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**Research on
Education and Technology (1980 - 1996)
Abstracts of Publications by the World Bank**

by
Michael Potashnik
Maria Gonzales
William Mayville

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Education Group - Education and Technology Team

Research on Education and Technology (1980 - 1996)

Abstracts of Publications by the World Bank

This document provides abstracts of all major publications by the World Bank on the role of informatics and telecommunications technology in education and human development.¹ These publications were produced during the period 1980 to 1996 by World Bank staff and consultants. As these abstracts illustrate, the World Bank has made important contributions to our knowledge and understanding of informatics and telecommunications technology in education in developing countries. This has taken the form of both empirical research in case studies of country experience using technology and the development of methodological approaches to issues such as the cost analysis of implementing technologies. Bank research has assisted education officials and researchers in developing new perspectives on the issues and options for using technology to overcome the major challenges facing educational infrastructure and modernization in client countries.

These abstracts were prepared by the staff of a newly established Education and Technology Team in the Human Development Department's Education Group. The role of the new Ed Tech team is to provide leadership within and outside the World Bank on education and technology issues in developing countries. To this end, the Ed Tech team has established a research agenda for FY97 to generate new knowledge and understanding about how informatics and telecommunications technologies can help address the key issues of quality, access, and effective management in education. The Ed Tech team is also establishing an Education and Technology Learning Network within the Bank and externally with key institutions around the world to exchange knowledge and information about education and technology issues in client countries.

Abstracts of Publications

The abstracts cover four main types of research: a) case studies of distance education projects in Africa, Asia and Latin America, (b) information technology and economic development, (c) analyses of technology and its role in higher education, and (d) studies of computers and computer networks in schools.

Case Studies of Distance Education Projects. Hilary Perraton, David Hawkrige, Dean Jamison, Francois Orivel, Paud Murphy and other authors in the 1980s and early 1990s produced important case studies on distance education in developing countries. In *Alternative Routes to Formal Education* (1982), Perraton and other distance teaching specialists examine the costs and effectiveness of

school equivalency and teacher education programs in Brazil, Mauritius, Malawi, Kenya, Korea, and Israel. The results of these studies generally confirm that distance teaching for out of school students and adults offered considerable savings over more orthodox alternatives. However, the savings were only achievable in those programs that could maintain high enrollments and low teacher fixed costs. The studies also show that the most successful projects are those using a simple media such as correspondence and radio. The studies also suggest that distance education can solve problems of quantity and quality in education and serve as a valuable tool in an educational crisis.

Murphy and Zhiri (1992) edited a collection of seminar papers on the relative effectiveness and costs of distance education in secondary-education and teacher training in Africa. Some principal conclusions of the seminar were that study-center systems in most countries were generally more successful than independent study programs for secondary-education, that distance education for preparing teachers proved very effective and costs less than conventional programs, and that despite some positive experiences of using distance education in Africa to solve a variety of educational problems, policymakers, education practitioners, and parents have viewed distance education as a second-rate, second best alternative. The seminar produced a series of practical recommendations to support and extend quality distance education in Sub-Saharan Africa.

In *Education Technology: Sustainable and Effective Use*, (1991) Marlaine Lockheed, John Middleton, and Greta S. Nettleton brought together a series of excellent articles that synthesize 20 years of experience in the use of technology in different educational settings encompassing general to higher education. Most of the articles focus on experience in the use of technologies for distance education, especially radio, although attention is given to the limited applications of computers and other technologies in the classroom. A main finding is that despite evidence of effectiveness and successful applications, educational technologies are not widely adopted by developing countries due to a lack of understanding as to the "right" conditions for their sustained and effective use. The compendium offers practical advice on the right set of conditions for cost-effective and sustained use of various technologies.

¹ These abstracts are also being made available to public officials and researchers on-line through out the world on the Internet via the World Bank's Human Development Department's Home Page: <http://hco/html/hcovp/edu/contents.html>.

Information Technology and Economic Development.

