Interactive Radio Instruction

Confronting Crisis in Basic Education

A.I.D. Science and Technology in Development Series

Agency for International Development

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A.I.D. SCIENCE AND TECHNOLOGY IN DEVELOPMENT SERIES

Agency for International Development

Radio Learning Project

Education Development Center
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Foreword

For several decades the Agency for International Development has sponsored research in agriculture and in health and nutrition in the poorest nations of the world. The agency's longstanding commitment to systematic research and development in education complements its other research interests. Since 1973, A.I.D.'s Bureau of Science and Technology/Office of Education (S&T/ED) has supported the design of an innovative and effective methodology for strengthening education in developing countries: interactive radio instruction (IRI). The technology is old. Radio has been used for distance education for more than half a century. But interactive radio is new, and its effect on learning is demonstrable. Interactive radio instruction helps to build the human capacity on which economic and social development depends.

There is no longer any doubt that basic education is linked with impressive gains in the productivity of farmers. Primary schooling, especially for girls and women, correlates strongly with lower rates of infant mortality, higher rates of maternal survival, and better nutrition for all members of the family even in the poorest nations. A.I.D.'s Science and Technology in Development series has described several of the agency's research efforts in the areas of agriculture and health—among them the production of larger harvests in the testing fields of Bangladesh, the development of an effective program for the control of malaria, and the dissemination of oral rehydration therapy, a technique for the treatment of dehydration related to intestinal disorders that saves the lives of as many as a million infants a year. A.I.D. has also invested $20 million in the design and implementation of interactive radio instruction—by far the largest effort in educational research and development for the poorest nations of the world.

This is an efficient use of donor funds. A.I.D. can't defray year-to-year educational expenses in the 65 countries in which it has missions, but it

can invest resources in the design and testing of technologies that poor nations, after the development phase is over, can afford. IRI is the result of a major, sustained effort to improve education at low cost. Such efforts can have a very significant impact if their products are inexpensive and effective. Interactive radio instruction meets both criteria.

IRI has the potential to be as powerful an innovation in the process of development as A.I.D.'s interventions in agriculture and health. The beginning of the United Nations Fourth Development Decade, which focuses on human development, is an opportune moment for the fuller implementation of interactive radio in the poorest nations of the world. IRI directly addresses four crucial issues in basic education: relevance, equity, access, and effectiveness. It provides its audience with standardized instruction of high quality. It successfully teaches literacy and numeracy to children marginalized by poverty and isolation in their own countries. Like improved nutrition and higher rates of family income, literacy and numeracy correlate with increased life expectancy. IRI does not make distinctions between ethnic groups, it does not prefer urban to rural children, it does not target boys at the expense of girls.

The effectiveness of the model depends on its systematic instructional design (carefully planned and sequentially structured curriculum) and on the teaching strategies that differentiate it from earlier schools broadcasts that attempted to enrich or enhance classroom experience. IRI delivers intensive, daily lessons in the core curriculum. It mandates continuous interaction between the learner and the radio teacher or teachers; immediate reinforcement or correction of student responses; a segmented program format that allows for repeated exposure to new topics, distributing practice in new skills over a sequence of lessons; and a careful system of formative evaluation. But its success also depends upon its responsiveness to the unique educational needs of the poorest nations. Because it is a *methodology* for teaching and not a series of content specifications, IRI provides an instructional template for the improvement of primary education. It guides the timing and presentation of new topics and offers a model for the reinforcement of skills. IRI doesn't impose content. Instead it shapes and orders objectives from national curricula to produce instructional materials that are likely to be enthusiastically received by teachers and students alike.

Experience in many different projects conducted on four continents shows that IRI helps children achieve impressive learning gains. These educational yields are quantifiable, like an abundant harvest or a census of lives saved through a medical intervention. But IRI, which is blind to everything but the humanity and the innate eagerness to learn of its listeners, offers more than convincing statistics. It puts the child at the center of the instructional model. This is what distinguishes IRI from

other useful educational interventions like textbook development and teacher training: in the exchange between teacher and student, it focuses on the child, and elicits an excitement and interest in learning that often amounts to joy.

It's not controversial to observe that learning is the catalyst for economic and social development; it shouldn't be controversial to observe that delight in learning intensifies its catalytic effect. As we confront in the last decade of the century such global challenges as stagnating or failing economies, growing disparities between the rich and the poor, increasing numbers of people marginalized by war as well as by economic conditions, the degradation of the environment and the coincident growth of population, catalysts for development must come from basic education. IRI offers an inexpensive and effective model for providing basic education, and it is available for rapid implementation throughout the developing world.

Preface

This book is based upon the accumulated wisdom and experience of the people who design and implement interactive radio. I have benefited from their careful and fully documented reports, papers and books, as the list of Works Consulted shows. Of particular importance were the three-volume *Radio Mathematics in Nicaragua* (Searle, Friend and Suppes, 1976-1980); *Teaching English by Radio* (Imhoof and Christensen, 1986); and *Radio-Assisted Community Basic Education (RADECO)* (Eshgh *et al*, 1988). For sharing their time as well as their writings, I am indebted to Joan Larcom, Thomas Tilson, and Dolores Alvino of the Education Development Center; Jamesine Friend of Friend Dialogues of North Carolina; Philip Sedlak, Mark Herrling, Barbara O'Grady, Frances Hays, and Judy Brace of the Academy for Educational Development; Michael Laflin and Stephen Anzalone of the Institute for International Research; Maurice Garnier, Department of Sociology, Indiana University; Mardell Raney and Sybil Eakin of the Agency for Instructional Technology; and James Hoxeng and Clifford Block of the Agency for International Development. Thomas Tilson wrote Appendix A: Implementation, Sustainability, and Costs. My thanks to Joan Larcom, Thomas Tilson, James Hoxeng, Jamesine Friend, Clifford Block, Paula Gubbins, Judy Brace and Dolores Alvino for reading the manuscript.

Joan McTigue Zirker

List of Acronyms and Abbreviations

ACPO	*Acción Cultural Popular* (Colombia)
A.I.D.	Agency for International Development
AVANCE	Association for Socioeconomic Advancement and Development (Honduras)
AVANCE/SEI	AVANCE's *Sistema de Educación Interactiva*
BANFES	Basic and Nonformal Education Systems (Lesotho)
BSPP	Basic Skills Pilot Program (Thailand)
CENADI	*Centro Nacional de Didactica* (Costa Rica)
CIESPAL	*Centro Internacional de Estudios Superiores de Communicación para America Latina* (Latin America)
CRECERA	*Centro Regional de Communicación Educativa* (Ecuador)
HRLP	Honduras Radio Learning Project
IRI	Interactive Radio Instruction
NGO	Non-government organization
PEEP	Primary Education Efficiency Project (Honduras)
RADECO	Radio-Assisted Community Basic Education (Dominican Republic)
RLAP	Radio Language Arts Project (Kenya)
RLP	Radio Learning Project
RMN	Radio Mathematics Project in Nicaragua
RSP	Radio Science Project (Papua New Guinea)
SEEBAC	Secretariat of Education, Fine Arts, and Religion (Dominican Republic)
S&T/ED	A.I.D.'s Bureau of Science and Technology/Office of Education

1

Interactive Radio and Basic Education

I. Interactive Radio Builds Human Capacity

> Becoming literate does not mean simply gaining the capacity to interpret written symbols, but rather assuming a series of role behaviors, adopting specific values and aspirations, and incorporating into one's world view the concepts that are part of the exercise of political, economic, and social-cultural decision-making in a country. The mechanical skill of learning to read simply adds the final details to a much broader picture (White, 1977).

In traditional schools interactive radio teaches children the mechanical skills of literacy and numeracy; the model extends access to those skills to those out of school as well. This is how IRI builds human capacity: it begins with the final details of a much broader picture. Command of those details is important to parents in the isolated villages of Cortico, Arriba, Camboya, and Algodon in the Dominican Republic. When they try to say what they hope their children will gain from being educated, they don't think about loftier objectives like personhood and empowerment, but about the specific, daily issues on which their livelihood hinges: "I want my children to learn so I will not be cheated at the store when my harvest is weighed . . . so they can read farm bulletins to me and I can improve my crops." "So they can read directions for medicine" (Fshgh *et al*, 1988). They want their children to be able to help them with the crucial details of their lives. They also want them to be able to do more, to *be more*. But the circumstances in which they live make it impossible for them to subsist without their children's daily labor.

In 1983 there were 120,000 unschooled children in the Barahona region of the Dominican Republic. From dawn until late afternoon those children were at work picking coffee, cutting and carrying cane, or hauling garbage. Often they were with their parents in the cane or coffee fields, working side by side with them. Even if there had been money to spare for school uniforms and supplies there was no time to spare. There were no teachers either in their remote communities, and few newspapers or books even for those few who could read, and communication with other isolated villages was usually difficult and sometimes impossible. There was little hope for conventional instruction in the mountainous region. But there was one familiar tool that might help: radio.

After the printing press, radio is the oldest of our technologies for mass communication. Because of its low cost it is the most democratic. That makes it unglamorous. In North America and Europe and the prosperous Pacific Rim people now regard it as a source of background music and background news. They prefer television. In Barahona and throughout the developing world, however, where television reaches only a small and predominantly urban audience, radio still performs its first, magical function: it connects listeners with faraway places and teaches them about other people.

The technology is uncomplicated and inexpensive, and it ignores the geographic and economic barriers that isolate places like Cortico, Arriba, Camboya, and Algodon. There are more than 5,500 radio stations and over two hundred million radio receivers in the poorest nations of the world. Those numbers are growing because radio is nondiscriminatory. It serves people who live at the geographic and economic margins of developing countries. In remote rural areas like the southwestern Dominican Republic it often provides the only means of communication with the larger world. You don't have to be literate to listen to the radio and you don't have to have access to social services. All you need is access to a receiver.

Studies show that people believe what they hear on the radio. The process is simple: they listen to the news and they learn about the world. The more they learn, the more they are. The more they are, the more they want to be, and the more clearly they can think about their positions in their communities, their countries, the world. The more clearly they can think about their positions, the less marginal those positions become. Information arms them for their own development and for the development of the institutions by which they are governed; and radio arms them with information.

In the past the relationship between the audience and the receiver was passive: radio voices spoke and people listened. Often they learned a little. Sometimes they learned more. The relationship between the radio voices

and the audience mimicked the traditional teacher-student relationship. One spoke; the other kept silent. But the unschooled Dominican children had no experience of that teacher-student relationship, so they adapted easily to a new kind of listening when Radio-Assisted Community Basic Education (RADECO) went on the air at four o'clock in the afternoon of January 24, 1983.

This was the first of a four-year cycle of daily, hour-long, interactive radio broadcasts during which RADECO provided, as it still provides, instruction in reading, writing, math, music and games, and natural and social science—a core curriculum—for children *after* their work day has ended. Instead of simply receiving information, the Dominican children respond actively, immediately, and repeatedly to their radio teachers, Sonia, Miguel, Carlitos, and the *abuelo*, who is a reliable source of grandfatherly wisdom. The children's participation is crucial to the interactive radio model, which replaces the radio monologue with a learning dialogue. This doesn't mean that there are two-way transmissions between students and teacher; although the interaction is only simulated, it is real to the children, who respond as eagerly to the radio teachers as if they were personally in the classroom listening attentively to what the children say.

Although radiophonic schools have produced basic-skills broadcasts for many years in Colombia and in other countries of Latin America, the interactive relationship between the radio teacher and the listener-learner is a recent innovation in the struggle to strengthen education and to extend educational access. RADECO's goal was to take the place of formal schooling for children in the province of Barahona. It has succeeded. Tests of students in the RADECO classrooms show that they are learning as much of the core curriculum in an hour each day as students who attend traditional schools for several hours a day. While most of the other IRI projects seek to improve instruction in traditional schools, RADECO had a different objective, grounded in specific local circumstances in the Dominican Republic—lack of access to schooling for many children in an isolated region. This is the model's great asset. It is *adaptable* to specific local circumstances.

Work began on the first version of IRI in 1974 when the Radio Mathematics Project (RMN) was established in Nicaragua. RMN, a pilot program designed by the Institute for Mathematical Studies in the Social Sciences of Stanford University and A.I.D./Washington's Technical Assistance Bureau, and funded by the Nicaraguan Ministry of Education, was charged with the responsibility of developing and implementing a *method* for teaching mathematics to primary-school students by radio. The method created a product: "a set of educational materials of proved value that could be used at almost no cost to improve the schooling of

future hundreds of thousands of Nicaraguans" (Friend, Searle, and Suppes, 1980).

And the method *was* a product. In fifteen years since Nicaragua, IRI has proved to be a sturdy yet pliable methodology for use in traditional schools. It has provided effective instruction in English as a second language in Kenya, Lesotho, Swaziland, and Belize, mathematics in Nicaragua, Thailand, Honduras, Costa Rica, Bolivia, and Ecuador, science for the upper primary grades in Papua New Guinea, and health in Bolivia. In addition, interactive radio was applied outside of the traditional school setting in the Dominican Republic.

Interactive Radio Programs Around the World

Program Start	Country	*Math*	*ESL*	*Spanish*	*Science*	*Teacher Training*	*Health*
1974	Nicaragua	N					
1980	Thailand	A					
1980	Kenya		N				
1980	Nepal	A				N	
1981	Dominican Republic	A		N			
1986	Papua New Guinea				N	N	
1987	Honduras	N	A	N			
1987	Bolivia	A/N					N
1987	Lesotho	A					
1988	Costa Rica	A				N	
1988	Ecuador	A					
1989	Belize		A				
1990	Swaziland		A				
1990	Guatemala	A		N			

KEY: N = New Curriculum Model Developed
A = Adapted Curriculum Model Used

Figure 1.1

IRI is supported by A.I.D., and has during its research and development phase relied on technical assistance from expatriate professionals, but it is *not* a cultural imposition. Math lessons for Nicaraguan students were written by Nicaraguan writers in consultation with Nicaraguan curriculum specialists, and they followed the Nicaraguan national curriculum. Lessons in English as a second language for primary school children in Kenya were written by Kenyan writers from the Kenyan curriculum;

scripts for the Radio Science Project in Papua New Guinea are being developed by writers from Papua New Guinea.

Each IRI project is shaped by an array of technological, geographical, and sociological constraints and one economic one: cost. The IRI model was conceived as a cost-effective way of delivering instruction of high quality to large numbers of students. One of its principal attractions, according to Dean Jamison, formerly of the World Bank, "is that costs have been designed to be kept, and have been kept, to a small fraction of the cost per student per year [of traditional schooling] in the countries involved. $0.50 per student per year—or even less—is a typical figure." Estimated recurrent costs for the dissemination of first-grade radio math programs in Thailand, after development, is $0.44 per student per year; the estimated recurrent cost of transmitting RADECO lessons is about half the cost of building and staffing conventional classrooms.

Taramai Ledri for the Radio Science Project

Fourth-graders in Papua New Guinea respond eagerly to a Radio Science question.

We can document the low cost of IRI projects, but there wouldn't be any point in that documentation if we couldn't prove that the model was effective as well. In Nicaragua average mathematics test scores in a first-grade classroom rose from 39 percent to 65 percent after a year's broadcasts of Radio Math. In Kenya students in experimental Radio Language Arts classrooms scored 18 percentile points higher on achievement tests than children in control classrooms. In Thailand Radio Math students outscored their peers in traditional classrooms by 16 percentile points. The Dominican results have been impressive: children in RADECO classes do as well as children in traditional schools in reading, and better in math.

IRI works because it actively *engages* students in the learning process, because it drafts highly qualified teachers to plan and write radio lessons, because its system of continuous classroom observation and evaluation of learning gains provides data on the effectiveness of each program and uses that data to improve subsequent prog[illegible] because it creates excitement in the community of learners, among [illegible] school administrators, and parents, and because it is able to use broadcast facilities already in place throughout the developing world to reach Kikuyu children in Kenya, students in the Basic Skills Project in the remote Maha Sarakham region of Thailand, and children in the isolated *altiplano* of Bolivia.

Because it uses an inexpensive, intermediate technology appropriate to its settings in developing countries, the IRI model conserves resources for the design and production of programming. Curriculum is always at the heart of interactive radio instruction. The radio scripts drive each project, and the demands of content, shaped by principles of effective instructional design and specific local circumstances, drive the scripts. These are the constants of interactive radio instruction: systematic instructional design, rigorous formative evaluation, and a child-centered orientation that builds delight in learning into the model.

II. The Crisis in Education in the Poorest Nations

Crisis in basic education is the background for the U.N.'s Fourth Development Decade. As stagnation in economic growth intensifies the burden of their foreign debts, developing countries are finding it more and more difficult to provide basic education for their citizens. Many of the world's poorest nations are now obliged to reserve up to a third of their annual budgets for the repayment of foreign debt (Fuller and Heyneman, 1989). The share of spending assigned to education in the poorest nations has fallen from 16% to 12% since 1970 (World Bank, 1987, 1988).

Demographics don't improve the forecast. Child population doubles every 20 or 30 years, and UNESCO (1983) estimates that 800 million

children will be in school in the poorest nations by the turn of the century. At the same time, 100 million children who are now unschooled guarantee that even if the future looked brighter for basic education, illiteracy would continue to afflict the Third World long beyond the year 2000.

The paradox is simple. Enrollments are going up while spending goes down. More children are enrolling in school, which means that more teachers are needed. But teachers in countries where enrollments are skyrocketing may not be as well trained as their predecessors, and when they face large numbers of children in multi-grade classrooms they may be impossibly overburdened. Malawi provides an instructive example. In 1970, the pupil-teacher ratio was 43:1; today it is 63:1. Per pupil spending has fallen 4.1% per year in real terms since 1970. In the critical area of spending for instructional materials, Malawi can now invest only $ .50 per pupil per year. In Bolivia that figure is $ .80 per student per year, in Brazil $4, in Sweden $300 (Fuller and Heyneman, 1989). Declining expenditures for instructional materials are troubling because studies show that these materials have consistently favorable effects on student achievement in developing countries (Fuller and Heyneman, 1989). Every year, teachers in the poorest nations are being asked to instruct more and more students with fewer and fewer resources.

For over 600,000 children in Latin America, Africa, and Asia, interactive radio has provided effective instructional materials—radio broadcasts and supplementary print materials (worksheets, notebooks, and teacher's guides). The children in underequipped schools have benefited from these instructional materials. So have their overburdened teachers. With new sources of funding from a range of international agencies interactive radio can help more children in the poorest nations, where crippling disadvantages like uncontrolled population growth, subsistence agriculture, a disease-bearing water supply, the absence of health and social services, and isolation from the means of communication converge.

III. The School Setting

In rural areas of Latin America the typical school is a small structure built of concrete blocks. It has three or four self-contained classrooms, each with a single door to the outside. There is no interior hallway. Large window openings provide light and air, but often there is no glass—the openings are covered with wire mesh. Many of the schools in Latin America have no furniture. Classrooms are empty, except for a chalkboard and maybe a broom. There is usually chalk, sometimes provided by the government but more often by the teacher, but other classroom supplies are unlikely to be available.

Urban schools tend to be larger than their rural counterparts, but often they function less well. Many are old, ramshackle structures, partitioned by flimsy, pseudo-walls into classrooms where there is little light or ventilation. They suffer the same insufficiencies of supplies as rural schools and must contend with the noise of urban industry and traffic as well. Children in city schools seem to be no better provided with furniture than children in the rural areas. Often in the morning you can see them walking to school, carrying their own little chairs on their heads.

These are the facts of educational life in Latin America. When staff members wrote the Radio Math broadcasts for Nicaragua they took all these circumstances—the noise, the crowding, the lack of supplies—into account. The conditions under which schooling took place in Nicaragua determined the presentation of content in the broadcasts. In Kenya lessons in English as a second language were also designed to accommodate specific local circumstances. Such circumstances are built into the design considerations of every IRI project.

Cultural and physical constraints, as well as principles of pedagogy, shape the broadcasts. Can the children hear the radio when buses or trucks roar past the school? Does it make a difference whether students sit at desks in urban schools in Kenya or on a shelf of rock in an *enramada* (a modest shelter, often just a roof on four support posts) built by parents of the RADECO children in Barahona? What can script writers do to accommodate Bolivian children whose first language is Quechua when they adapt radio math lessons in Spanish? What social problems does IRI have to consider in countries that are multicultural and multilingual, like Kenya? How can IRI staff members preserve the rigorous and systematic instructional design of earlier projects when they adapt radio lessons for rapid and inexpensive transfer to new locations? What are reasonable qualifications for the *radioauxiliaries* who are hired to facilitate broadcasts for the unschooled children of the RADECO project? How do you persuade a district supervisor to encourage the use of English as a Second Language lessons in Lesotho, where participation in the project is voluntary?

The experimental nature of the early IRI projects enforced the habit of asking questions like these, and established the groundwork for the model's success in Nicaragua and Kenya. In Nicaragua this fundamental question was part of the original research contract between A.I.D. and Stanford University: can primary mathematics be taught in a developing country by radio? The Radio Language Arts Project in Kenya was to answer a second basic question: could the methodology implemented in Nicaragua be adapted to the very different field of language? A.I.D. believed that the answer was yes, and that another major effort in research and development was justified. The purpose in Kenya was the same as in

Nicaragua, to produce a prototype, first for local use, then for use in other nations.

