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Discusses instructional technology as a potential solution for the educational disparity which exists between urban and rural areas of developing countries. Related problems on teacher participation, costs, and governmental and/or commercial control of technical media are examined. It is pointed out that instructional technology is only one educational alternative, and that the quality of instruction must be high; however, choosing such technology has the advantage of providing high quality teaching to educationally deprived areas. The analysis considers the difference between formal and non-formal education, the influence of foreign agencies, and the tendency of the educational system to ignore the special needs of rural areas. Analytic processes discussed in the report include planning, problem analysis, choice of alternate solutions, implementation of the alternative, and monitoring the chosen system. Organizational charts are used to describe potential relationships among participants and to provide analyses of potential change impact. Cognitive and non-cognitive criteria as well as potential cost of instructional technology systems are presented.

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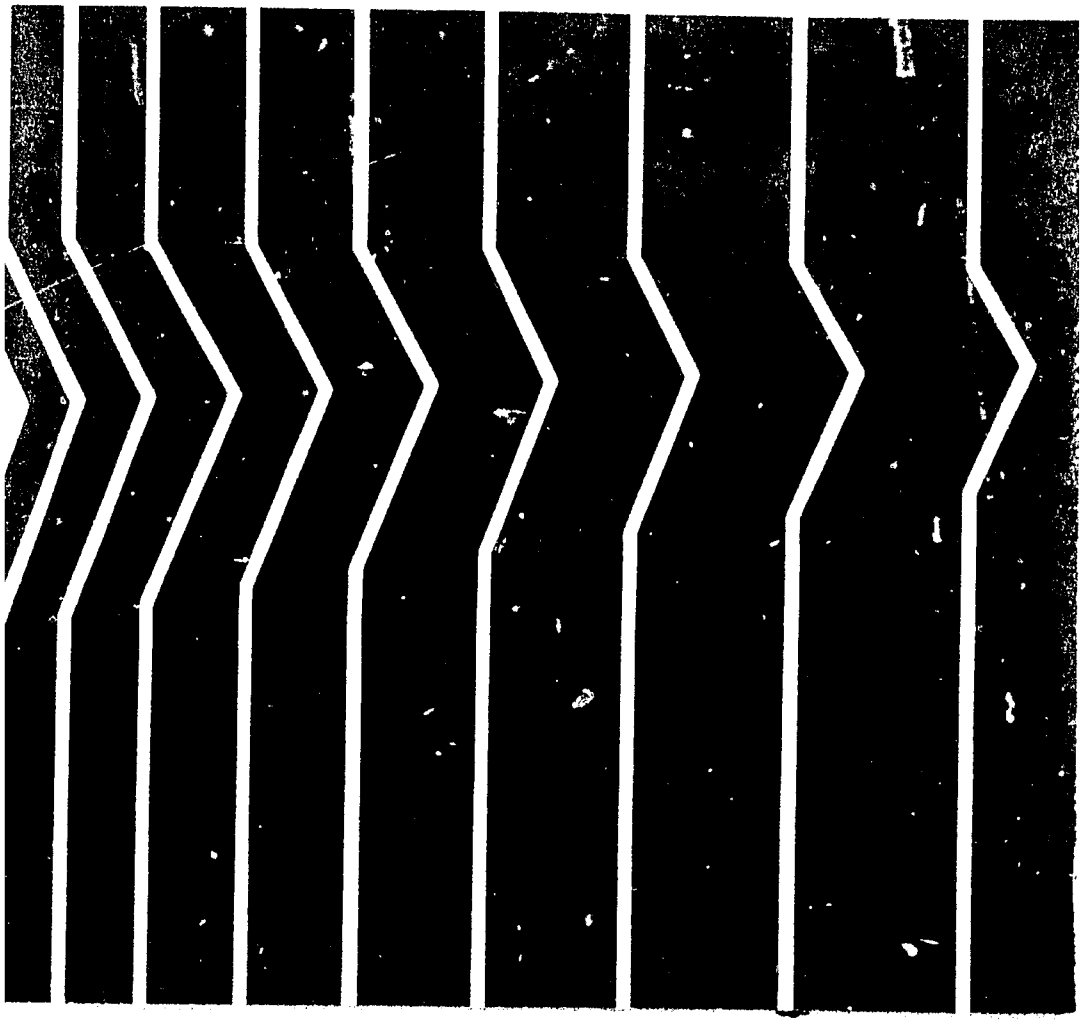
Decision-Making Processes in Education

Stuart Wells



Stuart Wells

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Decision-Making Processes in Education

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FOREWORD

Guy Benveniste

All the instructional technologies, among them, educational television and radio, have received considerable attention in the literature on the modernization of the third world. This was particularly true of the period in the 1950s and 1960s, when these new approaches seemed full of promise. Young educational planners were confident that with available educational technologies, it would be possible to revamp and expand tired educational systems radically, to adapt them rapidly to the needs and realities of modernization and development. It was thought that centralization and mass distribution of these educational technologies could bridge the gaps created by vast numbers of poorly trained or unavailable teachers. For example, it was thought that mathematics might be taught in villages as mathematics, not as rote learning of strange incantations. In short, it was hoped that education might be transformed in a short time by transmitting directly across the land the knowledge of the very few and very best well-trained teachers.

These bold hopes were supported by what little analysis had been conducted; the economics of the new technologies did not seem impossible, as long as care was taken to design systems adapted to local realities, such as population density, availability of energy sources, availability of supporting institutions, and so on. The politics of the new technologies seemed—I say, seemed—most attractive. Everyone concerned made speeches in favor of innovation and change. At international meetings, ministers of education expressed the hope that their countries might pioneer in these new endeavors, and they often pointed with pride to the various pilot projects underway. The manufacturers of equipment were helpful; the various aid agencies and the foundations were interested. As I say, the politics seemed promising.

The technology and know-how did not seem insuperable. To be sure, it was clear there would be problems with energy sources, with reception, with maintenance, and with program design and follow-through. But experience would be acquired, and these challenges would be met.

The 1950s and 1960s have passed, and the 1970s are almost gone. The new educational technologies have not transformed education in the third world; yet they are still very much in evidence in all countries, and they are still discussed and proposed, and the same hopes about their utility persist. Stuart Wells's book is a timely reminder of their potential importance and also of the complexities involved in making them reality. By focusing on the decision-making processes in education, he allows us to pay attention to a wide variety of political and technical factors that need be considered if plans are to become reality. In the 1950s and 1960s planners tended to disregard the importance of the processes of decision making for new innovations in ongoing educational

systems. In those days, the "politics of expertise" were considered below the dignity of technicians. But, with the passage of time, with experience and the contributions of a new literature in this area, this has become an important aspect of planning.

There exists in all developing countries a public administration, a political machinery, a style of bureaucracy, and, within these, an educational system, with its status ladder, its incentives for attracting teachers, its unions, its protections against firing, and its controls to regulate performance of educators and students. There also exist other organizations that have a stake in the new educational technologies: broadcasters, manufacturers of equipment, parent and student organizations, political parties, and on and on. Each and all of these see advantages and threats in the new approaches, and all these actors have important roles to play in the implementation of a change program. Planners cannot disregard them.

It is sometimes easy to forget that in most developing countries, the administration of education is far more centralized than in the United States. Usually, there exists a national ministry of education that has extensive responsibilities for primary or secondary education and sometimes for higher education. In certain federal countries, India, for example, the state ministries of education seem to be more influential than the federal government in the making of many educational decisions affecting the states. In other federal countries, such as Mexico, the federal ministry of education is by far the most powerful institution controlling education. These ministries of education usually have similar characteristics. First, they tend to be less innovative than other ministries. This may be because of their low prestige in the affairs of state or simply a reflection of their large numbers of committed teachers who may resist some changes. But whatever the cause, in most countries where administrative practices have been modernized, say, in finance, public health, and agriculture, the ministry of education has often lagged and often still operates as it did 20 or 30 years ago.

This indicates that in most developing countries, a significant portion of educational decision making is in the hands of a large bureaucratic system that has been able, over time, to consolidate and routinize its practices to minimize tension and friction among the various components of the educational administration. Therefore, ministries of education are often composed of relatively autonomous departments, for example, primary, secondary, technical, vocational, adult, out-of-school, and visual aids departments. These departments maintain a fierce autonomy, thus providing a modicum of security to their staff. They busy themselves with their own concerns and limit cooperation with other departments to a strict miminum. Careers are usually started and terminated within departments. To avoid the need for coordination, every effort is made to routinize practices and provide rigid rules that allow for limited interpretation or innovation.

The ministers of education are political appointees. But a new minister

of education inherits a bureaucracy that he or she does not completely control. For example, the lack of information and the lack of statistics ensure the independence and autonomy of departments in their resistance to succeeding generations of ministers (and their immediate staff) who come and go according to the vicissitudes of the political process of the nation.

It might, therefore, be an oversimplification to assume that the existence of centralized ministries of education ensures or facilitates the introduction of national innovations in education. A well-disciplined set of quasi-independent empires, each in its own way, can resist any change that might threaten the established routines that provide security and continuity to each department.

But it would also be erroneous to assume that these routinized bureaucratic organizations fail to innovate. Faced with a changing external environment where, as a result of economic, social, and political changes taking place in the world, new pressures are brought to bear on old structures, the various autonomous departments of ministries of education do innovate, but innovations are usually limited in scope and only go beyond the confines of any one department when the right "bureaucratic engineering" is applied.

Ministers who are appointed for a limited period of time or who know from experience that their appointments cannot last for too long usually seek to achieve some change during their brief tenure. They often will ally themselves with some innovators who are seeking changes. They may be able to organize coalitions of innovators across departments. This is where careful planning can make a difference.

At times, of course, ministers or presidents may attempt to break bureaucratic rigidity and structural compartmentalization by creating new organizations to bypass existing ones. And new organizations may flourish, consolidate their hold, and innovate. However, if the new organization seriously threatens the security of the existing ministries or departments, it may be eliminated or absorbed.

These are practical problems planners have to consider, and we need to systematize our thinking about these issues because they are just as important as the more conventional definitions of what is technical. What we must keep in mind is that, whether we like it or not, most education operates in a well-established bureaucracy that we cannot abolish, and, therefore, to bring innovations in the system requires serious consideration of these factors.

What Stuart Wells has done is to provide us with a first systematic presentation of some of the relevant tools of analysis that can be used to shift decisions about educational technologies given the fact these take place in educational bureaucracies. His purpose is to provide a better understanding of decision making and thus permit the adaptation of educational systems to the changing needs of its clientele, namely, the needs of future generations.

This is an important area of research, and I am pleased that a grant from the Agency for International Development (AID) permitted this work to be carried out at Berkeley in 1973/76.

