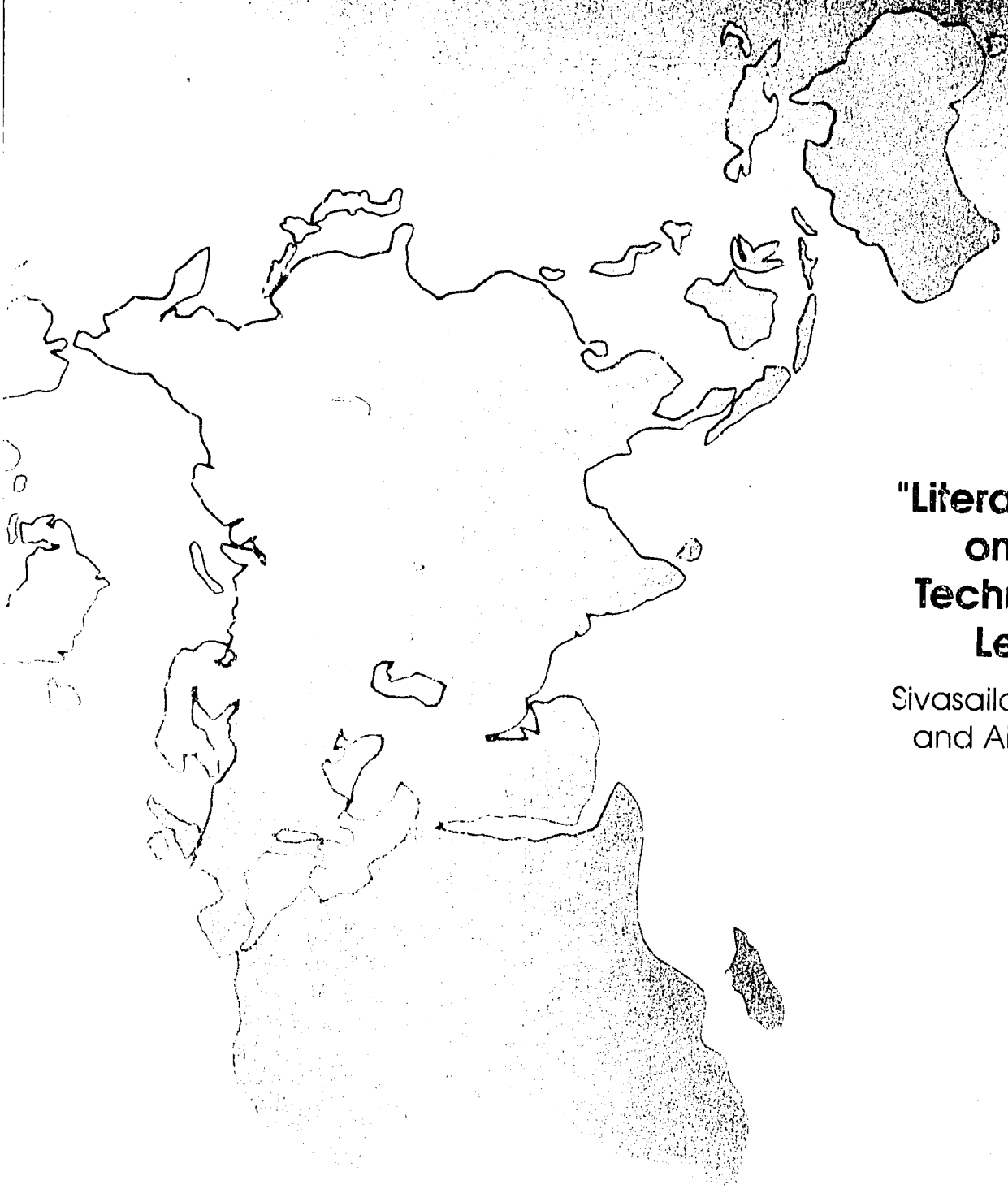
RESEARCH REPORT SERIES

JULY 1988 NO. 2



"Literature Review on the Soft Technologies of Learning"

Sivasailam Thiagarajan
and Aida L. Pasigna

B • R • I • D • G • E • S
Basic Research and Implementation in DevelopinG Education Systems

The Basic Research and Implementation in DevelopinG Education Systems Project (BRIDGES) is directed by the Harvard Institute for International Development and the Harvard Graduate School of Education, under Cooperative Agreement No. DDP-5824-A-5076 with the Office of Education, Bureau for Science and Technology, United States Agency for International Development. Also participating in the Project are the Institute for International Research, Michigan State University, the Research Triangle Institute, and Texas Southern University.

The BRIDGES Group includes educators researchers, planners and policymakers committed to improving opportunity and quality in Third World schools. The goal of their collaborative effort is to identify policy options that will increase children's access to schooling, reduce the frequency of early school leaving and repetition, improve the amount and quality of what is learned, and optimize the use of fiscal and educational resources.

The *BRIDGES Research Report Series* is edited by the Harvard Institute for International Development. The *Series* is a collection of reviews of the state-of-the-art in research, and original research reports on basic education in developing countries. Each review summarizes research about a particular policy issue and suggests policy options. Original reports on BRIDGES-sponsored research present new information about the impact and costs of specific alternatives that the reviews have identified as most promising.

The views expressed in this document are those of the author and do not necessarily reflect those of the United States Agency for International Development.

BRIDGES RESEARCH REPORT SERIES July 1988 No. 2

"Literature Review on the Soft Technologies of Learning"

Sivasailam Thiagarajan
and Aida L. Pasigna

Sivasailam Thiagarajan and Aida L. Pasigna are Vice President and Senior Research Scientist, respectively, at the Institute for International Research, Inc. They coordinated a large-scale modularized programmed teaching project in Liberia (which is scheduled for nationwide adoption) and are currently coordinating a small-scale posterized programmed teaching project in Belize. Thiagarajan has done additional work on soft learning technologies in India, Bangladesh, and Indonesia; Pasigna, in the Philippines, Indonesia, and Malaysia.

Prepared for Project BRIDGES
(Basic Research and Implementation in DevelopinG Countries)

Harvard University
Cambridge, MA

USAID Contract DPE-5824-A-5076

Foreword

The BRIDGES Project is an effort to communicate across geographical and cultural barriers, in order to increase the available options for those who seek to improve their education systems. There is, however, a risk that the bridge will be seen as a one-way technological panacea, a solution to all problems in any context. Because the Project originated in a "high technology" society, some might expect BRIDGES to place an unbalanced emphasis on "technological" solutions to educational problems in developing countries, meaning by "technological" those ways to improve education that rely on satellites, television, computers, and other hardware purchased at great human and foreign exchange costs. (It is unfortunate that the term "technology" has come to be associated exclusively with the mechanical, chemical, and electronic inventions of the early-industrialized countries instead of being used as a generic term for the wide variety of tools and techniques that humans devise for transforming the world.) BRIDGES research reviews suggest that these "hard" technologies of instruction are not cost-effective alternatives (see "Using Instructional Hardware for Primary Education in Developing Countries: A Review of the Literature," by Stephen Anzalone). Instead, significant improvements in learning outcomes can be achieved–at low cost– using knowledge and skills found in every country.

There is a *caveat*. The gains in learning outcomes will require abandonment of the technology of instruction currently used in almost all developing countries. There will be resistance to this change, by educators who want to hold on to "tradition." The great irony here is that in almost all developing countries, the current instructional technology came with colonial domination. Curriculum content and instructional techniques were originally developed by educators in the so-called metropolitan countries, pursuing different objectives in a very different historical context.

The current and "traditional" technology of instruction can be characterized as one in which content and methods are derived from the logic and requirements of the subject matter or discipline being taught. In this context both what is taught and how it is taught are determined by "experts" in each subject. Efforts to improve learning focus on *curriculum development*, subject matter specialists focus their attention on the latest developments in the discipline, and the objective of instruction is to replicate in the student the knowledge and thought of learned persons.

The research, amply cited in this review, demonstrates the power of an alternative technology for instruction. This alternate approach–which many effective teachers will recognize as what they have been doing for some time–begins with the learner rather than the learned. Emphasis is more on *how* people learn than on what they should learn, on *instructional* design rather than curriculum design. The objective is for the child to learn what is possible for children to learn rather than what adults know (which may not be possible for the child to comprehend).

The objective is for the child to learn what is possible for children to learn rather than what adults know...

Emphasis on the learner *increases* the importance of the teacher. Now the teacher is not just a device for transmitting expert knowledge to children. Instead, the teacher must be a strategist who designs an instructional approach that takes into account the capacities and interests of students, and who is capable of adopting new tactics as those capacities and interests change. Thiagarajan and Pasigna recognize that not all teachers are capable of adapting their teaching to the learning characteristics of students, sometimes because of a lack of basic knowledge about the subject matter. Instructional design approaches can solve this problem by providing beginning teachers with highly-structured teaching guides that indicate clearly how to recognize

and reward appropriate learning responses by children.

The results show that students who are taught by teachers using instructional design achieve more of the curriculum learning objectives than students taught by the "traditional" curriculum design technology. The cost of the technology is low, much lower than the so-called "hard" technologies of instruction (see Anzalone, 1987). The results are also culturally specific, because instructional design pays attention to the characteristics of learners–who are themselves part of a specific cultural context. Because of this flexibility, instructional design, as it has been developed in the Third World, has a universal application. The bridge spans continents.

We offer this review not as a catalog of pre-packaged solutions from the North, but as further evidence to support the basic assumptions of the BRIDGES Project: that there are affordable means by which education in developing countries can be improved, and that these means have already been invented and tried out, in the Third World. BRIDGES hopes to continue sharing these experiences across countries.

Noel F. McGinn
July 8, 1988

Table of Contents

Executive Summary 2

Section I: Procedure 3

Section II: The Problem and Solution 4

Section III: Conceptual Framework 5
- Systematic Approach 5
- Systems Approach 6
- Learning Technologies 6
- Soft and Hard Technologies 6

Section IV: Generalizations from the Survey 9
- Instructional Development 10
- Instructional Design 11
- Instructional Materials 12
- Textbooks 14
- Instructional Methods 15
- Teacher Variables 16
- Organizational Variables 18
- Cost-Effectiveness 19

Section V: Concluding Thoughts 22
- Limitations of the Data 22
- Suggestions for Future Research 23
- Policy Recommendations 24

References 26

Executive Summary

Traditional solutions do not respond to the expanding demand for primary education in developing nations. Learning technologies offer cost-effective alternatives. These technologies are characterized by a systematic instructional development process and validated instructional design principles. This review deals with soft technologies of learning associated with conventional devices such as blackboards, media such as print, and methods such as mastery learning.

Generalizations from the review include the following:

• Systematic instructional development process and instructional design procedures are effective—but not widely used in developing nations.

• The textbook is the most prevalent type of instructional material in developing nations. Modularized materials, programmed learning materials, and workbooks are gaining in popularity.

• Programmed teaching has produced impressive learning gains. Different types of tutoring (by peers, advanced students, parents, and paraprofessionals) enhance the quality of education. Small-group methods (e.g., peer group learning and instructional games) are cost-effective. Individualized instruction (with alternative learning resources matched to the characteristics of the individual learner) does not appear to be cost-feasible.

This review deals with soft technologies of learning associated with conventional devices such as blackboards, media such as print, and methods such as mastery learning.

• Effective use of soft technologies may require changes in the teachers' role. Teachers accept the tight structuring and guidance required for implementing instructional systems that use emerging technologies.

• Conventional school organizational structure does not facilitate effective use of soft technologies of learning. Staffing and scheduling changes can increase their cost-effectiveness. Emerging technologies should take into account the resources and constraints of Third World schools.

Within the limitations of the data, the study makes the following policy recommendations:

• Instructional development and design procedures should be used more extensively in conjunction with educational reforms in developing nations.

• Programmed teaching should be used in primary schools to compensate for the lack of qualified teachers.

• Self-instructional programmed learning materials should be used in higher grades since they require literacy skills.

• Textbooks and workbooks should be improved by the application of various instructional development procedures and design principles.

• Different types of tutoring should be implemented to augment conventional teaching approaches.

This state-of-the-art literature review deals with the "soft" technologies of learning. The review begins with a description of the procedure used for identifying documents and deriving generalizations. It briefly identifies educational problems and technological solutions within the domain of the review and presents a conceptual framework of learning technologies and a classification of the domain into soft and hard technologies. Following this, generalizations related to soft technologies of learning are presented under eight headings. The concluding section of the review discusses limitations of the existing data, suggests areas of fruitful future research, and offers some policy options.

Section I: Procedure

To focus our search for (and through) the appropriate literature, we began by creating a conceptual framework of learning technologies. We reviewed the critical attributes of learning technologies as depicted in the educational technology literature, and modified the list of attributes to suit the context of primary schools in developing nations. This conceptual framework was dynamic: it determined our sources of information, and these sources, in turn, modified the framework.

Initial sources of information were based on Institute for International Research, Inc. (IIR) staff members' combined expertise in implementing learning technology projects in various developing nations. We have had access to a large number of evaluation reports, research studies, project reports, review documents, and fugitive literature related to a series of complex integrated learning technology projects for primary education in seven developing nations. These projects include Project IMPACT in the Philippines (Socrates, 1983), Project PAMONG in Indonesia (Nichols & Dilts, 1984), Project RIT (Potar, 1984) in Thailand, Project INSPIRE in Malaysia (Nichols, 1982), the IEL Project in Liberia (Pasigna, 1985), Project PRIMER in Jamaica (McKinley, 1981), and the UPE/IMPACT Project in Bangladesh (Claveria, 1982). In addition to published documents, we gathered responses to a specially prepared questionnaire from the staff of some of these projects.

On a broader scope, we identified several pieces of literature in the area of learning technologies. These include the following:

- Reports from major learning technology projects in developing nations
- Books on research and evaluation of learning technologies in developing nations
- Journal articles on research and development in learning technologies in developing nations
- Excerpts from the Sector Analysis Reports from the USAID-funded Improved Efficiency of Educational Systems (IEES) Project dealing with learning technologies, instructional development, and instructional materials
- Data-based critiques of learning technologies in developed and developing nations
- Reviews and meta-analyses of research related to learning technologies in developed nations

This list of documents was continuously expanded through additional input from experts and through secondary references cited in the initial documents that were reviewed.

