to both organizational and pedagogical details, and lessons can be gained from experience around the world.

4

Costs and Cost-effectiveness

While issues related to infrastructure and program design can determine success, the greatest obstacle to expanding the use of distance education and ICTs in Africa is the costs associated with effective use. This analysis aims at highlighting the key issues in costing and financing distance education systems and ICTs. First, we discuss four important concepts in analyzing the costs and cost-effectiveness of distance education and ICTs. Next, we analyze current information on the costs and cost-effectiveness of systems of distance education. Finally, we examine the information on the costs of adding quality using ICTs.

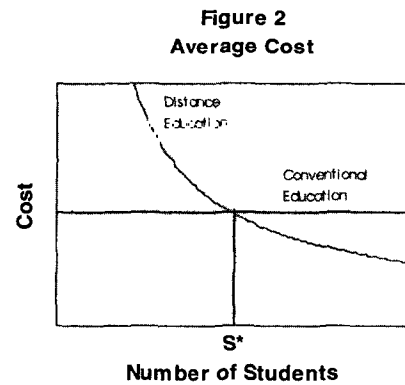
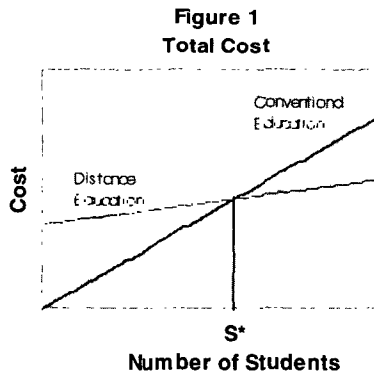
Calculating costs

There are a number of important concepts to consider when calculating costs and cost-effectiveness of distance education and ICTs in education. Four are discussed here: (a) the importance of calculating all of the costs; (b) the difference in the relationship between fixed and variable costs between distance education systems and conventional systems, and the impact of that on average and marginal costs; (c) the importance of calculating opportunity cost; and (d) the unit of cost comparison.

In regard to the *calculation of all costs*, many planners are unaware that providing hardware is actually a very small part of the total cost package associated with the introduction of any technology. The normal rule of thumb for introducing computers to classrooms is that the cost of the hardware repre-

sents *no more than 25 percent of the total cost* (TAC 1997). Peripherals, software, network infrastructure, support and maintenance, and training are critical additional costs. Even when relatively simple technologies, such as radio, are introduced the cost of the receiver is often the only cost considered. As has been discussed earlier, there are significant costs associated with developing programs, broadcasting the programs, training teachers in utilization of programs, assisting to support maintenance, and ensuring a regular power supply. This last is critical everywhere where electricity is costly, and in many rural areas without electricity.

The relationship between fixed costs and variable costs is also crucial in considering ICTs or distance education systems. Fixed costs are those costs required to develop and operate a learning system regardless of the number of learners served. These include the investment costs of developing and distributing lessons, broadcasts, and software. They also include the administrative costs of the institution that organizes the learning. Variable costs are those costs that depend directly on the number of learners in the system. These comprise teachers' salaries, facilities, books, and other materials. Most, but not all, capital costs are fixed; however, the number of radios, televisions, and computers depends on the number of learners. Typically, the proportion of variable to fixed costs is higher for conventional education than for distance education.



The fixed cost of course or lesson development, software, broadcasts, and management systems becomes more economical as it is spread among more users. This is where distance education systems may have a cost advantage over traditional systems. However, the cost advantage is only gained when student numbers are high. As Figure 1 shows, total costs increase more slowly in distance education systems than in conventional systems. Therefore, when the system has enrolled a particular number of students (s^* below) the total costs of the distance education system is less than the total cost of the conventional system. The average student cost for conventional instruction can be high because of the costs of teachers' salaries, policies that limit teacher to student ratios, and costs of building and maintaining facilities. The average cost of distance education programs can be lower when the fixed costs are spread over large numbers of learners—as well as because of the reduction in the amount of teacher time in the learning process and because most learning does not take place within regular school facilities. This is shown in Figure 2.

In conventional instruction, the average cost for each student and the marginal cost—what it costs to add an additional student to the system—are often about the same. In systems that use communications media in the teaching/learning process and where the skill in labor (the trained secondary teacher for example) is replaced by the technologies or a combination of technology and a less expensive facilitator, the marginal cost of adding an additional student is always lower than the aver-

age cost. To take advantage of economies of scale, it is economically attractive to expand the number of students to the point where the marginal cost of adding another student approaches the average cost. In determining whether a program makes sense, it is necessary to look at three areas not often reviewed together: implementability, the ability to go to scale, and sustainability.

When comparing the cost-effectiveness of two systems, such as distance education and conventional schooling, a third important concept is *opportunity cost*. From the student's perspective, enrollment in a distance education program is likely to save the costs of room and board, as well as the opportunity costs of unemployment. Students in distance education programs can work throughout their school years, which is often difficult in campus-based programs (Jurich, 2000). For example, the teacher in the classroom studying through a distance education system does not have to leave his or her classroom to advance professionally and learn new skills. This has significant implications for the teacher's well-being, and for the continuity of education throughout the education system. Opportunity costs play a smaller role in cost comparisons at the lower levels of the education system.

It is also important to bear in mind *the unit of cost comparison*. While the most common unit of comparison is the cost per pupil or per student, this unit can be misleading because graduation rates tend to be lower at distance-learning institutions than at residential colleges or conventional schools (Jurich, 2000). Enrollment does not imply that the student

gains from the experience, whether she is studying in school or at-a-distance. More meaningful units for comparison may be the cost per course-completer or the cost per graduate. However, it is also important to consider that some students study at-a-distance simply to further their education and not necessarily to graduate. Costs per graduate do not capture this and cost per module of learning may give a better comparison.

The unit of comparison is even more difficult to define where technologies are used to improve quality in regular classrooms. In these circumstances, the key unit to compare may be the cost of adding one unit of quality—but, units of quality are neither easy to define nor measure. Nevertheless, decisions about adding computers to classrooms or introducing radio instruction should be made based on the additional cost *and* the effectiveness. If it costs ten times as much to introduce television in classrooms as it does to introduce radio instruction, but the learning benefits are more than ten times as great, then it may make sense to introduce television where affordable. However, where the differences in learning gains are not so marked, the better decision may be to introduce radio instruction.

