PN-ABE-830
ISN 59943

PERSPECTIVES ON THE USES OF EDUCATIONAL TECHNOLOGY FOR BASIC EDUCATION IN DEVELOPING COUNTRIES

Recommendations of the
AID Research Advisory Committee To A.I.D.

MEETING OF JUNE 23-24, 1988

Office of Research and University Relations
Bureau for Science and Technology
Agency for International Development
Washington, D.C. 20523

/1/

USE OF EDUCATIONAL TECHNOLOGIES IN BASIC EDUCATION

Report from the A.I.D. Research Advisory Committee

The Research Advisory Committee (RAC) based its discussion of educational technologies in basic education on a report by a specialized panel entitled, "Perspectives on the Use of Educational Technologies in Basic Education in Developing Countries." The panel, which was organized by the Board on Science and Technology for International Development (BOSTID) of the National Research Council, met on May 19,1988 to examine several issues of educational technologies for basic education, and develop a discussion document for the June 23-24 meeting of RAC.

The following themes, which were taken from the executive summary of the Panel's report and which appeared in issues papers prepared by A.I.D. staff, were discussed by the panel and by RAC:

1. The instructional effectiveness and institutional and economic feasability of learning technologies, including computers and broadcast media, in grades 1-9 (basic education).

2. The role of technologies in the analysis, management, and evaluation of educational systems in developing countries.

3. The effectiveness and feasability of "soft" technologies, including textbooks, peer tutoring, and training methodologies, as compared with "hard" technologies.

4. Identification of areas in learning theory, cognition, or educational innovation where A.I.D. should initiate R&D.

Other items were mentioned in issues papers but were not addressed in detail by the panel or by the RAC, including (a) rationalizing priorities of technology in basic education vs. technology in secondary, vocational, adult, or distance education; (b) clarifying the interaction and relationships of the educational needs of young children with their other developmental, nutritional, and health-related needs; (c) overall educational assistance strategies and tactics.

The RAC accepts and endorses the report of the panel. RAC supports the following findings and conclusions from the report, adding a sixth item:

1. Radio. Interactive radio works well and is cost-effective as a classroom technology for mathematics and second language instruction in the early grades. Dissemination of existing radio curricular should continue with the goal of reaching many more students. Although interactive radio is not equally effective for all subjects and age groups, further R&D on other promising appropriate uses of this broadcast medium should be supported.

2. Management Tools: Management information technology can help planners and policy makers understand educational systems as complex wholes. The BRIDGES (Basic Research and Implementation in Developing Education Systems) and IEES (Improving Efficiency of Education Systems) projects already include decision support components. These experiments should be scrutinized for shortcomings in an ongoing process of debugging and refining decision support systems suitable for educational planning and policy-making in developing countries. Analogies with educational assistance methods in the U.S. are relevant and should be investigated in detail.

3. Participatory Development: Participation of host country personnel from beginning to end and at every level is absolutely essential in any educational assistance program. A goal of an educational technology project should be to create a cadre of technically proficient host-country citizens who can not only sustain and extend a workable project, but also create or implement new ones. It is through skilled human resources that effective projects get leverage and become widely disseminable. How to develop host country human resources effectively on large scales is a research problem for A.I.D. in all programs, not just education or educational technology.

4. Computer-Based Instructional Technologies: Individualized computer-assisted instruction in mathematics and reading is successful on a large scale in several different instances in primary education in the U.S. Research on the feasability of rugged, inexpensive delivery hardware for this existing software, with suitable concern for cultural and linguistic differences, should be undertaken.

5. Other Instructional Technologies: Established non-computational classroom technologies such as books and science kits are effective but often lacking in LDC's. Development projects to increase the usability and to further decrease the costs of textbooks should be undertaken. Computer-based publishing, for example, holds promise as a technology that could reduce costs of providing regional, national or local editions of textbooks or other printed materials used in the classroom.