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I would like to express my gratitude to many individuals. Guy Benveniste and Judith Balderston administered the research aspects of the project at Berkeley where work of this book was begun and created an atmosphere conducive to research. Jo-Ann Work served excellently in her capacity as administrative assistant and helped to eliminate many of the obstacles to successful research. Robert Berke provided research assistance in earlier stages of the work. Roger Pritchard gave valuable and insightful editorial comments on what I mistakenly thought to be a final draft. The work of typists Mabel Chan, Jan Cronhardt, Kathy Rothschild, and Barbara Travers in translating my penmanship to the printed page is very much appreciated. Dean Jamison and Steven Klees have been valued friends and colleagues for many years, and working with them has greatly influenced my work on this book. I, for better or worse, retain responsibility for the content.

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LIST OF ABBREVIATIONS

CAI	Computer-assisted instruction
GOES	Government of El Salvador
IBRD	International Bank for Reconstruction and Development
IIEP	International Institute for Educational Planning
ITV	Instructional television
NHK	Nippon Hoso Kyokai

CHAPTER

1

INTRODUCTION

EDUCATIONAL PROBLEMS IN DEVELOPING COUNTRIES

Developing countries have many severe educational problems: low participation rates combined with high population growth, disparities between urban and rural areas, lack of teachers, employment difficulties for school graduates, high illiteracy rates, high dropout rates, and a heavy reliance on foreign aid and personnel. These problems must be dealt with. Despite unemployment problems that do exist in some countries for skilled labor, increased education for more of the people and higher skill levels are important components of development. From his analysis of rate of return studies of developing countries, G. Psacharopoulos (1972) concluded that economic returns to developing countries are higher for investment in human resources than physical capital and that investment in education contributes to the rate of growth of output. It would also be difficult to argue that higher health standards, higher literacy rates, and increased use of more productive agricultural techniques acquired through education are unimportant elements of modernization.

Participation Rates and Population Growth

P. H. Coombs (1968) paints a very dismal picture for developing countries. He reports increasing social demand, participation rates, and school-age population growth that will put increasing pressures on educational systems throughout the developing world. Social demand is influenced by the prospects of economic development for society and benefit for the individual. This social demand translates to increased demand at all levels of education. With increasing population, the number of people to be served by the educational system

will increase even if participation rates (percentage of children in school from a given age group) remain the same. The problem is compounded further by increasing participation rates, although participation rates for all educational levels in many developing countries are still low. For example, Brazil increased primary school participation rates from 28 percent in 1950 to 50 percent in 1963 and secondary school participation rates from 10 percent in 1950 to 25 percent in 1963. Educational systems will have to grow just to keep in place, and, therefore, to improve participation rates, much larger growth is necessary.

The magnitude of the educational gaps and lack of qualified teachers can be seen in Table 1.1 (from Egwinn 1972).

D. Jamison (1971), in an analysis of primary education in Indonesia, demonstrated the impact of rising population on participation rates and financing of the system. He concluded the following:

1. If real costs increased by 4 percent per year, real expenditures would have to double by 1980 to keep real participation rates from falling.
2. To have a participation rate of 89 percent in 1982 with 4 percent per year real cost growth, real expenditures would have to increase by 10 percent per year.
3. If real expenditure growth equalled real cost growth, participation rates would drop from the current 60 percent to 51 percent in 1975 and 42 percent in 1982.

He then proceeded to analyze the costs of alternative technologies to determine whether or not the relationship between rising enrollments and rising expenditures could be diminished, and concluded that a system with increased utilization of radio would reduce the expenditures necessary for increasing enrollment.

Urban-Rural Disparities

The problems of participation and population growth can be coupled with disparities in educational systems between urban and rural areas. For example, in Nigeria (Lyle, Chesswas, Kahnert, and Griffiths 1967), only 10 percent of the school-age population in rural areas attended school, while 75 percent attended in Lagos. Educational systems in urban areas tend to be of higher quality than those in rural areas. The prospects of better education in the urban areas and hence better employment opportunities have induced rural-urban migration patterns, as in the Ivory Coast (Chau 1972), removing people from rural areas where they may still be needed for agricultural development. The problem of providing quality education in rural areas is compounded by the difficulty in placing teachers in rural areas.

TABLE 1.1

COMPARATIVE EDUCATION INDICATORS

Country	Year	Literacy Rate	Primary Participation Rate	Primary Student/Teacher Ratio	Secondary Particiaption Rate	Secondary Student/Teacher Ratio
United States	1968	98	97	26	80	20
United Kingdom	1969	97	98	28	58	18
Ethiopia	1970	7	17	51	5	34
Nigeria	1971	n.a.	34	37	4	23
Brazil	1969	65	64	31	16	n.a.
Colombia	1968	73	70	40	21	13
Indonesia	1970	43	71	40	13	22
Thailand	1971	70	90	42	25	33

n.a. = Not available.
Source: Egwinn 1972.

Lack of Teachers

A lack of teachers may exist throughout an entire country or within particular areas (usually rural) of the country. In either case, the lack of teachers may be attributed to relatively more attractive employment opportunities for skilled persons outside the education sector. One frequently observes teacher shortages in rural areas and teacher surpluses in urban areas. This problem, as discussed by D. Jamison, S. Klees, and S. Wells (1976), is affected by relative wages paid for other employment: wages are too high in urban areas and too low in rural areas. Another explanation given for the lack of employment opportunities for graduates in the teaching profession traces the problem to low participation rates and lack of educational facilities. For example, while Indonesia had participation rates of only 50 percent at the elementary level, 20 percent at the middle level, and 10 percent at the secondary level, J. H. van der Kroef (1974) reported that 20,000 teachers were unemployed.

Employment Difficulties for School Graduates

Many developing countries are experiencing increasing unemployment and underemployment of school graduates at the same time that the demand for education is rising rapidly. M. Blaug, P. R. G. Layard, and M. Woodhall (1969) discussed the employment problem in India, while D. Turnham and I. Jaeger (1970) discussed the problem for developing countries in general. The analysis of rates of return to education undertaken by Psacharopoulos (1972) provided a key to the existence of this employment problem. Economic returns of education are higher for individuals than for society. That is, with education subsidized by the public and the cost reduced to the individual, a person is better off seeking more education even with a high probability of becoming unemployed.

Illiteracy Rates

A high illiteracy rate is another major educational problem for developing countries. The literacy rate for selected countries is shown in Table 1.1. Coombs (1968) estimated a figure of 450 million illiterate adults, or 60 percent of the population, of UNESCO member states. Honduras (Lyle, Martins, and Torfs 1967) instituted radio schools to deal with an illiteracy problem that involved 75 percent of the rural population. In Nigeria (Lyle, Chesswas, Kahnert, and Griffiths 1967), 80 percent of the total population was illiterate.

Dropout Rates

High dropout rates often occur when the student has more attractive opportunities, usually employment opportunities outside the educational system and/or when the student feels that the curriculum of the educational system is not relevant to her or his needs or potential opportunities. In part, dropouts become a problem in a society that places a higher value on completion and certification than on knowledge and abilities.

Foreign Aid and Personnel

The final set of educational problems facing developing countries derives from the often heavy dependence on foreign aid and foreign personnel. In El Salvador, aid from the United States was very influential on the plans for development of the educational system and choice of an instructional television system (Hornik, Ingle, Mayo, McAnany, and Schramm 1973). When this aid was temporarily stopped because of fighting between El Salvador and Honduras, the project was slowed considerably. Tanzania, in planning for the education sector, assumed a large inflow of foreign aid (Bennett 1972). The plans were upset when the heavy foreign commitment did not materialize. The former French colonies in Africa, such as Niger (Le Franc 1967b) and the Ivory Coast (Klees and Jamison 1973), also are heavily reliant on foreign financing. In part, this financing restricts the educational flexibility of developing countries in that the countries may start responding to the opinions, desires, and analyses of the donor agencies and nations. For example, while El Salvador might have chosen instructional television regardless of the availability of foreign funds, there was an initiative from the U.S. government to begin a pilot project in instructional television somewhere in Latin America (Mayo and Mayo 1971).

Reliance on foreign personnel also can be damaging. For example, in Nigeria, the large exodus of foreign teachers forced the Ministry of Education to use increasingly less qualified teachers to maintain existing programs (Lyle, Chesswas, Kahnert, and Griffiths 1967). In Samoa, foreign teachers raised the greatest resistance to the implementation of televised instruction (Schramm 1973b).

THE ROLE OF INSTRUCTIONAL TECHNOLOGY

What Is Instructional Technology?

Instructional technology is one of several alternative solutions to many of the educational problems. To an economist, technology is any process used

to produce some output. In this approach, radio, television, or simply classroom teachers would be alternative instructional technologies. The common usage of "technology," and the one used in this book, is to associate the term with some type of equipment. The traditional educational system, in which information is conveyed from one person to one or more persons through personal communication, will not be considered to be an "instructional technology." Radio, television, films, and computers are instructional technologies.

Why Is Instructional Technology Chosen?

The choice of instructional technology to solve an educational problem is made as a result of a planning process. This planning process (described in detail in Chapter 2) includes a statement of goals, a selection of criteria to measure progress toward attaining the goals, an identification of participants (persons or groups affected by the decision, responsible for implementing the decision, or potentially constraining the decision), an identification of resources (financial, personnel, equipment, and time) currently or potentially available, the generation of alternatives, and an analysis of alternatives with respect to the chosen criteria.

The first decision to be made for any given educational system is the overall structure of the system. A major classification for this choice is between formal and nonformal education. Formal education may be viewed as education that takes place in a structured, established environment. An additional provision, based on the Western model of education, in defining a formal educational system is that there exists a normal progression through some specified educational cycle with certification at the completion of the cycle. Formal education typically includes elementary, secondary, and higher and technical education. Nonformal education has come to mean anything that excludes formal education. In developing countries, nonformal education generally includes health, population, nutrition, and sanitation programs, agricultural development, and literacy training. However, the subjects normally taught in a formal educational system may be taught in a nonformal educational system and vice versa.

The decision on overall structure is important, although it is not covered in this book. The emphasis is on the second area of decision making: given an educational structure, formal or nonformal, which alternative instructional system (for example, instructional technology, traditional instruction) is best according to specified criteria?

Instructional technology is a potential solution to problems in both formal and nonformal education. Participation rate problems are typically associated with formal educational systems. Illiteracy is typically a problem of nonformal education. A lack of teachers in rural areas, dependence on foreign aid and

personnel, and high dropout rates may be associated with both formal and nonformal education.