Costs of expanding access

In distance education programs at all levels and for teacher development, there has been a strong reliance on the use of print materials to replace classroom instruction. (Even students at the British Open University depend primarily on self-instructional printed materials for the bulk of their learning). Consequently, the cost of the teacher or lecturer is often reduced considerably, depending on the type and frequency of face-to-face meetings. There can also be significant cost savings from classroom use, since students either get together infrequently or in makeshift buildings. In Malawi, for example, the use of correspondence education with tutorial support through study centers was shown to operate at one-fifth the recurrent cost per student of that in a regular secondary school (Curran and Murphy, 1992). Perraton (1993) concluded that the costs of the National Correspondence College in Zambia resulted in per student costs for secondary education at be-

tween one-quarter and one-twentieth of the costs at a regular secondary school. Another comparison of pass rates in the Junior Certificate examination in Malawi showed that, on average, the costs per examination pass for study center students were about half the costs of those of secondary school students between 1998 and 1990 (Murphy, 1993). These numbers are significant: in the case of Zambia, four to twenty times the current enrollment could be served at the same cost using distance education. In the case of Malawi, the numbers participating in secondary education could be increased by 55 percent were all junior secondary education offered in study centers and all senior secondary education offered in secondary schools.

The same cost advantages hold true for teacher development programs that use distance education. Perraton and Potashnik's (1997) review of fourteen projects (four in Africa) concluded that distance education could be conducted at about one-third to two-thirds the cost of conventional education, and in a number of cases the cost per graduate was also lower. These programs tended to rely on traditional technologies, mostly print. It is not yet known what effects the use of newer technologies will have on costs. This review indicates the importance of not letting go of the traditional technologies, but rather, strengthening and augmenting them where they are effective. Nielsen and Tatto (1991) examined the cost effectiveness of distance education for training teachers when compared to on-campus pre-service and in-service training in Sri Lanka and Indonesia. In the first case, the distance education program proved to be more cost-effective. In Indonesia, a similar comparison produced mixed results.

Similar cost advantages exist in distance education programs at the tertiary level, notably in open universities. Table 7 indicates how costs in open universities compare with those in conventional universities in the same country. Many of the open universities listed are mega-universities, with enrollments achieving economies of scale. Table 7 also shows that student fees are significant parts of the per-student costs. One can question why students in distance education institutions are required to incur privately a larger proportion of the costs of

Table 7
Per-student costs at open universities

Institution	Distance education cost per student as % of conventional cost per student (\$)	% of per-student cost paid by student fees
Anadolu University, Turkey	13	30
South Korea National Open University	13	n/a
Indira Gandhi National Open University, India	n/a	86
Open University, Thailand	40	76
Universitas Terbuka, Indonesia	n/a	30
Open University, United Kingdom	50	50
University of the Air, Japan	39-47	43
Fédération Interuniversitaire de l'Enseignement à Distance, France	n/a	62
Open Learning Institute, Hong Kong	25-40	n/a
Open University, Sri Lanka	43-66	70
National Centre for Distance Education, Ireland	73	n/a

Source: Daniel (1996); Dhanarajan (1994), as compiled in Saint (2000).

their education than students in conventional universities. One can also question the ability of African nations to reach these numbers given small population groups in certain educational areas, such as engineering or medicine at the tertiary level.

Course development at open universities contributes to the high fixed costs incurred by distance education institutions. The Open University in the U.K., for example, invests up to three years and as much as \$1.5 million to produce a new course (Potashnik and Capper, 1998). However, costs in Africa are likely to be much lower. In South Africa and Kenya, tertiary level courses using ICTs were developed for about \$40,000 per course (Saint 2000). Theoretically, if the fixed costs of courses designed for smaller specialized population groups could be shared across countries, these costs could be distributed across a larger number of learners. The Africa Virtual University is testing this concept. While not

yet proven, this approach would not necessarily be confined to the tertiary level and could address the high fixed costs of other specialized courses at the secondary level or in teacher training.

Costs of improving quality

Unlike distance education systems designed to increase access, applications that use technology to improve the quality of conventional educational programs usually result in *increasing* the per-student costs of providing education at that level. This happens because applications take place in existing facilities and involve no reductions in teaching time. These costs vary according to the technology used, the nature and quality of programming provided, and the amount of time students spend learning with the technology.

For the application of IRI in primary schools, costs are likely to be in the range of US\$3 to US\$8 per

Table 8
Comparative per-student costs of educational technologies (1998)

Technology	Application	Scale (# of learners)	Per-capita cost (US\$)
Radio (large program)	Primary basic skills	1 million	3.26
Radio (small program)	Primary basic skills	100,000	8.12
Computer/Internet (large school)	Secondary laboratory	600	72.00
Computer/Internet (small rural school)	Secondary laboratory	150	98.00

Source: "Latin America and the Caribbean: Education and Technology at the Crossroads." Discussion paper (1998).

pupil reached, depending on the size of the program (Adkins, 1999). These numbers include the per-pupil annualized investment costs for developing the radio lessons. When the lessons have been developed and the system is in place, however, the annual recurrent costs have been calculated as \$2.32 (large-scale program) and \$2.97 (small-scale program). The cost of using television is usually higher than the cost of using radio. Typically, television costs are more than ten times as high per student reached. Studies of the costs of computers in schools in developing countries report widely varying annual per student costs—in the ranges of \$18 to \$63 (Perraton and Creed, 2000), \$78 to \$104 (Potashnik and Adkins, 1996), and \$84 (Osin, 2000). A study of costs of computers in developing countries for WorLD (Cawthera, 2000) projects dramatically lower costs (under \$20) when certain assumptions apply. These contrast with a study for World Bank that found computer costs in Barbados to be over \$600 (Bakia 2000). While there is a disparity among studies, even low estimates are in the double digits.

When education technologies are used in the classroom to improve quality at the primary and secondary levels, their costs must be added to those of the conventional education program because they do not replace teachers, textbooks, or any other inputs in the budget. A compilation of data by the World Bank shows the following kinds of added costs, which vary according to the application and scale (Table 8).