Throughout the review of the literature, we identified various generalizations regarding the use of learning technologies in developing nations. Each tentative generalization was recorded on an idea processing software (*Maxthink*). Generalizations supported by several documents from different sources were moved up in the priority list. The final set of generalizations was categorized into instructional development, instructional design, instructional materials, textbooks, instructional methods, teacher variables,organizational variables, and cost-effectiveness.

At various stages during our review, we checked our intermediate conclusions with individuals knowledgeable in the field of learning technologies in developing nations. These experts raised questions about some generalizations, confirmed others by providing additional information and leads to documentation, and helped reconcile seemingly contradictory findings.

***..a single teacher is assigned to the first grade* with more than a hundred students *and another single teacher is assigned to the fifth grade* with fewer than 20 students.**

Section II: The Problem and Solution

Educators in developing countries all over the world share a number of dreams as they strive towards development and progress. One dream that has proven to be elusive has been that of achieving universal primary education. A UNESCO survey conducted in 1980 (Coombs, 1985) showed that in developing countries:

> [The] educational pyramids . . . bore little resemblance to what their ministers had envisaged at the regional educational conferences held in the early 1960s in Karachi [and] Addis Ababa. . . . By 1980, the target year for completing universal primary education, not only was every developing region still a long way from the goal, but it was doubtful if many countries would reach it even by the year 2000.

And the dream goes beyond a universal primary education that will promote the development of the nation's vast human resources; the ultimate goal is to provide affordable, quality education for everyone (Nichols, 1980; Flores, 1981). The dream becomes more elusive in the face of attendant problems that prevent its attainment: educational systems in developing countries are beset by a lack of textbooks and other instructional materials, overcrowded classrooms, poorly qualified teachers, high attrition rates, high illiteracy rates, and disparities between urban and rural schools, just to name a few (Wells, 1976; Coombs, 1985).

One dream that has proven to be elusive has been that of achieving universal primary education.

Ellson (1973) cites a cluster of problems that developing countries face as they attempt to achieve universal primary education:

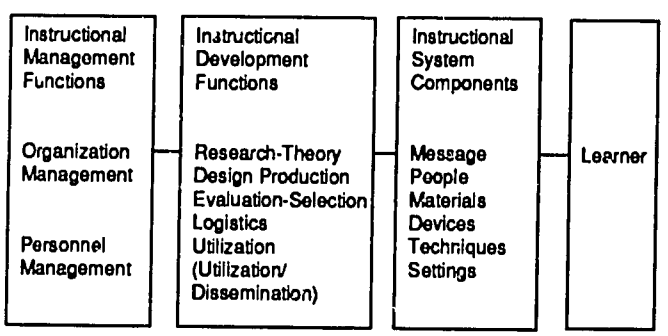
> The aim itself immediately poses the problem of numbers, the "quantitative problem." The conventional solutions to this problem—more teachers, more schools, more teaching materials, etc., produce corresponding shortages. If expansion is pushed rapidly, the shortage of trained teachers is most crucial . . . [T]his shortage typically results in the "qualitative problem," an actual decline in the average quality of primary education. Such a decline . . . frequently occurs when enrollment is abruptly increased.

It does not come as a surprise, therefore, that analyses of educational problems in various developing countries (e.g., IEES, 1985c) have linked poor quality of instruction, particularly in the primary schools, to poorly qualified, undertrained teachers and the "scarcity of textbooks and learning materials which impedes optimum teaching effectiveness of even the better trained teachers" (USAID Project Paper 669-0130, Problems of Education Systems in the Third World). Nichols' (1980) timely and wise reminder regarding low cost learning systems would apply just as well to any type of technological intervention that may be contemplated as a solution to educational problems in a developing country. With too many assumptions and too little knowledge of conditions in a particular developing country, it would be easy to design a system that is entirely inappropriate to the needs and resources of that country. Government officials, administrators, teachers, parents, and students might be willing to try out a different technology if it holds promise for improving the cost-effectiveness of education. However, a final judgment about the technology will come only when it has been tried and shown to deliver on its promises.

Section III: Conceptual Framework

Our definition of learning technologies is based on the widely accepted definitions of educational and instructional technology provided by the Association for Educational Communications and Technology (AECT) Task Force on Definition and Terminology (1977). Figure 1 illustrates the elements and the relationship of the domain of instructional technology according to the AECT definition.

Figure 1: Domain of Instructional Technology



Systematic Approach

Learning technologies focus on the facilitation of the achievement of prespecified learning goals and objectives by a predefined group of learners. They utilize a *systematic* approach and a *systems* approach.

At the macro level of courses, learning technologies use a systematic instructional development process. This process involves *analysis* of the instructional needs, context, learner characteristics, tasks, and objectives. The next step is to design an outline for the learning system. In the *production* stage, various components of the learning system are produced and integrated. In the *evaluation and revision* stage, prototype components are tried out with representative learners and the package is modified. In the *implementation* stage, the learning system is installed in the school. This systematic instructional development process is often a critical feature of all learning technologies.

At the micro level of lessons, systematic instructional design principles are normally employed in learning technologies. These principles determine the sequence and structure, and the instructional methods and materials that facilitate the students' learning process. The principles generally occur in the following order (Gagne & Briggs, 1979):

- Gaining attention
- Informing the learner of the objectives
- Stimulating recall of prerequisite learnings
- Presenting the stimulus material
- Providing learning guidance
- Eliciting the performance
- Providing feedback about performance correctness
- Assessing the performance
- Enhancing retention and transfer

At a more micro level that deals with single units of instruction, the systematic approach involves applying known principles to facilitate the acquisition of different types of learning. For example, a systematic design for teaching a concept (e.g., a square) might use the following sequence (Merrill & Tennyson, 1980; Jacka, 1985):

- Presenting clear-cut examples of squares
- Focusing learners' attention on various attributes of the sample squares
- Presenting matched examples and nonexamples (e.g., a square and a rectangle) to focus learners' attention on the critical attributes

At their best, learning technologies incorporate a systems point of view. Thus, a complete learning system consists of messages, people, materials, devices, techniques, and settings.

• Presenting divergent examples (e.g., squares of five different sizes) to focus learners' attention on irrelevant attributes

• Requiring learners to recognize and to verbalize critical and irrelevant attributes

• Requiring learners to classify a set of examples and nonexamples

• Requiring learners to construct their own examples and nonexamples

At a still more micro level, systematic instructional design procedures are applied to facilitate the clear presentation of information, reliable elicitation of student responses, and meaningful feedback. Message design principles (Fleming & Levie, 1978), text-layout principles (Hartley, 1985; Jonassen, 1982), and text-illustration principles (Levie, in press) are used to effectively present the instructional content in the printed format. Criterion-testing principles are used to construct items that validly measure learner achievement (Shrock, et al., 1986). Feedback principles are used to provide reinforcement and remediation to the learners.

Systems Approach

At their best, learning technologies incorporate a *systems* point of view. Thus, a complete learning system consists of messages, people, materials, devices, techniques, and settings. Ideally, the learning technology approach should attend to each of these components and to the interrelationships among them.

Learning technologies are developed and implemented within a broader system (of primary education), and all the constraints, resources, and the context of this broader system are taken into account. The inputs, processes, and outputs of learning technologies are analyzed, designed, and evaluated from a systems point of view (Awa, 1982). Attempts are made to maintain congruency among the four major functional components of the learning system: intents, contents, teaching-learning activities, and means of evaluation. Finally, another aspect of the systems point of view is the focus on providing a complete system. Materials and methods for learners are supplemented with corresponding materials and methods for teachers, supervisors, and support personnel.

Learning Technologies

During the survey of literature, we identified several types of learning technologies which were frequently mentioned in the literature (see Table 1 on page 7 for an illustrative list). To simplify the process of synthesizing the literature, we classified learning technologies into various categories. Here are some dimensions we used for the classification:

• **Design and delivery technologies.** Some technologies are primarily used for the design of an instructional intervention (e.g., systematic instructional development). Others are primarily used for the delivery of instruction (e.g., the same instruction may be delivered through the technologies of computer-assisted instruction, interactive radio, or distance education through mail). Some technologies are suited for both design and delivery (e.g., programmed learning is both a method of designing instruction and of delivering it).

• **Macro and micro delivery technologies.** Some technologies are suited for designing or delivering instruction on a nationwide basis (e.g., back-to-basics curriculum and radio education). Others are suited for use at the local classroom or student level (e.g., posters made by teachers, and tutoring).

• **Teacher-centered and student-centered technologies.** Some technologies are mediated by the teacher (e.g., direct instruction and programmed teaching) while others are directly delivered to the student (e.g., programmed-learning modules and individualized instruction).

• **Materials-centered and methods-centered technologies.** Although all learning technologies usually have a materials component and a methods component, they may be classified according to their primary choice. For example, textbooks represent a materials-centered technology, whereas flexible scheduling reflects a methods-centered technology.

While the creation of these classification schemes enabled us to keep track of the literature, they are not of any major practical significance to the end user of the literature survey. No educational planner is likely to be interested only in micro technologies or in delivery systems. Hence, our survey focused on all types of learning technologies.

Soft and Hard Technologies

For the convenience of our analysis, we have divided learning technologies into hard and soft domains. Hard technologies are electronic hardware and various strategies associated with their use. Primary school instruction involving audiocassette recorders, educational radio, educational television, hand-held

Table 1: Illustrative List of Learning Technologies

Accelerated Learning
Accreditation
Action Research
Adjunct Programming
Applied Skills Manuals
Apprenticeship
Audio Cassette Recorders
Audio-Tutorial System
Audiovisual Devices
AV Production
Back-to-Basics Curriculum
Basic Skills Practice
Behavior Modification
Behavioral Objectives
Bilingual Education
Boarding
Self-Supported Schools
Bush Schools
Classroom Aids
Classroom Observation Systems
Community Involvement
Competency-Based Teacher Testing
Computer-Assisted Instruction
Computer-Assisted Teacher Training
Computer Drill & Practice
Computer Games
Computer Managed Instruction
Computer Simulations
Construct Lesson Plan
Criterion-Referenced Testing
Decentralization
Demonstration Schools
Diagnostic/Prescriptive Instruction
Disincentives for Poor Performance
Distance Education
Duplicating Technologies
Educational Radio
Educational Television
Enrichment
Examination Reform
Flexible Facilities
Flexible Schedule
Framegames
Functional Literacy
Hand-Held Electronic Devices
Home Schooling
In-School/Off-School Program
Individualized Instruction
Information Mapping
Inservice Training
Instructional Games
Instructional Modules
Instructional Supervisors
Intensive Educational Campaigns
Interactive Videodiscs
Itinerant Teachers
Job Redesign and Enrichment
Kibbutz Schooling
Laznov Method
Learning Centers
Learning Posts
Learning Teams
Lecture Method
Libraries
Local Adaptable Instructional Material
Localizing Scheduling
Low-Cost Learning Systems
Management by Objectives
Mastery Learning
Materials Distribution
Materials Management
Media Centers
Media Production
Microcomputers
Microteaching
Montessori System
Motivational Engineering
Multigrade Teaching
Multigroup Scheduling
Nomadic Education
Nonformal Education
Nongraded Schools
Nuclear-Satellite Schools
Parent-Child Center
Peer-Group Learning
Performance Aids
Personalized System of Instruction
Posterized Programmed Teaching
Preschool Interventions
Privatization of Schooling
Process Science Curriculum
Programmed Learning
Programmed Teaching
Programmed Tutoring
Protocol Materials
Radio Instruction
Reduced Instructional Time
Remediation
Selection of Instructional Materials
Simulation and Roleplaying
Special Education
Steiner Method
Student Tutoring
Systematic Instructional Design
Systems Analysis
Tavistock Approach
Teacher Centers
Teacher Effectiveness Training
Teacher Evaluation
Teacher Incentives
Teacher Salaries
Teacher Selection
Team Teaching
Teaching-Learning Unit
Teams-Games-Tournaments
Teletext
Televised Instruction
Textbooks
Token Economy System
Training Workshops
Translation and Cultural Adaptation
Tutorials
Volunteers and Paraprofessionals
Voucher Systems
Workbooks

electronic learning devices, videocassette recordings, interactive videodiscs, microcomputers, and teletext are examples of hard learning technologies. The literature on hard technologies is reviewed in a companion paper entitled "Using Instructional Hardware for Primary Education in Developing Countries: A Review of the Literature," by Stephen Anzalone.

Soft technologies are conventional devices such as chalkboards, media such as print, and strategies associated with them. Soft technology products include textbooks, posters, programmed learning materials, programmed teaching modules, structured text, instructional games, simulation and role-playing materials, and workbooks. Techniques and methods for improving instruction also fall within the soft technologies category. Individualized instruction, mastery learning, diagnostic/prescriptive instruction, the Montessori system, peer tutoring, and personalized systems of instruction are examples of such soft technologies. A special subcategory of soft technologies focuses on guidance provided to the teacher. Included in this category are ready-made lesson plans, teacher's guides that accompany textbooks, and various checklists, worl sheets, and other such job aids to improve classroom instruction. Organizational and management techniques in classrooms and in schools also fall within our scope of soft technologies. Team teaching, differentiated staffing, multigrade teaching, use of paraprofessionals and volunteers, flexible scheduling, localized scheduling, nongraded school structure, and multipurpose use of school facilities are common examples of these techniques. Finally, various processes involved in the development and design of instructional methods and materials (instructional development process and instructional design procedures) also fall within our definition of soft technologies.