6. Advanced Technologies: Emerging high-density information packing technologies (optical disks, vertical magnetic recording, etc.) possibly coupled with satellite transmission offer growing opportunities for reaching large and remote populations at potentially very low costs per person. The television set is increasingly important in villages as a visual education center, with the complex tasks of software development and management of high-technology equipment handled from outside. Such technologies could be used for addressing knowledge needs for health, hygiene, farming, child-care, etc. as well as supporting the fundamentals of basic education. RAC recommends selected investments in research and pilot projects to evaluate these new technologies so that when and as they become cost-effective, A.I.D. and LDC's are prepared to realized their benefits and opportunities. We recognize that this will mean some otherwise feasible projects with current technology will go unfunded. However, we feel that the potential future stream of benefits flowing from new technologies more than offsets the immediate losses. The experience with "current" technologies demonstrates that many benefits of a new technology are rarely understood until they are applied and observed.

The RAC notes additionally that the area of improving performance of educational systems and utilizing new educational technologies is one where there is great commonality of problems and experience in the U.S. and LDC's. There is significant opportunity for mutually beneficial experimentation and learning in this area. USAID's program of research on developing educational capabilities and technologies should draw from and feed back to similar experimentation and learning in the U.S.

The RAC finds reason to be supportive of the current and projected programs of the Office of Education in the Bureau of Science and Technology and would like to see work on basic education expanded within the limits of available resources. Preferably, it can be given additional support based on the crucial role of basic education in any country's national development.

The panel's report, minus the executive summary (Pages 1 & 2), is attached. The executive summary has been incorporated into the foregoing.

PERSPECTIVES ON THE USES OF EDUCATIONAL TECHNOLOGY FOR BASIC EDUCATION IN DEVELOPING COUNTRIES

Comments for the
AID Research Advisory Committee Meeting of
June 23-24, 1988

Prepared by a Panel of the Board on Science and Technology
for International Development
Office of International Affairs
National Research Council
Washington, D.C. 20418

Sponsor
Office of Research and University Relations
Bureau for Science and Technology
Agency for International Development
Washington, D.C. 20523
Contract No: DAN-5052-0-00-6037
June 10, 1988

5

INTRODUCTION

This report is based on a one-day BOSTID panel meeting on educational technologies in developing countries held May 19, 1988 at the National Research Council (NRC) in Washington D.C. The purpose of the report is to provide input to the Research Advisory Committee of AID which is charged with advising AID on its overall research agenda, of which research on education and educational technologies is a part.

The topic of how best to use educational technology in developing countries is especially complex because of the various educational levels, student populations, and cultural settings that exist worldwide. It is an elusive topic because the operative definition of "technology" in the educational assistance community is a spectrum, including raw paper on the one extreme and specialized microcomputer laboratories on the other. The panel deliberately limited itself to consideration of basic education (grades 1 through 9) and focused on computer technologies as applied to basic education. The reasons for this focus are:

1. AID has been directed to increase its assistance activities in the area of basic education.

2. Computer technology will inevitably affect education in LDCs. Computational devices hold promise for increasing productivity and changing the modalities of providing basic education. Some countries like Egypt and Peru are already embarked on a computer acquisition program for their schools. But AID does not now have an R&D emphasis on instructional computing at any educational level.

Focusing on one technology for basic education had advantages: First, coverage of all educational technologies at any level of education is not possible in one day. Anzalone (1988), however, has carefully surveyed the literature on the use of instructional hardware for primary education in LDCs, and that paper is essential background for the present report. Second, some participants were deeply skeptical of instructional computing as such; but by making a case for non-computational technologies, their views added balance and depth. Finally, the effectiveness of AID ED/S&T resides in its knowledge of educational systems and its practical expertise in understanding how to improve them. The terms of reference and the panel's findings identify specific areas where knowledge needs to be acquired and other areas where it can be used more effectively.

THE PROCESS OF EDUCATIONAL INNOVATION IN DEVELOPING COUNTRIES

It is helpful to summarize the panel's view of how technology-based educational innovations occur in developing countries. The long term, highly successful AID interactive radio mathematics projects provide valuable working models of how to design, develop, and disseminate innovative educational technologies in LDCs. Aspects of the radio

projects serve as concrete points of reference for the following observations about the complex and lengthy process of educational innovation in general and innovative educational technologies in particular.

Systems-Oriented Needs Analysis. Successful educational R&D projects require shrewd and accurate needs analyses based on knowledge of how education works as a system and how it is positioned as a cultural, political, and economic entity in a particular host country or region. Projects require persistence and patience throughout the development process. If a project is a success at the end of the demonstration and proof-of-concept phases, dissemination and replication can yet introduce new complexities and problems.