Generally, the costs reported above and technology cost comparisons often do not clarify what kind or quality of learning experience is provided, how long it lasts, and whether it is meaningful. Again, it should be clear that, although cost comparisons between the uses of different technology can provide an overall order of magnitude that is useful for planners, these comparisons could be misleading. Much depends on exactly how the technology is used, the number of learners served, what educational purposes are being addressed, and so on.

There have been very few comparisons of the impact of different interventions on quality. Those that have been done provide some evidence for the cost effectiveness of interactive radio instruction when compared to alternative investments in improving the quality of primary school instruction (Lockheed and Hanushek, 1988; Adkins, 1999). Adkins compared cost-effectiveness of IRI programs in math and language with investments in textbooks and teacher training. The findings showed that IRI was more cost-effective than the textbook or teacher training programs (Adkins, 1999, p. 43).

Interpreting costs and affordability

Orivel (2000) has suggested another way to look at the issue of the cost of using ICTs and whether this would constitute an affordable option to improve the quality of classroom learning in Africa. Using cost information from studies in the United States, France, and Latin America, Orivel concluded that

the *hourly* cost of learning with a computer is about \$1.70. A typical forty-hour per year student usage would therefore cost about \$68. (This is consistent with the \$72 per year typical large-school Internet application reported in Table 7). Orivel compares an hourly expenditure of \$1.70 for computer-based learning with the costs of face-to-face instruction with a teacher, which he calculates to be at about \$0.10 per hour for basic education in the population of the forty-seven least developed countries. The use of interactive radio would be about \$0.07 per hour (using the \$3.24 annual cost report in Table 7 and assuming 100 half hour lessons per year). The use of computer technology in primary schools would have to demonstrate “very attractive comparative advantages in order to justify such a gap in relative costs” (Orivel, 2000, p. 149).

Another way to interpret the relative burden of the per student costs associated with the use of ICTs is to compare them to overall public expenditures for education at a given level, and then to an estimation of the part of the educational budget available for discretionary spending. For the first of these, the average public expenditures on education in Sub-Saharan Africa (1997) are as follows: primary, \$143; secondary, \$378; tertiary, \$1611 (UNESCO, 2000). An addition of \$70 for an ICT application involving computers would represent a 49 percent increase in the budget for primary education, 19 percent for secondary, and 4 percent for tertiary.

It may be better to look at add-on ICT costs in terms of potential discretionary spending—that is, what is “left over” after such things as teacher salaries and facilities costs have been paid. Potential discretionary spending is often estimated to be 20 percent of the annual total per student expenditure at a given level of education (Adkins, 1999). In 1997, average per-student potential discretionary spending would be \$28.60 for primary, \$75.60 for secondary, and \$322 for tertiary. Some of these funds would be allocated to conventional materials, such as print textbooks and other basics.

If an application involving the use of computers costs the \$70 estimated above, it would be difficult to see how African countries could afford to pay for this out of potential discretionary spending avail-

able at the primary and secondary levels. There would be considerably more flexibility at the tertiary education level. This would probably require some hard trade-offs within existing budgets, since a 22% increase in discretionary spending might be difficult to obtain in countries where spending on tertiary education is over four times per capita GNP. On the other hand, if an application costs \$3.24 per primary student annually, even if the cost structure were not changed, it might be justifiable.

Who bears the cost?

The issue of who bears investment and recurrent costs involves a sharing of responsibility between governments and external agencies, on the one hand, and between the government and users, on the other. At the primary and secondary levels, many ministries of education have not had the development budget to invest in the up-front costs of designing and launching good-quality distance education programs. Typically, international funding agencies have shouldered the costs of developing innovative distance education programs. The expectation is that ministries of education should be able to cover recurrent costs in their annual budgets. However, salaries consume a large part of the recurrent budget of primary and secondary education. With changes in administrations or priorities, a number of radio- and television-based programs proven to improve the quality of education have not been taken to scale. If a ministry chooses to support a large-scale implementation of a distance education program that has added recurrent costs, it faces the imperative of restructuring recurrent costs—possibly changing the balance between budgets for salaries and for non-salary items to incorporate the additional costs of the new technology or reducing the spending on items such as textbooks, so that new technologies can be used.

At the post-basic education levels, there is the added possibility of sharing costs between the ministry of education and students. While the trend for basic education is to shift costs more to the public and away from families, students at higher education institutions may be able to shoulder more of the costs for their education. This becomes especially

viable at open universities, where students need not live on campus and can take courses while earning an income. However, as a study of in-service teacher education in Sri Lanka and Indonesia by Nielsen and Tatto (1991) points out, this does not always work in practice. In both countries, it was found that students in the distance education program incurred higher private costs than those in conventional programs. This includes a large proportion of opportunity costs, since time spent in training, even those conducted at a distance, requires students to forego income from secondary sources. In Sri Lanka, the private costs incurred by students were modest and did not pose a problem. In Indonesia, however, the private costs borne by students (64 percent of total costs as compared to 29 percent for on-campus students) were a burden with negative consequences for enrollments. A study by Nielsen and Djalil (1989) found that in Indonesia when private costs are beyond 16 percent of students' annual income, the incentive to enroll in courses begins to erode.

The cost-sharing issue at universities is partly an equity issue. At traditional residential universities, the mostly elite group of students has been heavily subsidized. Governments have the option of reducing subsidies for on-campus students, which would make more funding available to subsidize off-campus student participation in distance education programs. Political opposition to shifting subsidies has inhibited some governments from experimenting with new cost structures at the university level. The eventual proliferation of distance education possibilities will no doubt strengthen the rationale for having students bear more of the cost of their university education while perhaps spreading subsidies among more students.

The use of computers and ICTs in education has often been predicated on assumptions of cost recovery from other sources of revenue. Many applications of computers in education are implemented through public-private sector partnerships. This is common in industrialized countries and in Latin America and Asia (Anzalone, 2000). These partnerships typically involve a public authority and commercial interests or corporate philanthropy. Al-

though the sources of private sector funding to offset the costs of introducing new technology into education are more limited in Africa than in other parts of the world, public-private partnerships are something that African countries will have to explore.