Technology systems, in particular television systems, have been used to meet more rapidly the increasing demand for education and to improve participation rates. Instructional technology may be used to improve the quality of education in rural areas by concentrating teaching talent in the production of media programs and dispersing these programs to rural schools with less qualified teachers. While the technology system may alleviate problems in rural areas created by teacher shortages, it may magnify the problem of teacher surpluses in urban areas. Technology systems may also magnify problems associated with foreign aid and personnel, as the investment in equipment is often large (necessitating some form of foreign aid), the equipment is produced in developed countries, and the developing country may be deficient in the technical skills needed to operate the technology system (necessitating the use of foreign personnel).

Nigeria (Lyle, Chesswas, Kahnert, and Griffiths 1967) decided to install a television system to help alleviate its illiteracy problem (80 percent of the population). It can be expected that the television system will result in a more rapid exposure to the literacy programs. If dropout rates are associated with more attractive opportunities outside the school system, it is unlikely that a technology system will affect dropout rates. However, if the problem is due to irrelevant curricula, then a technology system based on centralized curricula may result in higher dropout rates in localities. The typical curriculum is urban-based and is not relevant to rural development needs. Hence students are induced to migrate to urban areas once they have completed their education—unfortunately, because the technology system often is introduced to improve the quality of education in rural areas and to reduce this migration. One major reason for introducing instructional television in the Ivory Coast (Chau 1972) with higher quality instruction was to reduce high dropout rates, which had meant it took 21 student years to produce one primary school graduate.

The major focus of this book in the second area of decision making is to provide information on the instructional technology alternatives. This focus is further limited to radio and television for several reasons: radio and television have been used extensively in developing countries; foreign aid donors have tended to favor radio and television; radio and television have a potential for a high degree of centralization and coordination although these are not necessarily positive characteristics; and some of the more individualized forms of instructional technology, such as computer-assisted instruction, are expensive and in experimental stages in developed countries.

While many radio and television projects have included the distribution of printed materials, these materials and other classroom materials are not considered as separate alternatives. As C. S. Benson (1972) noted, educational

systems in developing countries are seriously lacking in all forms of classroom materials and the effect of increased distribution has not been sufficiently analyzed. This book will not correct this deficiency, as the analysis presented here is based to a large extent on printed information on specific educational projects in developing countries.

How Has Instructional Technology Been Used?

Instructional technology has been used in a variety of ways in developing countries. W. Schramm (1973a), in his study of instructional technology, distinguished between using technology to reform, to extend, or to upgrade formal education in developing countries. E. McAnany (1973) discussed five alternative strategies for the use of radio in developing countries: open broadcast with unorganized audience (voluntary and unstructured reception), radio instruction with organized learning group, radio rural forums with discussion leaders aimed at disseminating agricultural information, radio "schools" for nonformal learning groups, and radio with community participation groups. R. Hornik, J. Mayo, and E. McAnany (1973) discussed mass media in rural education for the following purposes: the extension of formal education, the development of basic skills for rural people, the provision of practical information and advice, and the stimulation of community development. D. Jamison (1972) mentioned the use of mass media for teacher training and for the substitution of teachers in one or more subjects.

O. Kreimer (1973) provided an extremely comprehensive list, with brief descriptions, of television projects in operation throughout the world. His descriptions included the purpose of the project (primary, secondary, or higher education; technical schools; adult education; continuing professional education; community development; in-home education; and teacher training) and the organization of the project (nationally institutionalized, regionally or locally institutionalized, and pilot projects). The information he provided is limited, but it does indicate the wide variety of uses of television in the developing and developed countries. However, projects in the developing countries tend to be more concentrated in primary and secondary education and community development and in pilot and small-scale projects. For example, in primary education, eight projects in Africa, seventeen projects in Latin America, and eight projects in Asia were mentioned. Of the primary educational projects, none of the African projects, only two of the Asian projects, and two of the Latin American projects were nationally institutionalized.

J. Maddison (1971) provided brief information on the frequency of broadcast and utilization of literacy programs via television and radio in Africa and Latin America. W. Schramm (1971) and J. A. Ross et al. (1972) discussed the use of media in many countries for family planning.

Television has been used in major reforms or development of educational systems in El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), Samoa (Schramm 1973b; Schramm, Nelson, Odell, Vaizey, and Spaulding 1967a), the Ivory Coast (Klees and Jamison 1973), and Korea (Morgan and Chadwick 1971). In these countries television has been concentrated in the primary and secondary educational levels. In El Salvador, television has been used to increase enrollment without a loss of quality. In Samoa, the major emphasis has been on improving the quality of instruction to compensate for the general lack of qualified teachers. In the Ivory Coast, television has been used to expand the primary educational system with the goal of providing universal primary education by 1980–85. The plan in the Ivory Coast has been for the addition of one grade level per year. In South Korea, television is an integral part of the development of the formal educational system. While the El Salvador, Samoa, and Ivory Coast projects include plans to use qualified teachers in the classroom, the plans for South Korea involve teachers of varying levels of ability for fixed groups of students; that is, television is used to compensate for lesser qualified teachers. All four countries are utilizing open air transmission of television from ground stations to provide the core of the curriculum.

In Washington County, Maryland (Wade 1967; Wells and Klees 1976), television has been used for the past 19 years for enrichment purposes in an already existing school system. Televised lessons are distributed via cables to all schools in the county and for all grade levels. In Mexico (Mayo, McAnany, and Klees 1975; Klees 1974), television has been used to extend secondary schooling to rural areas and with teachers of lower quality than those in the regular secondary schools. The teachers used in the television schools for secondary education were only trained to the primary level.

F. Harbison and C. A. Myers (1964) used a variety of indices to compare relative development stages of national economies. The stated goals of the television system might also be used as an index of development. In developed countries, there has been a wide variety of uses of television, ranging from instruction in elements of single courses at different educational levels in formal educational systems to whole curricula for continuing education. Television in higher education has been used in introductory courses in psychology and economics to teach all or part of the course. There has been a growing use of television in developed countries to provide education to adults who may be employed full time. The Open University in the United Kingdom and the State University of Nebraska are providing televised course work for undergraduate education (Kreimer 1973). Small-scale systems at Stanford University (Wells 1975a) and at many other universities throughout the United States have been braodcasting television to businesses to provide continuing education for engineers and managers.

While these types of systems are within the realm of possible applications

of technology for developing countries, they do not really meet their primary problems. With few exceptions, television in developing countries has been used mainly in formal educational systems for expansion of the systems or for substitution of less qualified instructors.

The use of radio stands in contrast to the use of television, although some similarities do exist. Radio has been used in many instances to expand education to outlying regions. Australia combined radio with correspondence to reach isolated areas (Schramm 1973a). Mexico has used radio to provide the core of schooling to rural areas (Spain 1973; Schmelkes de Sotelo 1973), and Thailand (Ratanamungala 1972; Schramm et al. 1967b) has used radio for enrichment purposes where it was felt that the teacher might be deficient in such abilities as English and music. McAnany (1973), as previously mentioned, discussed a variety of other situations where radio has been used in institutionalized instruction.

The major difference between radio and television derives from using radio extensively for development information and for education of out-of-school persons. Perhaps the best known use of radio for out-of-school persons has been Radio Sutatenza instituted in 1947 in Colombia by Father Salcedo. Schramm (1973a) reported that it broadcast 19 hours per day from three radio stations to 20,000 radio schools and 167,000 students in 1968. To support this operation, there were 200 full-time staff, with 200 field workers and 20,000 unpaid volunteers. In addition, there were 130 people involved in publishing support materials. Radios were used for teaching health, literacy, mathematics, economy, and spirituality. As part of the broadcast day, five hours of entertainment and six hours of programming for nonradio school listeners were included.

The other major use of radio has been for radio rural forums. Viewing agriculture as an important element of the development process of many national economies, the emphasis in radio rural forums, first used in Canada (McAnany 1973), has been the dissemination of information on agricultural techniques. These rural forums have been used extensively in India (Mathur and Neurath 1959; Schramm et al. 1967c; Mathur 1972). Farmers would meet with a discussion leader to listen to a broadcast. The broadcast might be devoted to a new technique or a response to local development problems. The broadcast and ensuing discussion would be aimed at aiding in understanding of new techniques or instigating direct community involvement in some project.

PLAN OF THE BOOK

The main purpose of the book is to analyze the use of radio and television in developing countries. This analysis is undertaken by employing information derived from case studies of instructional technology systems in developing

and developed countries. The aim of the analysis is not to survey every project in the world in which radio or television has been used for educational purposes but to use projects that have been analyzed by other researchers. Among the projects used in this analysis are the instructional television projects in Samoa, El Salvador, Mexico, the Ivory Coast, Colombia, Peru, Nigeria, Niger, Senegal, and Washington County, Maryland, as well as instructional radio projects in Mexico, India, Thailand, and Ghana. Information from a much larger group of projects (predominantly from the United States) will be used to determine the effectiveness of instructional technology as compared with traditional instruction. While situations may well differ among developed and developing countries, the experiences of other countries with instructional technology may help planners in a particular country to estimate the expected results of introducing instructional technology.

The focus of this book is to provide an objective analysis of instructional technology without being either a proponent or critic. However, it is entirely possible that proponents will find this book to be overly critical and critics will think it overly supportive.

There are three important factors that explicitly or implicitly enter much of the analysis: the difference between formal and nonformal education, the influence of foreign agencies, and the tendency (predominantly in formal education systems) to ignore the special needs of rural areas.

Three related analytic processes are discussed in the first three chapters: planning (Chapter 2)—the analysis of a problem and a choice of an alternative to solve the problem; implementation (Chapter 3)—the manner in which the decision is carried out; and evaluation (Chapter 4)—the monitoring of the system once a decision has been implemented. The general approach in each of these chapters is to describe the process involved, the models used in the process, associated problems, and special aspects of the process related to instructional technology. These chapters are of a general nature, and the processes, models, and problems described for planning, implementation, and evaluation may be applied to nontechnology system. However, in these descriptions a discussion of the potential impact of an instructional technology on the general aspects of processes, models, and problems is also included. The discussions in these chapters of special aspects of instructional technology include descriptions of additional factors that must be considered when instruction technology has been or will be chosen to solve some problem in education.

Another common feature of these chapters is the use of organizational charts to describe potential relationships among participants in each of the processes and to analyze the potential impacts of changes in the relationships with respect to control of the the process. Among the groups considered in this analysis are foreign agencies, the ministries of education, and other domestic ministries, teachers, communities, the planning group, project management, and the evaluation group.

Chapters 5 and 6 contain specific information from instructional technology projects on many of the criteria that would be used for planning purposes: cognitive and noncognitive criteria (Chapter 5) and costs (Chapter 6). Cognitive criteria are usually measured by test scores. Noncognitive criteria include attitudes of students and teachers toward the system, social attitude change in the students, dropout rates, repetition rates, and attributes of the overall operation of the system.