Participatory Project Design. It has been repeatedly demonstrated that a critical component of successful projects is the participation of a core of host-country personnel in decision-making, policy-setting and operational leadership over the entire life-cycle of a project. Whether the technology is computers, radio or textbooks, host-country involvement leading to local expertise and long-term leadership is critically important.

Practical Effectiveness Based on Theoretical Foundations. Beyond careful project design and participatory development, R&D involving educational technologies must be based on established, well-understood and practical learning theories, and be directed toward essential components of the school curriculum where technological innovation can increase effectiveness, improve quality, decrease costs, or allow resource reallocation. The challenge of research on educational technologies for developing countries is to formulate a research program that not only advances knowledge but also has real payoffs on the educational frontlines.

Long-Term Dissemination Strategies. Educational systems of LDCs are inherently difficult to change, so innovations are unlikely to spread rapidly. Accordingly, if an innovation requires specialized technology, successful dissemination over the long run requires a robust and stable technology and established, permanent educational content. The interactive radio mathematics project has been active for more than 15 years. Dissemination of its curriculum and instructional method continue to be undertaken more than a decade after its intial use in Nicaragua. For a survivable, disseminable educational technology for LDCs, both medium and message must withstand a test of time on the order of at least two decades.

These criteria are not easily satisfied, but they reflect concerns of the panel about helter-skelter acquisitions or uncritical infatuations with new technologies (e.g., interactive television or computer conferencing). It is entirely appropriate to examine possible technological innovations in developing countries with healthy skepticism. Given the broad working definition of technologies, some would advocate a measured skepticism: textbooks are less problematic than computers. Any maladapted technology--a religiously offensive textbook, a radio overly sensitive to humidity, a fragile computer in a primitive school, or a

snowmobile for Egypt--seems to support this skepticism. On the other hand, technologies will be a dominant feature of the foreseeable future; they hold some promise and offer great challenges, not the least of which is the management of technological innovation. But the management of innovation is not the same as control of it, as a look at the computer revolution shows.

The Computer Revolution. An important fact about the spread of computers in U.S. education is that it has occurred largely without systematic planning. It has been driven by private and corporate consumers in a wealthy society already eager for, accustomed to, and proud of high technology. Schools have frequently benefitted from corporate equipment gifts, and there are several examples of thoroughgoing computer-based learning systems for the primary grades that are demonstrably effective and commercially viable. But in education, some planned computer innovations appear to have been counterproductive. To take just one example from the U.S. experience, Lockheed & Mandinach (1986) argue that centrally planned but poorly taught computer literacy classes are connected with decreasing interest in computer science among high school graduates. They suggest that the emphasis of these courses might better have been the use of applications programs instead of programming as such.

The experience of other countries with educational computing has varied from highly prescribed national hardware, software, and curriculum reform efforts to simply placing microcomputers in schools. More developed countries see educational computing as essential to maintaining competitiveness in an increasingly technological society, while less developed countries frequently add to that perception a strongly felt need not to be excluded or left behind.

Computer marketing strategies and software design are consumer--oriented, and since 1975 at least four generations of personal systems have passed by. In the same period we have seen only one generation of interactive radio appear, mature and begin to be widely disseminated. The time scale of the consumer model, and probably off-the-shelf consumer products themselves, are inappropriate for educational applications in developing countries. The price is too high; the pace of change is too fast; and the applicability to primary education is not direct. This panel expressed reservations about expending R&D or direct assistance on computers as such. In a word, the view of the panel was that AID ED/S&T should not finance the computer revolution.

A Strategic View. The panel, however, agreed that AID ED/S&T should pursue R&D on specialized interactive technologies that do individualized instruction in mathematics or reading and are embedded in rugged, inexpensive, battery or solar-powered portable hardware.

This specific recommendation is responsive to a general theme: that it is timely for AID to take a strategic view of how to satisfy the demand for basic education in the circumstance of continued strong population growth in Africa, Asia, and South America.

Learning gains for all kinds of children have been demonstrated in the U.S. using computer-managed drill and practice programs in reading and mathematics, developed and refined over a period of 25 years. These programs work because the instruction is individualized and interactive. It is individualized both in the sense that students get immediate, personal feedback and in the sense that it is possible to design individualized regimens to reach a given learning objective. It is efficient in the sense that engaged time-on-task is increased while allocated classroom time can be reduced, and dependence on highly variable teacher knowledge and skills is decreased.