IRI staff members learned to answer specific questions about each lesson along with the general questions that the IRI experiments in Nicaragua and Kenya addressed. This was another innovation: consistent quality control, based on intense and continuous observation, in the classroom and outside of it. Staff members listened to the radio lessons with the children and their teachers, and they studied the school settings. In the process they came to understand sociocultural constraints as well as ineffective teaching strategies.

2

The First Phase: Nicaragua

In 1973 the U.S. Congress amended the Foreign Assistance Act and directed the Agency for International Development to concentrate its efforts on the "poor majority" in the least developed countries of the world. That set in motion the process that produced interactive radio instruction. The Agency for International Development had always been interested in education in developing countries, and many of the rural schools in place in Nicaragua in 1973 had been built with construction loans from A.I.D. But this legislation provided a new initiative for A.I.D.'s research bureau, redirecting its early and successful work in educational television towards the lower-cost alternative of radio.

From the beginning, A.I.D. committed itself to a long-term effort of at least ten years. The task was formidable. Radio was familiar and unexciting, and educational radio had proved to be only marginally effective in earlier projects. But the agency took the position that the technology that delivers the instruction is less important than the quality of the educational content it provides (Block, 1988), and set out to reinvent educational radio for the poorest children in the poorest nations of the world. In July of 1973 A.I.D. contracted with Stanford University's Institute for Mathematical Studies in the Social Sciences to fund a project "designed to investigate, in a detailed and systematic way, the use of radio to teach mathematics in the primary-school classrooms of a developing country" (Searle, Friend, and Suppes, 1976). During that process, RMN created interactive radio, a methodology that was both exciting and effective.

The Site

Radio was the logical choice because it is inexpensive and ubiquitous and because it has the capacity to standardize instruction for all students.

Math was the logical choice because teachers—especially those in remote areas, for whom teaching conditions are usually unfavorable—often lack confidence in their ability to teach mathematics, and because a math curriculum would be adaptable for use in many different countries. Nicaragua was chosen as the site of the experiment for a number of reasons: the positive response of government officials to the proposal; the availability of a radio transmitter and appropriate schools; the national use of Spanish as the language of instruction (in a multilingual country the project would have been impossibly expensive); the availability of Nicaraguan curriculum specialists and other professionals; access to a recording studio; the national implementation of a modern mathematics curriculum; and a level of development typical of many poor countries (Friend, Searle, and Suppes, 1980).

On April 1, 1974, A.I.D. and the Nicaraguan Ministry of Education signed the formal agreement that established Radio Mathematics in Nicaragua (RMN). Stanford staff members Jamesine Friend, Thomas Tilson, and Julia Ledee arrived in Nicaragua in June, and on July 1 the headquarters of the Radio Mathematics Project opened in Masaya, 30 miles southeast of Managua. Two years earlier Managua had been devastated by an earthquake that killed more than 10,000 people—in a city of 400,000—and flattened the commercial district. Evidence of the destruction was still visible throughout the capital in the summer of 1974, but the political situation in Nicaragua seemed relatively quiet, and by September, staff members (including Nicaraguan co-director Vitalia Rojas de Vrooman,

Nicaraguan children during a Radio Math lesson.

curriculum writer David Cardoza, and educational researcher Luis Ramirez) were writing, recording, and pilot-testing a series of six radio lessons for use during the 1975 school year.

Those lessons were based on research Patrick Suppes and his Stanford team had done on the determinants of effective learning. Their work in computer-assisted instruction had yielded two principles that would be crucial to the effective use of radio: that children learn not from the words they read and hear, but from the tasks they do (active learning); and that they learn best when their practice of new skills is organized into short periods of time distributed over many days, weeks, or months (distributed learning).

Curriculum

By the end of the 1975 school year staff members had developed a model of curriculum design, produced and broadcast 150 first-grade lessons, and refined the technique of continuous classroom observation and analysis of achievement that Jamesine Friend identifies as the basic innovative characteristic of the radio methodology. The model of curriculum design had four levels of increasing specificity:

1. Curriculum structure
2. Lesson format
3. Segment content
4. Single exercise (Searle, Friend, and Suppes, 1976)

In that first year staff members concentrated their efforts at the top level, curriculum structure. They had determined that decisions about "what topics are to be taught, how they are to be taught, and how the available instructional time is to be allocated" would have "the greatest impact on how much children learn" (Searle, Friend, and Suppes, 1976). In doing so they put decisionmaking about specific content and specific techniques of presentation at the heart of the RMN model. Other design considerations were important. This one was crucial to the effectiveness of the RMN lessons, and continues to be crucial in all subsequent IRI projects.

Here is how the process began: "With each year's curriculum our first task was to . . . determine the intent of the Nicaraguan syllabus and to transform it into a set of clearly stated behavioral objectives that would serve as a foundation for the year's course" (Friend, Searle, and Suppes, 1980). Once those objectives had been specified, decisions about lesson format, segment content, and single exercises were much easier to make. The RMN staff revised the sequencing of topics in the national syllabus to accommodate the principle of distributed learning and systematic review. "By applying specific goals derived from the recommendations of the

Ministry of Public Education," they developed realistic objectives and produced "non-controversial materials with a high probability of acceptance" (Friend, Searle, and Suppes, 1980).

Acceptance came at all levels of the Nicaraguan system—and outside of it. Many adults listened to the Radio Math broadcasts at home or as they worked, and staff members tried to accommodate this enthusiastic out-of-school audience (estimated at 20,000) by keeping supplementary materials to a minimum. But the primary audience was, of course, schoolchildren, who *attended* to their radio teachers with remarkable concentration and learned mathematics concepts and operations quickly. Researchers talk about how the interactive model mimics a conversation between students and their teachers, but RMN lessons went beyond mimicry to create real dialogues, timed so that student responses to questions and instructions occurred smoothly, without interrupting the natural flow of the exchange. The children's listening skills and response time typically increased over the course of a year's broadcasts, and the RMN lessons accommodated that change. Response pauses shortened, actors spoke faster, and children answered instantly. Continuous classroom observation and regular testing provided confirming documentation for what teachers and children had already discovered about RMN: it was working.

How RMN Helped Teachers

And it was working in ways that made the teacher's job easier. RMN took all its design considerations seriously. It imagined as its typical audience children in an ill-equipped classroom in an isolated rural school, whose unsupported, inexperienced young teacher had more than one grade to teach—as over half of rural teachers do in Nicaragua—and it produced radio broadcasts that acted as surrogate teachers, "completely self-contained and understandable to the children without intervention" (Friend, Searle, and Suppes, 1980). During the broadcasts the radio functioned as an assistant to the teacher. But after the radio lesson had ended, the teacher was fully in charge of post-broadcast activities. In multi-grade classrooms in Nicaragua RMN broadcasts freed the teacher to attend to the needs of children in other grades when first graders listened to their lessons, thus increasing the teacher's efficiency and benefiting all the children in the classroom. In Kenya, where there were no multi-grade classrooms, teachers were much more fully integrated into broadcast activities. The role of the teacher, of course, varies according to the curriculum of each IRI project.

The teacher's cooperation is always the starting point for a project like

RMN. Teachers are the only means of access to the children. They have to be in their classrooms, with their radios in working order, if the children are to hear the broadcasts, and they must have a reason to turn the radio on at the time of the transmission. RMN scriptwriters understood this. They also understood that educational radio and TV programs often fail because teachers stop using them after early bursts of enthusiasm generated by non-teachers. It was obvious that RMN lessons must work for teachers as well as for students. In a country where a teacher may be assigned from 40 to 100 children in up to three different grades in a single, unfurnished classroom, this was absolutely essential.

RMN lessons actually *relieved* the teacher of tasks. The radio math broadcasts took the place of conventional lessons and thus shortened teacher prep time. Teachers were never asked to spend time or money to provide supplementary materials. Counting and sorting exercises specified that children should gather sticks or stones or seeds for their math activities. The content of RMN lessons was not threatening to teachers, and the nonbroadcast activities were well within their abilities. But most important of all was the *effectiveness* of the lessons. RMN lightened the teacher's workload and it achieved remarkable learning gains for students. One important guarantee of those gains was IRI's procedure for formative evaluation.

Formative Evaluation

At the beginning of the project, RMN staff used the familiar 'revision' model for curriculum development: write and record a program, broadcast it and test the results, and then revise it. With this model they produced a series of six lessons that appeared to work well. It seemed clear that what they needed next was an extended sequence of lessons that would allow them to measure meaningful learning gains over a significantly longer period of time. But the assumption of the revision model—"that a specific product (a lesson, for example) can be improved by testing it with representative members of the target population and making the changes suggested by the data obtained from the field test" (Friend, Searle, and Suppes, 1980)—demanded a lengthy and repetitive experimental phase for the project, and increasingly it seemed irrelevant. Field testing had begun to yield information on which effective *new* lessons could be based, lessons that without field testing or revision, nevertheless proved as successful as the lessons that *had been* tested and revised. "In other words, the 'specific product' that we had been testing was not the individual lessons but the instructional techniques that were used in those lessons" (Friend, Searle, and Suppes, 1980).

The discovery that it wasn't necessary to field test and revise each lesson before widescale broadcasting was important. It suggested a new procedure for formative evaluation based on the feedback system that industry uses to control continuous processes: "in this model output is continuously monitored and any deviation from the desired outcomes causes an automatic compensatory adjustment of the input parameters" (Friend, Searle, and Suppes, 1980). Thus, if the children failed to achieve mastery of a new skill in 70% of its appearances on tests or worksheets, observers would recommend changes in the instructional segments that taught the skill. Of course RMN couldn't automate the mysterious process of learning, which resists reduction to statistics. But it could measure the learning gains that constitute 'output' in this model, and staff members could create a production schedule that carefully monitored the children's learning gains and adjusted teaching strategies accordingly. The model allowed production to go forward instead of backward: lessons were still field tested, but data were used to improve subsequent broadcasts, not to revise and rebroadcast earlier ones.

How did RMN staff monitor outcomes? At first they relied on the results of classroom observation and analyses of student worksheets; after 1976 they added weekly tests in selected classrooms. But classroom observation always provided the most useful information about the radio lessons. Although there was early disagreement about how to measure such results as student interest and attention, staff members learned to interpret as well as to record what they saw in the RMN classrooms. Children were delighted with the broadcasts, even though they included few diversions. This might not be a statistic, but it was certainly a fact.

From their observations and interpretations staff members learned many things: "what kinds of entertainment the children preferred, how long the lessons could be and still hold the attention of the children, how long instructional segments should be, what kinds of instructions were ambiguous, how fast the pace should be, and how long we should pause for children to complete different tasks like writing numerals, solving addition exercises, or making simple drawings" (Friend, Searle, and Suppes, 1980). They learned, in fact, everything they needed to know to make RMN effective. The tests they used in the formative evaluation model demonstrated that children were making impressive gains in all the topics RMN covered, and of course the children and their teachers knew that they were learning swiftly and well and enjoying themselves at the same time. But the only way to answer the fundamental question on which RMN was based—can mathematics be taught by radio to children in a developing country?—was by undertaking careful evaluation of the differences in learning gains between children who took the radio lessons and those who did not.

Thailand—The First Adaptation of Radio Math

Pattama Sang-Jan, Centre for Educational Technology, Bangkok

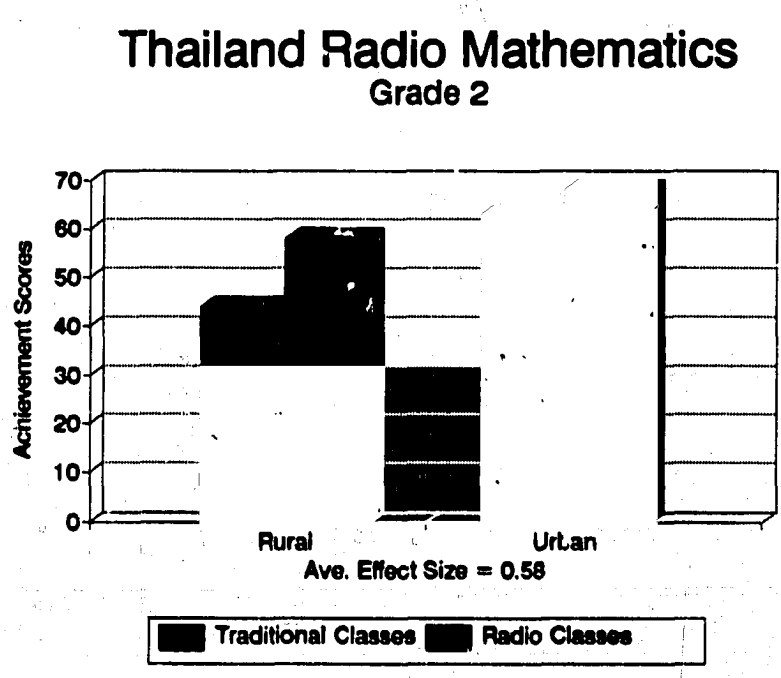
Thai children have been working with interactive radio math since 1982.

During the Radio Math project in Nicaragua and as specified in the original contract, Stanford University supervised the translation of the radio lessons into English. A year after the completion of RMN, those translations were translated again, this time from English into Thai, for the Basic Skills Pilot Project (BSPP), which was supported by the World Bank's Fifth Education Project in Thailand. The particular occasion for the adaptation was the finding by the Thai Ministry of Education that children in the remote northeastern part of the country showed much lower achievement levels in mathematics than children who lived in the more heavily populated and developed region around Bangkok in the Central Plain. This disparity between urban and rural schools repeated, of course, a familiar pattern. The Thai Ministry of Education hoped that IRI could help to redress the inequity on which the difference in achievement scores was based. Although radio education wasn't new to Thailand, there were no courses in primary school math like the lessons developed in Nicaragua, and the pilot adaptation of the second grade broadcasts was clearly experimental. Since the standard radio education series in Thailand lasts 32 weeks, the number of lessons was shortened from 175 to 160 to accommodate that schedule. In May of 1980, at the

(Continued on page 34)

beginning of the Thai school year, the pilot broadcasts began. Sixteen schools in the isolated Northeast participated in the project, along with 16 schools in the Central Plain. Comparisons between children in the experimental schools and children in the 32 traditional schools showed very significant gains for those who had heard the Thai Radio Math lessons. But the most striking discovery came when radio-instructed children from the two regions of Thailand were compared with radio classes in Nicaragua: students in the Thai Northeast, who were most disadvantaged, gained more than students in the Central Plain or students in the original radio classes in Nicaragua. The adapted lessons were most successful in the isolated, underserved region where the need for them was greatest.

By 1984, the Thai replication of all three years of RMN lessons was available for broadcast to primary schools throughout the country. It is noteworthy that Thai scriptwriters needed expatriate technical assistance only during the first cycle of adaptation (of the second-grade lessons), and for a few weeks during the second cycle (of the third-grade lessons). After that the Thai staff worked independently, and successfully, on their own national version of Radio Math. Thai Radio Math provided welcome evidence for the portability of the IRI model.



Summative Evaluation

The purpose of summative evaluation is to judge the curriculum package on its own merits and in comparison with other alternative methods of instruction, in this case traditional teaching of math in a conventional classroom. Anecdotes that might be instructive in formative evaluation are irrelevant in summative evaluation. Its intent is scientific and its methods are statistical. Since summative evaluation makes inferences to a larger (and future) population of students, it has to match its methods to the treatment that larger population will receive. So the children who participated in the summative testing were new to the process. And the methodology was complex (see Friend, Searle, and Suppes, 1980, Chapter Four). But it's possible to state the results relatively simply: in every grade students who took the radio lessons learned significantly more than children in conventional classrooms.

Here are the conclusions RMN staff members drew from the summative tests:

1. At all grade levels students learn the topics taught by radio lessons better than students learn in traditional classrooms, as measured by a test of mathematics achievement.
2. Radio lessons help rural students overcome the performance deficit they show compared to urban students.
3. Students of all abilities show significant learning gains after radio mathematics lessons.
4. Boys and girls of equal ability learn equally well from radio lessons.
5. Students attending school during a period of political turmoil show surprisingly small decreases in mathematics achievement scores, at all grade levels (Friend, Searle, and Suppes, 1980).

These are carefully judged statements of fact. They are intentionally colorless. But the utilitarian prose nevertheless reveals reason to celebrate. RMN redressed various inequities among learners. It demonstrated that the "poor majority"—children who were made marginal in their own countries because they lived in isolation from urban areas and social services—could benefit significantly from radio math lessons. It demonstrated that radio lessons were not sex-discriminatory (though radio lessons alone cannot, of course, compensate for the attitudes and practices of an entire culture). It demonstrated that children with lower ability showed learning gains as impressive as children with higher ability. Altogether, the findings of the summative evaluation of RMN (Figure 2.1) added up to an unequivocal, affirmative answer to A.I.D.'s question: can mathematics be taught by radio to children in a developing country?

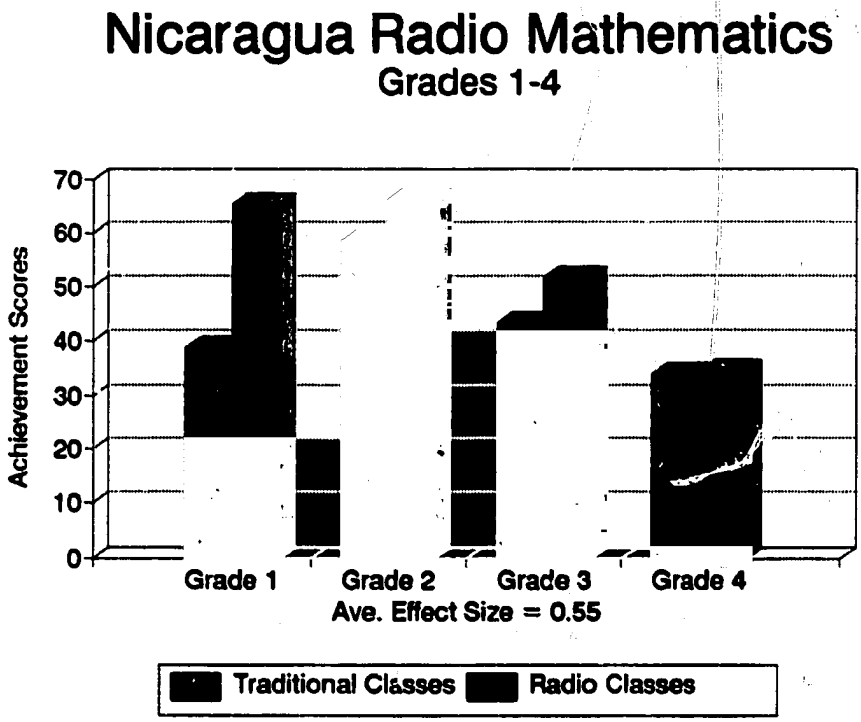
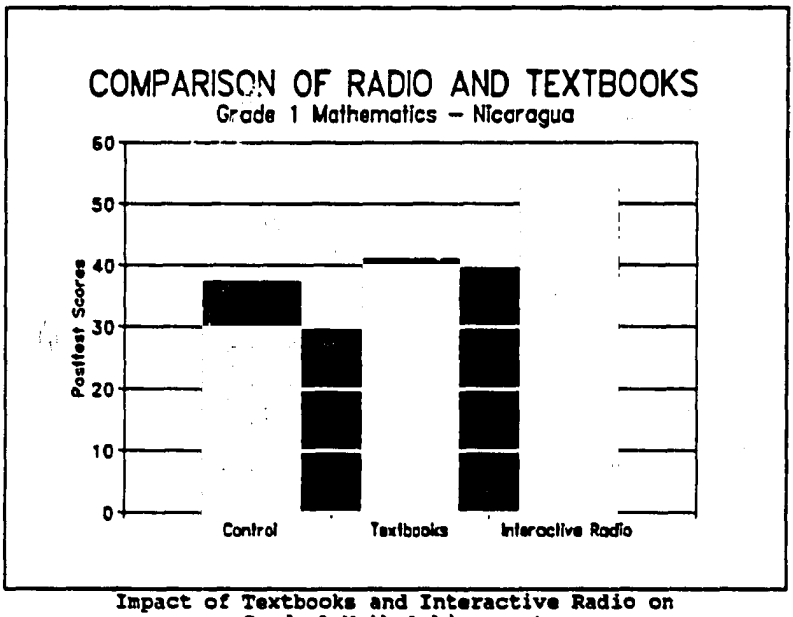


Figure 2.1

And a study that compared interactive radio with another educational intervention in Nicaragua confirmed those findings. As part of RMN, Jamison *et al* carried out an experiment with three groups of children in first-grade math classes. The first group had a limited number of textbooks, typical of classrooms in traditional schools (control group). In the second group the supply of textbooks was ample: one for every child (textbook group). The third group of children heard the interactive radio lessons (radio group). There were no significant differences among the three groups of children on the pretest. The mean posttest scores for each group, using the class as the unit of analysis, is shown in Figure 2.2. There was a marked impact on achievement from both interventions. Availability of textbooks increased student posttest scores by about 3.5 items correct; the radio lessons increased the scores by the much greater margin of 14.9. Although the textbooks resulted in a significant increase in learning, the impact of IRI was much greater (Jamison *et al*, 1981).