Naggy K. Hanna has played a lead role in the analysis of information technology in economic development. In four World Bank Discussion Papers, published in the 1990s, Hanna provides a comprehensive examination of information technology and development from different perspectives. None of these publications is particularly concerned with education or human development however, Hanna's examination of the broader topic of information and economic development provides a context within which to understand the important role of technology in education and human development. In his first publication *The Information Technology Revolution and Economic Development*, (1991) Hanna wrote about the transformations in the industrialized economies resulting from the information technology revolution and the challenges posed for the developing countries in overcoming the "information gap". He also argued for new policies and strategies to alleviate "information poverty" in many areas, including education. In education, he called for reorienting the prevailing pedagogy to encourage and teach students to manage information as part of the learning process. In a second publication *Information Technology in World Bank Lending: Increasing the Development Impact* (1993), Hanna called attention to the dramatic growth in lending for informatics development in World Bank projects and proposed measures for enhancing institution-wide management and learning to improve the Bank's performance the benefits derived by client countries. In a 1994 publication *Exploiting Information Technology for Development*, Hanna set out to develop a national strategy for information technology development and diffusion, using India as a case study. In *The Diffusion of Information Technology*, (1995), Hanna turned his attention to analyzing the policies and strategies for information technology diffusion in the major industrialized countries and recommended lessons for the developing countries.

Education Technology in Higher Education. The role of interactive technology in higher education has been the focus of recent studies by B Boh, Michael Crawford, Tom Eisemon, and Lauritz Holm-Nielsen. B Boh in two publications *Interactive Educational Technology In Higher Education* (1994) and *Scientific Information and Literature: Production, Acquisition, Availability, Access to and Use of Scientific and Technological Information for Research in Industrialized and Developing Countries*, examines a wide range of information and telecommunications technologies and their use in higher education teaching, research, and database management. In his 1994 study, Boh summarizes research showing improved effectiveness, higher quality, increased enrollments, and cost-effectiveness of technologies when used appropriately. However, he also calls attention to obstacles in implementing interactive technologies when there are inadequate technical, administrative, financial, and political environments. Boh suggests ways to surmount these obstacles and a positive vision for the future of universities in developing countries. Crawford, Eisemon and Holm-Nielsen in *Interactive Technology and Electronic Networks in Higher Education and Research: Issues and Innovations* (1995), like Boh, argue that multi-media and network technologies when

used properly in a institutional environment favorable to innovate, have the potential to close the current gap learning and research gap between universities in developed compared to developing countries.

Computers and Computer Networks in Schools. The role of computers in primary and secondary schools in developing countries has been the focus of two articles by Michael Potashnik. In *Computers in School, Chile's Educational Network*, Potashnik presents a case study on an innovative pilot computer network project in Chile, funded under two World Bank education loans. The project, known as "Enlaces" had successfully linked some 180 primary and secondary schools in a model pilot project that offers useful lessons for the effectiveness and sustainability of technology projects. The challenges of expanding the project on national basis are also discussed. The paper includes a cost analysis of the project prepared following a methodological approach used by Potashnik and Adkins in *Cost Analysis of Information Technology Projects in Education: Experiences from Developing Countries* (1995). The aim of the latter study is to assist education policy makers and planners in analyzing the costs of programs to introduce and maintain information technologies in schools. The paper draws on actual project data from several Latin American countries to illustrate the methodology. Strategies for reducing costs and increasing projects benefits are provided in the conclusion of the paper.

Towards a New Knowledge Agenda

An increasing number of countries are seeking advice and financing from the Bank for informatics and telecommunications components of education projects. This trend can be expected to increase rapidly over the next five to ten years. Recent Bank policy statements have acknowledged the importance of educational technology and encouraged countries to experiment with cost-effective solutions. The World Bank will need to enhance its capacity to provide sound and up-to-date advice to countries on the introduction and deployment of informatics and telecommunications in education. To this end, HDD's Education and Technology Team is launching a new agenda for research and dissemination on the following topics: service delivery models for computer applications in schools; system approaches to project design; evaluation of learning outcomes from computer-assisted instruction and interactive distance learning; building effective institutional support mechanisms for planning and management of technology programs; educational software solutions drawing on developments in cognitive psychology; cost analyses of technologies used in education and training; searching for lower cost-effective technologies for use in schools; building effective teaching and learning networks among teachers and students; and use of educational technologies for training out-of-school youth and adult learners.