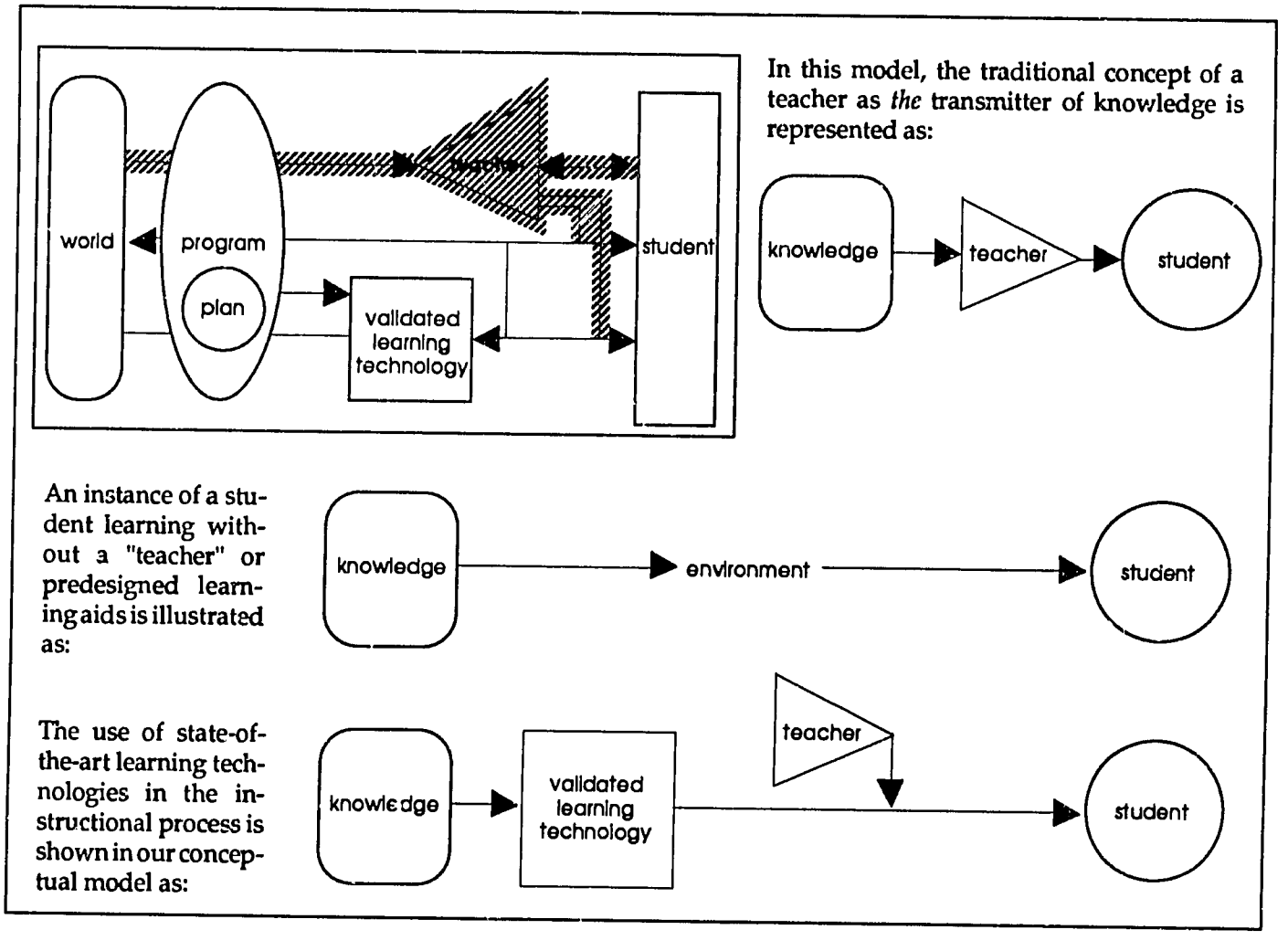
There are no quick fixes to educational problems. No single discrete technology is ever likely to make a significant improvement in the efficiency of instruction. As Wells (1976) points out, the systems approach to educational improvement requires integrated combinations of appropriate technologies. In our literature review, we focus on such combinations rather than on isolated technologies.

Section IV: Generalizations from the Survey

When properly implemented, a systematically developed and validated learning technology should produce positive results in terms of teaching competence and learning outcomes. In theory, the teaching-learning process is facilitated by instructional interventions that make available to the teacher well-designed, validated materials and teaching procedures to deliver instruction effectively. This is implicit in our conceptual model of how learning takes place, which is an adaptation of Ellson's model (INNOTECH, 1977). (See Figure 2 below.)

This last instance shows the teacher implementing the validated learning technology which provides for an optimal teaching-learning environment. Within this framework, learning technologies are especially useful with untrained or undertrained teachers. If the technology is cost-effective, its use would have tremendous impact in developing countries where the problem of untrained teachers and limited financial resources are potent deterrents to the attainment of quality education.

Figure 2: "A Generic Model of Teaching-Learning, and Three Variations"



Furthermore, learning technologies are most effective with creative, professionally trained teachers because they provide a set of systematically validated instructional and management strategies. It is not surprising, therefore, that our survey shows that the use of soft learning technologies produces comparable, and oftentimes superior, teacher and student outcomes.

The next section contains a set of generalizations from the survey of literature on soft learning technologies. The generalizations are listed under eight headings:

- Instructional development
- Instructional design
- Instructional materials
- Textbooks
- Instructional methods
- Teacher variables
- Organizational variables
- Cost-effectiveness

Instructional Development

Learning technologies usually utilize a systematic instructional development process for the production of materials and methods, which are delivered to the learners through a variety of media. Although there are variations among different models for the systematic development of instructions (Bass & Dills, 1984; Harmon, 1983; and Gustafson, 1982), the process generally consists of stages of analysis, design, implementation, and evaluation and revision.

Under ideal conditions, instructional development proceeds in the following manner: During the *analysis* stage, a needs analysis is undertaken to identify the critical requirements for instruction; a systems analysis is undertaken to identify constraints and resources in the instructional context; an analysis is undertaken to identify student characteristics which heighten or lessen the effectiveness of the learning technologies; an instructional analysis is undertaken to identify the types of learning involved and to specify the instructional objectives. On the basis of these analyses, appropriate media (e.g., print or radio) and methods (e.g., programmed instruction or discovery learning) are selected. The *design* stage begins with an outline for the learning system. Appropriate instructional materials and methods are produced to help prespecified types of learners achieve prespecified sets of objectives. During the *implementation* stage, physical facilities are prepared; teachers and other key personnel are trained; and the instructional system is implemented. Suitable modifications are made to reduce or eliminate problems identified during the initial period of implementation. *Formative evaluation* is built into the preceding three stages of analysis, design, and implementation. This evaluation uses both expert review and student tryouts of the learning package. Based on the feedback from such evaluation, the system is revised to improve its instructional and motivational efficacy, and cost-effectiveness.

- **Effectiveness of systematic instructional development.** The reliability and the effectiveness of systematic instructional development have been established in a number of studies in different parts of the world, with different types of learners, and in different contexts. Recently, Ellson (1986a, 1986b) reviewed 125 studies of improved productivity in teaching which met his stringent criterion of the experimental group outperforming the control group by a relative productivity ratio (RPR) of 2.0 or more. Ellson defines RPR as the ratio of the effects (effectiveness, cost, efficiency, or cost-effectiveness) of an experimental treatment and of a comparison treatment, which is used as a baseline. His review reveals systematic instructional development to be a common element among most of these successful examples.

Learning technology packages, developed through systematic instructional development, appear to have consistently produced high levels of learning gains in the IEL Project in Liberia (Thiagarajan & Pasigna, 1985), Project IMPACT in the Philippines (Wooten, Jansen, & Warren, 1982), Project PAMONG in Indonesia (Nichols & Dilts, 1984; Mudjiman, 1981), Project RIT in Thailand (Potar, 1984), and the New Curriculum Reform Project in Somalia (IEES, 1985). Institutions such as INNOTECH in the Philippines (Flores, 1981), the Korean Educational Development Institute (Morgan & Chadwick, 1971), and the Curriculum Development Center (1985) in Somalia have conducted (and continue to conduct) several instructional development projects in primary education. The built-in evaluation activity in these projects generally supports the generalization that systematic instructional development results in effective learning packages.

The success of instructional development can be attributed to the fact that any systematic, rational approach is probably superior to the disorganized approaches frequently used for the design of conventional learning systems. Also, instructional development is based on the principles of instructional design (discussed in the next section) which, in turn, are based on

empirical laws of learning. Further, repeated formative evaluation and revision increase the probability that the summative evaluation will yield effective results. However, some recent critiques (Megarry, 1983) suggest that systematic instructional development has failed to live up to its sales talk because, having disavowed its behaviorist origins, it has failed to find an alternative theoretical basis; all parts of its systematic model have come under attack; and even educational technologists have not been able to practice the systems approach they preach.

• **Prevalence of systematic instructional development.** In spite of its apparent effectiveness, the systematic instructional development process is not used extensively in developing nations. (This observation is also true of many developed nations, except in the case of training in business and the armed forces.) There is very little spontaneous use of the instructional development *process* in formal education, particularly in primary education (Thiagarajan and Pasigna, 1984). However, we have seen some unplanned examples of the *products* of this process being used by educators at various levels. Even when used, the instructional development process is most often applied to special situations rather than to mainstream education. In Indonesia, the instructional development process is most extensively used in modularized materials for primary education in remote areas, with out-of-school student populations, and in small schools (Dilts and Mudjiman, 1984).

Experience with the systematic instructional development process in developing nations suggests that approximately a third of the project time is spent on analyses and another third on evaluation. The distribution of time (and of other inputs) for analysis activities appears to be incompatible with the usual need for the rapid production of instructional materials in developing nations. Similarly, time spent in field testing and revision appears to be contrary to the belief that competent writers should be able to create effective instructional materials the first time around.

Systematic instructional development appears to differ from curriculum development procedures (Sachsenmeier, 1983). In curriculum development, the emphasis is often on the subject matter content. Although content is an essential element in systematic instructional development, it is only one element. Educators in developing nations appear to have greater familiarity with curriculum development procedures than with the instructional development process. They are often unable to understand the complexity of the latter. In some instances, systematic instructional development has run counter to textbook production projects and practices. Textbook producers are more interested in the visual appeal of illustration while instructional developers focus on clarity and relevance to the text. This is another factor which has inhibited the use of systematic instructional development. In reality, however, both the process and the products of instructional development can significantly enhance the development and use of textbooks (Snyder, 1982).

An additional factor that inhibits the large-scale adoption of systematic instructional development in developing nations is the unavailability of trained personnel. Very few university programs in the Third World provide training in this multidisciplinary process (Osborne, 1986). In most instructional development projects, such training is provided through technical assistance from developed nations. This has been a temporary solution to the personnel problem at best. Another inhibiting factor for the adoption of the instructional development process is that it requires interdisciplinary teams of instructional designers, curriculum specialists, illustrators, production specialists, and evaluators. It is difficult to assemble such an instructional development team even in developed nations—and still more difficult to manage the diverse people in such a team (Pasigna, 1983; Coldeway & Rasmussen, 1984). These difficulties are magnified in developing nations.

So far, instructional development projects in developing nations have required heavy initial investments. Since educational projects are frequently evaluated in terms of the quantity of materials rather than the quality of instruction gained, the cost-effectiveness of systematically designed instructional materials has not been conspicuous. It is difficult in developing nations to invest heavily in activities such as analysis and evaluation since their products are often intangible and since they do not directly contribute to such things as increased number of pages. Recent trends in using shortcut strategies in the instructional development process, translating and culturally adapting products from one country to another (Perrot & Padma, 1981; Rojas, 1985), regional collaboration in instructional development, and the selection of inexpensive media and formats (Nichols, 1982) show potential reduction of costs.

Instructional Design

Instructional *development* and instructional *design* are the macro and the micro aspects, respectively, of

producing learning systems. In this framework, instructional design is a subsystem within instructional development. It is possible to go through the stages and steps of the instructional development activity and to ignore instructional design (Clark, 1986); such a mechanical process results in ineffective materials and inefficient methods.

The field of instructional design contains many prescriptions (e.g., Briggs, 1977; Gagne, 1977; Reigeluth, 1983; Richey, 1986; Romiszowski, 1982, 1986) which are primarily based on empirical learning theories (previously from behavioral psychologists and, increasingly, from cognitive psychologists). Instructional design also borrows from media and communication, message design, developmental psychology, logic, evaluation, and social psychology. The activities in instructional design involve identifying the type of learning in a unit of instruction and sequencing and structuring the content, instructional activities, and evaluation designed to help a prespecified group of learners efficiently achieve a set of specific instructional objectives.

• **Effectiveness of instructional design.** The application of appropriate instructional design principles has been shown to improve the efficiency of learning. This conclusion is based on several research studies in various subject areas, at various levels of education, with various types of learners, and in different contexts (Beck, Omanson, & McKeown, 1982; Good & Grouws, 1978; Helms & Heller, 1985; Pratton & Hales, 1986; Retief, 1985; Romiszowski, 1982; Romiszowski & Arce, in press). The effectiveness of instructional design for primary education in developing nations has been repeatedly demonstrated in different projects (Flores, 1981; Potar, 1984; Morgan & Chadwick, 1971). Instructional design improves the efficiency of learning irrespective of the medium used to deliver the instruction. Meta-analyses by Clark (1983) and by Clark and Salomon (1986) suggest that it is the instructional design rather than the inherent superiority of any medium that contributes to the significant differences in studies that compare different media. Instructional design principles have been applied to a wide variety of media including print, radio, television, film, and computers. They have been applied to a variety of methods including teacher-based instruction, self-instruction, small-group activities, and programmed instruction. The same principles have been successfully used with traditional materials such as textbooks and worksheets and with traditional methods such as lecture and recitation.

• **Prevalence of instructional design.** Instructional design principles have not been widely considered in developing nations. Factors that inhibit the adoption of systematic instructional development (e.g., lack of trained personnel, conflict with conventional approaches, inability to assemble multidisciplinary teams, and heavy input requirements) also contribute to the paucity of instructional design applications. The experiences of our colleagues in the field, as well as our own, suggest that, among other factors, existing evaluation and instructional practices do not encourage the implementation of instructional design. Classroom activities and assessment procedures in developing nations frequently reward rote memorization of factual content. Instructional design, on the other hand, requires a careful classification of different types of learning (often beyond mere memorization or verbal recall) and prescription of learning strategies that enable students to exhibit competencies in such areas as problem solving and evaluation (Gagne & Briggs, 1979). However, in most developing nations, the classroom, the teacher, and the examination system are seldom capable of identifying and supporting the attainment of diverse learning outcomes. A change in the belief systems among teachers and in the examination systems among primary schools (Somerset, 1984) will probably be needed for large-scale utilization of the existing knowledge in instructional design.