Impact of Textbooks and Interactive Radio on Grade 1 Math Achievement

Figure 2.2

It's important to consider the *feel* of the radio instruction as well as its results. Radio Math elicited intense concentration, and that concentration was centered in the exercises themselves. When stories were introduced into the instructional segments in early broadcasts some of the children seemed bored. When the radio teacher told them to get out their worksheets their faces, their attitudes changed. It was the math that delighted them. Their confidence grew quickly as they succeeded at the carefully designed exercises set for them. The speed and accuracy with which they worked increased over the years of the broadcasts. They were poor, many of their parents were illiterate, their teachers were often inadequately prepared, and they lived in rural areas of an impoverished country, but they were learning, and learning well, the most painstakingly developed primary math curriculum in the world.

By all these counts, RMN was a triumph. The project began at a relatively peaceful moment in Nicaragua's history, and ended four and a half years later during the Nicaraguan revolution, when broadcasts were often disrupted, attendance at school could be dangerous, and there was fighting throughout the country. But these adverse circumstances only underlined the success of the project. Radio, a not-very-high technology already established throughout the developing world, had the capacity to

teach primary math to children. The prototype worked, and it worked as staff members had hoped it would, for all students in Radio Math.

RMN is still working, as recent adaptations for primary grade students in Bolivia and Ecuador confirm. Its earliest replication in Thailand was a success. Its second adaptation for children in RADECO schools in the Dominican Republic also demonstrated its sturdiness. But effective and adaptable math lessons were only its first fruits. RMN *created* interactive radio. The principles of the model that would teach English as a second language, initial reading, science for upper primary grades, and health and nutrition to children throughout the world were all established in Nicaragua.

3

The Second Phase: The Radio Language Arts Project in Kenya

> As quickly as emerging countries threw off their yoke of colonialism, they burdened their students with education conducted in a foreign tongue. This was not a new burden, but a continuation of the educational system developed by the colonialists to educate the bureaucrats necessary to administer the country . . . . As international educational planning became part of national political and economic planning and development in the early 1960s, integrating an international language into school curricula was deemed essential . . . . This development goal, coupled with the need for international political communication, guaranteed a place for international language—most often English or French (Imhoof, 1981).

This is how Maurice Imhoof, technical advisor for the "Radio English" component of the Basic and Nonformal Education Systems Project in Lesotho and formerly Project Director of the Radio Language Arts Project (RLAP), summarizes the background of language education policy in multilingual Africa: mother tongues have critical cultural importance, but the language of politics is either English or French.

These international languages were grafted onto the continent long before African nations won their independence in this century. They coincide with the imposition of the colonial order. Economists teach us that the demand for literacy depends upon and comes *after* structural economic change. In a subsistence economy people see the ability to read as relatively valueless (and if in fact they have no books or newspapers that

view is sensible). As exchange economies develop, however, as towns grow into cities, as social differentiation comes to depend on occupation and income instead of ancestry, the desire for literacy becomes compelling. Those whom schools select for further education inevitably come to hold positions of power within an emerging social structure. Traditional informal education that prepares children for life as their parents have known it in their local communities isn't enough. Especially in Africa, modernizing societies are likely to consist of many cultures, for which a single, local set of norms and values is inadequate (Thompson, 1981).

Literacy in a single language is inadequate too. In a multicultural, multilingual country like Kenya, for example, where students may speak any one of 40 different mother tongues, they must also be literate in English, because only those who can speak and read and write English can continue in school beyond Standard 3. Starting in Standard 4, English is used as the medium of instruction (in the lower primary grades, Standards 1-3, it is taught as a subject for an average of five hours a week).

One of the reasons Nicaragua had been chosen for the Radio Math project was that it had a single national language, Spanish. But for the second crucial prototype project in interactive radio instruction, which was to design and implement a program for teaching English by radio, specifications for site selection had changed. Now a multilingual, multicultural setting was the qualifying factor. Because of its many native languages and its highly developed infrastructure, Kenya was chosen as the location for the Radio Language Arts Project.

On September 26, 1979, eight months after the last expatriate RMN staff members left Nicaragua, A.I.D.'s Bureau of Science and Technology/Office of Education entered into a contract with the Academy for Educational Development in Washington, D.C., to develop a radio-based instructional program for teaching English. To some it seemed unlikely that radio could be used to teach language, since language lessons involve guided practice in speaking and writing. But A.I.D. supported RLAP because of its conviction, confirmed by all the evidence from Nicaragua, that radio lessons could improve primary education quickly and cheaply.

The subject might appear difficult—it was difficult, and it was radically different—but the methodology deserved another test. And IRI had some documented advantages. There was a significant history of the use of radio to teach foreign language in Thailand and the Philippines and Brazil in the 1950s, and earlier in Sweden, the Netherlands, and England (Imhoof, 1981). For the underqualified teacher of English, as for the underqualified teacher of mathematics in Nicaragua, radio offers useful assistance. It releases teachers from the burden of creating constant exchanges of information in their second language and provides them with reliable substitutes, the radio actors (Imhoof, 1981).

Radio Language Arts teacher directs a first-grade class in English as a second language.

Teaching a Second Language

In Kenya the interactive model still depended on the three linchpins of Radio Math: systematic instructional design, distributed learning (instruction in each operation or competency is divided into many brief teaching segments and distributed over many lessons) and continuous review of the children's responses and their learning gains. RLAP used radio as intensively as RMN had, in half-hour lessons broadcast every schoolday. But because imitation and repetition take less time than mathematical computations, it increased the number and pace of pupil responses significantly. Like RMN, RLAP's *English in Action* broadcasts reinforced the responses immediately, maximized "time-on-task" by conducting the entire lesson in English—the radio lessons covered three times as much content in a half hour as traditional lessons (Anzalone, 1988)—and varied the style and pacing of instructional segments. But the *conception* of the radio lesson as an entry point for illusion, and the relationship between the radio broadcast and the classroom teacher, were new.

As we've seen, RMN staff members had discovered that Nicaraguan schoolchildren were young enough, and innocent enough of media-

saturation, not to need entertainment during instructional segments. The broadcasts included songs and simple physical activities as *respites* from the intense concentration they required. But jokes, riddles, and stories were unnecessary. The intensity of their participation motivated the children who listened to Radio Math. They were learning secrets about the mysterious though not alien world of numbers, and the process of discovering the codes that rule that world was fascinating in itself.

Because it forces children to abandon their mother tongues, if only temporarily, learning another language is a different and riskier business. The children must be willing to submit to displacement, to a degree of disorientation, especially at the beginning of the process. They need an incentive to do so. Radio Language Arts made an incentive of illusion. The radio became a point of entry through which interesting characters appeared in the classroom and introduced the children to an invented world, a world that was varied and inviting enough to focus their concentration, as math operations had for the children of RMN. Illusion was minimal in Radio Math lessons. For *English in Action* it was a central value, of increasing importance and increasingly elaborated as the children acquired more skills in the language.

A New World in the Classroom

The primary agents of illusion were the radio characters. In the Year One broadcasts the children met Juma, Rosa, Chege, Akinyi, Mumbi, and Mr. B, who taught the alphabet; Year Two and Year Three scripts introduced Safiri, Tina, Sara, and Rono, and as secondary characters the Hamisi family: mother, father, son and daughter, grandparents, aunts, uncles, and cousins. Other characters included a fisherman and his son. They all lived together in a rural community that from the beginning felt familiar to most of the children because it was like their own communities. But in the radio world the words were all different.

Describing that world in its own terms was exhilarating as well as risky. The children loved doing it. Radio Language Arts depended on their delight in the radio characters, and that delight proved reliable. Kenyan children accepted the residents of the radio world unreservedly. They didn't worry about whether they were really talking to Tina or Mr. Hamisi, and they didn't wonder why Rono could see what was written on the blackboard while Sara could not (Imhoof and Christensen, 1986). RLAP recreated the world for them, and scriptwriters could count on the children's commitment to the illusion. But it also depended heavily on the classroom teacher, who prepared the blackboard, identified the day's special participants, and presented regular complementary lessons, and

on supplementary materials for writing and reading. RLAP staff members, like their counterparts in Nicaragua, imagined the least favorable circumstances for the broadcasts and tailored the lessons to those circumstances, but relative insulation from the teacher would not work for the *English in Action* series. Language is fundamentally *social*; it depends on exchange, and many of its satisfactions are communal.

Language in Kenya

Communal satisfactions are difficult to achieve in a multilingual setting. That's another of the reasons why all schoolchildren in Kenya must learn English. Radio Language Arts operated in seven different districts of the country, each of which had at least three representative schools in the project. The principal languages of the schools in these districts were: Swahili in Kilifi District, Kamba in Machakos District, Maasai in Kaijado District, Kikuyu in Kiambu District, Kalenjin in Kericho District, Luo in Kisumu District, and Luhya in Kakamega District. The schools fell into three broad categories: those in which the majority of children spoke one mother tongue; those with significant minorities who spoke different mother tongues; and one school where there was a variety of mother tongues, none of them dominant.

Multilingualism increased the complexity of the experiment in Kenya, but it also confirmed the need for the exclusive use of English during the broadcasts. There was no *lingua franca* with which to give directions or explanations. Scriptwriters were obliged to fill all their radio minutes with English, half of it spoken by the radio actors, half by the schoolchildren.

Once again, as in other developing countries, students in Kenyan cities had advantages over those who lived in rural communities. It is much easier to learn English in Nairobi than it is in the countryside. City children hear it regularly in their out-of-school lives. Children who live in isolated communities, however, may never hear English except during the radio broadcasts. RLAP concentrated on the children in these rural schools.

Another difficulty was that standard Kenyan English is hard to define. Unlike African French, which shows less variation (the French required their African schools to use French exclusively, while the English allowed the use of mother tongues in colonial schools), African English sounds different in Nairobi than it does in Lagos. Within Kenya it sounds different in Kiambu District than it does in Kisumu District. Everyone agrees that Kenyan English is not American English, but there is substantial disagreement about how closely it ought to follow the British model.

The RLAP staff met this difficulty by agreeing to follow the British model for grammar and vocabulary while accepting variations in pronunciation and intonation (Imhoof and Christensen, 1986).

Curriculum

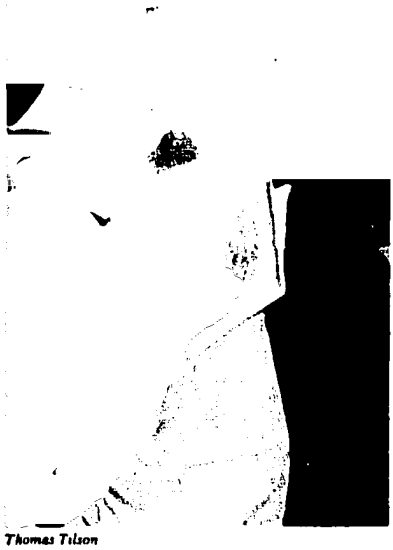
Staff members also agreed that they had to assume "zero-proficiency" in English language skills, despite the inclusion of urban schools in the project, and they designed the three-year sequence of broadcasts with this in mind. Standard 1 had a small, minimally characterized cast of radio voices. It concentrated on listening and speaking skills at first, postponing reading and writing exercises until the end of the year's broadcasts. By Standard 3, scriptwriters felt comfortable about introducing grammatical structures, concepts, and vocabulary during the reading segments of the broadcasts as well as in the listening and speaking segments. Like the RMN staff, who had followed the Nicaraguan national curriculum when they wrote the radio math lessons, RLAP writers followed the Kenyan curriculum when they drew up the 'scheme of work' for the radio broadcasts. From the syllabus for each Standard they specified behavioral objectives in the four skill areas of listening, speaking, reading, and writing.

In order to measure how successfully the lessons were meeting the behavioral objectives they had specified, the RLAP staff assembled a team of 20 classroom observers from the regional teacher resource centers assigned to the project, and conducted a 10-day training workshop in November of 1981. Pairs of observers were assigned to 10 schools. When *English in Action* broadcasts began in January of 1982, the observers were ready to undertake their duties, which included both formative and summative evaluation. They visited classrooms, recorded what they observed on carefully designed data sheets and rating scales, and took specific anecdotal notes; they administered formative tests; they interviewed teachers and children; they ensured that all tests and evaluation materials were returned to the project office in time for analysis; and they administered the summative evaluation tests at the end of each year's broadcasts (Imhoof and Christensen, 1986).

How the Scripts Evolved

Radio was *known* already when the prototype projects began in Nicaragua and Kenya. Studio production techniques such as sound effects, segues, and fading were already part of every radio producer's arsenal.

Lesotho—The First Adaptation of Radio Language Arts



Thomas Tilson

In Lesotho, a second-grade student of English in Action *uses her knee as a desk.*

Three hundred twenty-five of the primary-school teachers in the kingdom of Lesotho in southern Africa have more than 100 students in their classrooms. Some of these teachers are unqualified; all are so overburdened that it is impossible for them to teach effectively. Since 1985, the Basic and Nonformal Education Systems (BANFES) Project, funded by USAID, has been working in Lesotho to improve conditions for teachers and students, and to assure that all children have access to basic education through seventh grade (only 46% of children who enter primary school in Lesotho reach seventh grade). Sesotho is the native language of the Basotho people, but in Lesotho, as it is in Kenya, English is the medium of instruction in the upper primary grades. For students who want to stay in school, fluency in English is critical, but in the remote rural areas of this mountainous country, where children never hear English spoken outside of school, fluency is hard to come by. In 1987, with support from BANFES, the English Division of the National Curriculum Development Center designed and tested a pilot adaptation of the Radio Language Arts Project's *English in Action* series. The pilot was so successful, and generated so much excitement, that some schools began collecting money from parents to buy radios even before full implementation of the program was officially announced for the following year.

In February of 1988 broadcast of the Standard 1 lessons began throughout Lesotho, and in 1990 the entire three-standard series will be broadcast to 200,800 Basotho children. (*English in Action* is not a mandatory program, but 1100 of the 1200 primary schools in the country have purchased radios in order to receive the broadcasts). Anecdotal evidence strongly suggests that Lesotho's version of *English in Action*, which has been completely re-scripted and re-recorded by Basotho actors, is already improving the standard of English among students and teachers alike.

And everything teachers needed to learn about the radio could be covered in a few minutes during a teacher-training session. But radio is only one of the technologies of IRI. Systematic instructional design was the model's other, and more experimental technology, and it was still in the process of becoming during the years of Radio Math and Radio Language Arts. Formative evaluation was as critical to the development of systematic instructional design in Kenya as it had been in Nicaragua. It revealed to RLAP scriptwriters "the unbelievable number of ways in which a radio lesson can go wrong" (Imhoof and Christensen, 1986). Happily, it also revealed the positive effects of the "relentless interactivity" between the children and the radio characters, Safiri and Tina and Sara and Rono.

RLAP scriptwriters believed that constant exchanges of dialogue characterized good language teaching, so they asked the children to respond to the radio voices every few seconds. The target was 150 response pauses in a half-hour lesson. Visitors could see the results of this uninterrupted exchange when they observed RLAP classrooms. The children loved to sing the Good Morning song that opened each lesson (*English in Action* was broadcast five days a week at 9:30 a.m.); they loved to answer the radio's questions together; and they loved to be singled out for the individual responses, in words or action, that RLAP added to IRI's repertory. They were *alive* to learning during the radio broadcasts, and they had confidence in themselves. Teachers, classroom observers, headmasters, school inspectors, RLAP scriptwriters—everyone involved in the project—could see the results of that liveliness and confidence in the children's faces, in their movements, and in their eagerness to speak.

Summative Evaluation

Visible success doesn't translate into assessments of achievement, though, and once again, as in Nicaragua, summative evaluation was necessary. In Kenya it was undertaken by an independent organization, the Center for Applied Linguistics of Washington, D.C. Like the independent evaluators of RMN, these researchers found that children in the radio classes showed significantly improved achievement when they were compared with ESL students in traditional classrooms. The children were tested in the areas of listening, speaking, reading, and writing. In all four skills, the mean scores of the radio children were higher than those of students in traditional classrooms. The most striking difference appeared in the listening test for Standard 1 children: the radio children had a 23.4% to 15.5% advantage in this area. This shouldn't be surprising, since *listening* is everyone's instinctive response to a radio voice. It shouldn't be surpris-

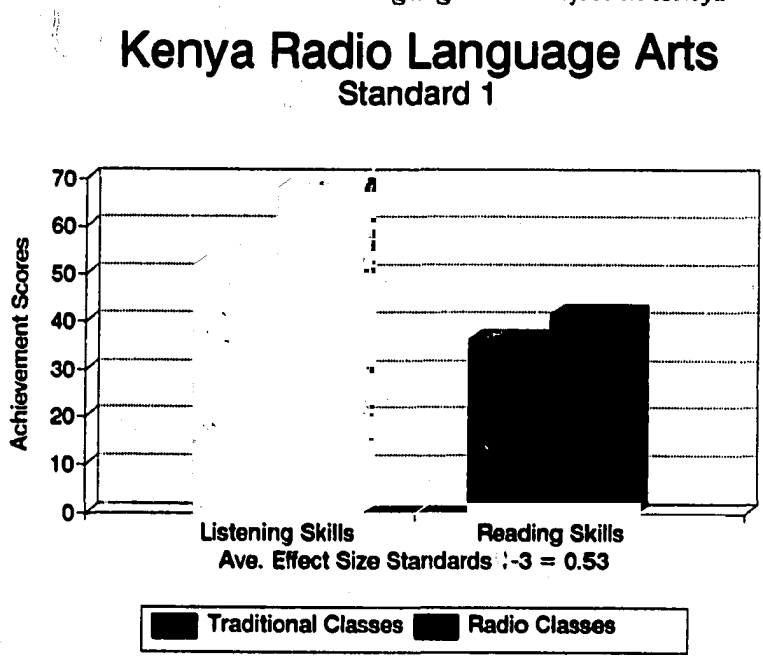


Figure 3.1

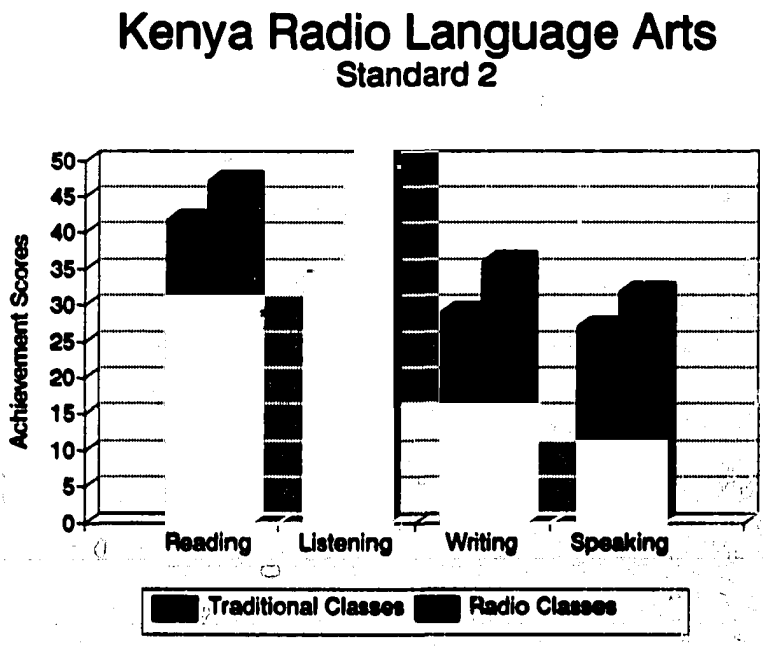


Figure 3.2

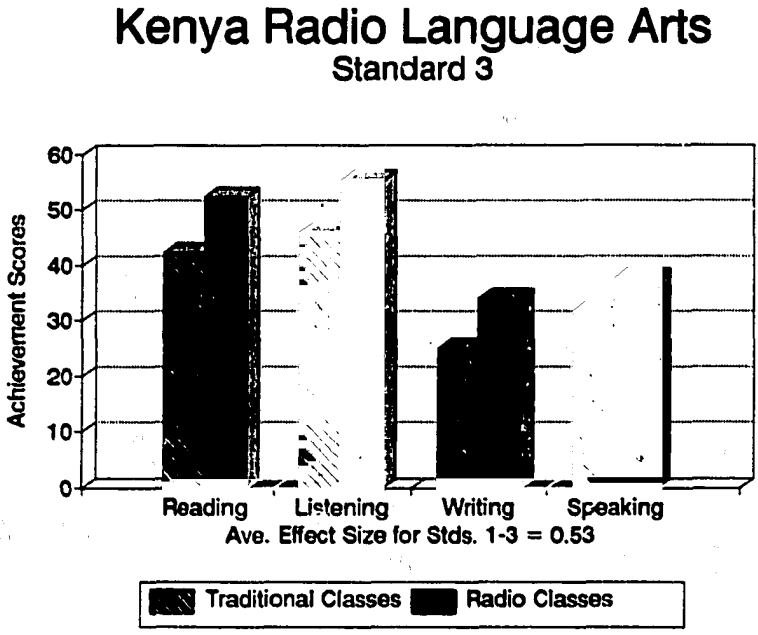


Figure 3.3

ing, either, that writing was the weakest of the four skills among the *English in Action* children (their scores, nevertheless, were significantly higher than those of children in the control classrooms).