Michael Potashnik,
Head, Education and Technology Team
Human Development Department - Education Group

ABSTRACTS

PUBLICATIONS ON EDUCATION AND TECHNOLOGY
BY THE WORLD BANK

1. Lockheed M., Middleton J., Nettleton G. (eds), (1991). **Educational Technology: Sustainable and Effective Use**. PHREE Background Series, Doc. No. PHREE/91/32. Washington DC: The World Bank, Education and Employment Division, Population and Human Resources Department. 354 pages.

This compendium synthesizes more than 20 years of experimentation and use of educational technology into an analytical framework for assessing its cost-effectiveness and sustainability. It examines key ingredients that allow a new technology to catch on and cause teachers, students, and administrators to adopt the innovation as useful - or even indispensable - in everyday school activities. It also reviews what has been learned from accumulated experience with educational technology by surveying major areas where technology is used, including: *Educational Technology: Towards Appropriate and Sustainable Use*, by M. Lockheed and J. Middleton. *Educational Technology and the Improvement of General Education in Developing Countries*, by S. Anzalone. *Uses and Costs of Educational Technology for Distance Education in Developing Countries: A Review of the Recent Literature*, by G. Nettleton. *Uses and Costs of Educational Technology for Vocational Training: Current Research in Canada and the United States with Implications for Developing Countries*, by A. Stahmer, A. Mehler, I. Bryan and M. Richmond.

A conceptual framework then is developed for understanding how theoretical approaches to educational technology have been applied as reflected in the following case studies: *Pilot Projects on Educational Technology: The Philippines Case*, by J. Middleton. *Computer Applications in Vocational Training in Norway*, by A. Taupe. *A Comparison of Open Universities in Thailand and Indonesia*, by D. Wilson. And *Sustainability in Four Interactive Radio Projects: Bolivia, Honduras, Lesotho, Papua-New Guinea*, by T. Tilson.

Applications generally have focused on schools at the primary level. These applications are less demand- than policy-driven by government planners. Distance education has grown rapidly but tends to serve only those students who matriculate at the secondary level.

With regard to sustainability, education policy-makers still question whether technology can make a large-scale contribution to improving educational effectiveness. The greatest suc-

cess has been in the improvement of textbook distribution. In distance education, the use of technology is essential, and technologies used successfully have been diverse, ranging from books to television. Use of technology in vocational training only recently has been attempted in developing countries, so it is still too early to predict educational outcomes.

Finally, the authors believe that the right conditions for cost-effective and sustainable use of educational technologies are straightforward: there must be a fit between the objective sought and the pedagogical capacity and cost-effectiveness of the technology chosen. Barriers to implementation must be identified, and the effective strategy for implementing change must be developed. The challenge for planners is to synchronize all the appropriate conditions and inputs.

2. Boh, B. (1994). **Interactive Educational Technology in Higher Education**. ESP Discussion Paper Series, Doc. No. 46. Washington DC: The World Bank, Education and Social Policy Department, Human Resources Development and Operations Policy. 76 pages.

This paper discusses the status of interactive technologies in higher education programs and provides recommendations for their use in both on-campus and distance learning courses. Two main types of educational technologies are reviewed: (i) computer-mediated instructional technologies that are individual, free-standing units, of which multimedia technology is the fastest growing; and (ii) technologies based on telecommunication networks. These provide asynchronous communication (e.g., electronic mail, computer bulletin boards) or synchronous, real-time instruction (audioconferencing, audiographics, interactive one-way television with audio-return, and interactive two-way and multipoint television). Possible uses of these technologies are illustrated and include those which improve the effectiveness of education, increase efficiency through lower-cost alternatives to conventional instruction, extend access to geographically, economically, or socially isolated learners, as well as technologies that produce graduates with heightened capacity to adapt to technological change and innovation.