Instructional Materials

A major product of systematic instructional development and of instructional design is a variety of materials that provide the curricular content and structure the teaching-learning activities in the classroom. Instructional materials come in a variety of media, forms, and shapes. Textbooks, workbooks, printed modules, study guides, audiocassette recordings, audiovisual packages, computer courseware, models, maps and charts, posters, teacher guides, programmed materials, self-instructional materials, instructional games, videotapes, activity materials, slide-tape sets, educational films, filmstrips, overhead transparencies, and science kits are diverse examples of instructional materials. In this section, we discuss generalizations regarding instructional materials designed and delivered primarily through the soft technology of print. A special section deals with textbooks in detail. A major source of information regarding the current status of instructional materials in developing nations is the various Sector Assessments published by the Improved Efficiency of Educational Systems Project on Somalia, Liberia,

Botswana, Haiti, and Nepal (IEES, 1983, 1984, 1985a, 1985b, 1986).

• **Prevalence and types of instructional materials.** Textbooks, printed visual aids, teacher guides, and even copybooks are still not available in primary classrooms in developing nations, especially in rural areas. Unavailability of instructional materials is only one reason for their absence in the classrooms. The lack of a distribution network often prevents instructional materials from being transported to schools outside the capital city and other urban centers (Messec, 1986). Also, our experiences with a textbook project and an instructional module project in Liberia, and the experiences of our colleagues in other developing nations, strongly suggest that the cost of textbooks and workbooks are frequently beyond the purchasing power of most parents and that the strategy of sharing or renting to reduce the cost has not been established in most schools and communities.

Print is the most prevalent instructional medium. Very little use is made of any electrical or electronic media (e.g., audiotapes or filmstrips). Even when textbooks and other printed instructional materials are available in primary classrooms, they are frequently supplied by European or American publishers. The experiences of our colleagues indicate that nontraditional instructional materials (e.g., materials other than textbooks) are among those most frequently imported from developed nations. The content of these instructional materials is often irrelevant to the local curriculum and culture. These irrelevancies frequently remain, even when the materials are translated or "adapted." And, even when instructional materials are locally produced, there is often a low correlation between their content and format and the scope and sequence of the curriculum. For example, we found U. S. social studies textbooks in use in Liberian classrooms. This results in internal effectiveness without any external validity relative to the curricular goals. In addition, instructional materials frequently do not suit the characteristics of the learners. For example, in Somalia, the reading level of some instructional materials is beyond the comprehension level of teachers (IEES, 1985c). Very few instructional materials appear to be written at a level suited to primary school children.

• **Modularized materials.** As a recent alternative to traditional textbooks, the instructional text for a specific subject area and for a specific grade is divided into a number of instructional modules. Such modules provide the base for individualized instructional approaches, and they are also used in conjunction with such methods as direct instruction (Englemann, 1980) and programmed teaching (Ellson, 1973). Data on instructional effectiveness indicate that modularized materials (when used in conjunction with such methods as mastery learning, individualized instruction, or programmed teaching) can bring about superior learning gains in comparison to the traditional use of textbooks (Zahorik & Kritek, 1980). However, modularized instructional materials, if not recycled, are usually more expensive than conventional textbooks (Windham, 1983), primarily because of the production costs associated with publishing a number of booklets instead of a single textbook. Also, modules used in individualized or programmed teaching approaches have extensive user instructions built into them, making them lengthier than the corresponding textbooks. However, when the cost of a module is compared to the combined cost of textbooks and teacher guides, such modularized instructional materials appear to be cost-effective.

• **Programmed learning materials.** Self-instructional materials which present instruction in small units (frames), require frequent active responses from the student, and provide immediate knowledge of the correctness of response are called programmed learning modules. The effectiveness of programmed learning in developed nations has long been established (Lange, 1967; Kulik, Shwarb, & Kulik, 1982), seriously challenged, and insightfully reconciled (Kemp & Holland, 1966). Long-term projects in Liberia (Chapman & Boothroyd, 1986) and Indonesia (Mudjiman, 1984) suggest that programmed instructional materials have a significant role to play in improving the efficiency of primary education in developing nations.

The success of programmed materials is apparently due to their ability to incorporate several powerful principles of instructional design. In spite of their effectiveness, however, conventional programmed learning materials do not appear to be feasible in the lower elementary grades. These materials require literacy and independent-study skills which are not in the repertoire of children in the first two or three grades. Hence, programmed learning materials cannot be used until later in the primary schools.

• **Workbooks.** By requiring students to answer a large number of questions, workbooks provide significant amounts of practice and feedback. Time on task is a major determinant of learning gains, and workbooks appear to keep children on task, thereby improving the efficiency of their learning. Next to textbooks, workbooks, especially those dealing with basic arithmetic, reading, and language skills, appear to be the most

...(instructional games) appear to provide effective and highly motivating instruction, especially in upper primary grades.

prevalent instructional material in developing nations. However, not much empirical data are available concerning their development and use. The following comments are based on our field experiences.

Workbooks primarily provide effective drill and practice for the reinforcement of previously taught skills. Therefore, for maximum effectiveness, they should be coordinated with textbooks and other classroom activities. Disposable workbooks, in which students write down their answers, appear to impose an unnecessary cost burden. Students can write down their answers to workbook items in their own copybooks; there appears to be no major additional instructional advantage in writing directly on the workbook except in the very early grades where children trace letters in learning to write.

• Other instructional materials. Very little empirical data are available on the use and effects of other types of soft technology instructional materials in the primary classrooms of developing nations. The following comments are based on field experiences (in India, the Philippines, Indonesia, Bangladesh, Belize, Liberia, Somalia, Nepal, and Malaysia) and appear to be worthy of further exploration.

Large-size visual displays of illustrations and text provide a cost-effective approach to information transmission to primary classroom groups. The use of posters (which are designed through the application of systematic instructional development and design and which are supported by appropriate teaching-learning activities in the classroom) promises to be cost- effective. Such posters can minimize the need for individual textbooks. A current study in Belize plans to explore the feasibility of posterized programmed teaching.

First graders need auditory input for initial instruction in language and reading to form the core for later instructional activities. Hence, at the first-grade level, instructional materials in the form of audiocassettes or educational broadcasts can be efficient (e.g., Searle, Friend, & Suppes, 1976).

Self-contained, small-group instructional materials (e.g., instructional games) appear to provide effective and highly motivating instruction, especially in upper primary grades (Coleman, 1973; Baker, Herman, & Yeh, 1981; Ellington & Addinall, 1984; Winner & McClung, 1981). These games provide a cost-effective approach for mastering basic skills and receiving iterative practice and drill. Additional advantages of games include their requirement of frequent and active responses from students, their ability to sustain high levels of on-task behaviors, and their capacity to make abstract concepts concrete. Recent studies in Belize suggest that a basic mathematics game (Allen, 1980) which has been successfully used in various U.S. projects is transferable to a different context and culture.

Textbooks

Textbooks are among the most enduring artifacts of educational systems in the modern world. The traditional concept of schooling invariably implies the use of textbooks, the ubiquitous chalkboard, and, of course, the teacher. If instructional materials are available at all in classrooms in developing countries, these would most probably be textbooks of some kind. Research findings from developing countries reported by Black and by Silberman (Kajubi, 1982) estimate that over 75 percent of classroom time and over 90 percent of the students' homework involve the use of textbooks. Unlike the other instructional materials discussed in the preceding section, many studies on textbooks—and reviews of these studies—are available (e.g., Neumann, 1980).

In Mexico, as in many other developing countries, efforts to provide free primary school textbooks are based on the assumption that the use of textbooks raises academic standards and increases the efficiency of a school system (Neumann & Cunningham, 1982). Research findings seem to support this assumption to some degree. Numerous studies conducted on variables such as teacher training and its impact on academic achievement in developing countries have reported equivocal results. In contrast, research findings in nine developing countries (Ghana, Thailand, Uganda, India, Chile, El Salvador, Brazil, Ecuador, and Malaysia) indicate clear and consistent evidence of positive relationships between books and achievement (Heyneman, Farrell, & Sepulveda-Stuardo, 1980). The reviewers observe that, compared to other potential correlates of school achievement (e.g., teacher training and class size), "the availability of books appears so consistently associated with higher achievement levels that it is worthy of more experimentation and close scrutiny as an instrument for affecting learning."

Based on recent experimental studies, Bruce Fuller (1985) reports unequivocal evidence about the magnitude of the effect of textbooks on academic achievement. One example that he cites is that of a sophisticated, controlled evaluation in the Philippines involving the introduction of textbooks to first and second grade pupils. The results showed an improvement which had twice the impact of what would have been

gained by lowering class size from 40 to 10 students. Similarly, significant results (although lower than in the Philippines) were found in an experimental program in Nicaragua in which students who received textbooks scored higher on math posttests than did those in control groups.

Heyneman, Farrell, and Sepulveda-Stuardo (1981) suggest, however, that it may not be just the availability of textbooks per se that makes the difference in the academic achievement of students in the various textbooks studies that have been conducted. Rather, it could simply be that students have material to read and to work with. Foster (1985) adds that the textbook availability findings are consistent enough to suggest the need for making low-cost materials available in primary schools. This would promote the habit of reading and thus increase the likelihood of sustained literacy through the so-called "saturation" effect. Coombs (1985) expresses a similar view in his discussion of the learning needs of rural children. He suggests that much depends on the availability of reading materials if school children (and school leavers) are to maintain and improve the level of literacy they have attained in school.

Not all textbook studies have yielded positive results. A study in Ecuador cited in Heyneman et al. (1981) shows nonsignificant results. The authors suggest that this result negates the assumption that "a textbook is a textbook is a textbook—that content and presentation do not matter." As with any other instructional material, appropriate content and good instructional design determine to a large extent whether or not learning occurs. Equally important to the effectiveness of a textbook, and any other instructional material for that matter, is how it is used by the teacher. The reviews cited earlier suggest that with untrained and undertrained teachers, well-designed textbooks and instructional materials are essential.

Instructional Methods

The teaching-learning activities in the classroom constitute the instructional method. These methods are closely related to instructional materials; a complete instructional system specifies both. In the new learning technologies, most instructional materials are accompanied by detailed guidance for the teacher and the students. New instructional methods are developed in which the performance of the teacher and students are carefully controlled.

• **Traditional vs. new instructional methods.** Traditional instructional methods in developing nations often contain activities that are considered inefficient (Stolovitch, in press). Most primary school classrooms in the Third World use the conventional approach, left over from colonial days, which features the teacher talking, children listening, the textbook structuring all classroom activities, with a lot of copying from the blackboard and memorization and recitation of factual information. These approaches are likely to be motivationally and instructionally ineffective in comparison with newer learning technologies. They are particularly unsuitable for helping students achieve higher-level learning objectives. In contrast to these highly prevalent approaches, any systematic instructional method which focuses on learning outcomes, guides teacher behaviors, and requires active student participation is likely to result in increased efficiency of learning. It appears that a few basic principles of instruction provide significant learning gains. These principles, derived from learning theories, include active student participation, immediate feedback on the correctness of their responses, guided practice opportunities, division of the learning task into meaningful units, providing appropriate examples and nonexamples, using analogies, and spacing the lessons. These principles can be used in various combinations to make different instructional methods. They can also be incorporated into self-contained instructional packages for use by individuals or small groups of students and require very little teacher intervention. Such packages are especially effective in regions where teacher absenteeism is a major problem, as in Somalia (IEES, 1985).

• **Programmed teaching.** A new teaching methodology called direct instruction (Englemann, 1978), structured tutoring (Harrison & Guymon, 1980), or programmed teaching (Ellson, 1976) is a special variation of programmed instruction. This methodology has proven effective for teaching basic skills and concepts in the primary classroom (Bereiter & Englemann, 1966; Ellson, 1973; Ebersole & Dewitt, 1972; Zahorik & Kritek, 1980). In general, programmed teaching is organized around modules which structure the instructional activities in the classroom by providing the lesson content, items for student response, and correction procedures. The function of the teacher in this method is to implement accurate and effective lessons developed by subject matter and instructional design experts. Paraprofessional teachers and older students can fulfill these functions without elaborate training. Programmed teaching has been successfully used in the Philippines (Pasigna, 1979), Indonesia (Dilts &

...tutoring in which upper primary grade children tutor lower grade children appears to result in mutual benefits for both...

Mudjiman, 1984), Bangladesh (Claveria, 1982), and Liberia (Kelly, 1983) in the primary grades. Evaluating this methodology from an economist's point of view, Windham (1985) recommends programmed teaching as the appropriate technology for improving the internal efficiency of African primary schools.

• **Tutoring.** Young children in the lower primary grades appear to require and benefit from the individual attention in tutoring sessions (Cohen, Kulik, & Kulik, 1982; Frey & Reigeluth, 1986; Thiagarajan, 1977; Allen & Boraks, 1978; Cooledge & Wurster, 1985; Heward, Heron, & Cooke, 1982). Used in conjunction with effective instructional materials, tutoring has been shown to be highly effective (Ellson, 1976). Cross-age tutoring in which upper primary grade children tutor lower grade children appears to result in mutual benefits for both the tutor and the student (Feldman, Devin-Sheehan, & Allen, 1976; Thiagarajan, 1977). Such cross-age tutoring, using programmed teaching materials, has been successfully employed in the IMPACT Project. Tutoring is also used to supplement such individualized self-instructional methods as the Personalized System of Instruction (Keller, 1968) and the audio-tutorial method (Postlethwaite, Novak, and Murray, 1972). Tutoring by parents and volunteer adults is an effective method, but it is generally not available as an option in most developing countries.

• **Small-group methods.** Team learning activities provide a new method for maintaining high levels of motivation and for achieving high levels of instructional efficiency in primary classrooms. In a method called teams-games-tournaments (DeVries & Edwards, 1973; DeVries, 1980), the classroom is divided into heterogeneous teams and instructional game tournaments are held among homogeneous groups. Within each team the students at different levels of ability coach each other; among different teams students at the same level participate in tournament competition. This approach has consistently produced effective instruction (Coleman, 1973) and is now being implemented in Belize. In another approach to collaborative learning, peer groups of learners work through programmed learning materials (Nichols, 1983). This and other team-mediated approaches (Johnson & Johnson, 1985; Slavin, Leavey, & Madden, 1982; Baker, Herman, & Yeh, 1981) suggest that small groups are capable of eliciting and utilizing cooperation and competition in learning.