Another Prototype is Confirmed

For the RLAP children, learning English was no longer merely one of the burdens of *realpolitik*, born in colonial history and sustained by the economic imperatives of national development. Instead it offered them power at the most personal level. The Radio Language Arts lessons gave them a guarantee for the future: they knew they would be ready to do well in Standard 4. They had undertaken something very difficult and they had succeeded at it. Of course they hadn't yet achieved mastery of English. But now they could reasonably *expect* to achieve mastery.

These are human results. When expressed statistically, they look different. Here is one uncomplicated way of putting it: if you take the control group as scoring at the 50th percentile, the children of RLAP scored at the 68th percentile overall. In Nicaragua, if you take the control group as scoring at the 50th percentile, Radio Math children had scored at the 76th percentile, 26 points higher.

The first two experiments in IRI were now complete. There would be two more pioneering efforts—RADECO in the Dominican Republic, the IRI prototype project for unschooled children, and the Radio Science Project in Papua New Guinea, which began in 1986 (see Chapter 6). But the summative evaluation of RLAP marked the end of groundbreaking research and development of radio-based courses in the two broadest areas of the primary curriculum, math and language arts. After Kenya, IRI entered its third phase. The adaptation of the radio lessons and the dissemination of the model to other countries began.

4

IRI Moves out of School: the RADECO Project in the Dominican Republic

Children in the radio classrooms of Kenya wore school uniforms: blue skirts or shorts with yellow shirts and blue sweaters in some districts, coral-colored dresses or shorts with blue shirts and blue sweaters in others. The children who attend traditional schools in the Dominican Republic wear uniforms too. Their dresses and shorts are tan, their shirts white. Even though 91 percent of children in the Dominican Republic go to school, this figure is misleading for remote rural areas. Before 1983, in the isolated and mountainous southwest, one-fifth of the children of primary-school age were deprived by poverty and distance of the education their parents wanted for them. Now there is RADECO.

Except that they don't wear uniforms, children in the RADECO schools look the same as other schoolchildren in the Dominican Republic. Visitors to their radio shelters can't tell that these children work all day in coffee or cane fields. They don't even look tired when they arrive at the *enramada* late in the afternoon to listen to the RADECO broadcasts that have for the last seven years provided them with nonformal schooling. The only difference between them and other children in the Dominican Republic is that they live in Barahona, where the disadvantages of poverty, isolation, and illiteracy converge, and they have no conventional schools. Instead they have RADECO, which gives them access to literacy, numeracy, social studies, natural science, music and games—the tools with which to fight their marginalized position in their country. In this region, radio provides the *only* point of access to such skills.

The children's isolation from traditional schooling is not just a matter of distance. "You know how the formal schools are," one mother says.

"They don't take the children without proper uniforms. And if the parents can't afford to buy clothes, they'd rather not send their children to school. Well, at RADECO, they'll accept them any way. Even if there's no time to get them clean, the children can go as they are, because the idea is for them to learn. What is important is that the children are taught. They're educated, without regard to material things." The uniforms and supplies that constitute "material things" in a formal school are beyond the means of parents in Barahona. They must concentrate on very basic provisions that keep their children alive: food, shelter, clothing. So their children are used to making do. If they have benches to sit on in the radio shelter, that's fine. If they have to sit on the ground, that's fine too. The shelters are built as inexpensively as possible of whatever materials come most easily to hand. In some communities the *enramada* is nothing more than a thatched roof on four support posts. In other places it will have stockade-style walls, or walls of rough, uneven boards, or both.

When there are walls, there are enough chinks in them so that you can see the movement of trees and people outside, where the community goes about its business with apparent indifference. But inside the shelter, while the children listen to the hour-long radio broadcasts, a remarkable

RADECO children meet with the radioauxiliary in their enramada.

process is going on. Unschooled children are learning the core curriculum of the Dominican Republic in an hour each day, and they are learning it *as well* as their counterparts in traditional schools, who spend three or four times as many hours in their classrooms.

Barahona province, which is close to the border with Haiti, includes a quarter of the land in the Dominican Republic and is home to 15 percent of the population. It is the poorest region of the country, and has the highest rates of illiteracy, malnutrition, and infant mortality. Housing is below standard. There is subsistence farming and some fishing in Barahona, and there are coffee and cane fields. Most of the children who attend the RADECO schools work at the same occupations as their parents. The work is hard, probably joyless. They work hard during the radio broadcasts too, but in the *enramada* their delight is both apparent and real.

Two Radio Traditions

That delight comes at the intersection of two traditions in instructional radio. RADECO adopts the techniques of IRI, but it also has roots in the *radiophonic* model created in Colombia over 40 years ago by *Acción Cultural Popular* (ACPO), an organization that pioneered basic education courses delivered by radio to people in remote parts of the country. ACPO sought to provide instruction in basic literacy. But RADECO offers more. The agreement signed by A.I.D. and the government of the Dominican Republic mandated three major efforts: to design an effective and inexpensive teaching program that would deliver the national curriculum to school-age children by radio, to adapt the content of grades one through four to the IRI model, and to train Dominican professionals to implement the program.

The IRI prototype projects in Nicaragua and Kenya were conceived and funded as experiments. Experiments offer opportunities for research. When the research data have been collected, evaluated, and summarized, the experiment typically ends. But RMN was so successful that fully detailed plans were made for national implementation of the math lessons after the pilot project was complete. Educational interventions cannot predict the political future, however, and the Nicaraguan revolution ended prospects for national implementation. In Kenya as in Nicaragua, the hope was that IRI would achieve institutionalization after the pilot phase. But the Kenyan government has not yet decided whether to institutionalize Radio Language Arts. Both projects had demonstrable learning gains and eager adherents among children, teachers, and parents; both projects have been adapted for use in other countries, RMN in Thailand, the Dominican Republic, Ecuador, and Bolivia, and RLAP in

Lesotho, Swaziland, and Belize; but neither had institutionalization written into its original contract.

From the beginning RADECO was committed to continuation. The initial agreement between A.I.D. and the Dominican government specifically implied this commitment: "It is expected that by the end of the project, SEEBAC (the Dominican Secretariat of Education, Fine Arts, and Religion) staff, as a result of on-the-job training and in-country workshops, will assume the responsibility of designing and disseminating additional radio education programs for primary school children between the ages of 7 to 14 years" (Eshgh *et al*, 1988). In March of 1986 that expectation was fulfilled when SEEBAC officially adopted the *Programa Radioeducativo* and made RADECO an integral part of the government-funded educational establishment. This was the first time IRI was *institutionalized*. The methodology was intended to provide developing countries with an effective and inexpensive way of improving basic education and guaranteeing access to all their children. When SEEBAC incorporated the *Programa Radioeducativo* into its operations, it accomplished IRI's original objective.

Curriculum

RADECO scriptwriters didn't know how their experiment would end when they began to adapt the radio math lessons in 1982. But they did know how the IRI model worked. RMN had proved that a 30-minute radio lesson in math ought to contain about a dozen instructional segments of a few minutes in length, and that each of the segments ought to be part of a sequence of such segments distributed throughout a sequence of broadcasts. And RMN provided the curricular model for the RADECO math lessons.

There was no curricular model for the reading lessons that would take up most of the remaining 30 minutes of the hour-long RADECO broadcasts. Curriculum specialists and scriptwriters had to develop a plan for teaching reading in the mother tongue. In traditional schools, the first-grade objective was to teach students to read and understand simple sentences. So this is how the RADECO writers proceeded. They divided the first-grade reading curriculum into five topics or "strands": letters, syllables, words, phrases, and sentences. Although the topics appeared to increase in complexity, they were not always arranged in perfect sequential order in the lessons. Exclusive concentration on letters lasted only until the children had mastered enough letters to allow them to understand syllables. Scriptwriters introduced syllables and words at the same time, and proceeded to instruction in reading simple phrases as soon as

the children had mastered enough syllables and words. A little later, scriptwriters introduced brief sentences into the lessons, and after that, the strands were mixed in the broadcasts (Eshgh *et al*, 1988).

Community Development

Curriculum design is always the primary obligation in interactive radio projects, but in the Dominican Republic another crucial effort had to be completed *before* the radio lessons were broadcast. Radio Math and Radio Language Arts had depended upon the existence of appropriate schools in their site countries. RADECO had to create its own school settings. Its community outreach component began with a census of the communities without schools in Barahona province. A staff of five undertook this preliminary work. The criteria for site selection were straightforward. The target community must not have a school; it must be within a one-day round trip from Barahona; and it must be reasonably accessible by roads or footpaths. Information about suitable communities was limited and unreliable, for often maps of the region were neither accurate nor current. Frequently community supervisors had to conduct their own demographic research. The work was difficult, but local people helped the supervisors: "many communities were found not by following a map or official guidance, but by following leads from local people—school teachers, cane cutters, or mayors" (Eshgh *et al*, 1988).

After possible sites had been identified, there were geographic, economic, and sociopolitical conditions to consider. Was the site accessible by motorbike? (In some cases supervisors had to walk the last few kilometers to a RADECO school.) Was the site subject to fierce rains that could interrupt transmission of the broadcasts and make delivery of supplementary materials impossible? What did the children in the community do *after* their primary workday had ended? Did they have other, part-time jobs, and if so, when? Did their families move from place to place after the cane or coffee harvests? Who were the leaders of the community? Once questions like these had been answered, and the RADECO school sites had been identified, there were three more steps in the community outreach process. Parents and local community leaders had to form a local school association. They had to build a shelter where the children could gather for the broadcasts. And a radioauxiliary had to be appointed and trained.

Radioauxiliaries are not teachers. But basic literacy is the major qualification for the job, and teachers who participated in RMN and RLAP would not be unfamiliar with the radioauxiliaries' duties: they operate the radios, they organize the classes, they follow the lessons in their daily

work guides, and they help the children when they can. Most of the radioauxiliaries are under 30 and male; most have completed four or five years in school.

RADECO differed radically from RMN and RLAP because of its elaborate community development activities. But once the students are gathered in the shelter and the broadcast starts, the classroom dynamics are very much the same in all these programs. In the Dominican Republic the typical 60-minute RADECO broadcast includes 200 pauses for students' responses. The lively and enthusiastic RADECO children tell the story of each lesson during those pauses: that radio can teach basic skills under adverse conditions and without the support of a well-trained teacher. Besides the radio, RADECO classrooms are equipped only with a chalkboard; students are given worksheets, pencils, and clipboards that take the place of desks. The *enramadas* confirm what participants in IRI programs discovered in Nicaragua, that furniture is not really important.

Summative Evaluation

Formative evaluation followed the same model for RADECO as it did in Nicaragua and Kenya, but summative evaluation was more difficult in the Dominican Republic because the circumstances in which RADECO children lived were so different from those of students in the public schools. Their communities put them at a very great disadvantage. Because they grew up in remote areas where there were no schools, no social or medical services, almost no significant family income, little communication with population centers, and widespread illiteracy, it was impossible to match them with control classrooms in which equally unfavorable conditions existed.

Children in formal schools had certified teachers. RADECO children, on the other hand, enjoyed smaller classes, and systematically developed instruction. They were older than public school students at the same grade level, and more of them were girls. They spent much less time in class, they had access only to the core curriculum, and the promotion policy for the radio classrooms was quite different: in traditional schools in the Dominican Republic and throughout Latin America, teachers require many students to repeat grades. (This was the case in Nicaragua even during the Radio Math project. Factors other than achievement seem to be involved in these decisions.) Repetition of a grade was uncommon for RADECO children.

For all these reasons, the comparison between RADECO children and public school students is inexact. Nonetheless, instructive conclusions can be drawn from it. In an item-by-item comparison of the results of the first grade posttest, RADECO children responded correctly 51% of the

time, while the control group averaged only 24%. The RADECO advantage in mathematics was greater than in reading. (One possible bias in the testing procedure was that instructions were given by radio, to which children from traditional classrooms were not accustomed.) The second grade posttest showed that RADECO children gave 10% more correct answers than children from the control group. However, children in traditional schools had a clear advantage in writing skills, especially with more difficult words and phrases. For the RADECO project, summative evaluation had to include correction for several possible biases, and when test data were analyzed excluding items to which the children made no responses at all, the disparities between the performance of the radio children and those in traditional classrooms narrowed, especially in reading, language, and writing scores. But it was still clear that RADECO children achieved mastery at least comparable to that of their counterparts in traditional schools in reading, language, and writing, and that their advantage in mathematics was significant.

In some ways this was the best news yet for interactive radio. Perhaps it wasn't surprising that the model should work so well in traditional schools. IRI, after all, allowed recruitment of the best teachers and curriculum specialists in the site country to write the scripts for a project and drafted or trained a professional radio production staff to record them. Comparisons between the instructional resources available to staff members of RMN or RLAP and the resources available to an inexperienced, underqualified young teacher with several grades to teach in a single classroom in a dusty rural school in Nicaragua or Kenya are simply unfair. The *instruction* itself was bound to be more effective if it was designed by experienced teachers working as part of a team, usually in a city or large town that provided production facilities.

But in Barahona province, where local conditions were so unfavorable to schooling that there was no hope that children could be educated without RADECO, the circumstances in which the students lived might have doomed the project from the start. Their families were so poor, the work they did during the day was so hard, their isolation was so unrelenting, their access to the materials of literacy so limited that even with the best instruction, delivered by the demonstrably effective interactive radio, the results of the project were by no means guaranteed in advance. That RADECO did succeed, that it continues to provide the core curriculum to otherwise unschooled children in isolated communities in the Dominican Republic, offers hope in World Literacy Year for 100 million children in the poorest nations who cannot attend school. It would be foolish to suggest that IRI projects could offer immediate help to all, or even most of those children. It would be more foolish still to overlook interactive radio instruction, which can certainly help many of them.

Institutionalization

When a ministry of education in a developing country considers the addition of an interactive radio program to its regular core curriculum, the cost of that program has to be classified as an "add-on"—as the cost of other educational interventions like textbooks or teacher training would be classified. In other words, the ministry must be willing to pay again for instructional materials in an area of the curriculum that it is already covering. Even if the new materials are much more effective than the old materials it is difficult to justify an expenditure that may impoverish some other area of the curriculum. An IRI project that achieves very encouraging learning gains may be more desirable than a traditional, unrealistic and unrealizable syllabus for primary math, for instance, but a ministry of education may not be able to afford such an improvement.

RADECO was an "add-on" too, even though it did not duplicate another educational effort. In Barahona before the RADECO broadcasts, there was *no* curriculum for 120,000 unschooled children. Without a curriculum there was no cost. RADECO provided the core curriculum, but at a potential cost estimated at about half that of building and staffing public schools in the region.

So it was an attractive option for the Dominican Secretariat of Education, Fine Arts, and Religion, and it was a project in which SEEBAC was already substantially invested when RADECO's first four-year cycle of radio lessons was completed. RADECO had drafted professional staff from SEEBAC from the beginning of the project, and RADECO staff members had kept in close contact with officials of the Secretariat. In 1984 RADECO's production department moved from Barahona to Santo Domingo, where SEEBAC technicians worked on the project. RADECO could demonstrate that its cost-effectiveness increased as the number of children and communities receiving the broadcasts increased. RADECO could demonstrate that "the per pupil (unit) cost of making four grades of radio primary education available to the nearly half million unenrolled school-age children would be about half the current unit cost in the formal system" (Eshgh *et al*, 1988).

The project had an array of achievement scores and cost estimates as arguing points, but most important of all, it had usable products: a staff trained in radio production, and the RADECO lessons themselves. In the last six months of the pilot phase of the project, RADECO invited SEEBAC officials into the radio schools in Barahona province to see how the model operated. What SEEBAC officials saw and heard in the radio shelters of the southwest was a more persuasive argument than any that a graph of learning gains or an elaborate cost analysis could offer. They saw the children *learning*, with enthusiasm and pleasure. They saw that the

parents of the RADECO children and other members of the local school associations were RADECO advocates. They talked to the radioauxiliaries. SEEBAC officials knew that the unschooled children of the Dominican Republic needed RADECO—there had never been any doubt about that. Now they saw what use the children and their communities could make of the project.

Early in 1986 SEEBAC formed a task force to review the RADECO project. In March, even before the task force had reported its findings, the Secretariat formally established the Department of Radio Education within its Educational Media Division. The project had succeeded in its own pedagogical terms, as its summative evaluation showed. But it had also succeeded politically by overcoming SEEBAC's early skepticism. RADECO introduced a new methodology into Dominican education, a methodology tailored to the Dominican curriculum. It did not impose alien content. IRI was a tool, not a threat.

RADECO Update

When the RADECO pilot phase ended in 1986, there were 34 radio schools with 60 classrooms (26 of them first-year, and 34 third-year). In 1989 RADECO had 57 schools and 80 classrooms (57 of them second-year and 23 fourth-year). Growth of the program has not proceeded at the pace that planners imagined. There are various explanations for RADECO's failure to expand—staff turnover, political disputes, uncertainties of funding. But *because* RADECO achieved institutionalization, such difficulties haven't spelled doom for the project. In August of 1989 RADECO organized a seminar for SEEBAC officials, Provincial Education Directors, District School Supervisors, members of the project staff, and representatives of international donor agencies. The purpose of the meeting was to discuss the current state of RADECO, and to draw up realistic plans for its future.

Conferees agreed about several things: that educators have a positive attitude about RADECO, and would like to see it expanded immediately; that a proposal for a pilot project in the poorest neighborhoods of Santo Domingo had merit; that the use of RADECO math lessons in the classrooms of inefficient formal schools deserved consideration; that followup studies of RADECO graduates would be useful; that assistance from donor agencies outside SEEBAC should be a priority.

It is crucial that RADECO shift from a materials-production mode (improvement of the radio lessons) to an expansion or coverage mode (Helwig and Galda, 1989). Otherwise the unit (per pupil) cost will continue to be high. Established methods for incorporating new communi-

ties into RADECO—adequate for the pilot phase—are too expensive and time-consuming for the national implementation phase that ought to follow (Helwig and Galda, 1989). Participants in the seminar discussed ways to achieve complete coverage of communities without schools in the southwest: one approach would use an intensive mass media campaign—through radio for most rural areas—to make RADECO visible to representatives from unserved communities. Coverage could be extended too in the poor urban areas of Santo Domingo, where many children are unschooled. And RADECO schools might take the place of some isolated formal schools that are not functioning well.

But these possibilities have prerequisites: increased funding from donor agencies; the hiring of additional project staff members; carefully designed plans for expansion; less intensive supervision of RADECO schools; different methods for training radioauxiliaries; efficiency in recruiting RADECO communities; increased cooperation within SEEBAC; greater collaboration among development agencies; a strong executive to supervise the expansion (Helwig and Galda, 1989). Of course it is very difficult for a poor country like the Dominican Republic to meet these conditions. But the benefits to Dominican children are guaranteed.

5

A Wider Role for IRI

I. The Process of Adaptation

> Replication or adaptation can mean any of several things: introducing an established system or methodology to a new host country where such systems are not in use, rewriting and re-recording existing materials for use in another cultural setting or in a different host country, or extensively modifying existing materials for use in some very different context. In designing RADECO, replication occurred in all three senses. (Eshgh *et al*, 1988).

Although RADECO was not technically innovative—the strategies of instructional design for interactive radio were firmly established after RMN and RLAP—the project created a new model for teaching initial reading in Spanish and broke new ground in the area of community development. These were genuine innovations, born in conditions specific to the Dominican Republic. But RADECO's use of RMN lessons was important too. For the first two years' math lessons, scriptwriters made changes principally for the sake of cultural differences. The number of lessons was the same (170), the lesson length was the same (30 minutes), the topics were essentially the same. But in the third and fourth years the Dominican curriculum proceeded at a faster pace than Nicaragua's, and lesson writers increasingly turned to the Dominican national syllabus rather than to the RMN lessons for guidance. The Radio Math material was still useful, and writers referred to it often. But it no longer provided close equivalents for RADECO's daily broadcasts. At this point "the project began to generate 'replications' in the third sense—increasingly divergent *adaptations* of RMN material, until finally, by year four, little script-by-script similarity remained" (Eshgh *et al*, 1988).

Planning for adaptations of the interactive radio model began at the conception of RMN. Translation of the lessons into English, from which it might be easier to translate into the language of the next host country, was an obvious first step, and it was made a matter of contractual obligation that Stanford should supervise that first translation of RMN lessons during the life of the project. Early in the development of interactive radio instruction people imagined that *replication* would produce precise copies—in different languages—of the model. They soon discovered, however, that this kind of reproduction was impossible. In the first adaptation of RMN for Thailand, scriptwriters had the advantage of a national syllabus for primary math that closely matched Nicaragua's. Nevertheless they had to make significant changes to accommodate fewer broadcast days, and they had to make room for division in the second-grade curriculum. Despite the similarities in their math curricula, Thailand and Nicaragua are half a world apart. Cultural revisions were by no means automatic. But the most important barrier to mechanical replication of the interactive radio lessons was embedded in the instructional design itself, which always calls for rigorous and systematic formative evaluation.