Potential problems and obstacles to implementation are also identified, including those that stem from inadequate technological, educational, economic, administrative, and cultural

environments. Finally, suggestions and recommendations are given for successful implementation and long-term sustainability of interactive technological systems at universities and colleges in industrial and developing countries. Among them: (i) to improve the technological environment, technical support and expertise should be available, maintenance and upgrading provided and hardware and software user-friendly; (ii) to improve the educational environment, planning and implementation of technology should begin with a clear educational goal, cooperation among all parties involved, and faculty and staff trained in the early stages of the technology-based innovations, with selection of technology depending on the discipline to be taught, the degree of interactivity required, and the learner audience characteristics; (iii) to improve the economic environment, stable financing is needed with a careful attention given to cost-effectiveness.

3. Boh, B. (1994). **Scientific Information and Literature: Production, Acquisition, Availability, Access to and Use of Scientific and Technological Information for Research in Industrialized and Developing Countries.** ESP Discussion Paper Series, Doc. No. 43. Washington DC: The World Bank, Education and Social Policy Department, Human Resources Development and Operations Policy. 56 pages.

The paper discusses the proliferation of scientific and technological publications and computerized data bases, and resulting challenges and opportunities for individual scientists, researchers, scientific communities, and nations. Trends in the literature are reviewed from sources such as scientific journals, books and patents, and computer-supported data bases accessible either on-line, via CD-ROM, or by personal computers.

Strategies are proposed for the acquisition of scientific and technological information, with methodologies delineated for its transfer into research and education.

The information and communication differences between industrial and developing countries are identified, and the main obstacles hindering the exchange, transfer, and use of scientific and technological (S&T) information discussed. In light of problems identified, recommendations are given for priority actions and programs to develop/improve the acquisition and use of scientific literature, data bases, and information services, as well as to promote the transfer of this knowledge into research, education, and development. The following actions are prescribed: (i) define information needs, (ii) establish reliable technical environments, (iii) assure stable funding, (iv) improve the coordination of activities among local/ national/ bilateral/ multilateral institutions, (v) include local scientists and information specialists, (vi) provide training and related assistance, (vii) organize S&T information networks among

individuals/institutions, (viii) provide pre-service training and continuous in-service education in S&T, (ix) assure transfer of "know-how," and (x) remove rigid bureaucratic procedures that keep S&T applications from taking place.

4. Crawford, M., Eisemon T., Holm-Nielsen, L. (1995). **Interactive Technology and Electronic Networks in Higher Education and Research: Issues and Innovations.** HCO Working Papers, Doc. No.HCOWP 62. Washington DC: World Bank, Human Capital Development and Operations Policy. 20 pages.

Interactive technology facilitates ways of processing and sharing information. The expanded potential of the new machines allows them to gather and present information in several media at speeds that keep pace with normal learning attention spans. They have the potential to increase educational effectiveness and efficiency by offering students on-demand access to numerous services and overcoming geographic and other barriers to using educational resources.

Interactive educational applications are considered a logical outgrowth of advances in three key areas: (i) processing and storage capacity; (ii) the ability to maintain and transmit with clarity the data signals among the components of individual machines and network nodes; and (iii) the compatibility of systems from different manufacturers. These conditions are increasingly commonplace in advanced industrial countries that have sophisticated technological infrastructures and qualified technicians. Universities and researchers were the first to incorporate interactive technology and electronic networks into their workplace by devising ways for computers to assist learning, classroom management, and information sharing. Successful use in education is characterized by significant attention to curriculum design early in the innovation process.

Innovators usually possess a high degree of expertise in their respective fields and are motivated by a desire for increased prestige. Institutional structures that reward time spent in technological pursuits with peer recognition or professional advancement aid the development of interactive applications. Successful projects provide ample assistance to end-users in traditional or easy-to-use formats, such as telephone "help-lines" or help-desks manned by technicians. Success depends on the familiarity and comfort of students and administrators with the technology employed.