One problem of developing countries is that inadequately trained classroom teachers produce a successor generation of inadequately trained classroom teachers. Another problem in these countries is that adequately trained classroom teachers possess skills greatly in demand in other sectors of the society. The skilled classroom teacher is the resource in shortest supply in the basic education process.

With carefully prepared curriculum, a device for individualized teaching of basic skills could serve as an educational prosthesis in many underdeveloped and developing countries for the remainder of the century. In line with the panel's emphasis on the requirement of participatory development, the curriculum should be jointly prepared with experts from the major language, cultural, and national groups so suitable variations of the curriculum are considered. AID's and other donors' experience in the social factors influencing the adoption and use of educatioanl innovations in LDCs should be a critical factor in all aspects of the design, appearance and dissemination strategy for the device.

Like interactive radio instruction, the use of computational devices for drill-and-practice in the primary grades improves learning and provides partial insurance against deterioration of instructional quality. And each has desirable side-effects simply by its presence in the schools: The regularity of instructional radio broadcasts helps organize the school day. The methods and content of either radio or computer-based instruction, while directed to pupils, also will teach the teachers. Computer-managed learning brings students to concrete achievement levels and provides an atmosphere of success for individual pupils and a school as a whole.

It must be emphasized that the relevance and strength of computer--based learning is not derived as much from characteristics of the hardware as from applications of learning theory associated with the development of computer-managed instruction. In particular, it has been found that present performance not only measures achievement, but also predicts progress. Successful, individualized instructional regimens can therefore be constructed to reach common learning targets. These methods are proven for basic skills in arithmetic, reading, spelling, and grammar. Curricula based on theories of this type exist, and in several instances have become long-term commerical successes in the U.S.

9'

As a technology-based innovation, computer-managed instruction has many similarities to radio. It is dissimilar in one respect: The radio project invented a curriculum that worked for radio delivery; but it did not invent the radio. The problem with classroom computing in LDCs is that while we have the curriculum, (as software per se, these curricula are not complicated), we lack inexpensive, specialized devices that will be reliable and practical in the countries of interest for a decade or more. It is generally agreed that the general-purpose microcomputer or workstation is too vulnerable in the circumstances and too expensive in the quantities required to be effective at the basic education level.

Participants in this panel, on the whole, agreed that computer-based methods work at the basic education level, and other things being equal, agreed that LDC's would benefit by access to such technologies in basic education. The problem is that in LDC's other things are profoundly not equal. The essence of this recommendation is to take proven curriculum, reduce it to inexpensive, specialized, reliable hardware, and try to break that impasse. This strategy takes advantage of a large U.S. R&D investment of many tens of millions of dollars in curricula developed and refined through trial and error over a period of 25 years.

NON-COMPUTATIONAL TECHNOLOGIES FOR THE CLASSROOM

As mentioned earlier, the operative definition of "educational technology" for the panel was a spectrum including paper and textbooks on the one hand to computers and computer laboratories on the other. While the breadth of this definition would not fully accord with Webster, where technology means applied science (the introduction of textbooks seems more like applying common sense), in LDCs textbooks and regular use of paper to prepare homework or classwork are innovations in the educational systems. In LDCs, the threshold of innovation is different, and the management of innovation difficult, regardless of what the innovation is.

The World Bank has studied the effectiveness of textbooks extensively and supported introduction of textbooks and other low-tech classroom materials. Some panel members explicitly argued that when measured by cost-per-student and by expected educational effects, books and paper--the basic technologies of literacy--make more sense than high-tech innovations. Likewise, supplementing the basic education classrooms with libraries makes sense. But, when the participatory aspects of dissemination are folded into even a low-tech, self-evident project such as books or libraries, managing and sustaining the innovation is non-trivial. Books have to be preserved or replaced from year to year. Education in the abstract may be desirable to parents, but if parents pay for teaching materials, books and libraries have to fit into their extremely limited spending plans. Parents may endorse spending their time to build, maintain or repair a school facility or make other capital investments; they may not endorse spending their money for books or other operating costs.