Chapter 7 is a summary of the information and analysis presented in the book in the context of the planning process described in Chapter 2.

CHAPTER

2

PLANNING

INTRODUCTION

Planning is the initial phase of decision making, and is a process involving identification and analysis of problems, goals, participants, available and potential resources, and alternative strategies to solve or alleviate one or more of the problems. From this perspective the decision to use instructional technology is only one alternative method for solving the educational problems of a country, region, or locality. The second section of this chapter contains a description of a planning technique for choosing an alternative solution. The basic technique can be used to attempt to solve any educational problem whether it involves formal or nonformal education. However, the example of an analysis presented in this section is based on a decision in formal education. The impact of instructional technology as an alternative solution on elements of the planning process is discussed in each of the subsections.

Planning models (discussed in the third section) are tools that help to process information and enable decision makers to assess the impact of alternative solutions. Models have taken a variety of forms and usually involve an attempt to describe elements of and interrelationships in the educational system. For example, student flow models, such as the one discussed by J. M. Ritzen and J. B. Balderston (1975), involve a prediction of the needs of the economy for certain skill levels and a model of the educational system in terms of numbers of students entering an educational cycle, dropping out at various points, enrolling in different stages of the cycle, and completing the cycle. It is important to realize that models of this type are not plans but extremely useful devices to help a decision maker understand the relationship of elements of a system and to predict the success of alternative strategies. A model such as the student flow model is useful for the policymaker in understanding how

he may be constrained in instituting a policy to increase the number of graduates in a given year in a given skill and in identifying critical problem areas that will affect his strategy implementation. The planning process involves an intelligent, careful analysis of the system with intelligent, careful use of relevant models. Other models described in the third section include cost, evaluation, rate of return, and labor force planning models.

The fourth section of this chapter contains an analysis of problems that occur in planning. These problems include the simple but potentially damaging difficulties of inappropriate data, misestimation, negligence of critical factors, and poor information systems. An additional important problem is the authority and perspective of the planning agency. Planning problems related specifically to the choice of instructional technology are analyzed in the final section. Other advantages and disadvantages of instructional technology and special aspects of planning for technology, including a variety of technical considerations, are also covered.

Planning is an important process that requires careful analysis. The decisions that will be made and implemented will require a large investment and will have, hopefully, major impacts on development. It is particularly important to plan for a decision to utilize instructional technology since these systems typically involve high initial investment costs. While there is considerable discussion in this chapter regarding potential impacts of the technology alternatives on the planning process and special aspects of planning for technology, there are fewer project reports to support these implications than are used to support the cost and evaluation analysis.

THE PROCESS OF PLANNING

Problem Definition

The first obvious step in planning is the recognition of a need for change. This recognition may come from an understanding of an existing problem or a potential opportunity. In general, a problem may be said to exist whenever there is a difference between actual and potential or desired performance. Therefore, to recognize the existence of a problem, one must develop a clear statement of goals and an ability to measure progress in meeting these goals.

If it is desired to have a given participation rate in education, and the participation rate falls below the desired level, then a problem is said to exist. It is important to differentiate between symptoms and causes of problems. If we merely correct a symptom and neglect the underlying cause, new problems are bound to rise, perhaps with new symptoms. In the case of a low level in participation rates, the situation is simpler. The symptom of the problem is low

participation rates, while the cause may be lack of financial resources for individuals or a lack of available educational resources. As mentioned in Chapter 1, there is a general disparity between educational facilities in rural areas and urban areas. If we wish to increase participation rates, we will probably have to compensate for the deficiency of resources in the rural areas. This deficiency, in terms of current resources, may be a lack of school buildings and/or qualified teachers. However, when we begin to explore solutions to the problems, we need not restrict our alternatives to increasing or balancing the distribution of current resources. The solution may, in fact, lie in seeking new educational structures and organizations or different instructional technologies.

In Chapter 1, many educational problems for developing countries were mentioned, among which was a heavy reliance on foreign financial aid and personnel. However, this is a problem only if this reliance creates or facilitates activities or decisions that the developing country would not desire to undertake in the absence of foreign influence or limits decisions that the country would make. The availability of foreign aid funds for projects involving technology or educational systems modeled upon Western institutions rather than alternative educational structures reduces the cost of the former choices to developing countries and may influence a decision in this direction. It should be realized that the reliance on foreign assistance is only a symptom of the problem of the developing country—an inability of its own to generate financial or human resources for the education sector. The problem of the impact of foreign assistance would be eliminated by refusing foreign funding and personnel, but the cause of the problem (a lack of resources) would remain and manifest itself in other symptoms, such as a decline in the quality of education or longer time spans to increase participation in the educational system.

Alternatives generated to solve problems in the education sector may have varying degrees of success in solving the problems but would not be expected to alter the existence of the problem or symptom-cause relationship. However, the alternative chosen may magnify some of the problems or create new ones. For example, one problem in developing countries is the disparity of resources between urban and rural areas. An instructional technology such as radio or television may reduce this disparity, but when the curriculum for the technology is centrally planned, the content may not be directed toward the needs of the rural area or the background of rural students. As a result, two things may happen: rural students who have acquired skills more relevant to employment in urban areas may migrate, thus reducing the labor force in rural areas; and development needs of the rural areas that may require different skills or work organizations than those of urban areas may not be satisfied. A technology system may also involve increased reliance on foreign aid due to large initial investment costs with concomitant involvement of foreign personnel in curriculum planning and evaluation and additional foreign exchange problems in the future for equipment replacement.

Goals

The recognition of a problem through a performance gap occurs through preparation of a statement of goals. Three important elements of goal statements are operationality, feasibility, and goal chains.

Operationality

While ambiguity reduces conflicts among participants, it also limits planning ability and recognition of where a performance gap exists. For example, the goal of improving the quality of education is not easily disputed until we begin to operationalize the goal and specify the dimensions of quality. W. Schramm, P. H. Coombs, F. Kahnert, and J. Lyle (1967) stated a goal of raising quality levels in classrooms with poorly qualified teachers and utilizing technology to achieve this without defining the means of measuring quality.

Quality may be measured in terms of the resources used: teachers, technologies, materials, or buildings, while others may view quality in terms of outputs: graduation, participation, dropout and repetition rates, performance on a variety of test measures or absorption of some set of social or personal values. It is clear that conflicts over definitions of quality might occur.

Another difficulty with ambiguously stated goals is the consequent difficulty in evaluating the success of a project. In Niger (Le Franc 1967a), the following were among the goals stated for radio clubs: to contribute to educational development, to cultivate democratic leadership, and to integrate adults into the national community. With goals so generally stated, it is difficult to formulate measures to determine whether or not the project is moving toward accomplishment of the goals.

Feasibility

The feasibility of attaining the goals is also important. For example, several years ago UNESCO analysts stated that one of the goals for developing countries should be universal primary education. J. Auerhan and E. S. Solomon (1972) stated this same goal for Asia when they called for free and compulsory education for seven years. The feasibility or likelihood of attaining the goal must be based upon resources currently and potentially available. It would be unwise to devote resources toward unattainable goals; frustration would be the likely result. The universal educational goal may be good for political purposes, but for planning purposes, it is necessary to determine the stages necessary to reach the goal.

Schramm (1973a) stated as a major objective of the television projects in Niger, Samoa, El Salvador, and the Ivory Coast the expansion of the primary

system. This is a feasible version of the universal enrollment goal, although as such not operational. To make the goal operational, critical questions related to number of students, grade levels, and geographic regions would need to be answered. It is important to remember that proper formulation planning in these countries would not be phrased as, given the existence of a television system, what goals can be formulated, but rather, given the goal of expanding enrollments along some set of dimensions, how might this goal be achieved (for example, is a television system a feasible and effective alternative)?

Goal Chains

The most important element of setting goals for educational systems is understanding and specifying a goal chain. It is unrealistic and unwise to view the education sector as separate from the rest of society. It is important to realize that goals set for the education sector may lead to the attainment of economic development goals or other goals of society not quantified in economic development terms. For example, lack of skilled personnel in a variety of employment classifications may lead to the educational goals of expanding enrollment. A goal of expanding enrollment may also be derived from a social goal of eliminating inequities in the educational system or diminishing urban migration caused by a lack of education opportunities in rural areas (with an awareness that the education may magnify the migration). Goals stated by Schramm, Coombs, Kahnert, and Lyle (1967) for increased literacy training are related to development goals of the country by providing individuals with the ability to improve their work productivity and to social goals of improving the responsibility of the population by training people to absorb information from printed sources. Schramm, Coombs, Kahnert, and Lyle (1967) and Auerhan and Solomon (1972) have stated goals with respect to the type of training necessary, such as science, mathematics, and technical skills, which are related to skill deficiencies in the economy.

Some developing countries still reflect the impact of the colonial period in setting educational goals, such as raising educational achievement of students in Samoa, including proficiency in English, to standards of students in the United States (Schramm, Nelson, Odell, Vaizey, and Spaulding 1967a). In Niger (Le Franc 1967b), one of the goals was related to learning the national language, French, which 95 percent of the people did not speak. South Korea (Morgan and Chadwick 1971) is undertaking the creation of an educational establishment that has many of the basic characteristics of the structure of Western institutions. It would seem evident that these educational goals should be pursued if they can be rationally tied to development goals of the country.

The major effect of the alternatives is on goal feasibility. While it has been stated that it is important to set feasible goals in the planning process, the

feasibility obviously is affected by the alternatives, and goals may need to be adjusted after the alternatives are analyzed. A rapid expansion of education to rural areas or universal education may become feasible only when a technology system is used. The technology system allows a dissemination of quality teaching ability that would not be available to many areas of the country if conventional instruction were used.

Participants

Participants may be groups affected by the policy (students, teachers, and parents) or those responsible for implementing the policy (teachers, technicians, administrators, and so on). For each of these groups it is important to identify individual goals and objectives to determine potential conflicts and constraint on the decision-making ability. For example, Blaug, Layard, and Woodhall (1969) determined that one of the causes of an excess of graduates in India was the fact that the private return to education exceeded the social rate of return. That is, the individual, in maximizing his own well-being, assesses his costs and his benefits for more education, whereas decision makers assess all benefits and all costs. In India, with education subsidized, there was an imbalance in the objectives of individuals and society with a consequent constraint placed upon a maximization of social well-being. Investment in education was too high, as many graduates could not receive employment commensurate with their training.