The use of sophisticated technology is thus conditioned by considerations unrelated to the potential of the hardware and software. These considerations often mean that the most basic services of high-performance computers receive the greatest use, especially in the initial phases.

Strategies for successful deployment should consider pedagogy and the various factors that influence use when considering the technical capabilities of interactive modes using computers.

5. Courier, K. (ed.) (1981). **The Educational Use of Mass Media**. Staff Working Paper, Doc. No. 491. Washington DC : World Bank. Education Department, Central Projects Staff. 125 pages.

This volume is composed of an introduction and seven chapters, all of which pertain to the educational use of mass media in Less-Developed Countries (LDCs). Each chapter focuses on one of the salient issues that LDC educators and decision-makers inevitably encounter when they think about using mass media to further a country's education and development. Issues include: (i) the potential use of audiovisual media; (ii) the choice between network and local broadcasting or some combination; (iii) the use of educational media for curricular improvement; (iv) the impact of radio on education and development; (v) the choice of language(s) for instruction and radio's role in language teaching; (vi) the possible expansion of educational TV in the 1980s; and (vii) the appropriateness of each media for use in LDCs. The original contributions were revised and abridged.

The chapters are: Jenkins, J. *Do Audiovisual Media possess Unique Teaching Capabilities?* Futagami, S.; Feliciano, G.; Hancock, A. *Nationwide Networking or Local Broadcasting*. Sakamoto, T. *Can Mass Media be Effective in Curriculum Improvement?* Perraton, H. *How can Radio be Usefully applied to Education and Development?* Lambert, W., Sidoti, N. *Choosing Instructional Languages for Educational Radio Broadcasts in Less-Developed Countries*. Horley, A. *What does Educational Television Offer us Now?*. Tifflin, J. *Selecting Appropriate Media*. The original contributions were revised and abridged.

Conclusions are that: (i) local broadcasting can contribute greatly to a country's sense of nationhood, and broadcasting facilities may well be within the economic reach of most LDCs; (ii) audiovisual media enable countries with a teacher shortage to reach greater numbers of students, train teachers, introduce new curricula immediately, and bring high-quality education to marginal communities that often are the last to benefit from the expansion of conventional education; (iii) a project is more likely to succeed when the planning initiative is local, a surplus of qualified applicants exists, and distance learning institutions are autonomous and linked to national and international networks.

6. Dahlman, C. (1995). **Technology, Development and the Role of the World Bank**. World Bank Working Papers, Doc. No.

53. Washington DC. World Bank, Human Resources Development and Operations Policy. 17 pages.

Knowledge and information are increasingly becoming the key factors of production and exchange, and this has major implications for developing countries and for such international development institutions as the World Bank. Technological innovations are so numerous and radical that they are deeply affecting competition, social organizations, institutions, materials and even life itself. Driving this rapid change are dramatic improvements in information and telecommunication technology, aided by advances in the tools of scientific inquiry and in the codification of knowledge. The most immediate consequence of these developments is to increase the speed of production and product development. This in turn is leading to a revolution in business practices. Time and speed are now more central to competitive success, providing an advantage to producers with the best links to the markets and the greatest flexibility. In addition, the continuing rapid decline in the costs of transporting information and goods due to advances in telecommunications and the use of information technology have led to the growing irrelevance of the boundaries of geography and even of time, unifying national economies in a fast-moving highly interdependent world economy. This paper explores whether the quickly changing, highly technical global economy presents a threat or an opportunity to developing countries. It discusses how developing countries acquire technology and how they can make effective use of technological innovations. It concludes with an overview of what role the World Bank has in supporting its clients in their attempts to create and nurture a climate conducive to acquiring and developing technology.

7. Hanna, N. (1991). **The Information Technology Revolution and Economic Development**. World Bank Discussion Papers, Doc. No. 120. Washington DC: World Bank, Information, Technology and Facilities Department. 57 pages.