Private funding to support new educational initiatives using technology typically supports the costs of launching the initiative—usually providing the hardware only or hardware and limited training—and rarely supports recurrent costs over the long term. As explained, the hardware represents about a quarter of the total costs. Another common strategy envisioned for containing the costs of using computers in schools is to make the technology available to other users outside classroom hours. In such cases, the revenues obtained from the other users would reduce the unit costs for the use of the technology in schools. It is too early to have evidence about whether this is likely to be a viable strategy for Africa.

Summary of cost considerations

In sum, the cost of a technology-based program depends on its combination of fixed and variable costs.

- The cost of the hardware represents about a quarter of the total cost of introducing technology to the classroom.
- Distance education systems have higher fixed costs and lower variable costs than the conventional alternative. Consequently, they can achieve economies of scale. However, the numbers of students must be high.
- Cost effectiveness is difficult to measure, but applications exist that are more cost-effective than the conventional alternative. This has been the case for many teacher development programs and some tertiary education programs.
- Technologies with higher fixed costs and lower variable costs, such as radio, can be inexpensive if they serve large numbers of students and recurrent costs are managed. Studies have shown that IRI in primary schools can deliver learning more cost-effectively than textbooks or increased teacher training.

- Technologies with higher variable costs and that work in conjunction with conventional teachers, such as personal computers, may increase quality but are unlikely to bring any cost advantage. Indeed, they may be prohibitive at the primary school level, where teacher supervision is a requirement. In higher education institutions and for teacher training, the cost of their use may be lower if they do not require faculty supervision.
- Technologies that rearrange the structure of educational costs and reduce large cost items, such as in-service teacher development, while they maintain or improve quality, are likely to be attractive. Distance education for teacher development is attractive for this reason.
- Low cost applications that increase quality may be justifiable if they fit within cost limitations.
- The issue of who bears the costs and how recurrent costs are covered after a program goes to scale must be addressed early in the program design.

5

The Way Forward

Many distance education and ICT applications are effective and affordable and will be important to educational development in Africa. Evidence also suggests that some applications may not be affordable for some countries at this stage, or may be too technically complex to implement on a large scale, particularly for basic education. The challenge for each country will be to determine what is the most appropriate application, and how proven systems can be adapted or restructured to meet their goals.

Investment in distance education and ICTs must be linked to national strategies for education, guided by regional and international experience. This will help countries to avoid approaches that work well at the pilot level, but are difficult to scale up or achieve high quality levels. Increasingly, resources are available to share information and pilot new initiatives to determine how they function and to demonstrate what role they might play within education sectors. Based on the findings of this paper, we offer the following suggestions for African countries, and then propose steps for the World Bank.

Advice to countries

Prepare national strategies for distance education and ICTs

National strategies for using distance education and ICTs in education will be most effective when situated within an enabling framework to develop the whole education sector, rather than being conceived

as plans for procuring and distributing technology. Strategies should be linked to significant educational goals and allow for content development and testing to make them effective. Strategies will also be most useful if based upon a realistic assessment of national conditions, including available infrastructure, institutional capacity, costs, and means of finance. Ideally, these should be part of a country-led education reform process and supported through sector-wide approaches. However, where these are not yet in place, the plans for using distance education and ICTs should not be developed in isolation from the government's plans for reforming the sector. Programs should be formulated after considering a wide range of organizational and technological options and in light of enabling conditions, such as changes in the telecommunications regulatory environment and experience from other countries. Capacity building on areas of distance education and ICTs should be incorporated into all education projects so that a broader range of options and the ability to implement them exist. Annex 4 provides a chart showing questions that countries must ask as they develop national strategies.

Build on what has worked

Some strategies have worked well in Africa and elsewhere—including using distance education and ICTs for teacher development, quality enhancement in primary schools, and increasing access to tertiary education. Countries should consider these strategies seriously when planning. For example, systems

that support teachers as they work in schools are more likely to be successful in preparing teachers for the reality of rural schools, unlike modes of teacher development that keep student-teachers in colleges for two or even three years. Distance education is an effective medium for in-school training. In addition, some countries might consider expanding access to second-level education using distance education. However, before doing so, countries should assess why positive experiences in a number of countries have not been sustained.

Invest in innovation

Building on experience and existing infrastructure will help ground new initiatives in an African context. In some cases, however, countries will find it useful to conduct a pilot project to develop and test a new initiative before including it in a project for wide-scale application. Areas such as hands-on teacher training and mathematics and science for tertiary and secondary education, for example, show promise, but models are still scarce. WorLD and GLOBE provide rich experience of the modes and problems encountered in introducing computers into secondary schools in Africa; and the “wireless” experiment that WorLD is mounting in Uganda will enhance this experience. It is critical that, within these pilots, costs are monitored carefully and effectiveness and cost-effectiveness tested.

Contain costs and support long-term financing

Governments will need to plan their financing to ensure long-term support for initial investments. The costs associated with new distance education and ICT applications are front-loaded, with a high level of fixed costs. Sometimes these fixed costs can be covered by a loan or grant and the more modest levels of recurrent costs assumed within the national budget by students, or by both. The recurrent costs of promising applications are likely to be significantly smaller per-student than the conventional equivalent. However, they are not negligible, and successful applications can lead to increased demand for the service, thereby increasing the overall fiscal burden. Governments should plan for the financial implications of increased demand at second-

ary and tertiary levels. Clearly, the introduction of high-tech and more expensive approaches to solving national educational problems is possible for a small number of countries in Africa. Many of these countries will have achieved UPE and are approaching USE. Their problems are not of access but of quality, and quality will likely include preparing young people for participation in a global society. In these circumstances, models from Latin America and Europe may offer something. Again, the long-term recurrent cost implications must be planned for within budgets

Operating within sector-wide approaches, external financing agencies will likely permit a more gradual transition from the original investment to full coverage of recurrent costs by governments and students. For example, they may provide for assisting in the burden of recurrent costs as programs seek to go to scale. (For example, the World Bank has supported, on a declining basis, the recurrent costs of supporting student teachers teaching in Malawi.) In addition, external financing agencies will probably support ministry efforts to contain the costs of using different technologies. This could involve negotiating favorable policies for the education sector to purchase hardware and software, obtaining favorable rates for telecommunications connections to schools, and reducing the cost of access to broadcasting stations.