Interrelationships among ministries and departments in central and local governments must be investigated to determine where authority should reside or where conflicts may exist. For example, if one of the goals for development is increased agricultural productivity, authority for planning for this goal may be assumed by the ministries of agriculture or education. It is important to realize the possibility of these conflicts and to plan for them.

The ability to implement some plan in the education sector will be related to the relative power in different ministries. In El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), support for the educational television system came from outside the Ministry of Education. It was not until Walter Benecke, a supporter of the television system, was appointed minister of education that the television alternative received sufficient and politically effective support to be implemented.

Foreign agencies and personnel are important participants affecting the planning, implementation, and evaluation processes. Foreign funds, a major financial source for technology projects, may be available only for certain types of projects. The aid may carry certain requirements with respect to a foreign role in curriculum development, project management, and evaluation. In accepting this involvement, the developing country may gain from expertise not available in the country, but lose control over the progress of the project.

Teachers and potential teachers are a major group of participants who will be affected by the decision and responsible for implementation of the decision. In Samoa, when foreign teachers resisted the change in the educational system, large-scale firing took place. In El Salvador, the implementation of educational reform, including major curriculum changes and the introduction of television, was affected by teacher strikes. Teacher strikes also affected the television project in Mexico. M. Carnoy and H. Levin (1975) argued that teacher strikes are to be expected in technology projects where a high investment exists and induces higher salary demands.

Project administrators must also be considered. Jamison, Klees, and Wells (1976) mentioned that, in the Ivory Coast, expensive batteries are provided by the central administration and electrical costs are paid by local administrators. Therefore, to reduce local costs, administrators choose batteries to operate televisions, even in areas where electricity is available.

An assessment of the skill requirements for different alternatives is important. For example, the choice may be between labor-intensive education and a mix of labor with capital. In Mexico, regular secondary schools used people trained for secondary teaching, whereas the television schools used television with people trained for primary teaching—and paid a much lower salary. For technology projects, it is also important to assess the skill requirements for maintenance and production activities. Training may be necessary to fill many of these technical positions or a further dependency on foreign personnel may be created.

Often, forgotten participants in the planning process are students and the community. P. Spain (1973) and S. Schmelkes de Sotelo (1973) argued that radio projects in Mexico were failing because no consideration was given to the development needs of the rural area.

Resource Appraisal

The next major step is to assess the resources available for meeting the problem. Resources may be actual or potential and include political resources, human resources, financial resources, physical resources, and time. Political resources (the political power of participants) and human resources (the persons or groups responsible for implementing the policy) have been discussed in the previous section.

Financial resources may come from internal sources or from foreign grants or loans. El Salvador has a mix of internal funds and U.S. aid ($1 million) and loans ($2 million) and a loan of $4.9 million from the International Bank for Reconstruction and Development (IBRD) for its television project. The Ivory Coast has relied upon a variety of donors for financial aid, including $5 million over five years from France, $1 million from UNESCO, $1 million from Canada, and a $11.2 million loan from the IBRD.

Physical resources are an especially important component for technology alternatives. In developed countries with existing transmission and power sources and of receivers (television or radio sets) and road networks, the choice of a technology is easier to implement. However, in developing countries, many areas may not be easily accessible and hence the ease of maintenance is reduced. Receivers are not likely to be manufactured in the country, raising the possibility of further technical imports. It is possible that some other educational alternative would draw upon the production capabilities of the country. Areas of the country may not have electrification, and alternative power sources may be necessary. Clearly, then, the costs and, hence, the desirability of a given alternative are determined by the current availability of physical resources.

The final important resource is time. A major impetus for the movement toward increased utilization of technology has been the long time span necessary to improve or expand the educational system through more teacher training. However, implementing a technology system, especially in circumstances where physical resources and human resources are deficient, may also result in a long time span between the beginning of the planning process and the final stages of implementation. The planning period for the television system in the Ivory Coast was four years and the implementation of the system involves the addition of one grade level per year. Preparation times for projects in Niger and Samoa have been three years. General planning in El Salvador for its television project took nine years.

There are two opposing impacts of time on planning. There should be sufficient time to undertake a careful analysis and implementation of the project, but not so much time that financial and political support for the project dissipates. The time factor affects the decision to use pilot projects or to engage in a full-scale undertaking. In Niger, so much time has been spent on the pilot project that the television system still serves only 800 students.

Generating Alternative Solutions

After assessment of the problem, goals, participants, and resources, one is faced with the generation of alternative means of solving the problem. As discussed in Chapter 1, technology systems have been used to solve a variety of educational problems: upgrading the level of instruction; extending and expanding the system; training for literacy; and dispersing agricultural, health, and other information and techniques. However, a technology system is only one alternative among many to solve these problems.

P. Freire (1970) has been more concerned with the content of education than the methodology and has reported substantial success in teaching literacy to adults by using literature that is politically controversial and directed to-

ward activities that people may undertake to alter the rural environment. The same philosophy may be applied to aid farmers to learn more productive agricultural techniques.

To expand schooling, differentiated staffing, wherein different skill levels are used for different parts of the learning process, may be used. A related alternative would be a structure that reduces the reliance on teachers by increasing the interaction between more and less advanced students. This alternative allows for expansion of schooling without an increase in the number of teachers. I. D. Illich (1971) favors the termination of the educational establishment (schools) and the creation of networks that allow individuals to interact with each other and to have access to information on topics or subjects of their own choosing.

The problems of education in developing countries are severe and require a willingness to explore a wide variety of alternative strategies. Unfortunately, much of the analysis has involved ways to extend schooling along the lines of the typical Western educational institution with grade levels and certification after completion of various segments of the educational cycle. Other alternatives have been suggested in planning studies. Chau (1972) analyzed different combinations of class size, television, and level of teacher training for the Ivory Coast. Jamison's (1972) alternatives for Indonesia include changes in class size (student-to-teacher ratios), classroom utilization rates, and length of school year through alterations in the number of hours per week and/or weeks per year. In cost analyses for Barbados (Durstine and Hudson 1972) and Poland (Podoski 1972), different alternatives were investigated, concentrating on team teaching and teacher training programs, respectively. In Uganda (Bennett 1972), alternatives analyzed included changes in class size and academic year and a work-study program to allow for practical experience.

A wide variety of organizational alternatives are also possible. For example, in the United States, experiments have been undertaken with local control, performance contracting (setting objectives and hiring groups to meet the academic objectives with money tied to meeting the objectives), and voucher financing (giving a voucher to parents and allowing them to choose the type of education the child would receive).

Choosing an Alternative

The final element of the planning process is the evaluation of alternatives and the choice of one or more of them. The criteria used to evaluate the alternatives should be derived from the goals. For example, if the goal is to expand the educational system with a certain level of quality, then one would want to know the numbers of students served each year and the expected level of quality from the given alternative.

It is unlikely that one alternative will meet all criteria used to evaluate the system. One system may reach more students more quickly than another, but at a higher cost or a reduced quality level. Alternatives, therefore, may be combined. Television systems in South Korea and Mexico have used classroom teachers with less training in combination with television. As mentioned, Chau (1972) compared the relative costs of expanding the educational system with combinations of different class sizes, levels of teacher training, and television. In a U.S. study of computer-assisted instruction, S. Wells, B. Whelchel, and D. Jamison (1974) used the criterion of constant cost and evaluated the relative trade-off between class size and computer-assisted instruction.

Techniques for evaluating alternatives include cost-effectiveness and cost-benefit analysis. Under the former technique, alternatives are analyzed to find the least costly way of reaching some goal or objective. For example, we may want to find the least costly way of extending the educational system to a fixed number of students by a particular year. Cost-benefit analysis is used to compare different projects that may be meeting different objectives. For comparison, usually it is useful to express benefits in monetary terms and choose that alternative with the superior cost-benefit ratio. The problem comes when benefits are not easily quantifiable, and different projects have different impacts on some set of criteria.

As a simple example of a methodology for choosing among alternatives that are to be evaluated with several criteria, assume three alternatives to meet the goal of extending the educational system. These alternatives could be television, increased teacher training to a specified quality level, and differentiated staffing with a higher ratio of students to teachers at a specified quality level. Each of these alternatives is to be evaluated along a set of criteria, including cost, participation rates, graduation rates, and academic achievement. Costs may be measured in costs per student-hour of instruction, cost per student per year, or total annual cost (operating and annualized capital costs) of a system. Participation rates are the percentage of children in a given age group who are attending school. Graduation rates are the percentage of students who complete the educational cycle from a given initial group. Academic achievement may be measured for a variety of subject matters or abilities. One may use average test scores for all students or for various groups of students and/or standard deviation of test scores to determine relative distribution.

As different alternatives will result in expansion at different rates, we also may want to compare the alternatives with the criterion of the number of years needed to reach a given participation rate. This will help recapture some of the dynamics of system expansion if we use average figures for the other criteria over a specified time period. This approach is crude but satisfactory for an illustration of choice among alternatives.

A further simplifying assumption is the neglect of uncertainty in the analysis. Whenever any predictions are made with respect to the future, uncer-

tainty looms as a potential complicating factor in the analysis. For example, a prediction that the average cost per student per year is $300 is derived from a set of assumptions regarding system component costs. The figure of $300 may represent the best estimate or expected value of the distribution. To undertake the analysis properly, we may want to attach a probability distribution to the cost figure. Rather than use a cost figure of $300, we may assume that there is a 70 percent chance that it will be between $275 and $325, a 15 percent chance that it will be between $250 and $275, and a 15 percent chance that it will be between $325 and $400 (there is no reason to assume a symmetrical distribution).

An alternative way to account for uncertainty is to undertake sensitivity analysis by determining how much the estimates of different criteria may vary before one would alter the decision considered best prior to the sensitivity analysis. For example, it is possible that the alternative with the estimated cost of $300 is the best choice even if the cost reaches $400.

In terms of academic achievement, we may want to include measures for a variety of subjects at different levels. For expository purposes, we will assume that only one test score is important, realizing that the problem is actually much more complex. Participation rates, graduation rates, costs per student per year, and academic achievement will be average figures for some fixed project length, n..For academic achievement, we can also include the distribution around the mean as a crude measure of equity for the system. An alternative measure of system equity includes distributions of values of educational resources, that is, we may prefer a measure of inputs to the educational process rather than outputs to determine equity within the system.

The first step in the analysis of choice is to rate each alternative for each criterion. It should be kept in mind that the example in Table 2.1 includes hypothetical numerical values to demonstrate the choice model. Information on results of evaluation studies of technology projects for criteria such as academic achievement, participation rates, and attitudes is presented in Chapter 5, and information on costs of radio and television systems is presented in Chapter 6. In Chapter 7, this information is analyzed in the context of the choice model discussed here. While the example given reflects a decision in a formalized school system, the model choice and the entire planning process are appropriate for decisions on nonformal educational projects.