Information is a major development resource, along with human, natural, and financial resources. Therefore, development agencies must understand the role of information and information technologies (informatics) in developing countries to respond to a rapidly-evolving global environment. The ongoing information explosion in industrialized economies contrasts sharply with the information "poverty" of developing countries. This poverty takes many forms, including poor information support for macroeconomic and sectorial policy formulation and implementation, limited access to information for rural populations, and isolation of researchers and professionals from international research findings.

Informatics applications offer new ways to capitalize on the managerial and institutional resources of developing countries,

with the most widespread benefits likely to accrue from applying them in priority sectors. Governments increasingly recognize their role as information providers and users, facilitators of information technology diffusion, and providers of information and communication infrastructures, as well as their role in setting informatics policies. During the 1990s the impact of information technology is felt increasingly. The author suggests that countries at all levels of development must keep pace with the information revolution and cannot afford to fall behind.

8. Hanna, N., Boyson, S. (1993). **Information Technology in World Bank Lending: Increasing the Developmental Impact.** World Bank Discussion Papers, Doc. No. 206. Washington DC: World Bank, Information, Technology and Facilities Department. 104 pages.

The Bank has emerged as a major institutional investor in information technology applications in developing countries, as information technology transforms industries, services, and jobs. Currently, almost 90 percent of Bank lending operations contain information systems components. This study examines the increasing trend in Bank lending for information technology applications. It was prepared in response to a need to evaluate formally the effectiveness of technology lending and measure its impact. The study uses qualitative and quantitative data, and should be viewed as exploratory research or as a progress report since the field is developing continuously.

The study found dramatic returns on investment in information technology applications, most notably in large automation projects. However, the Bank has not been proactive in this area. As a result, information systems components are spread over many projects; are often improvised, narrowly drawn, and isolated from one another; and few staff know of the Bank's involvement in information technology applications. The study recommends solutions to both the reactive nature of the Bank's lending policy and methods of measuring the impact of information technology.

9. Hanna, N. (1994). **Exploiting Information Technology for Development.** Bank Discussion Papers, Doc. No. 246. Washington DC: World Bank, Information, Technology and Facilities Department. 121 pages.

This paper proposes a framework for developing a national strategy for information technology development and diffusion in support of economy-wide competitiveness. Focus is on India, a developing economy with substantial promise to become a global player in software services. It is also a country where timely information is scarce and transaction costs high, thus providing a developmental context for demonstrating the strategic impact of this technology. The study first analyzes

the information and communication needs of India's economy and the constraints to a dynamic domestic market for information and software services. The competitiveness of the country's hardware and software industries is assessed. Translating the potential of informational technology into effective demand and successful application requires concerted action by both public and private sectors to develop policies, institutions, investments, and capacities. The study outlines the rationale for a coherent, long-term strategy for information technology tailored to enhance India's competitiveness and exports. The main elements are: (i) measures to mobilize demand in the private sector and target strategic applications for public sector modernization; (ii) programs to strengthen software industry capabilities and export networks; and (iii) policy and infrastructural measures to strengthen both supply and demand and lay the foundation for sustained development.

Various options are proposed in support of each element of the strategy. The respective roles of government and the private sector are explored. The argument is put forward that national information technology strategies could provide a coherent framework to exploit synergies and develop collaborative actions, and that governments can play key roles as catalysts, regulators, investors, users, and strategists.

10. Hanna, N., Guy, K., Arnold, E. (1995). **The Diffusion of Information Technology.** Bank Discussion Papers, Doc. No. 281. Washington DC: World Bank, Information, Technology and Facilities Department. 207 pages.

This study reports on the experience of Canada, Germany, Ireland, the Netherlands, Sweden, the United Kingdom, the United States, and Japan in designing, implementing, and adapting information technology diffusion programs over the last decade. The study examines the determinants of effective information technology diffusion and analyzes the national information technology policy portfolios to draw lessons and trends. In particular, industrial countries have shifted their emphasis since the late 1980s towards diffusion and aiding small and medium scale enterprises to adopt already-available information technology guidelines for designing information technology diffusion programs for maximum impact.