Classroom observations aren't replicable. Instructional staff members must build observation and testing into every new version of the IRI model. It would be easier and far less expensive to implement second-generation radio projects without providing for formative evaluation, but in the absence of formative evaluation the learning gains that made the prototype worth adapting in the first place would begin to erode. Jamesine Friend, Project Director for RMN and consultant to almost every IRI project that followed it, issues this caveat about the adaptation process: "It's very easy to imitate the *sound* of interactive radio. Almost any one listening to these programs can pick up on that sound, which is really basically programmed instruction. You say a little bit and you expect a response from the student. You say a little bit more and you expect another response, and so on. You have a rapid-fire exchange of questions and answers and little quick activities for kids to do. There's a change in topic every two or three minutes, and you can imitate that. But that's only part of the picture. If you don't have the whole sequence of instruction designed correctly, if you haven't thought of every detail, if you're not out there collecting information about whether it works or not, you're going to end up with a product that sounds like interactive radio, and doesn't teach any better than an average teacher could teach. And if you're not teaching any better than an average teacher, you have no business being on the air."

Interactive radio instruction *is* cost-effective, but it always costs something, whether it is funded by an international agency or by the ministry

of education in the site country. And every expenditure for an educational intervention in a developing country means that less money is available for other interventions. So the only justification for the implementation of IRI in the poorest nations of the world is that it provides *superior* instruction, based on thorough, research-driven planning of the broadcasts, down to the minute, and careful evaluation of how each lesson works in the classroom. If it were less demanding, it would be less effective.

II. New Generations in Latin America: Honduras

In 1985 A.I.D.'s S&T/ED established the Radio Learning Project (RLP) to supervise the dissemination and implementation of interactive radio throughout the developing world. The RLP is administered by the Education Development Center of Newton, Massachusetts, in consortium with the Academy for Educational Development in Washington, D.C. and Friend Dialogues of Shelby, North Carolina. The Honduran Radio Learning Project (HRLP) has received assistance from the consortium, and since 1986 has made Honduras a hub from which projects in IRI are radiating throughout Latin America. The Honduran Radio Learning Project is different in almost every respect—*except* instructionally—from earlier projects. First, it is part of a private-sector Honduran agency, the Association for Socioeconomic Advancement and Development (AVANCE), the principal interest of which is its publishing enterprise, and in particular the newspaper *El Agricultor*. HRLP is one of seven USAID-sponsored interventions in the Primary Education Efficiency Project (PEEP). It is lodged in AVANCE for a simple and familiar reason. The Honduran Ministry of Education, like SEEBAC in the Dominican Republic, was skeptical at first about the usefulness of interactive radio. As it did in the Dominican Republic, that skepticism has now disappeared. Recently the Ministry of Education has suggested incorporation of AVANCE's *Sistema de Educación Interactiva* (SEI) into its operations (Edgerton, 1989).

But in the beginning an experimental program always looks experimental, and AVANCE was no exception to this rule. The Cooperative Agreement that established AVANCE envisioned interactive radio as the powerful educational arm of an organization that sought to make a profit in its other undertakings. It mandated production of two series of interactive radio lessons, a 465-program math course, and a 465-program reading course. Although the math series was originally conceived as a second-generation adaptation of RMN, an important obstacle soon arose.

RMN was a complete course in primary math, designed to be used

without textbooks. Therefore it would have represented direct competition to the first-grade math texts that were being developed in one of the other educational interventions sponsored by the Primary Education Efficiency Project. Honduras couldn't afford such a doubling of effort. So AVANCE redesigned the proposed radio math course. It would teach mental arithmetic, it would be conceived "generically" so that it could be used with any standard textbook—a factor important to its marketability outside Honduras—and it would be developed from the Honduran national curriculum without the use of earlier radio models. The decision to redesign the radio math course took political realities into account: this is a critical precondition to sustainability after the pilot phase. IRI interventions must be effective and inexpensive if they are to achieve institutionalization. They must also be relatively uncontroversial.

The cost of development for *La Familia de los Números* (The Numbers Family), as the Honduran math series came to be called, was higher than the cost of adapting RMN, but it was still lower than the cost of any other original series in interactive radio. First-year summative evaluation demonstrated the superiority of instruction that justifies such cost. A comparison was made between three groups of Honduran children, one that received traditional instruction, one that used the new textbooks, and another that used the radio lessons in addition to the textbooks. The teachers of both the textbook group and the radio group received teacher training from the Primary Education Efficiency Project. At the end of the first grade, the same test was given to all three groups. In the traditional group, 38% of the children passed. In the textbook group, 59% passed. And in the radio group, 76% passed.

At first AVANCE may have regarded the need to develop an entirely original series as a misfortune. But it designed in *La Familia de los Números* an attractive product—to which Costa Rica quickly obtained the rights through funding from A.I.D.'s RLP—that generated striking results. And at the same time, it achieved sustainable nationwide implementation with a program entirely different from the one described in the originating agreement. In 1988, the math series reached 70,000 Honduran children in 3,000 classrooms. In 1990, *La Familia de los Números* will be broadcast to 100,000 first graders, 50,000 second graders, and 30,000 third graders throughout Honduras.

AVANCE may provide the most recent example of IRI's versatility, but the remarkable success of *La Familia de los Números*, despite its modest funding, is firmly linked to past experience. Research in and implementation of programs in interactive radio have now produced a large and useful body of information on which AVANCE staff can draw. Although HRLP has received invaluable technical assistance from Friend Dialogues of North Carolina—the only source for such help—the energy and

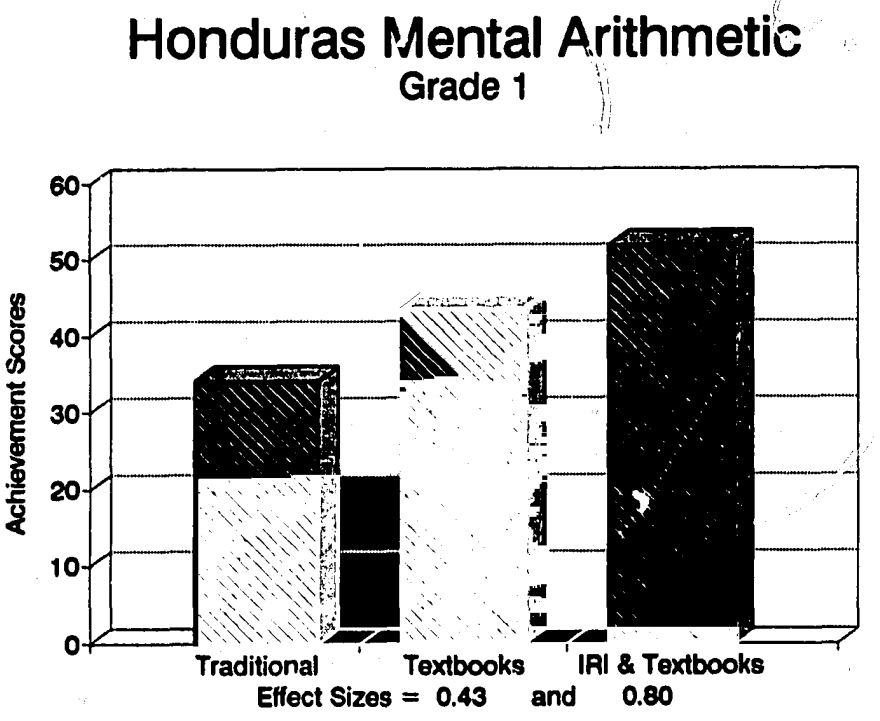


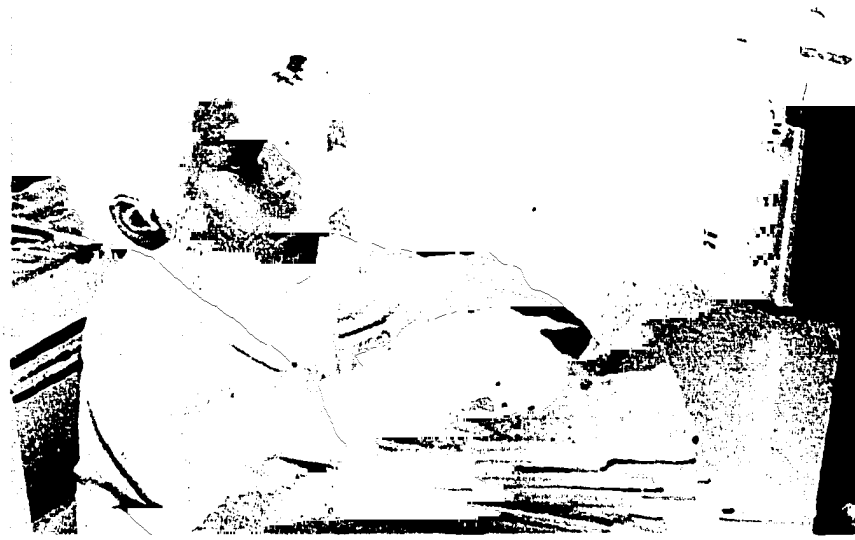
Figure 5.1

enthusiasm of AVANCE Honduran staff have yielded a series so good that Honduran teachers are actually willing to *buy* the supplementary materials necessary for its use.

The materials, four large posters and a teacher's guide, cost US $6; teachers can purchase the materials and a radio for US $45. By going to the international market for the radios, and, with the cooperation of the Honduran government, bringing them in duty-free, AVANCE was able to offer radios of very high quality for a very low price, which of course made the purchase attractive to teachers.

This is clearly a departure from the practice of RMN, which made extraordinary efforts to avoid costs to the teachers—in money or in time. However, it is based on local market research. AVANCE planned to sell supplementary materials to parent-teacher organizations for use in the schools, but through marketing surveys it discovered that Honduran teachers prefer to keep control over their instructional materials by buying the materials themselves.

Private financing for public education is a phenomenon that provokes reactions—often very strong ones—among educators. Such financing



Studio Francés, Tegucigalpa, for the Radio Learning Project.

La Familia de los Números is designed to be used with textbooks.

may not be possible in other nations--or it may be inadvisable. Nevertheless the Honduras Radio Learning Project establishes an alternative paradigm for funding interactive radio. Full-scale mobilization of public- and private-sector resources for basic education is imperative as we prepare for the next century in the last decade of this one, and AVANCE offers a good example of the mobilization of private-sector resources in Honduras. It is successful because it produces products for which there is a market. *La Familia de los Números* is only one of them.

In addition to the Spanish reading course specified in the Cooperative Agreement, and in response to its 1988 mandate to design profit-generating products, AVANCE has also begun adaptation of RLAP's *English in Action* series for marketing to the growing number of Latin American countries interested in ESL materials. With funding from A.I.D.'s RLP, Belize has already secured the rights to the first-year programs of *Let's Learn English*, sixty lessons of which it pilot-tested in 1989. Assuming positive results from the pilot test, Belize will begin national broadcast of the series in September of 1990. An interesting technical detail: AVANCE is not working from the original Kenyan scripts, but from the computer disks of the scripts revised for use in Lesotho. *Let's Learn English* is a third-generation adaptation, of which AVANCE plans to conduct a full longitudinal pilot study in Belize.

Because of the extra work required to design and implement *La Familia de los Números*, and because AVANCE undertook adaptation of *English in Action* in 1988, start-up of the Spanish reading course has been delayed. But the production schedule for the project has now been established. Radio Spanish will be the first fully researched and evaluated course in initial reading in the mother tongue ever to be developed for delivery by radio to schools in the developing world. RADECO's *Letras* (Letters) is a good series for its nonformal setting, but it isn't the reading course equivalent of Radio Math. Like *La Familia de los Números*, Radio Spanish will accompany a Primary Education Efficiency Project textbook, at least for grade one. (A project to begin in Guatemala in 1990 will teach Spanish as a second language to Indian children.)

Of course AVANCE hopes for a wide market for Radio Spanish throughout Latin America. In the meantime, it is establishing itself as a regional center for technical assistance in interactive radio. When officials of the Costa Rican Ministry of Education became concerned about math scores among their primary-grade children in 1988, the *Centro Nacional de Didactica* (CENADI) went to Honduras for help, and began broadcasting the first-grade lessons of *La Familia de los Números* within weeks. For

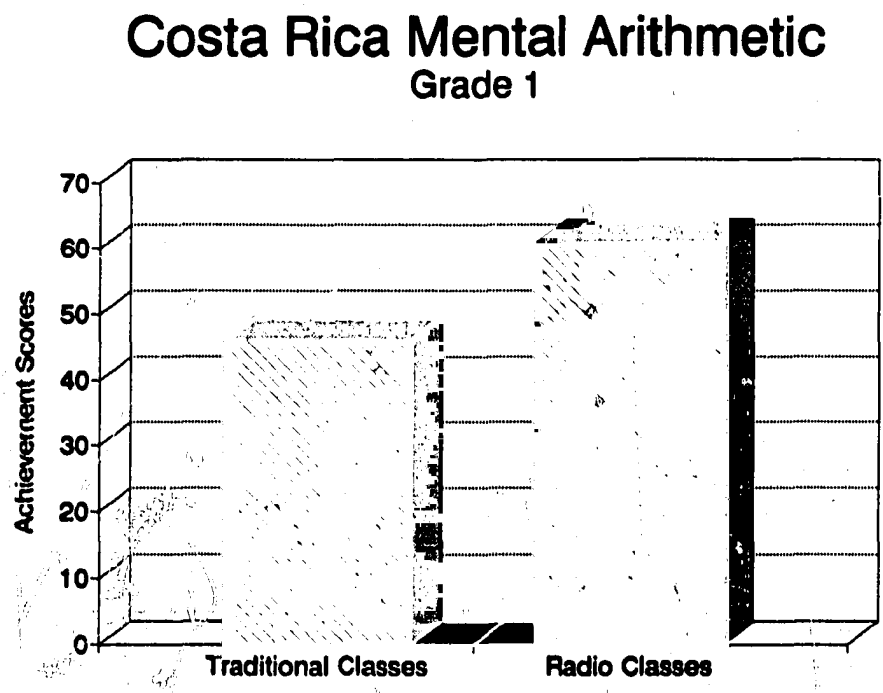
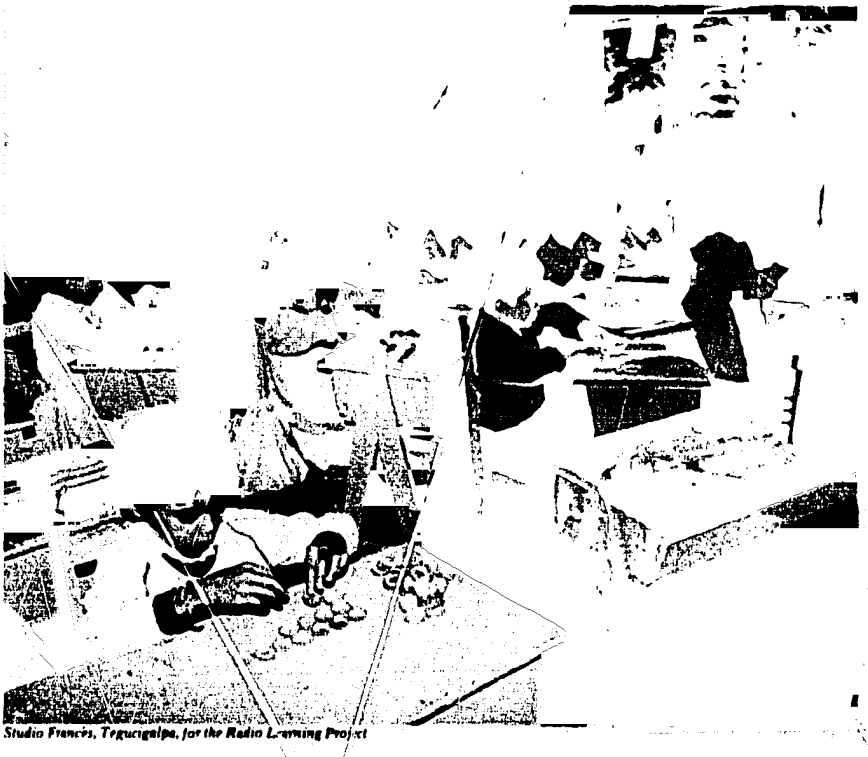


Figure 5.2

the pilot project, changes were needed only at the beginning and the end of the broadcasts. Those changes were made in Honduras.

After the pilot study, the Costa Rican CENADI staff rewrote some of the lesson segments, and sent the revised scripts back to Honduras for re-recording by the Honduran actors who had made the original tapes. Honduras provided most of the technical assistance (the RLP provided technical assistance as well) and provided it so efficiently that it established a new record for rapid, in this case almost immediate, implementation. CENADI's technical expertise also facilitated the transfer. The successful cooperation between these two agencies, one private, one public (CENADI is part of the Costa Rican Ministry of Public Education) provides an operational model for future projects in interactive radio. And it also provided the occasion for the development of a radio-based teacher training project in Costa Rica that would be available for use in other countries using interactive radio.



Studio Frances, Tegucigalpa, for the Radio Learning Project

In this multi-grade classroom in Honduras, first-graders listen to a radio lesson in mental arithmetic while their teacher assists their second-grade classmates in reading.

IRI is of course committed to children, but it is committed to teachers too. The Costa Rican radio-based teacher training program began with research into the math topics that teachers find difficult to teach, and children find difficult to learn, and two-thirds of the lessons will concentrate on those areas. But the first third of the series of twenty-nine radio lessons will explain what IRI is, what it does, and how the teacher fits into the model. Well-trained teachers, confident and competent in math, will support institutionalization of interactive radio in their national ministries of education.

Planning Ahead for Large-Scale Success
by Jamesine Friend

(This is an abridged version of a presentation given at the 35th Annual Conference of the International Communications Association in Honolulu, Hawaii.)

In the developing world projects that succeed on a pilot basis sometimes fail when implemented on a wider scale.

What are the barriers to success?

One way of classifying barriers [to the success of IRI projects] is on a tangibility scale ranging from items such as radios, batteries, and teaching manuals to such intangible factors as teachers not understanding the goals of the program or having poor attitudes towards the program. Another helpful classification approach is to look at the locus of existing barriers. The relevant localities for the type of educational program we are looking at here are found at the national, regional, and classroom levels.

At the national level the first challenge is whether or not the project should be implemented on a wide scale. Many political and psychological factors enter into this decision: whose vested interests are at stake; how committed a country is to educational improvements; whether there is a favorable attitude toward distance teaching; whether radio is perceived as substandard to television; and how well the pilot project worked.

There are funding questions as well. Do the decisionmakers think the project is worth the investment required? Does the country have the money to invest at the time? Even if it can be shown that these lessons are the most cost-effective solution in the long run, the start-up costs may not be affordable.

Of primary importance is the availability of a sufficiently powered transmitter in order to reach school sites with educational broadcasting.

(Continued on page 54)

Being dependent upon regular delivery of printed materials can cause continual problems. In general, it is easier to mount a one-time distribution effort than to count on maintaining regular materials deliveries to remote schools.

The distribution and maintenance of radios presents problems similar to those of print materials. Since most schools in developing countries do not have electricity, batteries must be used.

Teacher training is another challenge. Even if a well-organized system of teacher training is in place, not all teachers benefit from it because they may not learn about training opportunities in time, may lack the funds to travel, or may not be interested in further training.

There remains another type of barrier in the classroom in the form of teacher resistance.

In my experience, most classroom teachers are dedicated workers. They are usually willing to try anything that appears to improve the teaching environment, provided that the potential for learning will outdistance the perceived disadvantages of an innovation. Teachers view with some skepticism innovations proposed by outsiders who may not understand the conditions under which most of them work. Benefits, from a teacher's point of view, are increased educational opportunities for all or some of the students, and less work for the teacher. The advantage of a reduced workload is that time or energy saved in one subject area can be used to increase the quality of instruction in another subject.

Thus, it would seem to me that what is often labeled "teacher resistance" to innovation is often a rational balancing of conflicting desires. And a project that does not come out well in the balance is one that will fail at the barrier of teacher resistance.

III. Internationalization

Radio Math, Radio Language Arts, and the Radio Science Project, still in its pilot phase in Papua New Guinea, were all conceived in the United States by A.I.D.'s S&T/ED, which through its contractors appointed site-selection committees and organized and paid professional staff for the prototype projects. Local infrastructure was a crucial factor in choosing the site; it was important that ministries of education be capable of providing significant support to the intervention. Now that support is more important than ever. As countries in Latin America, the Caribbean Basin, Asia, and Africa, establish national centers for curriculum development—Lesotho and Costa Rica are just two examples—such centers, and organizations like AVANCE in Honduras, will develop and imple-

ment new radio projects for the 1990s and into the next century. In the process, they will serve as training sites for the international professional staff on whom the future of interactive radio depends.

IRI comes of international age with Honduras and the other Latin American projects now underway. The effectiveness of interactive radio needs no further demonstration. But the model needs widespread acceptance and sustainability in the poorest nations of the world. Acceptance and sustainability depend on internationalization of technical assistance and on new funding sources from developed countries. They also depend on the model's capacity to address the practical concerns of ministries of education in its host countries. From now on, evaluation activities must concentrate on factors—cost-effectiveness and local political realities—that are most likely to effect continued implementation or institutionalization of the projects (Terry, 16). AVANCE focused on these factors when it redesigned its math series so that it would *complement*, and not conflict with, the development of primary math textbooks, and when it began the adaptation of *English in Action*, for which it had identified a market.

Interactive radio has to look within and without, developing local resources while it finds new international funding. A flow chart would represent these efforts with arrows pointing in opposite directions. But it's crucial that those lines intersect again at some imagined point on the chart. For the time being, Honduras is the obvious case study. It is producing its own original radio series, disseminating them to other countries, and providing the technical assistance that assures success in the second generation of a radio project. (Changes for the Costa Rican version of *La Familia de los Números* are so minimal that it can hardly be classified as second generation.)