With the hypothetical numbers used in the table, different alternatives have varying advantages and disadvantages with different individual criteria, and no alternative is clearly superior with all of the criteria. The choice would be simple if one alternative was at least as good as any other alternative for all criteria.

The measures used for the criteria are different and have different meanings. Some attempt may be made to tie the nonmonetary criteria to a monetary measure, in which case the model becomes similar to cost-benefit analysis. This

may be done in two ways. The first method is to estimate the direct economic benefits from changes in the nonmonetary criteria (participation rates, graduation rates, mean academic achievement, number of years to reach 80 percent participation rates, and deviation of test scores). This can be accomplished if it is possible to correlate these measures with changes in salary levels or productivity.

The second method is even more complex and requires the decision maker to determine the social nonmonetary benefits and attempt to assign a monetary value to each of the social benefits. One approach is for the decision maker to assess how much money he would be willing to spend from a budget to improve a particular criterion given the expected change in social nonmonetary benefits from the improvement. Obviously, subjective judgments need to be made, and it would be far beyond the scope of this book to determine the optimal way of making subjective judgments. However, once the monetary equivalents for all measures of benefits were established, it would be possible to determine the best alternative by choosing the one with the highest net benefit (benefits minus

TABLE 2.1

Example Alternative, Criteria Matrix

Criteria	A Television	B Increased Teacher Training	C Differentiated Staffing*
(1) Participation rates (average over 10 years)	50%	45%	60%
(2) Graduation rates (average over 10 years)	60%	65%	50%
(3) Average cost per student per year (average over 10 years)	$22	$20	$15
(4) Mean academic achievement (maximum of 100; average over 10 years)	65	70	55
(5) Standard deviation of academic achievement (from 10 year distribution)	5	15	20
(6) Number of years to reach 80 percent participation rate	6	9	3

*Increased use of persons with less training.

Source: Compiled by the author.

costs) or benefit-cost ratio. The advantage of the monetary equivalent method is that policies to extend the educational system may then be compared with other projects in the education or other sectors of the economy.

A slightly different method is to rank the ratings of the criteria on scales of, say, 1 to 10, and to assign weights to the criteria. For example, for participation rates, we may assign values 6, 5, and 7 to television, teaching training, and differentiated staffing, respectively, and for mean academic achievement, we may assign 7, 8, and 4 to the alternatives, respectively. We would then take weighted averages for each alternative and choose the one with the highest score according to the following formula:

$$S_j = \sum_{i=1}^{n} W_i R_{ij} \qquad \text{for all } j = 1, \ldots, k \tag{2.1}$$

where S_j is the score of alternative j;
W_i is the weight assigned to criterion i; and
R_{ij} is the ranking of alternative j on criterion i.

Some very restrictive assumptions are implied in this weighted average. The first assumption is that a number derived by multiplying the weight by the ranking always has the same value. For example, a 7 assigned to one criterion with a weight of 1 has the same value as a 3.5 assigned to another criterion with a weight of 2. The second limiting assumption is that the criteria rankings are on a scale with equal intervals, that is, a one-unit increase for a given criterion always has the same importance.

One can see that there is no need to use a linear transformation of the initial measures to the scaled variable. One may assign scales to reflect increasing or diminishing importance to changes on different levels of the initial scores. This methodology may be amended to include minimum acceptable levels for any one or more of the criteria. The establishment of weights and minimum acceptance levels involves subjective judgment and is derived from a complex analysis of participation and power in decision-making frameworks.

Without completing the example, it should be clear from the table that each alternative has advantages and disadvantages with respect to different criteria as compared to the other alternatives. If high weights were placed upon participation rates and cost and speed of implementation, we would be likely to choose differentiated staffing. If high weights were placed upon graduation rates and academic achievement, we might choose increased teacher training, although the television system has an advantage in terms of distribution of test scores. The rankings also indicate that some combination of alternatives may be desirable, as for example, in South Korea (Morgan and Chadwick 1971), where a combination of television and differentiated staffing was used.

MODELS IN PLANNING

There are many different planning models for education. H. Correa (1967) provided an excellent review of these models, and he also has edited a volume with a wide variety of examples (1975). It would clearly be beyond the scope of this book to investigate in detail all aspects of the many planning models in use. It is useful, however, to discuss briefly some of these models and the potential impact of the technology alternatives on these models. There are models that provide information for planning the type of educational system to be established (cost and evaluation models) and models that are used to determine the amount of investment in education (rate of return, labor force planning, and student flow models).

Cost Models

In the comparison of alternatives in Table 2.1, information on costs and effectiveness was provided. With investment taking place at different points in time and utilization of the system varying from year to year, there are alternative models for determining the average cost of the system. In the example given in the section on choosing an alternative, an average cost per student per year for a 10-year period was included. With an expanding system, if we examined costs for the first few years of a project, they would be considerably higher than in later years of the project. This is especially true in the case of a technology project where there is a high initial investment in equipment, and the benefits are not realized until the utilization of the system grows.

Four cost models are discussed in detail in Chapter 6 with data from a variety of sources. These models are component cost analysis, annualized cost estimates, time structure of costs and utilization, and opportunity costs. Costs are measured in terms of dollars per student or per student-hour. Also, limitations of this basis of measurement are analyzed in Chapter 6.

Component cost analysis is undertaken by hypothesizing an educational system in terms of a geographic region, dispersion of student population, and instructional time devoted to instructional technology. From the characteristics of the educational system and an itemization of the components of the instructional technology system, one uses estimates of manufacturers' costs for each of the components to determine costs of the instructional technology system.

Annualized cost estimates are determined from actual project experience. The basic technique is to assume an interest rate and a lifetime for the capital costs (production, transmission and reception equipment, buildings, and so on) and to calculate annualized values of these costs by multiplying the investment cost by an annualization factor, a(r,n), given by

$$a(r,n) = [r(1 + r)^n]/[(1 + r)^n - 1] \tag{2.2}$$

where r is an interest rate and n is the lifetime of the capital cost.

These annualized costs are then added to recurrent costs for a given year of the project and divided by the number of students in that year (or number of student-hours, which is calculated by multiplying number of students by the average hourly exposure to the instructional technology system) to determine costs of the system. (A more sophisticated technique for this analysis using cost functions is discussed in Chapter 6.)

The third model, time structure of costs and utilization, is used because technology systems often involve large initial investments and low utilization. A calculation of an annualized cost for an early year of the project would lead to very high cost estimates. The model also is useful for decision makers because it reveals the declining average costs of the project and informs the decision maker about the number of years required for the costs to reach acceptable levels. The basic technique is to list costs in the year incurred and utilization of the system (number of students or student-hours) for that year. The costs are actual expenses and there is no attempt to annualize capital costs. From these data, one then calculates a matrix of AC_{ij}'s, the average cost per student (or student-hour) from year i to year j, given by

$$AC_{ij} = \frac{\sum_{k=i}^{j} C_k d_k}{\sum_{k=1}^{j} N_k d_k} \tag{2.3}$$

where d_k is a discount factor equal to $1/(1 + r)^{k-i}$
r is an interest rate;
C_k is costs in year k; and
N_k is utilization in year k.

The final model is opportunity costs. The basic purpose of this technique is to assume a fixed budget for the education sector and to estimate the cost reduction from a change in some other aspect of the educational system required to accommodate the instructional technology system. This technique is used in Chapter 6 for an analysis of increases in class size and teacher training.

Evaluation Models

The set of information for determining participation rates, graduation rates, and academic achievement is derived from models of the educational process. In these models, one attempts to correlate outputs of the system with

inputs. In the situation where there are many outputs and inputs, two possibilities exist. S. Wells (1975b) demonstrated that one may take a given input and divide it among the production processes for several outputs or a given input may have a simultaneous effect on many outputs. For example, we may divide television broadcast time among several subjects and expect a small interaction, for example, the mathematics broadcast might have little effect on language training. However, utilization of the television system may have simultaneous impacts on social attitudes, graduation rates, and continuation rates. If an input is having simultaneous effects on more than one output, it is possible that the input may have a negative effect on one or more outputs and a positive effect on others. Suppose that as we increase the amount of television time devoted to mathematics instruction, mathematics achievement scores increase and some measure of social interaction of students declines. If the times devoted to other academic courses are not altered, we would not expect any change in achievement levels in these courses. A decision to increase television mathematics time would have both a positive and a negative impact, and it would be the task of the administrator to determine what the relative trade-offs are and how much television mathematics should be used.

We have two different models: one that would help determine how much of the alternative to use and the other to determine which alternative would best meet the objective. It should also be noted that this information for the planning process must, of necessity, come from experiences in countries other than the one undertaking the planning. (In Chapter 5, results of the effectiveness of alternative media will be drawn from developed and developing countries.) To demonstrate the use of the two models, assume a situation with only one output score and two alternative systems. We will then have the following variables:

O is the student's score on an achievement test;
T is the number of hours of television used;
E is the number of credits a teacher has beyond the minimally accepted level;
I_j is a vector of values of j other inputs to the educational process, such as textbooks, class size, initial test scores, basic intelligence scores, and socioeconomic status;
T_D is a variable that takes the value 1 if the student is in a classroom using television and 0 otherwise.

Assume that the information is drawn from a project where the student is either in a classroom with television and a teacher with minimum training or in a classroom where the teacher has more than minimum training. To make the experiment, informative students must be exposed to different amounts of television or teachers with different amounts of training. Equation 2.4 provides

information for the choice among alternatives, and equations 2.5 and 2.6 provide information for the amount of input to be used. We then have the following equations (assuming a linear form for expository purposes):

$$0 = a + b_0 T_D + \sum_{j=1}^{n} b_j \bar{I}_j \tag{2.4}$$

where b_j is the marginal impact on the output from an additional unit of input and b_0 is the average difference in effect between television and teacher training.

If b_0 is positive and statistically significant, there is an advantage to the television system; if it is negative and statistically significant, it indicates the amount of advantage (on the average) for increased teacher training. An insignificant value would indicate an inability to differentiate between the two systems.

$$0 = c + d_0 T + \sum_{j=1}^{n} d_j \bar{I}_j \tag{2.5}$$

where d_j is the marginal impact on the output from an additional unit of input j (for students in television classrooms) and d_0 is the marginal effect on academic achievement of a one-hour increase in television exposure.

$$0 = e + f_0 E + \sum_{j=1}^{n} f_j \bar{I}_j \tag{2.6}$$

where f_j is the marginal impact on the output from a one-unit increase in input j (for students in classrooms with higher levels of teacher training) and f_0 is the marginal effect on academic achievement of a one-credit increase in teacher training.