There may be possibilities for cost sharing through student fees at higher levels of education. In Africa, where the costs of higher education in terms of GNP per capita are about eight times as high as the average for the rest of the world, this is likely to be an important source for financing the expansion of tertiary education. Evidence for the potential of student fees is the increasing presence of private providers of distance education in Africa. The use of the newer ICTs is also likely to make it more attractive for many students to assume a share of the costs of their education (although this remains to be tested) and to make possible public-private sector partnerships as a way of increasing resources to extend higher education. How much of the costs of education students are able and willing to pay will vary from country to country and program to pro-

gram. But such a determination is essential for developing effective strategies for using distance education and ICTs in education.

Support national capacity for program design and management

Designing, implementing, and maintaining a national system of distance education and ICTs require broad-based skills that are not necessarily available in all African countries. Because the ability to troubleshoot and direct an intervention is essential to long-term success, countries will need to strengthen the national capacity of institutions and individuals to design and manage complex programs using technologies. Investments in institutional development and human expertise are important before programs are in place and require constant attention. This may involve mobilizing public and private resources to provide the national expertise to design and manage systems with increasingly sophisticated forms of educational programming and technical delivery options. Policies and incentives that make it attractive for highly qualified personnel to remain employed in national educational systems will also have to be formulated.

Create partnerships inside and outside the country

Forming partnerships among parents and local, national, and international groups to support country strategies will help in the design and implementation of the national strategy. It is difficult for many small countries to benefit from the economies of scale that accrue to some distance education and ICT applications, and even large countries will have difficulty supporting targeted quality improvement initiatives. Pooling resources across several countries is a way to maximize the technical expertise available for developing programs and reduce the burden of the high fixed costs associated with their development. These options can be difficult to manage, but are becoming more interesting for technology projects. Regional cooperation can also help increase the size of the population of learners served by programs, thereby allowing greater economies of scale. International partnerships, such as AVU, may reduce costs and share experience. Partnerships

are also necessary within the country to build support and involve key stakeholders. These should include governmental agencies outside education that are involved in areas such as telecommunications reform. Partnerships are also a way of building broad-based support for new policies and projects, developing institutional capacity, sharing experience, obtaining equipment and communications services at favorable prices, and reducing the share of public expenditures in new initiatives.

The World Bank's role

Sharing knowledge and information

Knowledge about distance education and ICTs is growing and being shared. The formulation of national strategies and plans for using distance education and ICTs will benefit from taking advantage of information and knowledge networks and closing knowledge gaps. However, knowledge gaps remain, and there is a scarcity of systematic information related to cost-effectiveness of different technologies, particularly over the long-term. Operational linkages between groups within the World Bank, such as groups working on education and those working in telecommunications and infrastructure, can be strengthened. During the past five years, the Bank has launched a number of initiatives to make available services that help create and share new knowledge for planning distance education and ICTs and conducting new studies. The Bank has established several networks and other mechanisms that will contribute to creating and sharing knowledge on a wide range of development issues (Vawda, 2001). Some of these are listed in Annex 4.

In addition to these mechanisms, the Africa Region's Human Development Department will support activities in countries that allow a systematic appraisal of options for distance education and educational use of ICTs, a sharing of experience between countries, and evaluations of applications. In each of the key applications addressing quality in primary education, math and science for secondary education, teacher training, and quality in tertiary education, the Bank will concentrate organized,

comprehensive support in at least one Sub-Saharan country. To contribute to the knowledge base, the Region will also carry out a number of case studies highlighting the findings in these and other areas and make them available. As the evaluations of WorLD and AVU are completed, they will be made available. The Africa Region will work closely with the World Bank Institute and the Human Development Network's Education and Technology Group in this work.

Separately, the Region will initiate work to examine the use of distance education and ICTs in Early Childhood Development, for nonformal and adult education and for vocational and technical training. The Region will also examine the impact for Africa of technology development and help analyze how countries learn about technology.

Supporting international partnerships and regional cooperation

A number of African institutions have the potential to support applications of technology and distance education. The most obvious of these is the Working Group on Distance Education (WGDE) of the Association for the Development of Education in Africa (ADEA). This is the only ADEA working group organized and led by African Ministers of Education. While WGDE has developed its work program very recently and will take time to become established, it is an important group for sharing and creating knowledge and building strategic partnerships across countries. The Region will continue to support WGDE. Other agencies working within Africa include the Commonwealth of Learning (COL) and the International Council for Distance Education (ICDE) in anglophone countries, and the *Consortium international francophone de formation à distance (CIFFAD)*, and the *Réseau électronique francophone pour l'éducation et la recherche (REFER)* in francophone countries.

The Region will collaborate with bilateral donors and other UN agencies through sector-wide approaches and within ADEA. These agencies can play a key role in programs that use technology, particularly if they are being applied in more than one country. Since these initiatives are large and require

management at different levels, collaborating among external financing agencies will make the job of African officials and experts easier and help ensure that appropriate activities are sustained. Activities can also be distributed across agencies since there is a variety of expertise in this area.

Finally, other international agencies, particularly UNESCO, have much to contribute. UNESCO's work on the Economics of Educational Media in the 1970s and 1980s was at the heart of understanding what the media cost and when they were successful. The Bank will continue to work with UNESCO as it develops its strategy.

Support country planning

The Region will provide technical assistance to countries planning to develop national strategies within frameworks for education reform. It will do this in cooperation with other agencies and partners, often within sector-wide approaches. In particular, the Region will make available the expertise gained in establishing the AVU to ensure that countries learn from that experience. In collaboration with WBI, the Region will support countries wishing to experiment with computerizing secondary schools and establishing electronic classrooms. Specifically, the Bank will provide dedicated, independent advice on the cost and effectiveness of a range of interventions being considered and assist countries to carry out such analyses themselves.

Finance innovation and application

The World Bank has several mechanisms to help initiate innovations. Learning and Innovation Loans (LILs) can provide resources for promising experiments and innovations that require further testing and piloting, especially those using new communication and computer technology. The Bank's InfoDev program provides grants to countries, organizations, or individuals for technology-related initiatives. For large-scale introduction of proven cost-effective technologies as part of its education lending, the Region can significantly increase support through traditional focused interventions or as part of broader strategic lending through APLs. In the process of developing loan and credit agree-

ments, the Bank will work with client countries to define sound plans and strategies for incorporating technology into education. It will help countries set priorities and define plans of action for investment programs.