As AVANCE has gained experience it has attracted the interest of educators throughout Latin America. Its studios—the second fully-equipped recording studio will be ready for use in mid-1990—are capable of producing four full-scale interactive radio production cycles at the same time, as well as several smaller-scale projects. Its computer system streamlines instructional design and facilitates scriptwriting, and it will continue to do so, as part of a permanent agency committed to future productions in IRI.

IV. Bolivia and Ecuador

"The Bolivian Radio Project has yielded the highest learning gains of any second-grade interactive-radio curriculum to date." (Fryer, 1989). That's a straightforward statement of a gratifying result for another adaptation of

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Bolivian children after a Radio Math lesson.

RMN. In Bolivia the institutional framework for IRI is very different from Honduras. The Bolivian Radio Project operates under the umbrella of *Fé y Alegría*, a Roman Catholic organization that administers hundreds of public schools for the Bolivian Ministry of Education. It began with the adaptation of RMN's second-grade lessons in 1988 for 9,000 children in 243 schools, and trained more than 250 Bolivian teachers and school directors in the interactive radio methodology. Broadcasts began in 1988. So did cooperation between Bolivia and Ecuador, when three members of the Ecuadorian IRI team briefly visited Bolivia and observed lesson adaptation, program planning and administration, teacher training, formative evaluation, test development, summative evaluation, and community organization—all familiar components of interactive radio instruction, and prerequisites to the five-month pilot study in Ecuador.

Like Bolivia, Ecuador used RMN for its adaptation. In both countries the model still proves its instructional integrity and generates real excitement. At first, the Bolivian project planned to develop the math program only through Grade 4 before starting work on language lessons

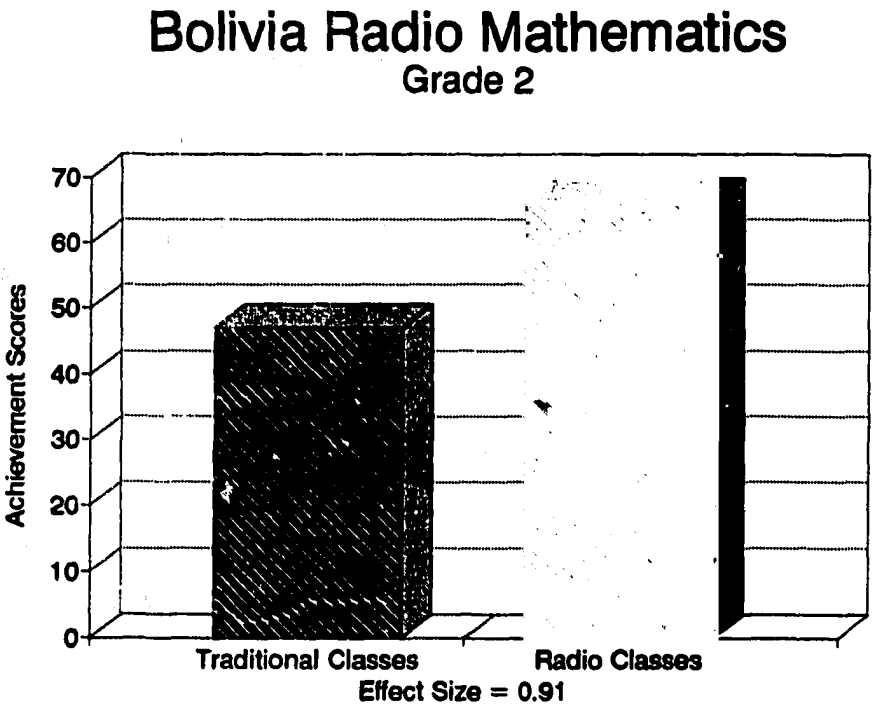


Figure 5.3

for Grade 1. But the radio math lessons proved to be so popular, both in the schools and with out-of-school youth and adults, and primary school teachers who had not participated in the project's teacher-training program, that the language lessons have been delayed until Bolivian staff members complete a radio math series for Grades 2-5. Enthusiasm for the Ecuadorian version of the model proved so infectious that it was impossible to test a control group accurately during the pilot study: teachers in the schools selected as controls tuned into the lessons and some of them borrowed teacher's guides from their colleagues in radio schools and had them copied for their classes. This violated the rigor of the summative evaluation, and so is anathema to the devoted researcher. But as a manifestation of interest in interactive radio it was welcome.

In Ecuador the focus was, as it had often been before, the multi-grade classroom. In Ecuador there were recording studios willing to donate studio time, radio stations willing to donate air time, and professionals qualified to work on the radio programs. Except for radio interviews with three staff members that were broadcast during the first week of school, there was no particular effort to market the project. But word about the

radio lessons, and spontaneous use of them, spread very widely from the beginning of the broadcasts.

In Ecuador as in Bolivia, summative tests showed very high learning gains in math. And as in Bolivia, where many children in the *altiplano* mining town of Kami speak Quechua outside of school, Ecuadorian Indian children showed learning gains as significant as those whose first language was Spanish—another instance of IRI's capacity to address inequities between one group of students and another.

The town of Kami is an ideal laboratory-site for interactive radio; it was chosen as the rural testing center for the Radio Education Project in Bolivia because of its sociocultural complexity. Kami is one of the poorest communities in the region of the *altiplano*. Many of its students must learn Spanish from their teachers because their parents speak only Quechua.

Kami also suffers from continuous teacher turnover. Graduates of Bolivia's Normal Schools must serve one year in a rural school—most teachers are unwilling to stay in Kami beyond that mandatory year. The town has one of the worst records in Bolivia of school days completed each year because schools close when the miners strike. They close when the teachers strike too. (In 1987, government-operated public schools in Kami completed only 53 of 200 schooldays; *Fé y Alegría* schools completed 135 days.) Even when no one is on strike teachers work only a four-day week. Each month they are given one long weekend to travel to the departmental capital to meet with administrators. Since public transportation between Kami and the capital is unreliable, the trip sometimes takes four or five days (Fryer, 1989).

Success under such unfavorable conditions is remarkable. Nevertheless, the children of Kami showed significantly larger learning gains than children from the suburban testing center in Cochabamba or children from the urban testing center in Trinidad, in the tropical lowlands of Eastern Bolivia. With the average control-group student at the 50th percentile, the average radio student ranks in the 81st percentile. This differential is very dramatic. Less dramatic but as significant is another statistic from testing in Kami: the average score for rural students in the experimental group (57.3 %) is higher than the overall mean score for urban students in the control group (55.1%) (Fryer, 1989).

Interactive radio set out to address the inequities between urban and rural schools in Nicaragua in 1974. It set out to address the inequities between urban and rural schools in Kenya in 1979. It set out to address the inequities between urban and rural schools in Thailand in 1980. In the Dominican Republic in 1982 it tackled the worst inequity of all, the lack of schools for rural children. In every case, it reduced the gap between the achievement scores of children in cities and those who lived in isolated

regions of the country, while at the same time improving literacy and numeracy for all the children within its compass.

Everywhere it created excitement. Sometimes the model encountered absolute barriers to institutionalization—barriers over which it had no hope of exercising control. The Nicaraguan Revolution, for example, ended prospects for continued implementation in that country. But hundreds of thousands of children in Asia and Latin America have nevertheless benefited from the lessons that were developed for Nicaragua. Children throughout Thailand heard the Thai adaptation of those lessons, and the Dominican Republic institutionalized RADECO's adaptation of RMN. Now RMN is proving its durability again in Bolivia and Ecuador, where prospects for eventual institutionalization are good.

6

Past and Present

Now, in 1990, interactive radio can be said to have a history, and it can be viewed from an historical perspective. In reviewing that history Jamesine Friend points out a pattern of experiment and innovation that met at first with skepticism and then, at each stage of success, and every time it proposed something new, encountered revised expressions of disbelief. Friend sketches her outline for the history of interactive radio in this series of questions and assertions: 1. Nicaragua Radio Mathematics Project (You can't teach math by radio); 2. Thailand Radio Mathematics Project (Can you take radio lessons from a country like Nicaragua and use them halfway around the world in a far different culture that speaks a quite different language?); 3. Kenya Language Arts Project (Math is easy. But what about teaching English simultaneously to children who speak dozens of different languages?); 4. RADECO (Radio works in schools that have real teachers, but will it work in nonformal education?); 5. Papua New Guinea (Math and English are easy. But what about science?).

Jamesine Friend was familiar with the first of these assertions because she had made it herself when Patrick Suppes of Stanford's Institute for Mathematical Studies in the Social Sciences asked her in 1973 if she was interested in directing the project that developed into Radio Math Nicaragua. Her first reaction was instinctive and immediate: "You can't teach math by radio." Then she began to think about it. Friend joined the selection committee that chose the site for the experiment, and within a few months she and her family had moved to Nicaragua. It didn't take long for the RMN staff to learn that you *can* teach math by radio. Summative evaluation of the achievement of the radio children spread the news to other educators.

RMN was a *research* project. It produced scientific data as well as simple human results. With that data, RMN challenged received opinion about how to improve education in the poorest nations of the world.

Before Nicaragua everybody in the educational community "knew" that there were only two useful interventions for the ill-equipped schools and underprepared teachers in developing countries: textbooks and teacher training. This conviction, Jamesine Friend observes, was mythic—that is, it was based on belief, not on research. RMN stood on different ground. In fact it began in *disbelief*. But the project demonstrated that interactive radio was another useful intervention, inexpensive after development costs had been met, and promising higher learning gains than either textbooks or teacher training, and it led directly to the second question on Friend's list, "Can you take radio lessons from a country like Nicaragua and use them halfway around the world in a far different culture that speaks a quite different language?" The question awaited proof.

In Thailand the research design was as rigorous as it had been in Nicaragua, but the purpose of the experiment was different. Did the prototype work in the second generation? As we have seen, the results of the Thailand Radio Math Project were impressive. It was clear that interactive radio could work equally well outside the particular circumstances of Nicaragua. Nevertheless, there might be an explanation for the success of interactive radio in both countries: "Math is easy. But what about teaching English simultaneously to children who speak dozens of different languages?"

This was the question for Kenya. RLAP answered it decisively. Interactive radio delivered effective instruction in English as a second language. Naturally the answer led to another question: "Radio works in schools that have real teachers, but will it work in nonformal education?" RADECO overturned belief that the traditional school setting was critical to the success of interactive radio.

> Perhaps the best example of radio's potential for increasing internal efficiency in primary education is the case of RADECO in the Dominican Republic. The evidence currently available suggests students perform at least as well on math and reading tests as students do in conventional schools in the region, but with *about half the time spent in learning at about half the cost* (Friend and Kozlow, 1985; Sanguinetty, 1985). Although we are not comparing full or identical sets of educational outcomes—indeed, Friend and Kozlow (1985) note that no comparisons were made in science and social science and that conventional schools aim at a wider range of outcomes than RADECO schools—the RADECO results are nonetheless impressive (Anzalone, 1988).

Now the Radio Science Project (RSP) in Papua New Guinea is trying to respond to Friend's fifth assertion about interactive radio: "Math and English are easy. But what about science?" The project has chosen diffi-

cult terrain for the experiment. There are few roads in Papua New Guinea, and outside Port Moresby and the Capital District that surrounds it, access to schools is difficult. Often the only way to travel is by airplane, and sometimes the school is a long walk from the airstrip. But once visitors arrive at a Radio Science Project site, they find themselves on more familiar ground. The typical school in Papua New Guinea is like its counterparts in Africa. It is a low, narrow building with a thatched roof and often a courtyard, and there is always a school garden. Pairs of children share desks in the schools of the National Capital District, the Central Province, and the Eastern Highlands Province, and since May of 1987, when the first lessons of the Radio Science Project were broadcast to 14 schools in Papua New Guinea, they have also shared the simple equipment on which Radio Science lessons depend—mirrors, glass jars, plastic cups.

Children in Nicaragua, Thailand, the Dominican Republic, Bolivia, and Ecuador collected seeds and stones and sticks to use in the exercises of Radio Math. They counted the objects they had gathered and arranged them in groups. In Papua New Guinea students in the upper primary grades use materials too, and in the same way, to understand the concepts of science. The mirror helps them to learn about light, how it travels in straight lines, bounces off some things, and passes through others. The glass jars and plastic cups help them to learn about air and its volume, and about the mixture of oxygen and other gases of which it is composed.

But even such simple materials as these are sometimes hard to find in the mountainous interior of Papua New Guinea. If the local stores are out of plastic cups, experiments for the "Air is Everywhere" lesson will have to be postponed. This is one of many variables with which RSP scriptwriters must struggle as they design the science lessons. Teaching math and language by radio *does* seem easier. Difficulty with materials is a matter of availability and distribution—significant considerations, but nevertheless mechanical ones.

RSP faces larger and more significant ethnographic difficulties in Papua New Guinea. In earlier IRI projects scriptwriters sought cultural congruity. The radio characters had to sound familiar. The world they created had to match or to parallel the world in which the children lived. This wasn't difficult, since scriptwriters always came from the countries in which the broadcasts took place, but it was certainly an issue—and continues to be one—with every new adaptation of an interactive radio series.

Cultural congruity can be checked by other members of the culture, and corrected if necessary. Usually this is just a matter of details. Math and language are relatively safe in this respect. It is unlikely that experiences with numbers and math concepts or with words and grammatical struc-

tures will actually contradict cultural belief systems. But science lessons sometimes do. Cultures *know* things, about biology, for example—just as educators know things about textbooks and teacher training. What they know may be myth. That doesn't necessarily mean it's not true. It just means that it hasn't been proved. If the science scriptwriters are lucky, the myth will also be capable of scientific proof. If they are unlucky, their lessons will conflict with the cosmology of their students.

This is a real problem for the Radio Science Project, and it's one that ministries of education in developing countries must also be willing to confront. Basic scientific literacy is as important in the poorest nations of

Thomas Tilson

A Bolivian student practices thorough hand-washing during a lesson designed to promote child survival techniques.

the world as numeracy and the ability to read and write, and sometimes more important. When interactive radio teaches techniques of child survival like Oral Rehydration Therapy to 10-13 year-old children in Bolivia, as it did in a 10-week pilot study in 1989, it provides them with scientific information of immediate impact. "Diarrheal disease and the resulting dehydration is the single largest cause of hospitalization and death among children under five according to Ministry of Health statistics. Their most recent data (1983) show diarrheal disease as the second highest cause of hospitalization among children between five and fourteen years of age" (McNulty, 1989). Children—especially girls—between the ages of 10 and 13 are often primary caregivers for their younger brothers and sisters, and what they know about preventing dehydration may determine whether their brothers and sisters live long enough to learn how to read and how to add. What primary school children in Swaziland learned from radio lessons about the importance of immunization against tuberculosis, polio, diphtheria, whooping cough, tetanus, and measles may have saved the lives of their infant brothers and sisters, and later may save the lives of their own children.

The Bolivian health lessons began with ethnographic research into cultural beliefs and attitudes about health issues, family health practices, children's roles in health and nutrition, and traditional stories about health and nutrition. Each of the lessons included a story, legend, or song. Individual student response was more frequent than group response, and some lesson time was reserved for discussion (McNulty, 1989). Scriptwriters depended upon ethnographic research to help make the messages in the series acceptable to the children, and used it to shape the presentation of those messages. But there may be points at which science and culture are intractably at odds, and at those points science must have the courage to challenge culture. When it does so in Papua New Guinea, it risks disbelief. Children, like their parents, are capable of choosing what they *want* to know.

But the Radio Science Project originates in the premise that children in a very poor country should be taught even those things that they don't necessarily want to know about science. They can benefit very greatly from an understanding of the principles that shape the physical world, and the process of empirical discovery that reveals those principles. RSP's impact can be significant, but so are the problems in delivering the lessons. RMN and RLAP hoped for and in most cases got more than minimal support from the classroom teacher, but the lessons were designed so that they could stand alone if necessary. That isn't possible with Radio Science. The difficulties it encounters are exemplified in a lesson about light that includes a simple experiment with mirrors. During the experiment students must divide their attention between their

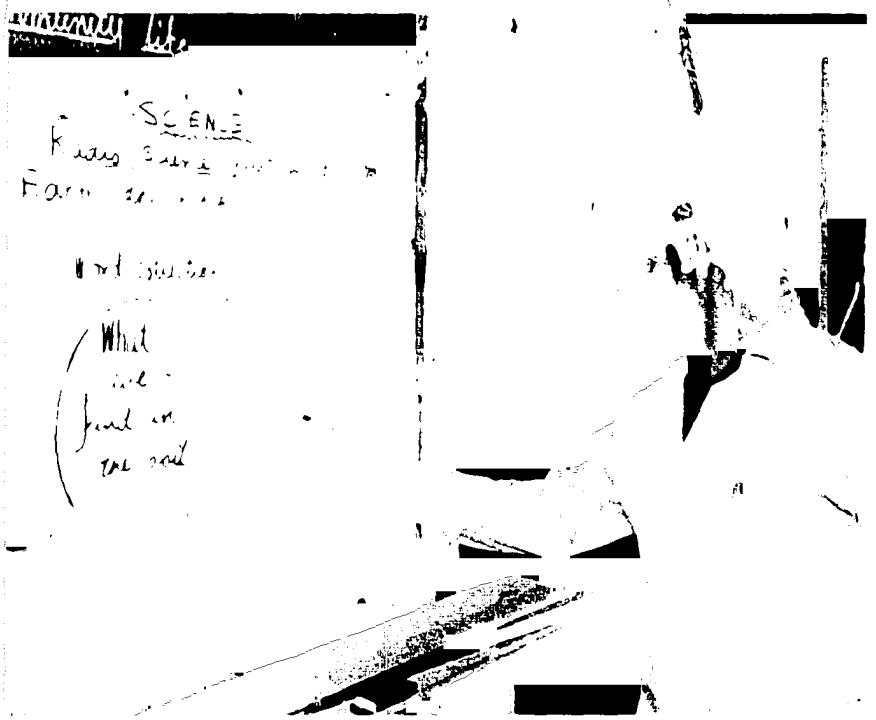
teachers, their worksheets, the mirrors they share with their desk partners, and the radio. And their teachers must guide them from one area of concentration to another.

Early Radio Science broadcasts asked students to perform their experiments during the pauses, when children in other IRI projects experiment with numbers or language. But it was impossible for many pairs of students to get help from the teacher within those time constraints, even though the experiment itself might take less than a minute. RSP scriptwriters have corrected that problem by limiting student activities during the broadcasts and assigning most hands-on experiments to the post-broadcast activities that are directed by the teacher.

This revision of procedure resolves the difficulty of completing such experiments, but it does something that RMN and RLAP tried to avoid: it puts the responsibility for the success of the lesson squarely on the teacher. For teachers who are ill prepared in science, more training is clearly necessary. A series of in-service cassette tapes that elaborates the information in *Notes for the Teacher* offers one way of providing the training, and a pilot test of this option showed that teachers appreciated the opportunity to learn more about the science *content* of the lessons. More training, at least initially, means more work for the teacher. But they are eager for the help. Teachers in Papua New Guinea are enthusiastic about the Radio Science lessons. They regard them as a decided improvement over the science guides that RSP replaces, and surveys show that they believe that what makes science more difficult to teach than other subjects is not its intrinsic complexity, but their relative lack of materials, their relative lack of time for lesson preparation, and their relatively weak backgrounds in science.

William Penias of the Papua New Guinea National Department of Education agrees with the teachers' views: "When the students graduate and go into the schools, they don't have the things they had in teacher training colleges. They don't have laboratories, materials, even something simple like candles if they need them. And if they don't find them, they don't improvise. They don't say, 'Here is a broken mirror, let me use a piece of this to demonstrate what we are trying to teach.'" The Radio Science Project, according to Harold Ure, Papua New Guinea national science educator, hopes to encourage teachers to find a use for that piece of broken mirror. "It is our aim to tell the teachers to use what they have around them. We don't try to use very sophisticated materials or equipment . . . I think the whole program can be taught with what we have around us."

Teacher training by radio is, as we've seen, under development in Costa Rica. And Nepalese teachers were the target audience of a large-scale training effort *via* radio that began in 1980. In the first phase of the Radio



Taramai Leder for the Radio Science Project

A teacher of Radio Science in Papua New Guinea prepares to lead a post-broadcast session. Radio-based teacher training in science content is an important innovation of the Radio Science Project.

Education Teacher Training Project (RETT) the focus was on methodology. RETT II incorporated interactive techniques into the radio lessons, which were designed to improve uncertified teachers' understanding of the core subjects of the Nepalese curriculum: English, mathematics, science, and Nepali. Teachers in Nepal had a personal incentive to listen to the lessons—RETT II prepared them for the examination for the School Leaving Certificate (SLC) on which their continuation in their jobs depended. In Papua New Guinea the teacher's incentive is professional. They listen to the twice-weekly broadcasts of *Education News*, which include information about upcoming RSP lessons (the lessons are also broadcast twice a week). As one teacher in a community school describes it: "All the program does is tell the teachers that 'Tomorrow you'll be teaching this lesson, you should have these materials ready, and you're going to run into these problems.' The teachers love it. They're getting usable information, and they're going to use it tomorrow. Teachers always like something they use the next day."