It should be understood that if no interactions exist between type of system and other inputs and if students are randomly assigned, one would expect that $b_j = d_j = f_j$ for all $j = 1, \ldots, n$.

We may extend the equations to include impacts on a variety of cognitive and noncognitive measures and graduation and continuation rates. To analyze the impact on participation rates, similar models may be used, although, quite obviously, it will not be the amount of time that the television is used that affects participation rates as much as it will be the amount of television receivers and the coverage of the system.

The evaluation studies reported in Chapter 5 all involve utilization of

models of the first type. However, an even simpler version is often used which excludes an estimation of the impact of other inputs.

Rate of Return Models

Rate of return models are used to determine the relative investment opportunities for education. The basic technique is to estimate the lifetime income streams for individuals with different levels of education and then compare this income with the costs of providing additional levels of education for an individual. The rate of return is that interest rate for which the discounted benefits (income) equals the discounted costs, where we solve the following equation for the interest rate, r:

$$\sum_{i=1}^{n} \frac{B_i}{(1+r)^i} = \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} \tag{2.7}$$

where B_i and C_i are benefits and costs, respectively, in year i.

Income is not determined by level of education only. Factors such as age, working experience, and socioeconomic status also may affect earnings. To control for the noneducational factors, regression analysis is undertaken, where income is the dependent variable and the independent variables include all of the contributory factors, including education.

If one is interested in differentiating among rates of return for different groups in society, the data first would be stratified into the relevant groups and the regression equations estimated for each group. For example, H. T. Thias and M. Carnoy (1972) stratified data for Kenya by ethnicity and sex and then for each group estimated equations with earnings as a function of age, father's occupation, parents' literacy, place of schooling, type of employment, and examinations passed.

From the estimated equation, one will obtain the effect of education on income, adjusted for a variety of factors. The additional income from a given level of education is assumed to be the benefits attributable to that level of education. If we compare these benefits with the costs to the individual (tuitions, fees, and income forgone during the educational period), we obtain the private rate of return, and if we add the total cost of education to forgone income, we obtain the social rate of return.

Education is typically subsidized, that is, tuition and fees are less than total per student costs, and the private rate of return is higher than the social rate of return. This difference in rates of return can easily lead to a higher demand for education than is socially beneficial. According to Blaug, Layard, and Woodhall (1969), this difference is the cause of overtraining in India where

there is an unemployment problem for graduates. The private rate of return adjusted for the probability of unemployment is still positive for individuals.

Another problem in planning for education that becomes evident through undertaking rate of return analysis is that the individual has limited alternative investment possibilities and is likely to demand increased education for small, positive rates, whereas society has many alternative investment possibilities, and these alternatives are likely to have higher rates of return than alternatives for the individual. This implies that an imbalance might always exist between an individual's demand for education and the socially optimal supply determined by equalizing rates of return for investment in many different sectors.

Carnoy (1974a) estimated the following approximate rates of return for primary, secondary, and higher education in developed and developing countries:

	Primary	Secondary	Higher
Developed	—	6	6
Developing	7	12	11

There is no rate of return reported for primary education in developed countries as there are very few individuals in these countries who are not primary school graduates. Therefore, it is not possible to calculate the benefits to primary education by comparing incomes of primary school graduates and dropouts.

In his survey, Psacharopoulos (1972) reported higher returns for education in developing countries than developed countries, although, as opposed to Carnoy, he reported a general tendency for a higher return to primary education than secondary education in developing countries. In comparing investment in education and investment in physical capital for developing (less than $1,000 gross national product per capita) and developed countries, Psacharopoulos found the following:

	Physical Capital	Education
Developed	10.5	8.3
Developing	15.1	19.9

The general tendency in developing countries is for rates of return to be higher for investment in education than in physical capital. This rate differential is extremely important for educational planning, as it indicates the need for increased investment in education. Psacharopoulos also, as expected, reported

a higher private rate of return than social rate of return for education in developing countries.

The problems of developing countries are increased further by the fact that the private rate of return is higher for emigrating to a developed country after education than remaining in the country. Obviously, in calculating social benefits, private income earned outside the country will not be considered a benefit to the country. Only income earned within the country represents an increase in domestic production.

Social rates of return are used for planning purposes for determining the total investment in education and the allocation of this investment to portions of the education sector. If rates of return were exceedingly high for primary education this might indicate the usefulness of further expansion of the primary system.

The major disadvantages of this type of analysis is that the rates of return as calculated are really directed at marginal changes. For example, suppose there is a high rate of return to primary education. This would be the rate of return expected for an additional person completing primary education. However, if a large-scale expansion of the primary system is planned, one cannot expect the rate of return to stay at this level unless the economy expands fast enough to provide employment at the same salary levels as existed prior to the expansion when the analysis was done. Thias and Carnoy (1972) found that rates of return declined in Kenya as the educational system expanded. A further but opposite limitation of rate of return analyses is that nonincome benefits of education and employment often are not considered. Inclusion of these benefits would raise the rates of return.

As the rate of return is calculated for an additional person, there will be computational errors in both benefits and costs for large-scale expansions of the system. The major impact of alternatives in education will appear on the cost side. The decision to expand a system must be considered in terms of the speed and cost of expansion. As technology is typically not used in current educational systems in developing countries, rates of return usually are based upon costs without technology.

The unique aspect of a technology system in relation to other alternative means of expanding the educational system is that a large initial capital investment is involved. The cost advantage for technology systems in these instances occurs when larger utilization levels are reached. The implication for rate of return analysis is obvious. If the calculated rates of return are to be used to make decisions about expansion, one must consider the means available for expansion. If rates of return have patterns of declining values as systems expand than for smaller expansions, a nontechnology system will have a higher rate of return than a technology system, whereas a technology system will have the higher rate for larger expansions. However, in comparing rates of return for small nontechnology expansions with larger scale technology expansions,

it is possible for the rate of return to be higher for the large-scale expansion: the lower average cost per student for the technology system may counterbalance the reduced income possibilities when many more people have been trained. The possibility then exists that if one plots rate of return versus number of students, rate of return may decline to some point and then begin to rise. However, this only occurs if one considers all possible alternatives. If one considers expansion through only a single alternative, then the rates of return are likely to decline as expansion increases for all alternatives.

There is an additional factor that will complicate the analysis: the rate of expansion. If declining rates of return are primarily attributed to a reduction of employment opportunities for the expanding supply of graduates, then it is likely that the problem will be compounded if the system expands at a faster rate.

A further limitation on the analysis is that most of the rates of return are calculated for quantity of education. There have been few studies of the effect of quality of education. Thias and Carnoy (1972) provide one of the few exceptions. They estimated salary differentials for different breakpoints on an exam and generally found that higher scores resulted in higher salaries. The next step would be to determine which inputs, for example, television and teachers, had the greater impact on quality. This would help to indicate which alternative was better.

Where major changes are planned for educational systems, it would appear that rate of return analysis is only useful if one includes employment and educational cost projections. If one were to use rate of return analysis to help determine the level of investment in education, one should integrate it with the choice methodology presented earlier. Furthermore, rate of return analyses are of limited usefulness for analyzing nonformal educational projects.

Labor Force Planning Models

Alternative models for determining investment in education are labor force planning models. These models also stress the investment aspects of education through a determination of the labor force needs in the country and an attempt to develop training in the education sector to match these needs. Clearly, if one wants an adequate supply of trained persons to avoid restricting the development process through skill shortages or increasing the reliance on foreign personnel, advanced planning is necessary. Skills require varying years of training, so the demand for skills must be anticipated and planned for by having sufficient numbers of people in the educational system such that students will be completing the required amount of education at the time the demand appears. For example, if a demand for a given number of nurses, n, is anticipated for year k and nursing is a two-year program, then in year k-2,

n/g persons must enter nursing training (g is the graduation rate). In order to have n/g persons entering the program in year k-2, one must be assured of sufficient graduates from the previous educational cycle to meet this and other skill demands.

It is possible to attract people who have completed the previous educational cycle in years earlier than k-2 back into the educational system for additional training. The potential for additional training can help to alleviate the problems that arise when too few individuals are available currently in the educational system. In order to have persons available to direct the training for the required number of people, further advanced planning is required.

The main purpose of labor force planning is to avoid the social waste that occurs when there are too many or too few trained people. Unfortunately, demand for labor analysis is often done in terms of completion of a given cycle of education (primary, secondary, and higher) rather than attainment of requisite skills or abilities.

In general, one may conceive of three broad areas for government policy derived from labor force planning: population size, demand for labor, and supply of labor. The first stage in labor force planning is demographic analysis to determine birth and death rates and population size for different age groups. This step is necessary in order to determine how many people will be available for training and to plan for the particular direction of development decided upon. Clearly, population policies to increase or decrease the birth rate can only be indirect (encourage larger families or disperse birth control information) and can be expected to have very long-term effects. The most direct influence a government can have over population is through immigration policies, and this may affect only small numbers of people. Population policy decisions basically are ineffective means to alter labor force planning. In most instances it is more important to undertake careful demographic analysis and predictions and utilize the information generated for demand and supply planning.

The degree to which the government can affect demand planning is a function of the degree of centralization and public control that exists. However, even in noncentrally planned economies a great deal of influence on industry growth may be exerted through subsidies and tax incentives to specific sectors of the economy. For example, in the United States, the demand for engineers is related to government military and aerospace planning. The demand for construction skills can be affected by subsidies to the housing industry through low-interest loans to buyers or builders or through direct government influence, as in road building. As the degree of centralization grows, more direct decisions may be taken on the amount of investment in different sectors. In any case, it is clear that policies to influence demand for labor are doomed to failure if no account is taken of the supply of labor that is currently or potentially available.

As the education sector is usually under direct government control, there is a large capacity for altering supply of labor responding to estimated demands from the private sector or planned demands from the public sector. Student flow models are used to analyze the number of students in the system and the number that will become available in order to determine the potential supply. Expansion of the system or subsidies for given skill trainings can be used to influence the number of students. If necessary, the number of places for students in given fields can be restricted.

An important component of labor force planning is the demand of the education sector for skilled labor. As mentioned by Coombs (1968), one of the serious problems facing educational systems in developing countries is the difficulty in attracting persons with sufficient training away from alternative occupations and into the education sector.

The choice of an alternative educational system can affect labor force planning policies by altering the demand for labor in the education sector. Technology projects involve very different requirements for labor. In situations where there are severe shortages of highly qualified teachers because of the attractiveness of alternative employment, technology may be used to provide quality education. The scarce resource of qualified teachers may be concentrated in the production of television and radio programs and distributed to classrooms that have teachers with lower qualifications or increase the ratio of students to qualified teachers. The use of technology means reduced labor force requirements in the education sector.