It is for reasons such as the above that the panel felt that all assistance projects must understand "how the system works" and involve host country citizens from the start in appropriate ways. Translated into an R&D recommendation, this means that project evaluations must not just focus on achievement or performance of students under controlled conditions, but also carefully study why the project was liked or disliked, joined or ignored by local citizens. Evaluations of education projects should try to identify replicable project components that foster educational leadership among host-country participants. Furthermore, understanding the strengths and limitations of the process of participatory innovation and development in other sectors such as health, nutrition and agriculture should help make it work in education.

NON-INSTRUCTIONAL COMPUTER TECHNOLOGIES

Planning Models. The use of computer-based tools for planning, forecasting, and decision-support is one way of coming to understand "how the system works." Both the IEES (Improving Efficiency of Educational Systems) and BRIDGES (Basic Research and Implementation in Developing Education Systems) projects have components that are surveying or actually developing software for educational planning. One such package, called STEP (System for Tracking Educational Progress), that models educational throughput in a limited way is complete.

This panel agreed with the proposition that decision support technologies should be investigated further, but did not discuss them in detail. But decision support technologies naturally extend to a problem that was discussed: the desirablity and difficulty of widely disseminating interactive radio for basic education. If the earlier analogy between interactive radio and long life-cycle products is followed out, dissemination can be thought of as a marketing problem.

AID's realization that customers for radio mathematics were not beating a path to their door in Washington spawned a project (Radio Learning Project) that more explicitly took a joint venture marketing approach with AID Missions and host country planners. The question that arises is whether demographic and market research tools have relevance for selecting schools or districts that are more receptive or ready to buy into an educational innovation. It is clear from the magnitude of the basic education problem, and also from the diversity of clients, that finding ways to get usable existing products to more customers will be as important as seeking new innovations.

Desktop Publishing. Because supplying textbooks and other print materials for classroom use is so effective, yet in many LDCs quite problematic, desktop publishing is promising. It can be used in many creative ways all through the system, from teacher training where individual teachers could prepare their own classroom materials to new models of textbook publication.

THE AID RESEARCH AGENDA

This panel took a detailed look at one component of the educational process, basic education, and within that component discussed technologies of various kinds. While there may be disagreement about which technologies, if any, to use in basic education, there is no doubt that computer-based technologies for learning must be better understood. In the practical context in which AID operates that means finding out how to transfer high-tech learning systems to presently "no-tech" situations in either the overcrowded urban or the primitive rural schools of developing countries.

Educational technologies have different applications at many levels of the educational system. It is essential that AID understand, preferably through practical experience, what computer technology can do for basic education, and how to evaluate its uses in ways relevant to the real needs and available resources of LDCs as opposed to doing "funny little experiments" of merely academic interest. The economic and political realities of LDCs mean that computer technologies in the classroom will be alternatives to proven, affordable methods such as textbooks and radio. The research challenge, therefore, is not simply to make computer technology work in basic education, but also to make it competitive in the LDC educational marketplace.

It is important to learn the limits of technologies. Even in American workplaces that are saturated with computers, we are discovering that productivity is not increased overnight. Some computer companies are taking a step back to study the institutional and social factors that characterize working in groups and exactly why the introduction of computers is not always productive. Such reflection on the larger social system of the workplace is not unlike this panel's insistence that the R&D agenda must include understanding how innovations fit into the entire educational system of a developing country and build in participation of the people affected by the change from the start.

Undertaking R&D on educational technologies in the critical area of basic education is not without some risk. But the risk of not doing it is also great--especially since technology in education is a powerful symbol of some of the things a developing country aspires to become. Rapid population growth and social change combine with advances in technology in ways that can outdistance poorly conceived assistance projects. Our suggestion to focus on stable components of basic education and fashion tools appropriate for that curriculum is one approach that can help to stablilize the situation. The other aspect is to shift the burden of sustaining improvement from donors to recipients. How to do all that summarizes our view of what AID's R&D agenda should be.

Acknowledgements. This panel was grateful for the contributions of the AID and World Bank resource persons who attended and made presentations. Special acknowledgement is also given to three invited resource persons, Dr. Marlaine E. Lockheed (World Bank), Dr. Arthur S. Melmed (New York University), and Ms. Sally G. Shuler (National Science Resources Center of the Smithsonian Institution/National Academy of Sciences).

COMMENTS WITHOUT COMMENT

This section contains comments by panel participants that seemed to the chairman to be especially cogent insights, assessments, or suggestions.