Build country capacity

In order to do this the Africa Region will seek partnerships with bilateral donors and others to do the following:

- Establish a special Regional advisory group (from outside and inside the Region and the Bank) to advise on investments and oversee the program. This group will comprise a number of internationally recognized academic observers and practitioners and meet virtually every two months. The group will meet in Africa once a year. The group's mandate will be to advise the Region on its work program and provide technical analyses of proposed projects and programs.
- Expand expertise in the area of costing technologies for education and the design and management of distance education systems.
- Build Regional knowledge of ICTs and distance education. The Region will mount a series of learning events (formal seminars, brown-bag lunches, study tours) for TTLs and clients to provide them with information on state-of-the-art developments in the technologies and distance education, and to assist them reflect on the applications of these in the African context. In addition, a program of workshops will be launched to assist TTLs and clients gain skills in cost analysis.
- Develop self-instructional guides for TTLs and clients to help them develop and cost applications. These are likely to include four toolkits in teacher development, quality in primary, mathematics, science and technology education in secondary and access to tertiary, as well as a template for costing applications.
- Develop a series of case studies on the costs and effectiveness of distance education and ICT applications. The cases will be carefully chosen with

other partners, and may be developed in cooperation with colleagues in the Education and Technology Group at the Human Development Network. They will be widely circulated. In particular, the evaluations of AVU and Worldlinks will be widely circulated.

- Begin analyzing the potential for distance education and ICTs to contribute to early childhood development, adult nonformal education, and industrial training, and examine experiences across regions related to learning about technology.
- Participate fully in partnerships. The Region will participate fully in the WGDE and encourage partnership with others agencies.

Conclusion

Despite positive experiences that go back almost a century, distance education and ICTs have not been used in a significant way to reach systemic educational goals in Africa. Distance education and ICTs have been too narrowly conceived and have not reached their potential for supporting educational reform. Global strategies for using educational technologies often do not address the realities of African communities and classrooms. In many places, the design of distance education and ICTs has been organized as a distinct system, disconnected from other educational resources and systems.

The potential for distance education to help improve educational quality and access is becoming more recognized and funded in Africa as new initiatives are developed and adapted. With growing interest and investment on the part of African countries in distance education and educational technology, the time is right for strategic action to ensure a wise use of resources. Research and analyses in cost and design contribute to the strategic decision process and can make it easier to use distance education and ICTs. African countries and those assisting educational development in Africa have the opportunity to exchange views and share information that will help map the way ahead.

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Annex I

IRI Activities in Africa

In 1980, Kenya became the first African country to use IRI, adapting the Nicaragua Radio Math program to improve the teaching of English as a second language. Scripts for more than 500 half-hour radio programs for the first three grades of primary school English were developed over a five-year period. Unlike the Radio Math program, Radio Language Arts actively engaged the classroom teacher in the radio lesson. Although the original Radio Language Arts project showed IRI students scoring nearly 20 percent higher than conventional students in one year, political barriers and issues related to recurrent costs kept it from being institutionalized (Bosch, 1997).

Lesotho introduced an English-language IRI program, *Let's Learn English*, in 1987, using close adaptations of the scripts developed in Kenya. It consists of 391 half-hour lessons broadcast daily to all the country's first through third grade classrooms. The program is now part of the official primary English curriculum and reaches an estimated 200,000 students each year (Helwig, Dock, and Bosch, in Dock and Helwig, 1999).

South Africa's English-in-Action program was piloted in 1992, and by 2001 was serving over 500 thousand children in disadvantaged schools. The South Africa program adapted the Kenyan curricula dramatically in an effort to ground it in the context of a changing South Africa and included a teacher-training component (Leigh and Cash, 1999).

Ethiopia's Educational Media Agency, which began broadcasting weekly radio lessons for primary

schools in 1971 in social studies, science, Amharic, and English, has recently begun adapting its programs to the IRI approach. It will begin with first grade English, broadcasting on a daily basis. Ethiopia is also beginning to provide training in IRI at the regional level in the decentralized education system (Tilson, 2000).

Guinea's National Institute for Research and Pedagogical Support (INRAP) initiated the broadest IRI program in Africa in 1998, which trains teachers in the use of IRI and child-centered approaches to teaching. In the 2000–01 academic year, IRI was introduced to grades 1 through 6 in every school in the country. Language, math, and science are taught in French, and early evaluations show that the rate of learning increases at least 6 percent as compared to control groups. Radio broadcasts are supplemented by print materials, posters (in grades 1 through 4), and science kits (in grades 5 and 6). This is the first instance of an IRI program in West Africa going to scale at the national level and is in the process of going through a broad array of evaluations (Lynd, personal interview, 2001).

Cape Verde started using IRI in Portuguese in the early 1990s and is still in the pilot stage. This project's contribution to quality in the classroom is unclear at this stage.

Zambia, which is an exception to the general trend of not using technology to support an alternative to conventional schools, is piloting IRI for out-of-school children, who are particularly vulnerable because of AIDS and poverty.

Annex II

Communication Infrastructure

Until about twenty years ago, most communications infrastructures in the world were based on telephone lines and broadcast airwaves. While “wired” and “wireless” media are still the two types of signal carriers, the technologies in each of these two groups have become far faster and more versatile. Yet, their availability is still limited in Africa.

- For every 1,000 inhabitants, telephone mainlines are accessible to one inhabitant in Niger, nine in Kenya, and forty-one in Botswana. This compares to accessibility to about 75 per thousand in Brazil, 166 in Malaysia, and 335 in Bulgaria. (Jensen, 1998). The average number of mainlines per person is about 18.5 per 1,000 in Africa, compared to 60.2 in Asia, 303.8 in North and South America, and 343.8 in Europe. The density of cellular channels is about 1.7 per 1,000 persons in Africa, compared to 13.5 in Asia, 69.2 in the Americas, and 117 in Europe. Most telephone lines and cellular hubs are concentrated in urban areas (Fillip, 2000).
- Fifty-three African countries have access to the Internet, and this is generally confined to capital cities. The African ratio of 1:5,000 Internet users compares poorly to the 1:40 worldwide ratio and 1:6 ratio in Europe and North America. Moreover, the majority of Africa’s one million Internet users reside in South Africa (UNESCO, 1999). In 1999, Republic of Congo, Eritrea, and Somalia were still without local Internet service.