Programs should consider technology life-cycles, the business needs of potential users, technological sophistication, and current exposure to international best practices. The study concludes by suggesting roles for governments, the private sector, and aid agencies to accelerate the benefits of information technology diffusion for development.

11. Hawkrige, D. (1987). **General Operational Review of Distance Education.** EDT Discussion Paper No. 68. Washington DC: World Bank, Education and Training Department, Op-

erations Policy Staff. 15 pages.

This study reviews Bank investments between FY63 and FY85 in 32 distance education projects. Distance education is an educational delivery mode that uses a variety of media and a feedback system to provide education to those unable to attend traditional schools. Lessons learned indicate that investments in distance education are most effective when there is agreement between the Bank and the Borrower on the educational objectives of the distance education component. Distance education has been used to advantage when it is: (i) sharply focused on improving the quality of teaching available; (ii) used to teach nonformal "equivalency" education to students otherwise without teachers or classrooms; and (iii) used to meet social demands and urgent needs for formation of human capital.

12. Murphy, P., Zhiri, A. (eds.) (1992). **Distance Education in Anglophone Africa: Experience with Secondary Education and Teacher Training**. EDI Policy Case Series, Analytical Case Studies. Doc. No. 9. Washington DC: World Bank, Economic Development Institute. 147 pages.

This book consists of papers presented at a seminar for senior policy-makers held in Zimbabwe between May 7 and 11, 1990. The seminar focused on distance education as an alternative to traditional secondary education and current practices in teacher training in Africa. World trends in distance education at the secondary level are reviewed including current use of and effectiveness of distance education systems in Africa, and options for improving distance education systems. The greatest educational challenge facing African countries is how to design a system or a learning package that both meets individual country's priorities and maximizes learning in a cost-effective way using the resources available. In this regard, distance education could make an important contribution in many African countries combining radio and correspondence techniques. Unfortunately many Africans regard nonformal venues of secondary schooling as a second rate education, especially distance education, which is geared to provide a second chance to those who dropped out or who were forced out of school for economic reasons.

Distance education in Africa should be closely aligned to national educational policies, and whenever possible integrated into the national system of education so that it gains more legitimacy as an acceptable alternative.

13. Muskin, J. (1992). **World Bank Lending for Science and Technology: General Operational Review**. PHREE Background Paper Series. Doc. No. PHREE/92/51R. Washington DC: World Bank, Economic and Development Division, Population and Human Resources Department. 108 pages.

The World Bank has increased greatly its involvement in the area of science and technology (S&T) over the past 10 years. This paper reviews and evaluates the Bank's S&T activities, particularly in the areas of higher education, industry and technology, and energy and infrastructure. Focus is on regional differences in lending for goals and objectives, common project components, and criteria for sector and project evaluation. The main conclusions suggest the need to increase the links between teaching, research and industry, the crucial role of access to information, the urgent need to increase incentives for both institutions and individuals involved in science and technology fields, and the importance of initiating formal dialogue within the World Bank concerning science and technology issues and priorities.

14. Perraton, H. (1982). **Alternative Routes to Formal Education: Distance Teaching for School Equivalency**. Washington DC: A World Bank Research Publication. 329 pages.

This book focuses on experience with distance teaching for formal education, its use to provide "equivalency" to formal school courses for individuals who, because of age, work commitments, lack of school places, or geographical location, are unable to attend regular schools. The first part of the book is on the scope of distance teaching and summarizes the chapters that follow. The book then concentrates on case studies of in-school equivalency programs at the secondary level, including two projects in Brazil, the Malawi Correspondence College, and the Mauritius College of the Air. Next, case studies of out-of-school equivalency programs are provided, including projects from Korea, Kenya and Israel, which offer courses in the context of secondary, university, and teacher training education. The final section reviews cost-effectiveness in the case studies and attempts to draw lessons useful for educational planners. The volume includes three appendices: a description of the methods of cost analysis used, a summary of information on alternative media for distance teaching, and an evaluation of a unique, privately-operated distance teaching system in Brazil.