John Daly: We (AID) are a place that has permission to make mistakes. We can do demonstration projects and R&D, realizing that one doesn't attain 100% success. Some of what we do will be pointing to the year 2000 and beyond. Educational technologies ought to be one of those areas, since costs of technologies are changing and since we are learning more about learning. If we can't go out and try some things, most of which may not be cost-effective or sustainable, but a few of which will form the basis for advances in the 21st Century, then AID is being too limited and conservative in its approach.

Norman Uphoff: As I was trying to assess for myself the adequacy of the results on interactive radio, since the results were assessed quickly after the intervention, I recalled the well-known "Hawthorne effect" from social science. When making an experiment the experimental group usually does better than it normally would in spite of the kind of experiment or materials. The people are being given attention, they are conscious of this, and they react favorably to that attention. It is well-known and well-documented. Our first reaction is that the Hawthorne effect contaminates the experiment. If one thinks about it, however, there are probably not many things that could be more important for LDC schools than Hawthorne effects. These schools are often neglected and and even demoralized. If someone from the outside comes into the school to say learning is important, your teacher is important, etc. that conveys a stimulus that is likely to improve motivation. A technology helps convey that sense of importance.

Stephen Heyneman: The answer (to whether educational quality is deteriorating) is that quality is going down. There are two ways to show that. What you put into a system in terms of physical and monetary imputs has something to do with what will come out. And that is more easily demonstrated in third world countries than in the United States. In poor countries children's achievement is more greatly affected by the school as contrasted with the home in more affluent countries. The second thing is that monetary inputs for reading materials and other non-salary based expenditures have gone down in real terms: in Latin America by one-third since 1974 for elementary schools. In Uganda there are only one-fourth the number of textbooks available compared to 1971.

William Cooley: I resisted coming to this meeting because the only developing country I have worked in is Pittsburgh, Pennsylvania. But the more I hear the discussion the more I think that experience is relevant. The first thing that is important about Pittsburgh is that the school system was down and out around 1980 but it has been turned around. What made the difference? The first technological application was something called the "needs assessment." We had to understand how that system works. We had to understand the many necessary conditions--there are no

sufficient conditions--for turning that system around. Only by reaching an understanding through the needs assessment could we begin to nudge it to a higher level of performance. The most necessary condition was that the teacher had to understand and participate in the change.

Marlaine Lockheed: This has to do with the costs of computer use as an educational technology. ... In the low income countries with which we work computers, from a cost basis, appear to be really inappropriate. Let's go one step further. A program like Writing to Read can do perhaps in one year, and I am just making up this number, what might take four years to do, or might never be done in some schools in some countries. These kids are reading and writing at the end of one school year. It might be that if we look at reading and writing in that way, it might not be so expensive. It's like the 150% improvement rather than the 10 to 20 per cent improvement. How fast can one get kids to learn? ... Could one get literate people in 9 months or one year?

Arthur Melmed: I don't think we should be apologetic about technology. It is the story of civilization. Capital intensive technology produces its effect by producing low costs in the long run. With low costs you can have more product or service units in any fixed budget. When you have as much basic product or service units as required, you can allocate the remainder to improve quality. I make the point that cost effectiveness alone for educational technologies is not the issue. We should be modest in our expectation that cost-effectiveness will dominate the decision process.

Sally Shuler: I would like to address the issue of textbooks. We clearly have evidence in the U.S. that demonstrates science textbooks are ineffective at the elementary school level. Children in this country who are learning from a textbook often don't seem to connect what they learn in school--what they read in textbooks--with real life. ... I see the enticement with interactive radio. It is more participatory for the student. So how does one move teachers away from the lecture (didactic) method? ... What are the alternatives? One way is to focus on inquiry methodology--that is, problem solving. Then complement that with educational technologies that give children a window on the world. Enrich what they have learned from problem solving to go beyond the local environment to the wider world. What are we teaching our children? "X" quantity of facts, a body of knowledge, or a set of skills that will help them to lead better lives? Textbooks do not do that in general at the elementary level.

William Cooley: We keep learning the same lesson: What continues are those interventions that have become institutionalized. This means local management, local participation (at all stages). Otherwise any intervention dies the day the donor leaves.