• **Individualized instruction.** In the U. S. and other developed nations, a number of comprehensive learning systems are available to provide individualized instruction wherein students use learning materials specifically designed or chosen to suit their individual interests, abilities, and experience. These systems include Program for Learning in Accordance with Needs (PLAN) (Flanagan, Shanner, Brudner, & Marker, 1976), and Individually Prescribed Instruction (IPI) (Glaser & Rosner, 1975). Key features of this method include instructional plans, alternative learning resources, criterion-referenced tests, and progress tracking charts. Individualized instruction provides personalized instruction which is highly efficient from the point of view of the individual learner. However, individualized instructional methods are not very prevalent in developing nations, perhaps because they are not cost-feasible. It is difficult to justify expensive individualization of instruction, especially for atypical learners, when access to education is not available to most learners. Also, individualized learning methods require a variety of instructional materials using different media, careful diagnosis of individual students, and extensive retraining of teachers (Evans, 1984). Programmed teaching and peer tutoring appear to be affordable alternatives for achieving individualization in developing nations.

In the upper grades of primary schools, the use of self-instructional programs permits individual pacing and scheduling. This flexibility may be important in developing nations especially if the students are older or if they are employed around the home, on the farm, and in other places. In most rural schools, it is very difficult for a rigid school calendar or class schedule to be maintained. There is a demand for instructional methods which permit students to progress at their own pace.

Teacher Variables

The teacher's role is affected by the materials and methods made available by learning technologies. These technologies also present several implications for teacher training.

• **The central role of teachers.** Since the early days of systematic instructional development, learning technologists have attempted to develop "teacher-proof" materials which can produce reliable and effective instruction independent of the characteristics of the teacher-implementor. However, programmed teaching, interactive radio instruction, and other such combinations of instructional materials and methods have clearly demonstrated the difficulty of eliminating the teacher variable from even the most tightly packaged

...attempts on the part of the instructional designers to bypass teachers and go directly to students have almost always failed...

instruction. Similarly, attempts on the part of the instructional designers to bypass teachers and go directly to students have almost always failed, especially in primary grade classrooms.

As Kemmerer and Wagner (1986) point out, students at the primary level are not capable of substituting inputs. Teachers are a pedagogical necessity because of their flexibility, their ability to provide auditory instructions, and their ability to process oral responses. Beginning students in early primary grades require a human teacher. Teachers are also a sociological and political necessity in the primary school. The face validity of teachers is so well established that any attempts at reducing or removing them from the classroom is politically and socially unacceptable. In our field experiences in Liberia and in other developing nations, such attempts are frequently perceived by the community as relegating them to second-rate educational services.

Traditional expectations held by the community for teachers are seldom attainable in most developing nations. The teacher is expected to be a subject-matter specialist and an instructional design expert. In primary schools, the teacher is expected to be equally skilled across different disciplines and capable of teaching all subjects to young children. This is an unattainable ideal, especially in view of the fact that primary school leavers are often employed as primary school teachers in such countries as Somalia (IEES, 1985c).

• **The changing role of the teacher.** Teachers perceive learning technologies as tools under their control, while learning technologists perceive teachers as a component in the instructional system (Nunan, 1983). This discrepancy in perception has often resulted in a mismatch between teacher needs and technology attributes. Even within the technology-as-tools framework, teachers have to be trained to become effective users of textbooks, tutoring, and other instructional materials and methods. Traditional teacher training does not prepare teachers to use learning technologies effectively. Teacher training institutions in developing nations implement heavily theoretical curricula frequently borrowed from their colonial past (IEES, 1985c; Agbenyega, 1980). Such curricula expect the teacher to transfer theoretical models from educational philosophy and psychology to the realities of the classroom. These curricula do not prepare the teacher to handle the devices, equipment, materials, resources, and methods of learning technologies. Nor do they prepare the teachers to benefit from programmed teaching and other structured approaches.

In situations where new learning technology methods and materials are adopted, the primary school teacher's role changes from that of a designer of instruction and planner of lessons to that of an implementor of packaged programs. The teacher, supported by learning technologies, follows directions in the instructional package and implements a predesigned set of activities. In most applications of individualized instruction, the teacher's role shifts from disseminating information to managing instruction. At the upper primary grades, most learning technologies encourage the teacher to lecture less and require the students to work more on their own. The teacher keeps track of the progress of individual learners, evaluates their achievement, diagnoses their problems, prescribes appropriate instructional resources, and provides remedial instruction.

In our experiences with low-cost learning technologies in six different countries, especially in the Philippines and Liberia, there is surprisingly little teacher resistance to such changes in their roles. In these countries, teacher educators warned us that very few primary school teachers would tolerate tight structuring of their classroom behaviors. However, our experience and that of those who worked in interactive radio instruction (Jamison & McAnany, 1978) suggest that the typical primary school teacher exhibits very little resistance toward the tight structure of learning technologies. If anything, "programmed" teachers in Liberia appear to welcome the structure and the guidance provided by the instructional packages.

Concerns were expressed by teacher educators about the increased workload imposed on teachers by learning technologies. In the IEL Project, for example, teachers elicit an average of seven student responses per minute (while providing corrective feedback) and continue this fast pace of instruction for 20 minutes at a stretch. This is in contrast to their earlier behavior of having the students read and copy materials from the textbook or from the blackboard. Although programmed teaching requires more effort on the part of the teachers, very few complaints were heard. Actually, teacher absenteeism in experimental schools was lower than in conventional control schools (Kelly, 1982). This is perhaps due to a variety of factors including an increased sense of personal efficacy, a reduced need for lesson preparation and instructional decision making, the availability of instructional materials, and immediate, visible payoffs in terms of student learning.

• **Staffing patterns.** Some applications of learning technologies require a reorganization of the staffing pattern in elementary schools. In the IMPACT system

...individualized mastery-learning... requires all students to master all instructional objectives while taking as much or as little time as needed.

in the Philippines, for example, many classroom activities are conducted by older students, paraprofessionals, or volunteers from the community (Mante, 1981). At the same time, the system requires master teachers and instructional supervisors to train, observe, and provide feedback to these implementors of the instructional system. A differentiated staffing pattern with qualifications both below and above the current levels of primary teachers was required. Applications of programmed teaching and similar technologies shift the burden of pedagogical decision making and subject matter expertise to the developers of the instructional package. Using specially designed materials and methods, nonspecialist teachers appear to be able to produce consistent and effective results. More people at the paraprofessional level and fewer at the higher level appear to be required.

• **Teacher training.** A competency-based training package is built upon an analysis of teacher tasks in a classroom. It is an application of systematic instructional development and instructional design to teacher training. The analysis of the teacher's task can be based on a specific set of instructional materials in a specific classroom context. Inservice teacher training on the use of new textbooks and curriculum materials has been undertaken in Somalia in lieu of the usual inservice workshops on generic skills (IEES, 1985c). Most preservice teacher preparation programs focus on providing remedial instruction on content areas rather than on instructional competencies (Agbenyega, 1980; IEES, 1985). For example, secondary school leavers trained to become primary school teachers often receive significant amounts of instruction in such academic areas as reading, language, and arithmetic. Such instruction appears to be inefficient since it focuses on the same topics covered earlier in their secondary schools and since it has very little direct relevance to what they will be teaching in the primary classrooms.

• **Teacher guidance.** An alternative to expensive preservice teacher training is to provide untrained teachers with better instructional tools and guidance (Nichols, 1980; Windham, 1985). The less sophisticated the teachers are, the more sophisticated the instructional design has to be in order to make the final product user-friendly and reliable. Instructional materials that are accompanied by detailed teacher's guides (which provide step-by-step directions for instructional activities) appear to be more effective than the materials alone. Similarly, checklists, worksheets, simplified decision tables, and procedural guidelines related to various teaching competencies appear to reduce the time required for preservice training. This trading-off of guidance for training is maximized in the programmed teaching technology which prespecifies all content and activities. In Liberia, for example, untrained teachers who received three weeks of training on the use of programmed teaching materials were able to produce student achievement equivalent to that produced by teachers who had undergone one or two years of teacher training (Kelly, 1982). On the basis of our experience, we feel that a beneficial side effect of the programmed teaching technology is the incidental on-the-job learning of the content and methodologies by the "programmed" teacher.

Organizational Variables

Learning technologies are delivered to the learner in an institutional context. The interaction between the organizational variables of the classroom, school, the education district, and the national education structure on the one hand, and the characteristics of learning technologies on the other, determine the overall efficiency of the system. Learning technologies require some critical organizational changes, and organizational realities force some important learning technology adaptations. The following generalizations are primarily based on the work in low-cost learning technologies (Flores, 1981; Cummings, 1984; Wooten, Jansen, & Warren, 1982). They warrant further empirical exploration in other learning technology applications.

• **Changes in organizational patterns.** The conventional organization of schools does not, in general, support the implementation of the materials and methods of learning technologies. For example, learning technologies stress individualization as a process and student learning as an outcome—in contrast to the group-delivery process and the covering-the-syllabus outcome found in many schools. Most applications of learning technologies have benefited from a more flexible classroom schedule (e.g., 20-minute cycles of direct instruction, practice, review, and one-module-a-day peer group work in the Liberian IEL system [Nichols, 1983]) which often permits individualized pacing of instruction and personalized sequencing of progress. The traditional school arrangement where children are required to spend one year to complete one grade is not as efficient as the individualized mastery-learning approach which requires all students to master all instructional objectives while taking as much or as little time

as needed. The efficiency of programmed learning, modularized instruction, and other such approaches is reduced if early finishers are required to wait for a specific date on the calendar before they can begin working at the next level of schooling.

Traditional resource utilization patterns allocate a disproportionately large amount of the budget to teacher salaries and an almost negligible amount to instructional materials. These patterns are based on a professional teacher-centered delivery system in classroom and schools. Often, even when less expensive and more efficient learning technology alternatives are available, the conventional classroom pattern is superimposed on them. For example, first grade classrooms in most developing nations have significantly larger enrollments than the final grades of primary education. However, very often in Liberia, a single teacher is assigned to the first grade *with more than a hundred students* and another single teacher is assigned to the fifth grade *with fewer than 20 students*. Programmed teaching and programmed learning technologies permit a more rational and equitable redistribution of teacher loads so that the total number of teachers can be less than the total number of classrooms and all teachers are responsible for approximately the same number of student-contact hours a day. However, such an approach is not utilized in the Liberian IEL schools because organizational patterns are very strongly entrenched. Similarly, many learning technologies allow nonprofessional adults and older students to efficiently deliver programmed instruction. These approaches can mobilize hidden community resources and improve instruction without the need for additional public sector inputs. However, ingrained organizational patterns tend to inhibit the use of such available resources.

• **Changes in learning technologies.** Newer instructional materials and methods have usually been operating at the peripheries of mainstream education for a long time. If learning technologies are to make a significant impact, they have to move into the mainstream of formal education and face the realities of teachers, classrooms, and schools. For example, in the implementation of the IEL system it became clear that a new schedule could not be created to meet the needs of the system; the MOE-mandated school schedule had to be followed. Even more important than that, the new learning technology had to fit the actual school calendars which varied widely from one region to another, depending upon the rainy season, the market days, and teacher absenteeism. To accommodate these variances, programmed learning modules were organized into a core group (to be finished by everyone), an optional group (to be completed if time permitted), and an enrichment group (to be studied by the faster groups) (Nichols, 1981). Similar flexible adjustments are required of all learning technologies if they are to be successfully implemented in actual classrooms and if their impact is to be fully realized.

Cost-Effectiveness

Before any decision can be made regarding the appropriate technology or mix of technologies to adopt or adapt, the educational planner's ultimate questions would be: Is it cost-effective? Can our country afford it?

The concern for cost issues is a most legitimate one. We share Levin's (1983) conviction regarding the importance of considering the results of cost-effectiveness analyses prior to decision making because "it can lead to a more efficient use of educational resources; it can reduce the costs of reaching particular objectives; and it can expand what can be accomplished for any particular budget or other resource constraint."

Ellson (1986b) recently selected 125 research studies in instruction that report differences in one or more indices of teaching productivity when two methods of teaching or two management systems are compared. Each of these studies reports at least one difference in teaching productivity that is large enough to be educationally significant. Ellson defines the "large enough educational significance" as a difference represented by a relative productivity ratio of 2.0 or more. Table 2 on the next page shows the nine different categories of learning technologies that are included in Ellson's collection of the 125 that satisfy the RPR > 2 criterion. It is interesting to note from the table that 70 percent of the exemplary studies involve learning technologies related to some form of programming instruction.

Reliable cost-effectiveness data are available and have been summarized (e.g., Jamison & McAnany, 1978) for instruction through radio. Similar data are not readily available for the softer technologies. Table 3 presents comparative data on the low-cost learning (LCL) systems that have been tried and implemented in seven developing countries. It shows data on the effectiveness, cost, pupil-teacher ratios, and the current status of each project in each country. The reason for the decision to limit the matrix to LCL systems is twofold: (1) information on LCL systems is most relevant to the needs and conditions in developing countries, and (2)

Table 2: Learning Technologies that Satisfy the RPR ≥2 Criterion (Based on Ellson [1986b])

Learning Technology	N	%
Conventional Teaching	8	6.4%
Augmented Conventional Teaching	8	6.4%
Conventional Teaching Plus Tutoring	7	5.6%
Content Modification of Teaching	7	5.6%
Procedure Modification of Teaching	2	1.6%
Programmed Learning	43	34.4%
Programmed Teaching/ Tutoring	29	23.2%
Partially Programmed Teaching	16	12.8%
Performance-Based Instructional Design	5	4.0%
Total	**125**	**100%**

documents obtained on the LCL systems provided the most comprehensive data on the application of learning technologies on a system wide basis.

The cost analyses shown in Table 3 for IMPACT (McMaster, 1978), PAMONG (Klees & Suparman, 1984), and IEL (Windham, 1983) were done at different times, so the dollar amounts may have to be readjusted to account for current rates and inflation factors. However, the percentages are still fairly accurate for comparing costs, and it appears that the IMPACT system has the most convincing figures in terms of cost-effectiveness and levels of achievement. In view of this, it seems rather unfortunate that lack of foresight among national education officials could be detrimental to the successful implementation of an otherwise viable system as illustrated in the case of IMPACT at its original project site in Naga, Cebu (Wooten, Jansen, & Warren, 1982).