Table 8 illustrates the telecommunications and Internet infrastructure in some African countries. It indicates the kinds and numbers of providers in Africa, their coverage, and their subscriber bases.

The key to Internet access is affordable telephone access. In most parts of the world, the key to increasing telephone access is through competitive telecommunications infrastructure. Competition usually results from increased privatization in the telecommunications sector. This is now occurring in Africa, with five privatizations in 1996–1997, compared to just one between 1990 and 1995. Still, fewer than half of Africa’s countries have taken steps to privatize their national telecom operator. Currently, the annual growth rate in main telephone lines is close to 12 percent, and a coalition of communications ministers from forty African countries articulated a vision to lay 50 million lines in Africa by 2003. This has become a project of the Pan African Telecommunications Union (PATU). Uganda’s experience with privatization provides evidence of the impact on access: the number of telephone lines increased from 40,000 in 1998 to 100,000 by the end of 1999. Most observers expect wireless technologies to dominate in the near future, which could also substantially improve access to rural communities (Fillip, 2000).

Table 8
Telecommunications and Internet infrastructure

Country	Market structure; # of providers	# of phone subscribers	Coverage in rural areas	# of ISPs	Estimated # of Internet Users ¹
Botswana	Privatized in 1997		None		1,000
Burkina Faso		21,000 ²	None	2	700
Cote d'Ivoire		87,700	None	5	
Ethiopia	Government owned		3-year plan for complete coverage ³	2	2,600 ⁴
Ghana	Privatized	Cell phones (81,000) Radio phones (2,100+) Wired/radio (150,000)	Radio phones rural (500)	6	4,500
Guinea	Privatized Sotelgui (Network operator center) Dedicated line users	35,000 to 40,000 in 1999	8 access points in cities Rural zones not electrified	5	550
Kenya	Privatized July 1999		None		15,000
Malawi	Government Owned	35,000	None		2,000
Mauritius	Govt. owned, plan to privatize in 2003	Cellular: 100,000 Wired: 275,000 Wireless: 50,000 planned	Some	1	20,000
Namibia					2,000
Nigeria	Privatized. About 30 providers		Electrified but frequent power shortages		Not less than 80,000
Senegal		81,988	Electrified but often down because of weather conditions	7	2,500
Swaziland					900
Tanzania	Privatized		None	1	2500
Uganda	Privatized April 1988 ⁵			5	20,000
Zambia					3000
Zimbabwe	Govt. Controlled (PTC)	360,000 phone lines 200,000 cell phones 3 Cell Nets	0.5% (1,800)	23	100,000

¹ Unless otherwise indicated, all figures in this column are taken from "Nua Internet—How Many Online" and are from January 1999.

² 1993 Estimate.

³ Joint plan between Ethiopian Telecommunications Corporation and UNDP to provide Internet service to entire country by 2003.

⁴ Most in Addis Ababa and likely to be international organizations, diplomatic core, government and NGOs.

⁵ Privatization resulted in more than doubling of phone lines from 40,000 in 1998 to 100,000 by 10/99.

Annex III

Satellite Infrastructure

In recent years, new projects in infrastructure have begun and are at different stages of development. As a result, the continent's telecommunications capacity should increase greatly in the coming years. The following partial list of projects illustrates the kinds and locations of new developments. Generally, submarine cables circling Africa provide higher capacity and lower costs for international transmission. Satellite communication, however, remains a cheaper option for less populated areas with limited traffic (Fillip, 2000).¹

RASCOM is an African satellite consortium formed in 1992 and owned by the African Post and Telecommunications Operators (PTOs). Its primary goal is to provide affordable telecommunication services to cover isolated and rural areas as well as interurban networks in each country. In addition, 400,000 public telephone booths will be installed in rural areas. Financing is through a partnership whereby private companies will finance and build the system and transfer it back to RASCOM after a period of ten years of operation.

The Common Market for Eastern and Southern Africa (COMESA) will establish a company called *Comtel* that will work with member states to improve the terrestrial telecom infrastructure links between neighboring countries.

The Pan Africa Telecommunications Network (PANAFTEL) was started in 1962 to reduce dependency on colonial links and to improve inter-regional communications. The International Telecommunications Union (ITU) is providing funds through its Initiative 2000 project to help improve the PANAFTEL terrestrial network. This assistance includes two projects: *AFRITEL* aims to strengthen the capabilities of national telecommunications operators to develop and better manage, operate, and maintain African telecommunication networks. *Industrialization Africa* aims to transfer know-how to African countries on the creation and operation of manufacturing in the telecommunications sector.

SAFE and SAT-3/WASC combines three panned schemes, linking West Africa with Southeast Asia via South Africa. The SA-3/WASC element links Dakar, Senegal, with Cape Town, South Africa via several West African countries. This coastal marine fiber cable is planned for operation in 2003. SAFE will link Cape Town with Penang, Malaysia.

Africa One is a cable project that will provide connections between African countries and between Africa and the rest of the world. The cable ring around the continent would connect twenty to thirty coastal landing points. Coastal and landlocked countries without direct access to Africa One would

¹ Fillip (2000) is the main source of the following list. Annex I presents a more detailed description of the technologies underlying these projects.

connect to the landing points via terrestrial fiber cables, microwave, and satellite systems. The project was initially conceived by the ITU and involves two companies, Global Crossing and Lucent Technologies.

Lockheed Martin Intersputnik (LMI) is a joint U.S.–Russia venture to provide satellite transmission capacity and value-added services, including video and data distribution, to African customers.

The *VITAsat* system will provide an electronic mail facility for health, education, disaster, and other critical information to and from areas of the globe with poor telecommunication infrastructure. It is promoted by the World Bank, USAID, and VITA (Volunteers in Technical Assistance), and will offer services to non-profit organizations.