15. Perraton, H. (1986). **Distance Education: An Economic and Educational Assessment of its Potential for Africa**. Education and Training Series Discussion Paper. Doc. No. EDT43. Washington DC: World Bank, Education and Training Department, Operations Policy Staff. 38 pages.

Distance education encompasses correspondence courses, open universities, and education in-school and out-of-school based on broadcasting by radio or television. It is defined as an educational process in which a significant proportion of teaching is conducted by someone removed in space and/or time from the learner. Within Africa, it has been used for teacher training, and for primary, secondary, and tertiary education. Many

African countries have offered in-service training to teachers using correspondence courses. In primary education, the most important application of distance-teaching techniques has been interactive radio, where radio is used for direct classroom teaching. At both secondary and tertiary levels, "equivalence" courses were developed offering an alternative route to formal qualifications for students outside school or college. Cost data are presented on all these applications, showing a reduction in costs at all levels. It is argued that the potential of distance education to increase access to education and reduce costs justifies further investment alongside other strategies for education development in Africa.

16. Potashnik, M., Adkins, D. (1996). **Cost Analysis of Information Technology Projects in Education: Experiences from Developing Countries.** Washington DC: World Bank, Latin America Country Department III, Human Resources Division. 31 pages.

This study is meant to assist education policymakers and planners in analyzing the cost of programs to introduce and maintain information technologies in schools. The study has three main sections. The first section discusses instructional uses and inputs of information technology programs in the primary and secondary schools of several Latin American and Caribbean countries including Belize, Chile, Costa Rica, Jamaica, and Mexico. In the second, the methodology used to calculate costs and assess the financial feasibility of proposed investments in information technology is reviewed. This section also provides data on the costs of selected information technology programs in Latin America. In the final section recommendations focus on how to reduce the costs and increase the benefits of proposed information technology programs.

17. Potashnik, M. (1996) **Chile's Learning Network.** In press. Washington DC: World Bank, Latin America Country Department III, Human Resources Division. 29 pages.

This study examines the Enlaces project and the role of Chile's learning network in the framework of the country's overall educational reform agenda for primary and secondary education. The study examines issues related to the design and implementation of networks drawing on the Chilean experience. These include: How should the objectives of learning networks be defined? What are effective strategies for their implementation? What type of training and technical assistance is required? What kind of monitoring and evaluation studies might be undertaken to assess the progress and impact of the network? What are the investments and recurrent costs of a network, and Are such networks affordable at the size and scale contemplated? The study also reviews the many challenges facing Enlaces in the years ahead as it moves from a pilot experimental project to a national program. The concluding sec-

tion draws some lessons from the Chilean experience that could be helpful to other countries in defining the role of the Internet and its linkage to classroom-based education in the coming years.

18. Zijp, W.(1994). **Improving the Transfer and Use of Agricultural Information. A Guide to Information Technology.** World Bank Discussion Paper, Doc. No. 247. Washington DC: World Bank. Agriculture and Natural Resources Department. 105 pages.

Investment in Information Technology (IT) generally has been in urban areas of industrial countries, despite the potential for cost-effective applications of IT in rural areas in developing countries. The benefits of IT in agriculture are summarized: reduced costs, increased storage, ease of use, speed, and access. Limitations include the need for complementary inputs, organizational change, improved information management, skills development, local involvement, policy changes, and removing social barriers. Examples are given of how IT can be used to make rural development better, cheaper and faster for beneficiaries, borrowers, and Bank staff. A number of simple, practical suggestions are given for achieving incremental benefits from IT applications. More comprehensive changes are proposed to achieve the full potential of IT, including a cross-suctorial approach to rural development, a more realistic model of technology transfer, and support for empowering the poor. The paper concludes with a number of next steps, including the need to increase awareness of and skills in IT and increasing targeted investments.

Ten annexes focus on various information technologies, that provide task managers with notions of what technology is available, its cost, advantages and disadvantages, and requirements to make it work.