Paul Evans: The bothersome thing is that we are not focusing on the children. We focus on product development. The objective should be, how can one help a large number of children in the quickest possible way? This might change the policy directives.

REFERENCES

Anzalone, S. (1988). Using instructional hardware for primary education in developing countries: a review of the literature. (Education Development Discussion Papers). Cambridge, MA: Harvard Graduate School of Education and the Office of Education, Bureau of Science and Technology, USAID.

Lockheed, M. & Mandinach, E.B. (1986). Trends in educational computing: decreasing interest and the changing focus of instruction. Information Technology and Education, 15, 21-26.

BIBLIOGRAPHY

Searle, B., Matthews, P., Suppes, P., Friend, J. (1979). Formal evaluation of the radio mathematics instructional program. Evaluation Studies Review Annual. Cook, T. (editor). Sage Publications, Beverly Hills, California.

Friend, J. and Kemmerer, F. (1985). Strategies for and costs of disseminating the radio language arts project throughout Kenya. In Interactive radio in education. Washington, D.C.: Agency for International Development and Institute for International Research, Communications Support Project.

Searle, B. (1985). Evaluations of Three Interactive Radio Projects. Development Communication Report, Number 49. Washington, D.C.: Agency for International Development and the Clearinghouse on Development Communication.

LIST OF PARTICIPANTS

Discussion Meeting on Educational Technology
May 19, 1988
Board on Science and Technology for International Development-BOSTID
National Research Council (NRC)

I. NRC Panel Members

Dr. Tryg Ager (Chairperson)
Institute for Mathematical Studies
in the Social Sciences (IMSSS)
Stanford University
Stanford, California 94305-4115

Dr. William W. Cooley
Learning Research and Development
Center
University of Pittsburgh
Pittsburgh, Pennsylvania 15260

Dr. Paul Evans
Educational Systems Division
IBM
Marietta, Georgia 30067

Dr. Stephen P. Heyneman
Economic Development Institute
The World Bank
Washington, D.C. 20433

Dr. Joao B.A. Oliveira
Economic Development Institute,
The World Bank
Washington, D.C. 20433

II. Participants

Dr. Clifford Block
Office of Technology
Bureau for S&T (S&T/ED) AID
Washington, D.C. 210523

*Dr. Rita Colwell
Maryland Biotechnology Institute
University of Maryland
College Park, Maryland 20783

Dr. John Daly
Office of the Science Adviser
Agency for International Development
Washington, D.C. 20523

Dr. Harold Freeman
Office of Technical Resources
Bureau for Asia and the Near
East, AID
Washington, D.C. 20523

*Dr. Robert Herting
G. D. Searle
Skokie, Illinois 6077

Dr. Curtis Jackson
Office of Res. & Univ. Relations
Bureau for Science & Tech., USAID
Washington, D.C. 20523

**Dr. Marlaine Lockheed
Population & Human Res. Dept.
The World Bank
Washington, D.C. 20433

*Dr. W. Parker Mauldin
Rockefeller Foundation
New York, New York 10036

**Dr. Arthur Melmed
New York University
New York, New York 10003

Dr. Frank Method
Bureau for Program & Policy
Coordination, USAID
Washington, D.C. 20523

---

* AID Research Advisory Committee Member

Mr. Floyd O'Quinn
Office of Res. & Univ.Reations
Bureau for Science & Tech., USAID
Washington, D.C. 20523

**Mrs. Sally Shuler
Smithsonian Institution/National
Academy of Sciences, National
Science Resources Center
Washington, D.C. 20418

Mr. Mark Rilling
Office of Education, Bureau for
Science & Technology, USAID

*Dr. Norman Uphoff
Center for International Studies
Cornell University
Ithaca, New York 14853

Mr. Norman Rifkin
Office of Technical Resources
Bureau for Africa, USAID
Washington, D.C. 20523

Dr. David Sprague
Office of Education, Bureau for
Science & Technology, USAID
Washington, D.C.20523

Dr. Gary Theisen
Office of Education, Bureau for
Science & Technology, USAID
Washington, D.C. 20523

III. NRC Staff

Mr. John Hurley, Director, BOSTID
Mr. Jay Davenport, BOSTID
Mrs. Eileen Payne, BOSTID

---

* AID Research Advisory Committee Member
** NRC Invited Resource Person