On the other hand, PAMONG costs more than the conventional system if used in regular SDKs (small schools). However, the system attains substantially higher levels of cost-effectiveness in large schools and "patjar" (learning posts for out-of-school youth and adults) alternatives, with its highest levels realized when system wide resources are spread over a million students. The strong support from the Indonesian Ministry of Education and the large-scale implementation being carried out all over that country indicate that the system is widely accepted.

The table also shows that the optimal class size for the IEL system in Liberia is 60 for programmed teaching and 70 for programmed learning. At this level, the cost savings per pupil are substantial when compared to all of the three textbook-based alternatives. What the table does not show is the other equally significant advantage the IEL system has over the conventional system in realizing significant savings from teacher costs, calculated to be approximately $59 per student per year based on 1983 student-teacher ratios (Thiagarajan & Pasigna, 1985). An added advantage is the increased competence that the system can provide to even the more "qualified" teachers. (This added advantage seems to hold true for all the LCL systems included in this study, except for the Jamaican project which was prematurely closed down, mainly due to political reasons.)

The reduction in instructional time on the RIT Project (under the column on "Cost-Effectiveness") appears very impressive, although the absence of dollar figures on per pupil costs makes it difficult to decide just how cost-effective the system actually is. One can only assume from the relatively large number of schools currently implementing the RIT system and from the highly optimistic projections for the next eight years that the program has succeeded in the experimentation and implementation stages and that, as far as the Thai government is concerned, it is both acceptable and affordable.

Summative evaluation results and cost data on INSPIRE and UPE/IMPACT are not available. Therefore, no conclusions can be made on these systems.

Notes for Table 3:

* Unless otherwise indicated, effectiveness is measured in terms of student's cognitive progress.

** A "patjar" is a learning post where out-of-school youth report for modular learning and posttests.

*** These are average costs based on comparative costs of IEL instructional materials and three proposed alternative approaches using textbooks:
A. Use of approved text at current prices (1984), one book per student.
B. Use of approved text at reduced prices resulting from World Bank Project, one book per student.
C. Use of approved text at reduced prices (WB) one book per two students.
The current prices of textbooks are much higher. Also, since the WB textbook project has been discontinued, Alternatives B and C are no longer available.

Table 3: Comparative Data on Low-cost Learning Systems

COUNTRY Project name and start/completion dates	PHILIPPINES IMPACT: 1974-79	INDONESIA PAMONG: 1974-79	LIBERIA IEL: 1979-85	THAILAND RIT: 1977-83	BANGLADESH UPE/IMPACT: 1981-84	MALAYSIA INSPIRE: 1978-	JAMAICA PRIMER: 1979-83
Grades and Subjects	1-6: All core subjects	1-6: Almost all subjects	1-6: All core subjects	1-6: Thai; Math; Science; Health; & Social Studies	1-5: Bengali; Mathematics; Environmental studies; English	1-3: All subjects	1-6: English & Mathematics
Status	As of 1981: Expanded tryout by various regions (33 schools) As of 1986: Original project site in Naga, Cebu & expansion schools in Lapulapu closed-lack of MECS support. Sapangpalay and other expansion schools in tryout regions still in operation	As of 1986: Expanded tryout in Bali (all districts); Kalimantan (180 schools, plan for 400); East Java (300 schools); & Sulawesi (approximately 5,000 schools)	As of 1984: Experimentation (Phase 1) in 15 schools completed; Expanded into over 100 schools. As of 1986: Awaiting plans for large-scale expansion (Phase 2); Now in 110 schools	As of 1986: Implemented in 2,000 schools; Plans: Implement in 3,000 schools in 1987 and in 10,000 schools within next 8 years	As of 1986: Expansion in 300 schools in all *thanas* (districts)	As of 1981: Experimentation in 15 schools (Gr.1 & 2); Materials for Gr. 3 being developed	As of 1981: Experimentation in Gr. 1,2, & 4 (Closed down after experiment)
Initial No. of Exptal Schools/ Enrollment	5 rural schools; 1068	4 rural schools	1 lab school; 5 system (rural) schools	10 urban & rural schools	1 Lab school; 5 rural schools	6 rural schools	5 rural schools
Technologies Used	Programmed teaching (PT); Programmed learning (PL); Self instruction (SI); Peer group learning; Peer/cross-grade tutoring; Radio lessons; Itinerant teachers	PT, PL, SI, Tutoring by adult community volunteers	PT, PL, SI, Peer group learning, Peer/cross-age tutoring	Group & peer-pair learning; Tutoring; Self learning; Teacher-mediated instruction	PT, Peer group learning, Adjunct programs	PT(teacher mediated)	PT, SI, Peer group learning
Products	PT & PL modules; M.E. & Applied Skills manuals; RL (scripts & readers); Teaching aids; Practice sheets; Management forms; Curriculum grids; Management guides; Integrated continuum	PT guides; SI modules; Tutor's guides; Management guides	PT & PL modules; Implementation handbook; Training manuals for pupils, teachers, instructional supervisors, & module writers; Arts & Crafts manuals; management & distribution system	Teachers guides; Student's booklets; Self-instructional materials	PT & PG modules; adjunct programs; training manuals; learning continuum	PT guides	Integrated continuum/ curriculum; teacher's guides, & self-instructional modules
Pupil-Teacher Ratio	Max: 144:1 Recommended: 100:1	Max: 100:1 Rec: 70:1	PT: 60:1 PL: 100:1 Projected overall ratio: 100:1	Max. Gr.1 & 2: 50:1 Max. Gr.3-6: Two 60-student classes per teacher	Data not available	Data not available	Data not available
EFFECTIVENESS* Measure Used	SOUTELE Tests (standardized MEC achievement tests) *(Source: Flores, 1981)*	Standardized achievement tests; school leaving examination *(Source: Klees & Suparman, 1984)*	Criterion-referenced tests Enrollment in IEL schools *(Source: Kelly, 1984)*	Criterion-referenced tests; Performance tests *(Source: Muang Mai School, 1984)*	Data not available	Data not available	Data not available
Success Rate	Pupil achievement in IMPACT schools equivalent to or better than pupil achievement in non-IMPACT schools	Student achievement equivalent to that of conventional primary schools	On the average, IEL students scored 17 percentile points higher than did the comparison group. Increase in IEL enrollment by 71% without increase in number of teachers	RIT students performed better than control students; RIT students in small schools perform as well as students in large conventional schools	Data not available	Data not available	Data not available
ANNUAL COST PER PUPIL LCL/Alternative System	$23.65 *(Source: McMaster, 1978)*	Small school alternatives: $103.90 Large school alt: $35.70 Patjar alt: $26.70 *(Source: Klees & Suparman, 1984)*	20 pupil classes: *** $3.05 40 pupil classes: $2.20 60 pupil classes: $2.13 *(Source: Windham, 1985)*	Data not available	Data not available	Data not available	Data not available
Conventional System	$47.37	Small school: $99.20 Large school: $40.50 Patjar: $31.40	20: A. $10.18, B. $5.09, C. $2.55 40: A. $10.18, B. $5.11, C. $2.55 60: A. $10.18, B. $5.09, C. $2.55	Data not available	Data not available	Data not available	Data not available
Cost-effectiveness/ Cost Analysis Findings	IMPACT system only costs 50% of the traditional system	Cost of system-wide resources only Rp 800 ($.80) when spread over one million students & included in the costs of each Pamong alternative; otherwise more expensive particularly in small schools	The IEL system is more cost-effective than any of the alternative textbook-based systems, especially in larger classes. Significant savings in teacher training costs would further increase this cost-effectiveness	Reduction in instructional time: Gr.1=15%, G2=25%, G3=40%, G4=70%, G5-6=80%. Overall reduction of no. of teachers by 2 for a six-class school. Cost of instructional materials for every student/school is lower than the annual salary of two teachers.	Data not available	Data not available	Data not available

Concluding Thoughts

Limitations of the Data

The literature surveyed in this review suffers from several limitations. They are listed and briefly discussed below.

• **Range of studies.** The literature represents a wide variety of studies ranging from opinions based on informal experience to objective data collected from tightly controlled experiments. These controlled studies frequently lack generalizability to conditions in developing nations. Field studies, on the other hand, appear to have sacrificed control for realistic conditions. Sometimes these field studies misrepresent reality since data collected as a part of the project with external funding and technical assistance are seldom representative of actual classrooms. Very few soft technologies appear to have been systematically studied in developing nations. Most available data appear to be from formative evaluation conducted by internal project personnel.

Most studies conducted in the U. S. are of questionable transfer value to developing nations.... It is equally unlikely that data collected from one developing nation will transfer to another.

• **Cross-national transfer.** Most studies conducted in the U. S. are of questionable transfer value to developing nations. U. S. schools have significantly more and different resources available to them. It is equally unlikely that data collected from one developing nation will transfer to another. All learning technologies need appropriate adaptation when taken from one nation to another. This makes it difficult to compare identical methods or materials across nations.

• **Level of technology.** Another difficulty in comparing the outcomes of different studies concerns the level at which a technology is implemented. Most technologies are superordinate sets of other narrower ones and subsets of broader ones. For example, *low-cost learning systems* contain such technologies as programmed teaching, programmed learning, cross-age tutoring, and flexible scheduling. *Programmed teaching*, in turn, consists of a number of instructional design attributes such as active responding, frequent responding, small steps, immediate knowledge of results, and gradual sequencing. These attributes are also found in other technologies such as programmed learning, instructional games, and tutoring. Clark and Salomon (1986), in their meta-analysis of research on educational media, point out that the factor which makes a significant difference in media studies is not the medium itself but attributes such as color, motion, three-dimensionality, and random access. By analogy, differences among learning technologies are likely to be due not to the technology itself, but to its instructional design attributes.

• **Labeling problems.** Often a single label stands for several different technologies. For example, *programmed instruction* may refer to several different approaches ranging from the small-step, linear programs of *circa* 1960 to printed texts with a few questions thrown in from time to time. Similarly, *instructional games* seems to refer to a variety of informal small-group activities.

• **Missing technologies.** Our field experiences have made us realize that several indigenous technologies are seldom studied under controlled conditions and seldom reviewed in English language journals. There is an assumption that traditional practices are usually inefficient. However, many represent time-tested approaches that have evolved around the cultural and social needs of the local community. Koranic schools in Islamic nations, for example, continue to efficiently teach critical basic skills and values to primary school children.

Suggestions for Future Research

Our literature review identified not only the technical knowledge currently available but also the critical gaps in this knowledge base. In this section of the review, we discuss a few possible research topics for the BRIDGES Project in the area of learning technologies.

• **Teacher variables and learning technologies.** Perhaps the most fruitful research area lies within the interface between teacher training and learning technologies. For too long, there has been an adversarial relationship between these two domains. Here are two possible avenues of mutual payoff in this area:

1. A study may be undertaken to explore the potential of such learning technologies as programmed teaching or individualized instruction for providing on-the-job training for preservice teachers. In most developing nations there is a shortage of trained teachers, and rather than pursuing the expensive traditional teacher training approach, we may rapidly deploy paraprofessional teachers armed with appropriate tools and guidance. Our experience with low-cost learning systems confirms the ancient adage that the best way to learn is to teach. Repeatedly teaching the carefully structured content in programmed teaching, for example, enables the unqualified and underqualified teachers to learn the lesson content along with their students. At the same time, by watching some of the basic pedagogical principles in action (e.g., eliciting responses from students and correcting errors), the teachers incidentally learn suitable teaching methodologies. This hypothesis is worthy of empirical validation.
2. Another research area is the potential use of instructional materials as teacher incentives. Informal evidence from low-cost learning systems suggests that teachers using new and effective materials exhibit higher morale, perhaps because of an increased sense of professional efficacy. Teachers using programmed teaching modules are less frequently absent from their classrooms than conventional teachers in the control groups in Liberia's IEL Project. This is in contrast with predictions that because "programmed" teachers have to work harder, they are more likely to be absent.

• **Instructional development and design.** Systematic instructional development and instructional design are capable of providing impressive returns on educational investments. However, these process technologies are not used as much as they could be in developing nations. Two studies in this area may help reverse the situation.

1. A study is needed on the development and implementation of more appropriate technologies for instructional development and design in developing nations (Stewart, 1985). Short-cut techniques, informal heuristics, and flexible formats are needed. Modified systems approaches that permit translation and cultural adaptation of existing materials have great potential for improved cost-effectiveness in instructional development.
2. A sociological study of factors that facilitate (and inhibit) systematic instructional development and design may enable us to improve our models for instructional development in developing nations.

• **Instructional materials.** The development (and implementation) of different types of instructional materials is another critical activity for improving educational efficiency in developing nations. Here are two suggested studies in this area:

1. We need systematically collected data on the effectiveness of nontextbook materials in primary classrooms (e.g., workbooks and posters). As a first step in this study, an inventory of types of instructional materials will help educators study their prevalence in the classroom.
2. Many well-designed textbooks and other instructional materials seldom reach the remote rural classrooms. A study of textbook distribution systems can help educational planners maximize the use of existing resources. We also need to figure out the appropriate training needs for maximizing teachers' use of materials without making them feel uncomfortable or threatened by the material.

• **Instructional methods.** This is likely to be a challenging area for conducting controlled studies that can yield useful results.

1. A qualitative study for the collection and analysis of descriptions of traditional teaching methods can provide useful insights into the diffusion of learning technologies. These traditional methods (e.g., apprenticeship or religious instruction) have evolved in different rural areas of developing nations over a long period of time. Educators can perhaps identify and recombine the elements of these methods to suit the needs of urban locations and modern times.
2. Alternative approaches to the use of modularized materials can be studied systematically. Modules play a key role in programmed teaching, individualized instruction, self-instructional systems, and mastery learning. If the same set of modules can be used flexibly under different management systems, more enhanced learning is likely to result.

• **Organizational variables and instructional technologies.** Very few studies have been conducted in this critical interface between institutions and instructional technologies. Learning technologies are implemented within organizational settings and they mutually interact. Here are two suggested research activities in this area:

1. A force field analysis of organizational facilitators and inhibitors to the use of learning technologies can help educational planners to implement them more efficiently. A cross-national study among diverse developing nations using different technologies may help identify similarities and differences among organizational factors.
2. Strategies and techniques for rapidly adapting learning technologies to suit the needs, objectives, resources, and constraints of the institutions and communities are urgently needed. The current practice of sending a complex and rigid package for use in different organizations may be the major cause of the short survival period of most innovative learning technologies.