Radio Science gives teachers something to use the next day, and works against a temptation that Elizabeth Oa, a teacher in an isolated community school, describes: "It is a fact that when we have too many subjects to teach, and there are no materials, we sometimes skip a science lesson and teach expressive art instead because it's easier." The RSP asks more from its teachers than other projects in interactive radio, but it also provides more training, through the now familiar means of radio.

How does its curriculum answer the needs of schoolchildren in the rural community schools where it operates? Since most school leavers will stay in their home communities, the plan for the project includes exposure to aspects of agriculture, communications, health, and transport, the practical activities of daily life in Papua New Guinea. But it includes biology, chemistry, and physics too, as the titles of the radio programs demonstrate: Characteristics of Animals, All Living Things Need Food to Live; What is Electricity?; Air is Everywhere; What is Soil Made of?; Putting Electricity to Work: Electromagnets; Ways of Measuring Periods of Time.

All science is local science. Harold Ure's view of the curriculum, that the materials for the whole program "are all around us," works in Hisiu village when RSP children undertake an experiment in judging soil texture after listening to the lesson, "What is Soil Made Of?" The radio actors ask the children to go outside and collect soils; some are assigned to collect garden soil, some clay, some sand. When the samples have been gathered, the teacher gives directions for the simple test. At first the children are awkward and their attempts to repeat the experiment fail. But gradually and with help from their teacher, they begin to see how the soils are separating, and they are able to make observations about the process.

The results of the first summative evaluation of 4th grade students in Papua New Guinea show that children are making significant learning gains—less dramatic than in other IRI projects, but this is to be expected for a radio program that is broadcast two days a week instead of five. It seems certain that the National Department of Education is interested in incorporating the Radio Science Project lessons as part of its science curriculum for Grades 4 to 6, but many problems remain to be solved before institutionalization. More teacher-directed support materials are needed. Questions about continuing costs of the program are unresolved. And technological difficulties must be overcome (Olsson, 1989). These are the kinds of concerns that occupy the attention of ministries of education, and RSP has to answer them quickly in Papua New Guinea, where the pilot project will end in 1991.

When Radio Science lessons are adapted for use elsewhere, the questions about its implementation will be different. Radio reception will be better in less mountainous countries, and unit costs will be lower in more

populous countries. Where schools are more accessible there will be fewer problems in the distribution of materials. Teachers in other countries may need less in-service training than teachers in Papua New Guinea. The cosmology of other countries will be different. Children will know different things about the principles that determine the shape of their world. But one thing will be the same. Teachers and children in the upper primary grades will still be glad to have something interesting to do in science tomorrow.

7

Directions for the Future

I. The Radio Learning Project

Records of learning gains in recent Radio Learning Project-assisted activities in Honduras, Costa Rica, Bolivia and Ecuador demonstrate that the model is growing more and more effective as local and regional organizations like AVANCE (Honduras), *Fé y Alegría* (Bolivia), CENADI (Costa Rica), and CIESPAL (*Centro de Estudios Superiores de Communicación para America Latina*), which will manage full implementation of Radio Math lessons in Ecuador, develop their own, site-country-based scriptwriting and production facilities.

In addition to providing resources to these projects, RLP has also sought to share information about IRI through two major international conferences, the first in Latin America, the second in Africa. In March of 1988 representatives of many countries interested in interactive radio met in Tela, Honduras, at a conference co-sponsored by AVANCE, to discuss design, implementation, and sustainability of interactive radio; in January of 1990, the African Conference on Radio Education, sponsored by the RLP and the Ministry of Education and Culture of Zimbabwe, was held in Harare. The focus of this conference was broader than that of the Latin American conference. It looked at radio education in school, and with adult, nonformal groups as well. The use of IRI is just now emerging in Africa, where interest in the model, for the moment at least, seems to involve applications to the complicated linguistic circumstances of the continent. But in Africa there is also interest in radio's potential for environmental education.

RLP maintains contacts with other countries where there is interest in

interactive radio: Botswana, Uganda, Tanzania, Zambia, Ghana, Guinea, Mali, Liberia, Vanuatu, Kiribati, and the Solomon Islands, Pakistan, and Swaziland (where a six-month pilot project in English as a second language, adapted from Lesotho's version of *English in Action*, has just begun). RLP also collaborates with the Union of National Radio and Television Organizations in Africa (URTNA) in the dissemination of its materials, and has held talks with UNICEF about possible cooperative efforts.

In order to promote worldwide implementation of interactive radio instruction, the project has identified four crucial areas of effort: increased efficiency in the adaptation process, social marketing that can guide the adaptation process, increased support from site-country donors and government agencies, and institutional strengthening for the agencies that are now managing IRI projects (RLP Annual Report, 1988). As we have seen, successful adaptation of two different math series is underway in Latin America: AVANCE's mental arithmetic course, *La Familia de los Números*, developed for broadcast in Honduras, is being adapted for Costa Rican children by CENADI; RMN is being adapted by *Fé y Alegría*, the Roman Catholic Agency that operates 300 public schools in Bolivia; in Ecuador, although the *Centro Regional de Communicación Educativo* (CRECERA) managed the successful Radio Math pilot, responsibility for national implementation will be vested in the larger Latin American organization, CIESPAL.

In all four countries community support for the projects has been remarkable. Social marketing has fostered this support, particularly in Honduras. There was no direct social marketing in Costa Rica, but Costa Rica obtained the use of *La Familia de los Números* from AVANCE through funding from RLP, and relies on RLP and the Honduran agency for technical assistance (though the level of technical expertise in CENADI is also very high). There was no direct social marketing in Bolivia either, but community support for Radio Math there is so strong that in 1988, when a month of instruction was lost due to strikes, parents in many schools took over the role of the striking teachers during the math broadcasts. In other places they organized the children into home listening groups (RLP Annual Report, 1988).

Cooperation and collaboration among these Latin American countries demonstrate how regional expertise in interactive radio can develop. The Radio Learning Project has provided resources to all the agencies involved in IRI, and with the continuation of the project in the next five years it will be ready to help establish other such regional centers in southern Africa, Asia (where 8 million Thai children are listening to educational radio broadcasts, some of which use the interactive model), and the Pacific.

II. The Child at the Center

In one of the Nicaraguan radio classrooms there was a boy of about 14, twice as tall as many of his classmates, who seemed bored during the broadcasts. He was in second grade. Members of the RMN staff visited his classroom regularly, and they got to know his habits. Often he had his feet up somewhere, on a bench or an adjoining desk, and he spent most of the lesson gazing out the window. When the other children responded in unison to the radio voices he assumed a rather superior look—he did not join them. But every time the radio actors asked the children to write something on their worksheets, the boy turned almost surreptitiously in his chair and recorded his answer. Was he really bored? His worksheets and tests demonstrated that he was learning the math lessons well. What did his behavior mean? That he was enough of an adolescent to feel the need to distance himself from the fun the younger kids were having? Or was it simply that he felt obliged to assume a dignity that matched his size?

To someone who observed the class only once, this boy would have appeared a hard case for interactive radio, the one indifferent child in an otherwise enthusiastic group of children. Yet he was learning. He seemed determined to conceal his interest, but he *was* interested. Maybe he had been to school before. In many poor countries children drop into school almost as often as they drop out of it. When parents need extra money they take one of their older children out of school for a while. Rosita stays on this year while Jorge looks for work; next year Jorge goes back to school and Rosita looks for work.

There's no way to guess how much math the boy already knew when he enrolled in second grade that year. Maybe he had learned the curriculum long before, when he was as small as the other children. Even so, there was no doubt that he was interested. The other children in the classroom were interested too. And they appeared to enjoy the lessons more than the older boy did. Because they smiled and shouted and sang with the radio actors, observers naturally assumed that they were having a good time.

But maybe that was just an impression. Maybe the 14-year-old boy was enjoying himself as much as the others. It would have been nice if he had been willing to talk about how he felt, but he wasn't. It would be nice to know what difference it made to him to be in that classroom that year, listening to those broadcasts and getting all the answers right, but that's impossible. It would be nice to know what difference it made to the other second graders to be in that classroom too.

We don't know the answers to these questions. The boy's feelings are a mystery to us. So are the feelings of the other children. We can only guess at them. But we can quantify their achievement. All the children—they are adults now—listened to the same broadcasts. The broadcasts came

from a single point at a fixed time; their "culture," content, and language were determined (Anzalone, 1988) by RMN staff members who worked at the project headquarters in Masaya. This is one of the central characteristics of interactive radio. It standardizes instruction. But does that mean that it standardizes learning? Summative evaluation in Nicaragua showed that radio children learned more than children in conventional classrooms, that RMN helped rural children close the gap that separated them from children in cities, that children who were slow to learn benefited as much from the lessons as those who were quick to learn, and that girls and boys of equal ability learned equally well.

But even though their scores on the same test items were compared and tabulated and analyzed, and researchers could give specific examples of what the children knew after the lessons, and how many in any given classroom knew it, the use the children would make of the lessons, in their own lives or in the national life of their country, remained unknown. Interactive radio still awaits a study of its long-term impact. When we have data about employment and income levels of radio children, and can compare those statistics with statistics about a group of control children, we'll be able to say more.

In the meantime, all we can do is speculate. As we do so, it's a mistake to assume that RMN was less valuable to the older boy than it was to the other children. The instruction is centralized with interactive radio, and verbal responses are standard. But learning isn't standard. Children may acquire the same information, but each child responds to it uniquely. Human capacity grows at a different rate, and in different directions, in each of us. Interactive radio operates through a machine—the radio—and according to principles borrowed from industry, but it is unmechanical at the point of impact, when it reaches the individual child.

When we think about the future of interactive radio, we must remember that the point of impact is the child, and that the model only achieves its *fullest* effectiveness within the child. Each child who learns something about the mysteries of the world, whether those mysteries are mathematical, linguistic, or scientific, adds to a private store of resources that is beyond the reach of formative or summative evaluation. Interactive radio puts the child at the center of the process of learning: it gives girls and boys direct access to their own resources. The model is public, communal, and active, but because it works uniquely in each child, its resonances are intimate and unlimited.

Appendix A

Implementation, Sustainability and Costs

Several technical issues must be addressed by host countries considering interactive radio instruction, including initial implementation strategies, management issues for long-term sustainability, and cost factors.

Strategies for Introducing IRI

Typically, IRI projects are developed within ministries of education, but private or non-government organizations (NGOs) can sponsor projects or play a collaborative role as well. The initiative for new projects can come from international donor agencies, outside technical specialists, or local institutions or individuals.

Honduras provides an interesting example of collaboration between a private institution and the Ministry of Education. At first the Ministry was skeptical about IRI; it had had a less than successful experience with instructional radio many years earlier and it was not certain about the reaction of the teachers' unions towards IRI. Even as the pilot activity began under the sponsorship of AVANCE, there remained some division within the Ministry about how much support to give this program. In the end, the Ministry of Education gave IRI its enthusiastic support with presentations on TV and radio and endorsements printed in newspapers. With the Ministry's approval, the project actively involved the national and regional supervisors in plans for teacher training. They, in turn, trained district supervisors who then conducted IRI training sessions with teachers who wanted to participate. The district supervisors also sold the package of instructional materials (teacher's guides, pupils' workbooks and, as an option, a radio) to teachers and received a commission. Over 180,000 children nationwide are now using the programs, yet it remains to be seen if AVANCE can adequately support the programs in the long run without institutionalizing IRI within the Ministry of Education.

Bolivia is another country where the programs have been developed outside the Ministry of Education. *Fé y Alegría* has been successful in rapidly expanding the use of the lessons, even to government schools that are not affiliated with *Fé y Alegría*. This has been a real grass-roots approach and there are numerous anecdotes of teachers and parents doing unusual things in support of the programs—teachers who would otherwise be on strike come in to teach the radio math class; in other classes where teachers are on strike, parents come in to give the math lessons; parents lend radios to the schools, etc. To date the expansion to 2,000 classes with 60,000 children in five of the nine districts across the country has been accomplished with no participation by the Ministry. Yet *Fé y Alegría* is not really equipped to handle full national implementation in terms of its mandate, financial resources, and administrative organization. For long-term sustainability, the Ministry of Education needs to be an active participant and supporter. The new Minister of Education has recently visited interactive radio classes and has become extremely enthusiastic, committed to promoting the expansion of the program.

In addition to being located outside the Ministry of Education, both the Honduras and Bolivia projects have something else in common. They were initiated by outside donor agencies, in this case by officers of the USAID missions.

Costa Rica and Ecuador demonstrate the success of local initiative. In Ecuador the initiative came from CRECERA and the National Supervisor for Distance Education. In Costa Rica the driving force was the new National Center for Teaching (CENADI). CENADI has developed a strong commitment to IRI for supporting rural schools, especially those with multi-grade classes. With only limited financial support from the Radio Learning Project, CENADI obtained the mental arithmetic materials from Honduras plus a few months of technical assistance from AVANCE and the Radio Learning Project. CENADI is showing what can be done with only limited outside support when there is strong commitment within the Ministry and where there are talented local personnel. CENADI has implemented the math programs in over 1,000 schools and within another year plans to reach all 3,500 of their target schools. With these activities well underway, CENADI is now examining the possibility of adapting the RADECO lessons from the Dominican Republic for their one-teacher schools; they are also interested in using the radio-English lessons adapted from Africa by AVANCE.

Lesotho provides yet another model for introducing IRI. Although IRI was introduced to the Ministry of Education through a technical advisor on an A.I.D. project (one who was very familiar with IRI), the English curriculum panel quickly took over the initiative, making plans for a pilot activity and subsequently planning for a full-scale project. They are making cultural adaptations to the original English language series developed in Kenya, but are not making significant curriculum changes. This level of adaptation can be carried out relatively easily.

One interesting aspect of virtually all of the new IRI projects is the need for a pilot activity, even though IRI projects in every country have resulted in significant achievement gains. Each new country feels the need to try it out for themselves. The issue isn't so much whether the children will learn (in a short pilot

activity, it's hard to measure this in any case), but they need to examine this technology in some detail over a reasonable amount of time in their own schools—to better understand the impact of the programs on their teachers, curriculum, broadcasting infrastructure, etc.; to develop the political support from teachers to top Ministry officials; and to understand fully the various components of the adaptation and implementation process (how the scripts are adapted and rerecorded, how print materials are prepared and distributed; how teachers are trained and how the evaluation is carried out). So far, in every country to date where a pilot activity has been conducted (excluding initial research and development projects), the pilot activity has led to full-scale implementation.

There has been considerable discussion about the adaptation process. From one perspective it seems so unnecessary. Why should Swaziland, for instance, go through the process of rerecording over 500 English lessons that are being used successfully in neighboring Lesotho? Clearly, there are not large cultural differences between the two countries, yet the Lesotho lessons do include national Basotho names and music, and the Swazis are not comfortable with this for their own schools. When the Kenya lessons were adapted for Lesotho, why couldn't potential regional interests have been taken into account with names, music and cultural references that would be acceptable throughout the region?

The resistance to regional lessons stems from a desire to provide materials to teachers and children that are truly national in character. The educators need to feel ownership of the materials, to feel that the materials are their own. And there seems to be no way of meeting those needs in most countries without adapting and rerecording the lessons. The Radio Learning Project encourages regional efforts and there is considerable interest among several Latin American nations in developing more generic programs. Implementation of this concept, however, is just beginning.

Long-term Sustainability

Once the lessons have been developed or adapted for a country, a management system is required to sustain the programs over the long-term. In the evolution of IRI over the last fifteen years, there has been a gradual shift from research and development projects as in Nicaragua and Kenya to pilot activities as in Ecuador, Belize and Swaziland and to full-scale projects as in Honduras, Bolivia and Lesotho.

Fundamental to the long-term success of any educational intervention is the support of the Ministry of Education. Long-term financing is also crucial and can come from the government and/or from a strong private institution.

The issues for sustaining a radio project are very different from those for developing programs or even carrying out a pilot activity. It's easy to provide schools with radios, batteries and support materials for a pilot activity. If a radio is broken or stolen, just replace it. Over time, however, more radios will need repair. And donor organizations may no longer be involved. And as new schools are built, new radios will need to be purchased. As print materials wear out, they must be replaced. Radio stations must continue to provide from 30 minutes to several

hours of broadcasting time each day. The lessons must be broadcast according to a schedule worked out well in advance. And new teachers have to be trained.

Radio is considered a "little media" (Schramm, 1973) as opposed to TV, an example of "big media." As a little media, radio is relatively inexpensive, readily accessible, and easy to manage. One of the problems with big media such as TV is that it is costly to provide, expensive to maintain and difficult to manage. It was fashionable in the 1960s to turn to television as "the" technological solution to the problems in education. Yet in all too many countries hope for educational TV has turned to disappointment. In countries such as Niger and Côte d'Ivoire the educational television crusade has ended and been replaced by less ambitious goals.

In retrospect, one might have expected this, for production costs are high, TV sets are expensive and not widely available in some countries, power sources for the TV sets are problematic, spare parts unavailable, and technicians inadequate. But what was not anticipated is that all too often TV failed to deliver quality education. Evaluation of educational TV has not demonstrated its clear effectiveness over other approaches. This is not a fault with the medium, but with the programming. The programming for interactive radio has proven to be a more powerful intervention.

The management and logistic problems that beset television can also be problems for radio. In one central African country, radio programs are broadcast to schools every day. But no one is listening. The reasons are not all that different from the reasons for the failure of educational television; only the relative costs are different. In this country each school was given a new radio in the early 1980s. Yet you can now visit almost any primary school in the country and not find a single radio. Whether the radio lessons be good or bad, no one is tuning in. What are the problems?

First, although radios in this African country are fairly common, they are not everywhere. And the typical small radio found in the home is not adequate for a classroom full of children, where the lessons must played at relatively high volume with undistorted sound. Thus, schools broadcasting requires good quality radio receivers and, usually, these must be provided by the radio project. (This does not mean that the radio project must pay for them.)

Of course, the radio signal from the transmitters must also reach the schools. And there must be adequate transmission time for broadcasting the lessons. Where this does not exist, distributing the lessons on audio cassette tapes is an option. In fact, most countries thinking about radio lessons consider the use of audio tapes as well, but usually drop this option once they understand the extra costs of buying, copying, and distributing the lessons by tape.

But getting good radio receivers to the schools is not enough. They need electrical power to work, and in most rural areas of the developing world, mains electricity is not available. Thus, batteries are required; these can be expensive and, in some places, hard to find. The ministry of education, or the communities, or the teachers must provide batteries on a regular basis. Fortunately there are alternative options. For example, the Radio Learning Project is conducting an experiment in Honduras with a low-cost solar battery power supply. It uses nickel-cadmium batteries that are recharged by a small solar panel.

There is yet another potential problem with radios. Although they are remarkably reliable and durable, they do break down at times. This requires readily available repair facilities or replacement radios. It also requires funds to pay for the repairs. Where school or community funds may not be sufficient to pay for repairs, the ministry of education may need to subsidize the repair costs. For example, school inspectors or supervisors may need to have spare radios available to loan to schools while they arrange to have the malfunctioning radios repaired. Where repair facilities are inadequate, a radio project may need to create new repair centers (perhaps serving the public at large as well as schools); this may provide an opportunity for some private enterprise initiative.

There are many reasons why radios cannot be found in the schools of some countries, among them lack of repair facilities and a shortage of affordable batteries. But there may be more subtle reasons as well. Someone has to be responsible for the radio and where it will be stored. In many schools there is no secure place in which to store the radio. Therefore, although several teachers may use a radio during the week, each night one teacher may need to take the radio home. Who is to do this? What is their responsibility if something should happen to the radio?

Furthermore, if teachers, communities, and schools are to make the kind of investment to keep a good quality radio in operating condition, the quality and quantity of the radio lessons must provide an incentive. Teachers, in particular, must perceive that any logistical difficulties with using the radio are more than offset by the help that the radio lessons provides in their classrooms. In some countries, although lessons are broadcast several hours each day, any individual teacher may only have two or three fifteen-minute lessons per week. Often the lessons are designed to be purely enrichment or supplementary; they aren't designed to help the teacher present the core instructional material. Often, especially when finances are limited and new programs can't be produced, the radio lessons are old, sometimes very old. Finally, the teachers may never receive a teacher's guide that describes the objectives and content of the lessons; and lessons may not be well integrated into the syllabus. Given such circumstances, it's no wonder that teachers may choose not to bother with all that is required—the time, effort, and expense—to ensure that there is a radio receiver in each class. IRI addresses these concerns: each teacher has at least a half-hour daily broadcast; the lessons teach the core curriculum; and teacher's guides are provided.

Furthermore, a project can be designed so that teachers purchase the radio at a subsidized rate. In addition to the advantages the radio lessons provide for children and teachers alike, the teachers benefit from ownership at a low cost.