Each of these projects contributes to the telecommunications “backbone,” which connects central points in Africa to other parts of the globe and to each other. There remains the need to connect institutional and individual users within cities, towns, and villages to the backbone. These “last mile” technologies are most likely to be wireless ones, which, though less extensive in their hardware requirements, will still entail the installation and maintenance of modern telecommunications equipment near towns and villages. Interventions at the primary or secondary level that feature computers as interactive learning tools require access to both backbone and last-mile communications channels (Filip, 2000).

Annex IV

A Chart for Developing National Strategies

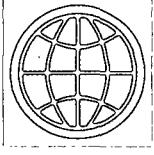
Issues	Questions to ask
Preparing national strategies	<p>How is distance education/ICT part of the country-led reform process, in place or planned?</p> <p>How is it set within a framework to develop education as a whole?</p> <p>How is the strategy linked directly to significant educational goals?</p> <p>Other developments in telecom?</p> <p>How does it allow for content development and testing?</p> <p>How will these issues be assessed realistically?</p> <ul style="list-style-type: none"> - Available infrastructure? - Institutional capacity? - Costs? - Means of finance?
Building on what has worked	<p>Does the national framework on education call for more, better teachers? If so, has the country provided teacher development at a distance?</p> <p>Does the national framework call for improving the quality of primary education? Does radio reach all schools? Has IRI been used in the past?</p> <p>Does the national framework call for expansion of tertiary education?</p> <p>Had distance education been utilized in the past?</p>
Investing in innovation	<p>How will the initiative build on local infrastructure and experience?</p> <p>Has the initiative been tested in a pilot project before scaling up?</p> <p>Has an evaluation been conducted? Is one planned?</p>
Containing costs and supporting long-term financing	<p>How will any or all of these handle front-loaded, high level fixed costs?</p> <ul style="list-style-type: none"> • Loans or grants • National budget • Student fees <p>How will recurrent costs be handled?</p> <ul style="list-style-type: none"> • External financing <ul style="list-style-type: none"> - for going to scale - for containing costs of technologies (favorable purchase policies, telecommunications connections, access to broadcasting) • Student fees
Supporting national capacity for program design and management	<p>What policies and incentives will make it attractive for high quality personnel?</p> <p>What resources, public and private, need to be mobilized to get expertise in design and management?</p>
Creating partnerships inside and outside the country	<p>Have the economies of regional cooperation been considered, too</p> <ul style="list-style-type: none"> - Maximize technical expertise? - Reduce the burden of high fixed costs? - Increase the population of learners? - Share experience? <p>Have in-country partnerships been sought with other stakeholders such as</p> <ul style="list-style-type: none"> - Telecommunications industries? - Other private sector partners?

Annex V

World Bank Groups Supporting Distance Education and ICTs

Those most relevant to the use of distance education and ICTs include:

- **The Digital Opportunities Task Force.** The Bank, in conjunction with UNDP, hosts the secretariat for this task force (known as dot force). It involves a collaboration of G8 Nations, developing countries, the private sector, and NGOs. The purpose of the dot force is to help bridge the global digital divide. Its mandate includes providing assistance in building infrastructure for ICTs and developing human capacity to make use of ICTs.
- **The Information for Development Program (InfoDev)** (<http://www.infodev.org>). This program assists knowledge sharing through policy advice and technical assistance in conducting feasibility and pre-investment studies in the area of ICT applications. It also awards grants to innovative ICT applications. Some 115 grants were awarded by the end of 2000, with 13 of them to educational activities (Vawda, 2001). InfoDev has supported a Bank study of the application of ICTs to support teacher development in developing countries, which will be available in 2001.
- **The Global Development Learning Network (GDLN).** The GDLN links clients and knowledge providers from around the world through interactive multi-site video, electronic classrooms, satellite communications, and the Internet. Some fifteen centers were in operation as of July 2000 (including seven in Africa). One hundred centers are planned by 2005.
- **The Task Force on Bridging the Digital Divide through Education** (www.worldbank.org/education/digitaldivide). The Human Development Network has a Task Force addressing the digital divide. The Task Force links the Education Network with other parts of the World Bank Group, including information technology, telecommunications, the International Finance Corporation, the World Bank Institute, and regional initiatives.
- **The Global Distance Education Network** (www.worldbank.org/disted). This is a guide to distance education, designed to help clients interested in using distance education for human development. The network has its core site in the Bank and is developing several regional sites with its partners. Each of the topics within the site contains selected articles and Web links.
- **Africa: Finance, Private Sector and Infrastructure (AFTIE).** Collaboration and operational linkages with this internal World Bank group can inform decision-making about the options in IT available for educational purposes.
- **Telecommunications and Energy Department.** This department of the World Bank helps to facilitate internal operational linkages and informed decision making in distance education and ICTs.



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In order to compete in today's global, knowledge-based economy, Africa must replace a reliance on natural resources with a flexible, educated, and healthy workforce.

But as Sub-Saharan Africa makes this transition, its greatest challenges will be in improving and expanding educational opportunity. Increasingly, solutions are being sought in distance education and information and communication technologies (ICTs) to enhance quality and access and to stimulate educational reform.

Experiences over the past decade have provided considerable knowledge about integrating distance education and ICTs into educational systems – and many countries have successfully combined organizational and pedagogical goals to create innovative educational solutions. Extensive research on distance education and ICTs indicates that many of these applications are as effective as conventional educational programs, and more cost-effective.

African countries, like countries everywhere, are hopeful about the educational possibilities offered by distance education and ICTs. Africa has had a long history of distance education and technology in education, and today, there are over 140 public and private institutions offering distance education programs in Africa.

This paper builds on the messages contained in the Africa Region's Sector Assistance Strategy—A Chance to Learn: Knowledge and Finance for Education in Sub-Saharan Africa. It examines the experience of distance education and ICTs, in Africa and some select experience from other regions. It reviews the supportive infrastructure, human resource, and organizational requirements for successful applications, as well as the costs structures, and evidence on cost-effectiveness. It concludes with advice for policy-makers and practitioners, in Africa, as they introduce or enhance use of distance education and ICTs within their educational systems. It also outlines options for how the World Bank can support client efforts and the actions needed to enable it to provide that support.

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