• **Low-cost learning systems.** This is the most studied and documented soft learning technology. It combines several different aspects of learning technology, including systematic instructional design and development, teacher training, and instructional methods and materials. Here are some suggestions for building on the long-term cross-national studies in this area:

1. Cost analyses of this technology have been conducted in Indonesia, the Philippines, and Liberia. Similar analyses in other countries are needed to complete the picture.
2. Low-cost learning systems appear to work with varying degrees of success in different nations, but we do not know which of several different adaptations may also suggest factors that facilitate the diffusion of this and other learning technologies. Most importantly, in all areas of learning technology there is a need to study why the available technologies are not being used to solve existing educational problems.

Policy Recommendations

A pure researcher may hesitate to recommend particular soft learning technologies until more reliable and generalizable data are collected, for fear of making inappropriate extrapolations. In contrast, policymakers in developing countries may be in a hurry to implement some of the more promising soft learning technologies, even in the absence of such data, for fear of denying educational access to large segments of the population. To assist such policymakers, we offer the following recommendations *based on limited data of questionable quality and on our best informed guesses.*

• **Instructional development and design.** Both logic and data support the extended use of systematic instructional development and instructional design procedures in all aspects of curriculum reform in developing nations. These techniques are especially useful in the following contexts:

- A national curriculum is going to be created or revised.
- General educational reform is going to be undertaken.
- New curricula are going to be introduced in schools.
- New instructional materials are going to be developed locally.
- New delivery systems (e.g., radio) are going to be implemented.

It is important that specific models for instructional development and design are selected to suit the resources and constraints of the local educational system to ensure maximum returns on the investment.

• **Programmed teaching.** This combination of materials and methods that empowers nonspecialist teachers to reproduce efficient instruction in primary classrooms is perhaps the most efficient soft learning technology alternative currently available for use in developing nations. Here are the appropriate conditions under which this technology could be most cost-effective:

Teacher variables. Trained teachers are not available in sufficient numbers, but untrained teachers can be recruited. Teacher turnover is high, making it difficult to obtain any significant returns on lengthy teacher training efforts. Content knowledge and methodology skills of current and potential teachers are low, making it unlikely that the teacher will be able to design appropriate lessons and implement them effectively.

Curriculum variables. Clearly defined curricula contribute to the efficient development of a programmed teaching system. Curricular reform can be effectively combined with the creation of such systems. Programmed teaching is best suited for the basic curriculum in all subject areas.

Classroom variables. Programmed teaching is especially suited for classrooms which contain a moderate number of students (e.g., less than 20). Such classrooms

are found in remote and rural areas of developing nations. Crowded schools in capital cities need to use subgrouping strategies to fully benefit from programmed teaching. Sparsely equipped schools can benefit from programmed teaching since the only essential requirement appears to be a blackboard.

Student variables. Programmed teaching is especially suited for the first three grades of primary schools where children have not yet mastered the rudiments of language and lack the skill and the motivation to engage in self-instruction.

Programmed teaching can be made more efficient in combination with differentiated staffing of teachers, tutoring arrangements for slower children, and reorganization of classroom facilities.

• **Programmed learning.** The use of systematically developed self-instructional materials that incorporate validated principles of learning promises significant cost-effectiveness in grades above the third. Here are the appropriate conditions under which programmed learning can achieve maximum efficiency:

Teacher variables. Trained teachers are not available in sufficient numbers and teacher turnover is high. Currently, teachers are not highly educated and they lack knowledge of the content area.

Curriculum variables. Clearly defined curricula are available. Programmed learning is suited for higher levels of the curriculum in all subject areas.

Classroom variables. Programmed learning is especially well suited to areas where well-equipped classrooms are not available. Since the basic delivery of instruction is individualized, the size of the classroom or the heterogeneity of the students does not reduce its efficiency.

Student variables. Programmed learning will work most effectively with students in the higher grades who are already literate and numerate. It is also especially effective with motivated students who are capable of independent learning.

Programmed learning can be made more effective in combination with a modularized, mastery-learning approach to education. It can also benefit from various types of tutoring and small-group activities.

• **Textbooks.** These instructional materials can contribute to quality learning at all levels provided certain conditions are met:

Teacher variables. Trained teachers are available in sufficient numbers. They have appropriate methodological skills.

Curriculum variables. The contents of the textbook correspond to the national curriculum.

Classroom variables. Textbooks are especially suited for homogeneous classrooms with fixed schedules.

Student variables. Textbooks are most effective in higher grades where the students have the prerequisite literacy and numeracy.

Textbooks are only effective if they are delivered to students. The development of new textbooks can benefit from the use of systematic instructional development and design principles. In many cases, programmed teaching or programmed learning may provide a cost-effective alternative to the production of textbooks. Modified approaches to programmed instruction can be combined with the use of textbooks to improve their efficiency.

• **Workbooks.** These instructional materials (in combination with textbooks) can increase the efficiency of education. For maximum effectiveness, workbooks should be carefully correlated with other instruction in the classroom and students should receive immediate and corrective feedback. Throwaway workbooks (in which students write their responses) do not contribute to instructional efficiency but cost more. Reusable workbooks are, therefore, more suitable for developing nations. Many instructional design principles can be incorporated in the production of such workbooks.

• **Tutoring.** Peer, cross-age, paraprofessional, or parental tutoring appears to be another cost-effective adjunct to classroom teaching in developing nations. Tutoring cannot replace mainstream instruction, but it can contribute to improving the quality of education at low cost. Tutoring of all kinds is especially powerful when the regular schooling is marginal and when structured (e.g., programmed) instructional materials are available.

These policy recommendations, it should be emphasized, are not supported by unequivocal evidence at this time. However, children in the classrooms of developing nations cannot afford to wait for all the data to be collected and analyzed. In this connection—and in conclusion—we may quote Ellson's (1986) words:

> [Learning technologies contain many data bases] that a critical scientist, as scientist, would probably reject. But as educators who are (or should be) looking to research for possible answers to practical problems, we are not acting strictly as scientists. We are acting as technologists, and in this role we cannot afford to be overcautious too soon. And, as members of the concerned public, we are in a position to ask those responsible why we are not teaching as well and as economically as the state of the art (or the technology) permits.

References

AECT. *The Definition of Educational Technology.* Washington, DC, 1977.

Agbenyega, C. *Curriculum and Courses for the Rural Teacher Training Institutes.* Monrovia, Liberia: Ministry of Education, 1980.

Allen, A. R., & Boraks, N. "Peer Tutoring: Putting It to the Test." *The Reading Teacher,* 32(3), 1978, pp. 274-278.

Allen, L. E. *EQUATIONS: The Game of Creative Mathematics.* Ann Arbor, MI: Wff'n Proof, 1980.

Anderson, L. M.; Evertson, C. M.; & Brophy, J. E. "An Experimental Study of Effective Teaching in First-Grade Reading Groups." *The Elementary School Journal,* 79(4), 1979; pp. 193-223.

Armitage, J.; Gomes, J. B. F.; Harbison, R.; Holsinger, D. B.; & Leite, R. H. *School Quality and Achievement in Rural Brazil: Results of Initial Analysis* (Project EDURURAL/NE). Washington, DC: World Bank, 1985.

Awa, N. *Educational Technology in the Third World: A General Systems Perspective.* Ithaca, NY: State University of New York, 1982.

Baker, E.; Herman, J.; & Yeh, J. "Fun and Games; Their Contribution to Basic Skills Instruction in Elementary School." *American Educational Research Journal,* 18(1), 1981, pp. 83-92.

Bass, R. K., & Dills, C. R. *Instructional Development: The State of the Art, II.* Debuque, IA: Kendall/Hunt Publishing Co., 1984.

Beck, I. L.; Omanson, R. C.; & McKeown, M. G. "An Instructional Redesign of Reading Lessons: Effects on Comprehension." *Reading Research Quarterly,* 17(4), 1982, pp. 462-481.

Biggy, M. V. *Using TV to Teach High Order Thinking Skills.* Paper presented at the National Conference on Technology and Education, Washington, DC, 1981.

Briggs, L. J. (Ed.). *Instructional Design: Principles and Practices.* Englewood Cliffs, NJ: Educational Technology, 1977.

Carter, A. P. *Project IRIS, Improving Reading Instruction School-wide.* Paper presented at the annual meeting of the Southeastern Regional Conference of the International Reading Association, Nashville, TN, 1980.

Chapman, D. A., & Boothroyd, R. *Programmed Instruction as a Means of Improving Student Achievement: A Look at the Liberian IEL Project.* Albany, NY: State University of New York at Albany, 1986.

Checkland, P. *Systems Thinking, Systems Practice.* New York: John Wiley & Sons, 1981.

Clark, R. C. "Defining the 'D' in ISD." *Performance & Instruction,* 25(1), 1986, pp. 17-21.

Clark, R. E. "Reconsidering Research on Learning from Media." *Review of Educational Research,* 53, 1983, pp. 445-459.

Clark, R. E., & Salomon, G. "Media in Teaching." In M. Whitrock (Ed.), *Handbook of Research on Teaching.* New York: MacMillan, 1986, pp. 1-67.

Claveria, O. B. *Report on the Implementation of the IMPACT Experiment—Universal Primary Education (IDS).* Dhaka, Bangladesh: Institute for International Research, 1982.

Cohen, P. A.; Kulik, J. A., & Kulik, C. "Educational Outcomes of Tutoring: A Meta-analysis of Findings." *American Educational Research Journal,* 1982, pp. 237-248.

Coldeway, D. O., & Rasmussen, R. V. "Instructional Development: A Consideration of Interpersonal Variables." *Journal of Instructional Development,* 7(1), 1984, pp. 23-27.

Coleman, J. "The Hopkins Games Program: Conclusions from Seven Years of Research." *Educational Researcher,* 1973, pp. 3-7.

Cooledge, N. J., & Wurster, S. R. "Intergenerational Tutoring and Student Achievement." *The Reading Teacher*, 39(3), 1985, pp. 343-346.

Coombs, P. H. *The World in Crisis in Education: The View from the Eighties*. New York: Oxford University Press, 1985.

Cummings, W. K. *Low-cost Primary Education: Implementing an Innovation in Six Nations*. Ottawa, Canada: IDRC, 1986.

Curriculum Development Center. *Annual Report of Activities*. Mogadishu, Somalia, 1985.

DeVries, D. L., & Edwards, K. J. *Using Teams-Games-Tournaments in the Classroom*. Baltimore, MD: Center for Social Organization of Schools, Johns Hopkins University, 1963.

DeVries, D. L. *Teams-Games-Tournaments: The Team Learning Approach*. Englewood Cliffs, NJ: Educational Technology Publications, 1980.

Dick, W., & Carey, L. *The Systematic Design of Instruction* (2nd Ed.). Glenview, IL: Scott Foresman, 1985.

Dilts, R., & Mudjiman, H. *UPT PAMONG: The Technical Implementation Unit for Primary School Instructional Management by Parents, Community, and Teachers*. Unpublished manuscript,1984.

Ebersole, E. H., & Dewitt, D. "The Soto Pupil-Team Program for Reading: An Experiment in Structured Tutoring." *Improving Human Performance*, 1, 1972, pp. 39-42.

Edmonds, R. "Effective Schools for the Urban Poor." *Educational Leadership*, 37(1), 1979, pp. 15-23.

Ellington, H., & Addinall, E. "Designing Educational Games for Less Able Pupils." In C. W. Osborne (Ed.), *International Yearbook of Educational and Instructional Technology 1984/85: Association for Educational and Training Technology*. New York: Nichols Publishing Co., 1984.

Ellson, D.G. "Tutoring." In N. Gage (Ed.), *The Psychology of Teaching Methods*. Chicago: National Society for the Study of Education, 1986a.

Ellson, D. G. "Improving Productivity in Teaching." Phi Delta Kappan, 68(2), 1986b, pp. 111-124.

Ellson, D. G. et al. *Programmed Teaching: Effective Teaching by "Unqualified Teachers."* Saigon: Regional Center for Educational Innovation and Technology, 1973.

Englemann, S. *Direct Instruction*. Englewood Cliffs, NJ: Educational Technology Publications, 1978.

Evans, R. M. "Troubleshooting Individualized Learning Centers." *Educational Technology*, 24(4), 1984, pp. 38-40.

Feldman, R. S.; Devin-Sheehan, L.; & Allen, V. L. "Child Tutoring Children: A Critical Review of Research." In V. L. Allen (Ed.), *Children as Teachers: Theory and Research on Tutoring*. New York: Academic Press, 1976.

Flanagan, J. C.; Shanner, W. M.; Brudner, H. J.; & Marker, R. W. "An Individualized Instructional System: PLAN." In H. Talmadge (Ed.), *Systems of Individualized Education*. Berkeley, CA: McCutchan Publishing Corp., 1975, pp. 136-167.

Fleming, M., & Levie, W. H. *Instructional Message Design*. Englewood Cliffs, NJ: Educational Technology Publications, 1978.

Flores, P. *Educational Innovation in the Philippines: A Case Study of Project IMPACT*. Ottawa, Canada: International Development Research Centre, 1981.

Foster, P. *Education in Sub-Saharan Africa: Some Preliminary Comments*. Unpublished manuscript, Universite' de Dijon, Dijon, France, 1985.

Frey, L. A., & Reigeluth, C. M. "Instructional Models for Tutoring: A Review." *Journal of Instructional Development*, 9(1), 1986, pp. 2-8.

Fuller, B. *Raising School Quality in Developing Countries: What Investments Boost Learning?* Washington, DC: World Bank, 1985.

Gagne, R. M. *The Conditions of Learning*. New York: Holt, Rinehart & Winston, 1977.

Gagne, R. M., & Briggs, L. J. *Principles of Instructional Design* (2nd Ed.). New York: Holt, Rinehart & Winston, 1979.

Glaser, R., & Rosner, J. "Adaptive Environments for Learning: Curriculum Aspects." In H. Talmadge (Ed.), *Systems of Individualized Education*. Berkeley, CA: McCutchan Publishing Corp, 1975, pp. 84-135.

Good, T. L., & Grouws, D. A. "The Missouri Mathematics Effectiveness Project: An Experimental Study in Fourth-grade Classrooms." *Journal of Educational Psychology*, 71(3), 1979, pp. 355-362.

Gustafson, K. L. *Instructional Development Models with Annotated ERIC Bibliography*. Syracuse, NY: ERIC Clearinghouse on Information Resources, Syracuse University, 1982.