Costs

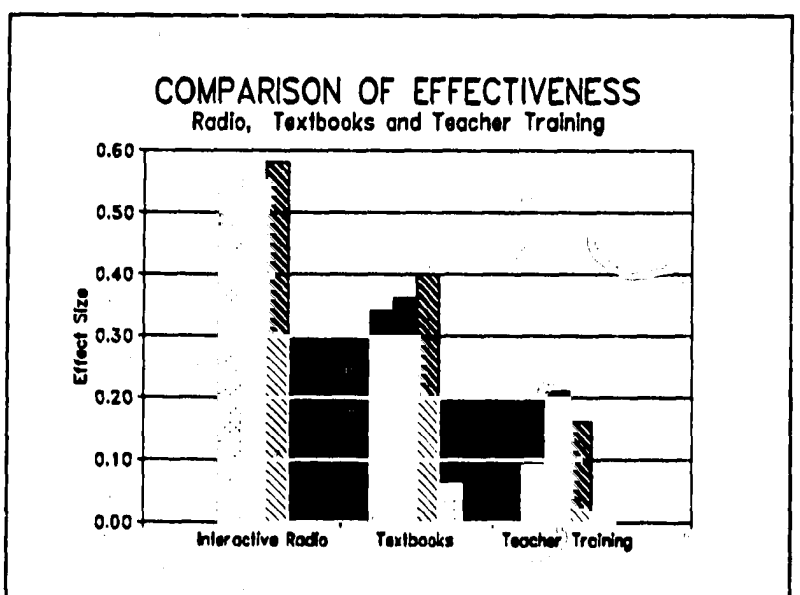
IRI is a cost-effective approach to help meet critical needs in basic education. So far in this book we have only looked at the effectiveness side of the cost-effectiveness equation. But costs are also a major factor. Not only must the materials be affordable, but they must provide benefits that are sufficiently desira-

ble, at least as desirable as could be obtained with other interventions (such as new schools, textbooks, or teacher training) for the same amount of money.

The typical case for using a distance education system is that it can increase access to education at a lower cost than could be provided through traditional means. This is the main argument for RADECO, where IRI lessons are being used in special radio schools in communities where there are no traditional schools. Evaluation results indicate that the children in RADECO groups learn more math and as much reading and writing as children in traditional schools in comparable communities.

But as with all distance education programs, the scale of implementation is the crucial factor in determining the cost per student. Many costs are fixed, that is, they don't change regardless of whether only one student or 100,000 students are listening. For example, these fixed costs include costs for developing the programs and transmitting the lessons. Thus, if only a few students listen to the programs, the per-student cost can be very high. Only with a fairly large listening audience, say at least 20,000 students, are these fixed costs shared sufficiently so that the per-student cost becomes less expensive than just expanding the traditional school system.

The economies of scale apply to the RADECO project in the Dominican Republic. The RADECO lessons are presently serving about fifty-seven communities, a number not sufficiently large to attain a low cost per student. However, a



Comparing Effectiveness: Interactive Radio, Textbooks, and Teacher Training

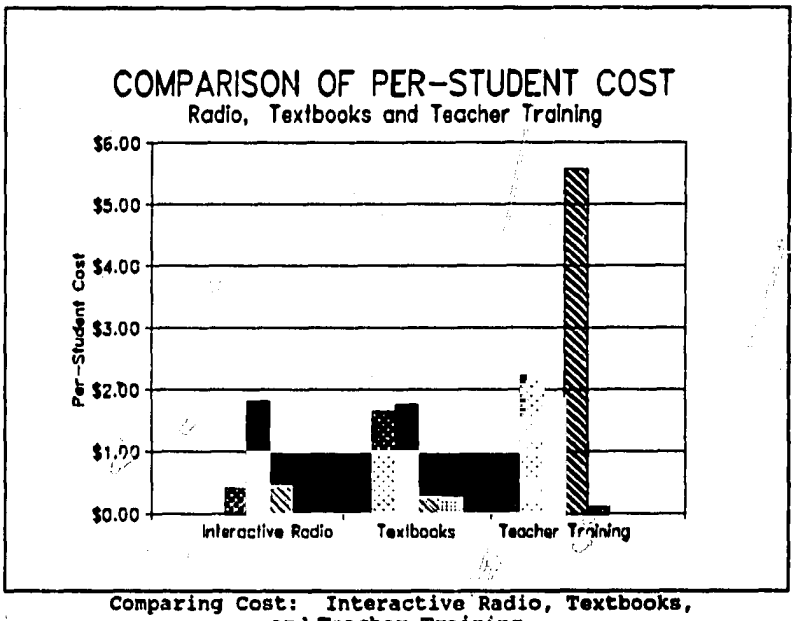
Figure 1

study has shown that if the program is expanded to about 200 communities, the cost would be about half that of the formal school system or about $15 per student (Sanguinetty, 1985).

The use of radio programs in traditional schools presents a very different situation. In traditional schools, if there were no broadcasts, the children would still study math or English, or whatever the radio lessons might teach. Thus, in this case, adding radio programs doesn't increase access to education. But it may be justified on other grounds.

There is only limited research that compares cost-effectiveness among different interventions. Lockheed and Hanushek (1988) examined several radio, textbook, and teacher training projects. They looked at the effectiveness of each in terms of effect size (a useful statistical measure for comparing results from different studies. It is calculated by taking the difference in scores between the experimental and control groups and dividing by the standard deviation of the control group.) and the cost per student. They then combined the cost and effectiveness to come up with a measure of efficiency. Figure 1 shows the relative impact on achievement of the interactive radio programs, textbooks and teacher training. Each bar on figures 1-3 represents a different study (e.g. there were three studies for interactive radio and four each for textbooks and teacher training.)

Figure 2 then demonstrates the relative cost of each intervention on a per-student basis.



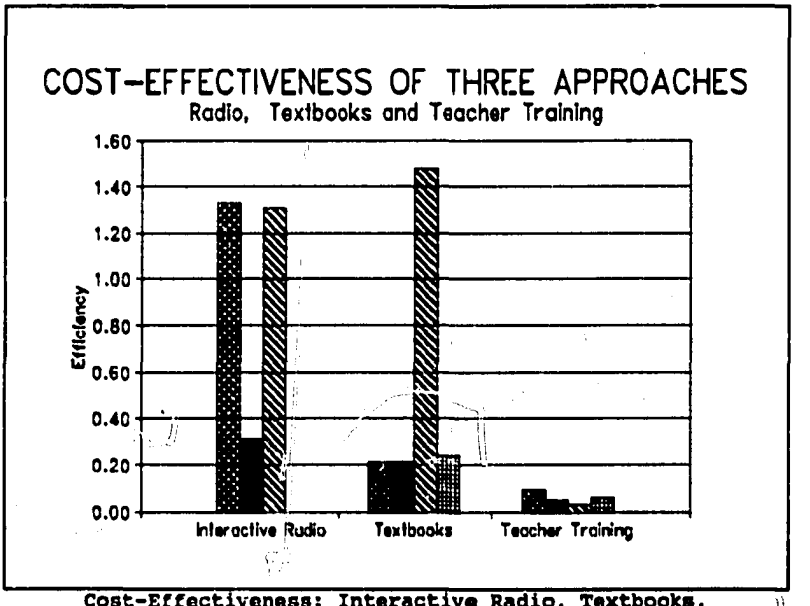
Comparing Cost: Interactive Radio, Textbooks, and Teacher Training

Figure 2

Figures 1 and 2 show two things. First, based on the studies reviewed by Lockheed and Hanushek, interactive radio shows the greatest effectiveness, followed by textbooks and then teacher training. Second, the costs per student of interactive radio and textbooks are comparable, and teacher training costs are very high.

Figure 3 shows the cost-effectiveness of each type of intervention, what Lockheed and Hanushek call "efficiency" or the effectiveness per US dollar.

The efficiency measure is calculated by dividing the effect size by the per-student cost. Figure 3 shows that, overall, interactive radio provides the greatest cost-effectiveness, followed closely by textbooks. Teacher training, based on these studies, is a poor intervention based on a cost-effectiveness analysis.



Cost-Effectiveness: Interactive Radio, Textbooks, and Teacher Training

Figure 3

Allocation of Expenses

It is important to know not only what the total cost is, but also who actually pays the costs. The allocation of costs is extremely important, for a Ministry of Education may not be able to afford radio programs without an arrangement to share

costs. Costs can be divided among several entities, including the Ministry of Education, Ministry of Information (for transmission costs), students and parents, international donors, and private corporations. Figure 4 illustrates how some of the costs might be shared, based on hypothetical costs for a Grade 2 mathematics program. In this hypothetical example, costs have been allocated to many sources in addition to the Ministry of Education, including the Ministry of Information (assuming it is in charge of at least one of the transmitters being used), international donors, families, and schools or teachers. The share of the expenses borne by the Ministry of Education is only $0.25 per child. International donors and the Ministry of Information also share the expenses totaling $0.15 per child. Parents would be responsible for $0.14 per child, and schools or teachers would raise funds to cover $0.13 per child. There are a great many options for allocating costs; each country needs to work out the funding support that is most appropriate given local circumstances.

GRADE 2 MATHEMATICS
ALLOCATION OF COSTS

Annual total program costs	Total Cost	Ministry of Education	Ministry of Information	Inter-national Donors	Imposed Family Costs	School &/or Teachers
Worksheets	$0					
Paper	$7,500				$7,500	
Pencils	$1,313				$1,313	
Clipboards	$938	$938				
Rulers	$1,406				$1,406	
Teacher training	$1,620	$1,620				
Teacher's guides	$915	$915				
Radio receivers	$5,853			$5,853		
Maintenance of radios	$2,133					$2,133
Power, battery	$7,558					$7,558
Power, utility	$75					$75
Posters, three colors	$5,242	$5,242				
Radio transmission	$9,534	$5,250	$4,284			
Duplication of worn tapes	$583		$583			
Air-conditioned storage	$350		$350			
Administrative & clerical	$2,295	$2,295				
Administrative overhead	$600	$600				
Administrative travel	$300	$300				
Delivery of materials	$1,747	$1,747				
Total Program Cost	$[illegible]962	$18,907	$5,217	$5,853	$10,219	$9,766
Per-Student Cost (75,000 students)	$0.67	$0.25	$0.07	$0.08	$0.14	[illegible]13

Figure 4

Impact of Internal Efficiency—Or How to Save Money by Spending Money

Another important consideration is the potential impact of radio programs on the efficiency of the education system. Internal efficiency basically refers to the extent to which children pass successfully through the school system on time. Dropout and repetition are major causes of inefficiency; an important index of inefficiency is the number of years of schooling that is required for each primary graduate. For example, in many countries there is high repetition and dropout and it may take twelve years of schooling for each sixth-grade graduate.

Say, for example, the objective of a radio series is to increase the learning of mathematics. Since the radio programs represent an added cost to the Ministry of Education, an important question is "Do these programs improve the efficiency of the school system?" Theoretically, if the children learn more math, then there should be an increase in the promotion rate from one grade to the next. If there *is* an increase, even a very small increase, then the programs may pay for themselves in terms of reducing the cost per graduate of primary school. Let's look at an example.

Assume the following:

- There are 40 students per class.
- The add-on cost for the radio programs is $0.50 per child per year, or $20 per class.
- The Ministry of Education spends $25 per student per year.
- The radio programs result in an increase in promotion rate of at least 5%, or, on the average, 2 children per class.

The calculations are straightforward. It costs the Ministry of Education $20 per classroom per year for the radio programs; these programs result in at least two more students being promoted to the next grade. Thus, for an extra outlay of $20, the Ministry will not have to pay $50 to educate two more students for another year. The net savings is $30.

$20 Spent for radio lessons	A minimum of two more children are promoted	$50 Saved by not educating 2 students an extra year	$30 Net Savings

The addition of radio programs to the formal school system is generally based on an argument to increase quality. And there are good data to show that IRI does, indeed, improve the quality of instruction. There are also arguments that good programs can improve the efficiency of the schools by reducing dropout and repetition; children learn more; they enjoy school more; and parents are more supportive of schools. Therefore, more children will stay in school and more of them will be promoted each year.

Unfortunately, studies that try to relate improved quality of instruction to changes in efficiency are rare. Yet there is a widely held assumption that raising the quality of instruction will improve internal efficiency. To the extent that this assumption may be true, interactive radio lessons, which are known to improve the quality of instruction, should also improve the efficiency of the school system.

Cost-Saving Measures for IRI

IRI, as with other ways to improve education such as textbooks and teacher training, can be expensive, especially when new programs are being developed. Yet there are ways to minimize costs and keep long-term recurrent expenses to a low level. The following are some cost-saving measures:

1. Use or adapt existing programs if at all possible, rather than develop new programs.
2. Design programs with minimal support materials, and make those materials reusable.
3. Make the programs easy for teachers to use so that teacher training can be kept at a minimum. Provide good teacher's guides and consider preparing special teacher-training radio programs to reduce time for face-to-face meetings.
4. For face-to-face teacher training develop an effective "cascade" or "multiplier" system whereby each new group of people being trained then carries out training of another group. For this to work well, develop excellent support materials, including audio tape, and (if the circumstances are appropriate), video tape material.
5. To reduce the cost of batteries for radios, examine solar power or other options, such as hand-crank-powered radios and tape recorders.
6. Don't invest in radio programs unless the target audience is large enough so that per-student costs are at least as low as alternative approaches.
7. Use radio broadcasts rather than audio cassette tapes for distributing the lessons, except for poor reception areas.
8. Use existing distribution systems such as school supervisors for sending out materials.
9. Use computers wisely for all phases of a radio project.
10. Don't avoid using outside technical assistance, but don't use more than you need.
11. Sell or lease radios to the schools or teachers, probably at an attractive subsidized price, and use the proceeds to establish a fund for buying new radios.
12. Get corporations as well as international donor organizations to underwrite some of the costs for radios and supporting print material.
13. Enlist the private sector in the school community to provide batteries, materials, and supplies.

Appendix B

Services Available through the Radio Learning Project

The Radio Learning Project offers products and services to educators in developing countries.

Introductory videocassettes of projects

Sample materials (scripts, audio tapes, project reports, and curricula):
- math (grades 1-4)
- reading and writing in Spanish (grades 1-4)
- English as a second language (grades 1-3)
- science (grades 4-6)
- health (grade 4 or 5)
- teacher training

Specialists to discuss potential radio projects; to help plan and implement projects; to train local staff in areas such as curriculum design, scriptwriting, radio production, and evaluations

Computer programs to estimate costs and simplify adaptation

Limited financial support

All inquiries should be directed to:

Mr. James Hoxeng, ST/ED
U.S. Agency for International Development
Washington, DC 20523

Telephone (703) 875-4490
Fax (703) 875-5490

Dr. Thomas Tilson
Radio Learning Project
Education Development Center
55 Chapel Street
Newton, MA 02160

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Telephone (617) 969-7100
Fax (617) 332-6405

The Radio Learning Consortium

The Radio Learning Project is a program of the U.S. Agency for International Development, Bureau for Science and Technology, Office of Education.

Services are provided by the Education Development Center in consortium with the Academy for Educational Development and Friend Dialogues of North Carolina. In Latin America the Radio Learning Project is assisted by AVANCE in Honduras.

List of Works Consulted

Agency for International Development (A.I.D.). (1988). *Oral Rehydration Therapy: A Revolution in Child Survival.* Weston, MA: Oelgeschlager, Gunn & Hain.

Agency for International Development (A.I.D.). (1988). *The Testing Fields: Research and Agriculture in Bangladesh.* Weston, MA: Oelgeschlager, Gunn & Hain.

Anzalone, Stephen. (1988). Using Instructional Hardware for Primary Education in Developing Countries: A Review of the Literature. Education Development Discussion Papers. Project BRIDGES.

Anzalone, Stephen. (1989). Educational Technology and the Improvement of General Education in Developing Countries. In *Technology and Teaching: Elements of Sustainability in Developing Countries.* Washington, D.C.: The World Bank.

Block, Clifford. (1985). Bilateral Aid in Communications: The U.S. Agency for International Development. Journal of Communication. (Vol. 35:2, pp. 27-38).

Block, Clifford. (May 1988). Discussion Paper: The Use of Educational Technology in Basic Education. Prepared for A.I.D. Research Advisory Commitee Working Group Meeting.

Block, Clifford H., *et al.* (1985). Interactive Radio in the Classroom: Ten Years of Proven Success. Washington, D.C.: Academy for Educational Development.

Booth, Elizabeth, and Corrales, Jose C. (1988). "Social Marketing + Interactive Radio = Educational Success." Development Communication Report, 62.

Clearinghouse on Development Communication. (1988). Interactive Radio Handbook: A Guide to Planning and Implementation. Washington, D.C.

Development Communication Report. (1988). Radio Learning Project: Articles Reprinted from Development Communications Report. Special Issue.

Edgerton, David. (1989). Honduras Radio Learning Project: Special Interim Report on Status of SEI, AVANCE's Radio Education Unit.

Jamison, Dean; Searle, Barbara; Galda, Klaus; and Heyneman, Stephen P. (1981). Improving Elementary Mathematics Education in Nicaragua: An Experimental Study of the Impact of Textbooks and Radio on Achievement. Journal of Educational Psychology. (Vol 73, No. 4, pp. 556-567).

Katak, Roland. (1989). Community School Science: A Difficult Subject? Some Teachers' Views on Science and Science Teaching in East Sepik and Western Province.

Lockheed, M. and Hanushek, E. (1988). Improving Educational Efficiency in Developing Countries: What Do We Know? World Bank Reprint Series. (Number 435, pp. 30-31).

McNulty, Judiann. (1989). Final Report: Interactive Radio Health Education Pilot Project in Bolivia, 1989.

Olsson, Micael. (1989). Papua New Guinea Radio Science Pilot Project Evaluation. Office of Education, Bureau of Science and Technology. U.S. Agency for International Development.

Education in Subsaharan Africa: Policies for Adjustment, Revitalization, and Expansion. (1988). Washington, D.C.: The World Bank.

Eshgh, Ruth; Hoxeng, James; and Casals, Beatriz. (Eds.). (1988). *Radio-Assisted Community Basic Education (RADECO).* Pittsburgh, PA: Duquesne University Press.

Friend, Jamesine; Searle, Barbara; and Suppes, Patrick. (Eds.). (1980). *Radio Mathematics in Nicaragua.* Stanford, CA: Stanford University.

Fryer, Michelle. (1989). First-Year Summative Evaluation: Second Grade Mathematics. November 1988-November 1989. Cochabamba, Trinidad, and Kami, Bolivia.

Fuller, Bruce, and Heyneman, Stephen P. (1989). Third World School Quality: Current Collapse, Future Potential. Educational Researcher. (Vol. 18, pp. 12-19).

Galda, Klaus. (1989). Trip Report—Radio Science Project, Papua New Guinea.

Helwig, John F., and Galda, Klaus. (1989). RADECO Revisited. The Future of Interactive Radio Education in the Dominican Republic. Paper prepared for the Radio Learning Project.

Helwig, John. F. (1989). Trip Report: RADECO Seminar.

Imhoof, Maurice, and Christensen, Philip. (Eds.). (1986). *Teaching English by Radio: Interactive Radio in Kenya.* Washington, D.C.: Academy for Educational Development.

Imhoof, Maurice. (1981). Reading by Radio: A Position Paper on the Use of Radio in Teaching Reading Skills for Educational Development.

Jamison, Dean, and McAnany, Emile. (1978). *Radio for Education and Development.* London and Beverly Hills: Sage Publications.

Radio Learning Project: Report of the First Seven Months. October 1985-April 1986. (1986). Newton, MA: Education Development Center.

Radio Learning Project Annual Report: Project Year 1, October 1985-December 1986. (1987). Newton, MA: Education Development Center.

Radio Learning Project Annual Report, 1987. (1988). Newton, MA: Education Development Center.

Radio Learning Project Annual Report, 1988. (1989). Newton, MA: Education Development Center.

Radio Science Project Annual Report, 1987. (1988). Newton, MA: Education Development Center.

Sanguinetty, Jorge A. (1985). The Replication of the RADECO Project in the Dominican Republic: Recurrent Cost Implications. Washington, D.C.: Development Technologies, Inc.

Schramm, Wilbur. (1973). *Big Media, Little Media.* Stanford, CA: Stanford University.

Searle, Barbara; Friend, Jamesine; and Suppes, Patrick. (Eds.). (1976). *The Radio Mathematics Project: Nicaragua, 1974-1975.* Stanford, CA: Stanford University.

Sedlak, Philip. (1988). Teaching Initial Reading by Radio. Paper Presented at the Second Latin American Conference on Interactive Radio in Tela, Honduras.

Spain, Peter; Jamison, Dean; and McAnany, Emile. (Eds.). (1977). *Radio for Education and Development: Case Studies.* World Bank Staff Working Paper No. 266. (Vols. I and II). Washington, D.C.: The World Bank.

Suppes, Patrick; Searle, Barbara; and Friend, Jamesine. (Eds). (1978). *The Radio Mathematics Project: Nicaragua, 1976-1977.* Stanford, CA: Stanford University.

Teas, Molly Maguire, and Tilson, Thomas. (1989). Bolivia: Instruction Through Interactive Radio. Mothers and Children: Bulletin on Infant Feeding and Maternal Nutrition.

Terry, James V. (1989). The Radio Learning Project: The Current Status—Options for the Future. A Review of Project Activities and Issues.

Tilson, Thomas. (1990). Radio Education: An Economic Perspective. Paper presented at the African Conference on Radio Education, in Harare, Zimbabwe.

Thompson, A.R. (1981). *Education and Development in Africa.* New York: St. Martin's Press.

White, Robert A. (1977). Mass Communications and the Popular Promotions Strategy of Rural Development in Honduras. In *Radio for Education and Development: Case Studies.* (Vol. II, pp. 200-259). Washington, D.C.: The World Bank.

World Conference on Education For All Background Document. (1989). Meeting Basic Needs: A New Vision for the 1990s.