Harmon, P. "The Design of Instructional Materials: A Top-down Approach." *Journal of Instructional Development*, 6(1), 1983, pp. 6-14.

Harrison, G., & Guymon, R. *Structured Tutoring*. Englewood Cliffs, NJ: Educational Technology Publications, 1980.

Hartley, J. *Designing Instructional Text* (2nd Ed.). New York: Nichols Publishing Company, 1985.

Heinich, R. *Educating All Handicapped Children*. Englewood Cliffs, NJ: Educational Technology Publications, 1979.

Helms, D. C., & Heller, B. *Using Research to Improve Instructional Effectiveness, Evolution of Achievement Directed Leadership (ADL)*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL, 1985.

Heward, W. L.; Heron, T. E.; & Cooke, N. L. "Tutor Huddle: Key Element in a Classwide Peer Tutoring System." *The Reading Teacher*, 83(2), 1982, pp. 115-123.

Heyneman, S., & Loxley, W. *The Impact of Primary School Quality on Academic Achievement Across Twenty-nine High and Low Income Countries* (Research Rep. No. RP0671-60). Washington, DC: World Bank, 1981.

IEES. *Nepal Country Workplan*, 1986-1987. Tallahassee, FL, 1986.

IEES. *Haiti Education and Human Resources Sector Assessment*. Tallahassee, FL, 1985a.

IEES. *Botswana Education and Human Resources Sector Assessment*. Tallahassee, FL, 1985b.

IEES. *Enhancement of School Quality in Somalia*. Tallahassee, FL, 1985c.

IEES. *Somalia Education and Human Resources Sector Assessment*. Tallahassee, FL, 1984.

IEES. *Liberia Education and Human Resources Sector Assessment*. Tallahassee, FL, 1983.

INNOTECH. *Reduced Instructional Time: Annual Report for 1977*. Quezon City, Philippines, 1977.

Jacka, B. "The Teaching of Defined Concepts: A Text of Gagne and Briggs' Model of Instructional Design." *Journal of Educational Research*, 78(4), 1985, pp. 224-227.

Jackson, L. A. "Enrich Your Writing Program with Mentors." *Language Arts*, 58(7), 1981, pp. 837-839.

Jamison, D. T., & McAnany, E. G. *Radio for Education and Development*. Beverly Hills, CA: Sage Publications, 1978.

Joannesson, D. (Ed.). *The Technology of Text*. Englewood Cliffs, NJ: Educational Technology Publications, 1982.

Johnson, R. T., & Johnson, D. W. "Student-student Interaction: Ignored but Powerful." *Journal of Teacher Education*, 36(4), 1985, pp. 22-25.

Kajubi, W. S. "Some Comments on the Content and Use of Textbooks in Developing Countries." In R. Gardner (Ed.), *Textbooks in Developing Countries: A Report of Meetings Held at the University of London Institute of Education*. London: Department of Education in Developing Countries, ULIE, 1981.

Keller, F. S. "Good-bye, Teacher...". *Journal of Applied Behavior Analysis*, Spring, 1968, pp. 79-88.

Kelly, E. *Evaluation of the Improved Efficiency of Learning Project*. Albany, NY: State University of New York at Albany, 1984.

Kemmerer, F. N., & Wagner, A. *Limits on the Use of Educational Technology: A Reappraisal of the Costs*. Paper presented at the International Conference on the Economics of Education, IREDU, Dijon, France, 1986.

Kemp, F. D., & Holland, J. G. "Blackout Ratio and Overt Responses in Programmed Instruction: Resolution of Disparate Results." *Journal of Educational Psychology*, 57, 1966, pp. 109-114.

Klausmeier, H.J. "IGE: An Alternative Form of Schooling." In H. Talmadge (Ed.), *Systems of Individualized Education*. Berkeley, CA: McCutchan Publishing Corp., 1975, pp. 48-83.

Klees, S. J., & Suparman, M. R. *An Evaluation of the Costs of PAMONG Schooling Alternatives in Indonesia*. McLean, Virginia: Institute for International Research, 1984.

Kulik, C.; Shwarb, B. J.; & Kulik, J. A. "Programmed Instruction in Secondary Education." *Journal of Educational Research*, 1982, pp. 133-138.

Lang, P. C. (Ed.). *Programmed Instruction*. Chicago, IL: University of Chicago Press, 1967.

Levie, W. H. "Research on Pictures: A Guide to the Literature." In D. M. Willows & H. A. Houghton (Eds.), *Illustrations, Graphs, and Diagrams: Psychological Theory and Educational Practice*. New York: Springer-Verlag, in press.

Levin, H. M. *Cost-effectiveness: A Primer*. Beverly Hills: Sage Publications, 1983.

Levine, D. U., & Stark, J. *Instructional and Organizational Arrangements for Improving Achievement at Inner City Elementary Schools*. Kansas City, MO: Center for the Study of Metropolitan Problems in Education, 1981.

Malsam, M. "Trends in Education: A New Look at IGE Systems." *Curriculum Review*, 19(2), 1980, pp. 110-113.

Mante, R. F. "Multiple Outcomes and Perspectives in the Evaluation of Project IMPACT." *Teaching Yourself in Primary School: Report of a Seminar on Self-instructional Programs*. Ottawa, Canada: International Development Research Centre, 1981, pp. 72-80.

McMaster, J. C. *Cost-effectiveness Analysis of Project IMPACT for the Philippines*. Manila, Philippines: Regional INNOTECH Centre, 1978.

Megarry, J. "Educational Technology: Promise and Performance." *Programmed Learning and Educational Technology*, 20(2), 1983, pp. 133-137.

Merrill, M. D., & Tennyson, R. D. *Teaching Concepts: An Instructional Design Guide*. Englewood Cliffs, NJ: Educational Technology Publications, 1977.

Merrill, P. F.; Tolman, M. N.; Christensen, L.; Hammons, K.; Vincent, B. R.; & Reynolds, P. L. *Computers in Education*. Englewood Cliffs, NJ: Prentice-Hall, 1986.

Messee, J. *Textbook Production and Distribution in Somalia*. Tallahassee, FL: IEES Project, 1986.

Montana State Department of Public Instruction. *Northern Cheyenne Follow Through Project, Lame Deer, Montana* (DHEW Grant No. G007902080). Helena, MT: Office of Public Instruction, 1980. (ERIC Document Reproduction Service No. ED 190 207.)

Morgan, R. M., & Chadwick, C. B. *Systems Analysis for Educational Change: The Republic of Korea*. Tallahassee, FL: Department of Educational Research, Florida State University, 1971.

Mudjiman, H. "Effectiveness of Learning Modules and Peer Tutors in Student Learning." *Teaching Yourself in Primary School: Report of a Seminar on Self-instructional Programs*. Ottawa, Canada: International Development Research Centre, 1981, pp. 81-91.

Neumann, P. H. *Publishing for Schools—Textbooks and the Less Developed Countries* (Working Paper No. 398). Washington, DC: World Bank, 1980.

Neumann, P. H., & Cunningham, M. A. *Mexico's Free Textbooks: Nationalism and the Urgency to Educate* (Staff Working Paper No. 541). Washington, DC: World Bank, 1982.

Nichols, D. G. *Low-cost Learning Systems*. Bethesda, MD: Institute for International Research, 1980.

Nichols, D. G. "Low-cost Learning Systems: The General Concept and Some Specific Examples." *Performance & Instruction*, 21(7), 1982, pp. 4-8.

Nichols, D. G. *Handbook for IEL Instructional Management*. Gbarnga, Liberia: Improved Efficiency of Learning Project, 1983.

Nichols, D. G., & Dilts, D. R. *Final Contractor's Report: Project PAMONG*. McLean, VA: Institute for International Research, 1984.

Nunan, T. *Countering Educational Design.* New York: Nichols Publishing Co., 1983.

Osborne, C. (Ed.). *International Yearbook of Educational and Instructional Technology 1986/87: Association for Educational and Training Technology.* New York: Nichols Publishing Co., 1986.

Othman, G., & Loganathan, K. "Assessing the Impact and Effectiveness of Project INSPIRE's Educational Materials." *Teaching Yourself in Primary School: Report of a Seminar on Self-instructional Programs.* Ottawa, Canada: International Development Research Centre, 1981.

Pasigna, A. L. "Success story: Liberia's Improved Efficiency of Learning Project." *Performance & Instruction,* 24(9), 1985, pp. 7-8.

Pasigna, A. L. "Developing an Integrated Curriculum for IMPACT." In J. Socrates (Ed.), *The IMPACT System of Mass Primary Education.* Quezon City, Philippines: INNOTECH, 1983.

Pasigna, A. L. "Interactive Learning Adds Impact to the First Grade." *NSPI Journal,* 18(7), 1979, pp. 6-7.

Postlethwaite, S. N.; Novak, J.; & Murray, H. *The Audio-tutorial Approach to Learning.* Minneapolis, MN: Burgess Publishing Co., 1972.

Potar, N. *Project RIT* (Reduced Instructional Time). Lopburi, Thailand: Project RIT, Muang Mai School, 1984.

Pratton, J., & Hales, L. W. "The Effects of Active Participation on Student Learning." *The Journal of Educational Research,* 79(4), 1986, pp. 210-215.

Reigeluth, C. M. (Ed.). *Instructional Design Theories and Models: An Overview of Their Current Status.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

Retief, T. *The 6M's before the 3R's: Teaching Basic Business Concepts to Illiterates.* Paper presented at the meeting of the National Society for Performance and Instruction, Chicago, IL, 1985.

Richey, R. *The Theoretical and Conceptual Basis of Instructional Design.* New York: Nichols Publishing Co., 1986.

Romiszowski, A. J. *Developing Auto-instructional Materials: From Programmed Texts to CAL and Interactive Video.* New York: Nichols Publishing Co., 1986.

Romiszowski, A. J. *Designing Instructional Systems.* New York: Nichols Publishing Co., 1982.

Romiszowski, A. J. "A Study of Two Varieties of Self-instructional Materials Used in Three Different Instructional Plans with Adults and Adolescent Studies of Mathematics in Brazil." *Performance & Instruction,* 21(7), 1982, pp. 9-13, 41.

Romiszowski, A., & Arce, J. *"Hi Tech" Used as "Appropriate Educational Technology" in Brazil.* In press.

Sachsenmeier, P. *A Basic Training Course in Systematic Curriculum Development.* Nairobi, Kenya: Kenya Institute of Education, 1983.

Schon, D. A. *The Reflective Practitioner.* New York: Basic Books, Inc., 1983.

Schramm, W. *Big Media, Little Media.* Stanford, California: Stanford University, Institute of Communications Research, 1973.

Searle, B.; Friend, J.; & Suppes, P. *The Radio Mathematics Project: Nicaragua, 1974-1975.* Stanford: Stanford University, Institute for Mathematical Studies in the Social Sciences, 1976.

Shrock, S.; Mansukhani, R. H.; Coscarelli, W.; & Palmer, S. "An Overview of Criterion-Referenced Test Development." *Performance & Instruction,* 25(6), 1986, pp. 3-7.

Slavin, R.; Leavey, M.; & Madden, N. A. *Combining Cooperative Learning and Individualized Instruction: Effects on Student Mathematics Achievement, Attitudes and Behaviors.* Silver Spring, MD: Centers for the Handicapped, 1982.

Snyder, C. W., & Richard, J. A. *Accommodation or Competition? Integration of Textbooks and Modules.* Monrovia, Liberia: Ministry of Education, 1984.

Socrates, J. B. (Ed.). *The IMPACT System of Mass Primary Education.* Quezon City, Philippines: INNOTECH, 1983.

Somerset, H. C. A. *Examinations as an Instrument to Improve Pedagogy*. Nairobi, Kenya: Chief Examinations Officer, Kenya Ministry of Education, 1984.

Spector, P. *Review of Learning Technologies*. McLean, VA: Institute for International Research, 1986.

Stewart, A. "Appropriate Technology: Does 'Appropriateness' Have Implications for the Theoretical Framework of Educational Technology? *Educational Communications & Technology Journal*, 33(1), 1985, pp. 58-65.

Stolovitch, H. D. *Traditional Teaching Techniques in Developing Nations*. In press.

Thiagarajan, S. "Interactive Individualization: An Intermediate Instructional Technology." *Educational Technology*, 17(1), 1977, pp. 39-44.

Thiagarajan, S., & Pasigna, A. L. *Final Contractor's Report: Improved Efficiency of Learning (IEL) Project*. McLean, VA: Institute for International Research, 1985.

Thiagarajan, S., & Pasigna, A. L. "Incorrect Equations Impede the Implementation of Innovative Instructional Systems in Developing Nations." *Performance & Instruction*, 23(7), 1984, pp. 4-5.

USAID. *Project Paper for the Improved Efficiency of Learning Project*. Washington, DC, 1977.

Wang, M., & Walberg, H. "Adaptive Instruction and Classroom Time." *American Educational Research Journal*, 20(4), 1983, pp. 601-626.

Wells, S. *Instructional Technology in Developing Countries: Decision-making Processes in Education*. New York: Praeger Publishers, 1976.

Windham, D. M. *Cost Analysis of the Improved Efficiency of Learning Project*. Monrovia, Liberia: Ministry of Education, 1983.

Windham, D. M. *Internal Efficiency and the African School*. Dijon, France: Universite' de Dijon, 1983.

Winner, A., & McClung, M. D. "Computer Game Playing—'Turn-On' to Mathematics." *Arithmetic Teacher*, 29(2), 1981, pp. 38-39.

Wolff, L. *Controlling the Costs of Education in Eastern Africa: A Review of Data, Issues, and Policies* (Working Paper No. 702). Washington, DC: World Bank, 1984.

Wooten, J.; Jansen, W.; & Warren, M. K. *Project IMPACT: A Low-cost Alternative for Universal Primary Education in the Philippines*. Washington, DC: Agency for International Development, 1982.

World Bank. *Colombia Staff Appraisal Report*. Washington, DC, 1982.

Zahorik, J. A., & Kritek, W. J. *Using Direct Instruction*. Milwaukee: University of Wisconsin, 1980.

Zeitler, W. R. "The Influence of the Type of Practice in Acquiring Process Skills." *Journal of Research in Science Teaching*, 18(3), 1981, pp. 189-197.