A further advantage of technology systems in terms of labor force planning is the relative speed with which new demands can be met. As mentioned previously, in attempting to meet the demand for a given skill one must not only ensure that sufficient numbers are in the educational cycle to meet the demand but also that teachers exist to train the students. This problem is partially alleviated through the use of technology. By concentrating teaching talent in program production and dispersing the programs through technology, it will be possible to provide training for students without first providing a full supply of teachers. With a technology system it will be possible to respond more quickly to changes in demand for skills that arise as labor force plans are constantly revised.

The final impact of technology systems on labor force planning is that the technology system creates its own demand for skills. To service the technology system, a new set of technical skills in production and maintenance is required. This requirement must be planned for.

Effective labor force planning must include a consideration of the alternative systems available for education. The alternatives not only alter the demand for labor within the education sector but also can alter the time it takes to respond to demands outside the education sector.

Student Flow Models

Student flow models are at the heart of educational planning. They are used to determine the likelihood of meeting labor force requirements and to help determine the required investment in education to purchase sufficient resources to service the number of students in the system.

In models of student flow, such as the one undertaken by Ritzen and Balderston (1975) for technical education in Bangladesh, the model is a dynamic counting over some number of years of students in the system. Ritzen and Balderston assumed that the major policy control variable for administrators in determining student flows was number of admissions. They assumed that other factors, such as dropout rates, promotion rates, and repetition rates (repetition rates being simply the difference between 100 percent and the dropout and promotion rates for each grade level) were not within the control of the administrators. After estimating these rates for different grade levels, one is able to determine the number of students who will graduate in a given year and the amount of resources that need to be allocated for the expected number of students. Their model is useful in determining the admission policies to meet estimated manpower demands and the costs of resources that need to be allocated to education. Ritzen and Balderston did not analyze alternative means of providing technical education, and one can assume that any projected expansion or reduction of technical education would not alter the relationship between students in the system and educational resources.

H. Magnussen's model for Norway (1972) is also a student flow model designed to help plan the extension of compulsory education. Magnussen considered three types of variables in his model: exogenous variables (determined outside the educational system), endogenous variables (determined within the system), and policy variables (determined by administrative discretion). Among policy variables were average class size and number of hours of instruction. The model helped him to determine the need for additional resources to service the increase in students. While he did not analyze alternatives, he found that extension of compulsory education with traditional inputs would entail a major increase in the number of teachers and that some form of instructional technology might be useful.

The major impact of alternative solutions such as the technology alternatives is not on the structure of the student flow model but on the results of the model. One may formulate the model purely in terms of the numbers of students entering the system, dropout and promotion rates, and the number completing the system and then determine the resources necessary to meet the influx of students. In determining those resource requirements, it is useful to examine alternative structures or technology for the system.

The alternative solutions might have different effects on participation

rates or the potential capacity of the system for new entrants in a given year. It would be incorrect to first formulate the model to determine the flow of students and then determine the necessary resource allocation to serve these students, as different alternatives will enable more rapid system expansions. The choice of administrators to alter the number of new entrants is restricted by the potential capacity of the system. This capacity is affected by the availability of alternative resources.

The alternative solutions may also have effects on dropout, repetition, and promotion rates. It is possible that every alternative (radio, television, differentiated staffing, and so on) will have the same impact on these rates. However, different impacts from each are also possible. For example, if promotion rates are based upon fixed standards and there is a relationship between academic achievement and the methods used to present the information, then a relationship will exist between the alternative chosen and the promotion rates. The same possibility exists for relationships between dropout rates and alternatives. Changes in dropout and promotion rates are legitimate objectives of educational reform and decision making. In addition to using academic achievement and social attitudes to evaluate systems, promotion and dropout rates also are relevant evaluation methods for analyzing an alternative or choosing among alternatives.

As with rate of return and labor force planning models, student flow models are affected in both the formulation and results of the model by a technology or any other alternative. In cases where major changes or new investments are considered for the education sector, the alternatives available for structuring the educational system interact with policy objectives. Goal feasibility was discussed in an earlier section of this chapter, noting that it is affected by alternative choices. Different systems, methodologies, or technologies will be feasible alternatives for different goals. Goals such as those set for labor force planning cannot be set independently of the potential means for meeting them.

Integrating the Models in Planning

Cost, evaluation, rate of return, labor force planning, and student flow models are important components of planning. In structuring a model for decision making, one must consider each of them. Cost and evaluation models provide information for choosing an alternative to satisfy goals in the education sector. Rate of return analysis provides information about the different benefits of investment to different levels of education or to different sets of students. Labor force planning models help to stress the importance of relating economic development and labor requirements to planning in the education sector. Student flow models help to isolate the manner in which students move

through the system and indicate the potential for meeting labor force plans and the demands to be placed on educational resources.

As an example of a more complete model, S. Bowles (1967) set as an objective for educational planning in Nigeria the maximum contribution to national income as measured by discounted values of lifetime earnings from additional years of education. His model was aimed at a determination of the total investment in education, its distribution among levels, the type of technology used, and the number of foreign personnel in the educational system. The results of his model demonstrated the need for rapid increase in primary education and a reduction in technical and secondary education, high productivity of imported labor, and increased efficiency attributable to greater use of new educational technologies.

Ritzen and Balderston (1975) developed a model for decision making on technical education in Bangladesh that related labor force projections to costs and student flows. The demand for labor was estimated to correspond with the type of training received in technical schools. They determined the optimal admission policy with student flow models and the budget with cost models. In Bangladesh, it was the policy that employment demands must be met, so the policy goals became maximum allowable rates of unemployment or underemployment (an oversupply of graduates was allowed for). While the model was structured on the basis of policy statements from Bangladesh, one might prefer a goal of minimizing the economic loss created by an oversupply or an undersupply of graduates. An oversupply results in unemployment or underemployment of graduates, and the investment in their education is a loss to society. An undersupply results in a loss to the economy through restricted output or higher costs due to increased utilization of existing resources (assuming that increased work from an existing member of the labor force is more expensive than work time for an additional member of the labor force). One can speculate that employers may desire an oversupply, as this would allow them greater flexibility in meeting fluctuations in production schedules by hiring and firing temporary staff and might also create a downward pressure on the wage level.

Information Needs

Planning is a complex process that involves much more than presenting a sophisticated mathematical model. Of importance in determining the use of a model is a realization of the information requirements of a comprehensive planning model and potential costs of analyzing the model. Ritzen and Balderston (1975) have an extremely useful section on information requirements and information flows. In their analysis, information requirements include estimated demand for new graduates in various years and estimated total capacity

of the educational system as determined by the fixed capital investment. This, in turn, would provide information for required recurrent expenditures and the number of new admissions possible. Detailed information on cost data for educational resources and cost and capacity data for existing resources and structures was also needed. In addition, adequate estimation of promotion rates and repetition rates (or dropout rates) were also necessary for determining the number of new entrants and expenditure required to produce sufficient graduates to meet the labor force requirements. As complex as their analysis is, it is simple in comparison to the problem of choosing alternative structures. They concentrated on one type of school, a subset of job requirements, and a fixed educational system where the relationships between resources and numbers of students do not vary, although the resource requirements may change.

In choosing among alternatives, one must have information on relationships of manpower requirements, participation rates, promotion rates, dropout rates, repetition rates, academic achievement, hourly costs, per-student costs, and so on for each of the alternatives. The information requirements are far more complex when a choice must be made. The decision on the structure of the educational system has consequences for the entire path of development of the country, and one might expect this decision to involve detailed information.

Cost of Modeling

The potential cost of analysis of a model (once the data have been acquired) can be seen from the estimates of J. B. Levine, R. W. Judy, and R. Wilson (1972) for a computer model of university systems relating the impact on inputs and outputs for different policies and structural arrangements. Their estimates are given in Table 2.2. The costs are only for processing the model and do not include data-gathering costs, which can be extremely high. Planners, therefore, must determine the potential benefit of obtaining additional information.

Given that perfect information is not possible when predictions are being made with respect to future demands for and supplies of labor and benefits and costs of a system, uncertainty will always exist. In fact, it is not necessarily true that new information is always desirable. The benefit from new information is the gain from increasing benefits or reducing costs by altering a decision that would have been undertaken if the new information had not been gathered. If a preliminary analysis suggests that new information could not be expected to alter the decision, it would not be worthwhile to incur the expense to acquire the information.

PROBLEMS IN PLANNING

There is a wide range of problems associated with educational planning in general that will result in difficulties even when careful planning procedures are followed. These problems include the obvious ones of data difficulties and uncertainty of estimates. Also, the more subtle but equally important problems of authority and relationships of planning agencies affect the objectivity of the analysis. There are problems related to the use of instructional technology, including failure to consider cultural and social values, lack of coordination with other development efforts, and inadequate content planning.

Data Problems

The series of case studies of the International Institute for Educational Planning (IIEP) (1972) analyzed by P. H. Coombs and J. Hallak (1972) contains many examples of potential planning problems (most of these studies were not involved with technology projects). In Tanzania (Bennett 1972), planning procedures involving student flow models and labor force requirement forecasts were made. However, the utilization of planning methodology did not guarantee successful results, as there were many misestimations along the way, including an overly optimistic estimate of funds from outside sources (34.5 percent of total expenditures expected compared with 5 percent actually received). The projected estimates of teacher costs also were too low as no account was taken of changes in teaching experience or qualifications that would affect total salaries.

TABLE 2.2

Cost of Processing Computer Model for Educational Planning

Type of School	Setup Costs	Setup Time	Annual Cost
Junior college (>3,000 students)	$ 50,000	6 months	$25,000
College (3,000 to 8,000 students)	75,000	9 months	35,000
University (8,000 plus students)	100,000	12 months	50,000
Medical school and hospital)	75,000	9 months	35,000
Elementary and secondary	50,000	6 months	25,000
Postsecondary system	100,000	12 months	50,000

Source: Levine, Judy, and Wilson 1972.

Chesswas (1972) provides a methodology for predicting the supply of teachers for Tanzania that would have provided a more realistic estimate of teacher costs. This study pointed to the need to predict accurately the requirements of a system and the supply of resources for that system (the objectives of the plan were basically met, and this was probably attributable to the increased number of Tanzanians and aid personnel in several positions). The simple method of multiplying the average salary of teachers by the number required resulted in an underestimate of 17 percent in the teacher cost estimate compared with Chesswas' method, which relied upon the composition of the teaching supply.

The need for careful estimates was also made clear in a case study of a vocational training program in Chile (Arrigazzi 1972). Rate of return analysis was used to determine optimum enrollment in the vocational training program. Recurrent costs accounted for 70 percent of total costs, while capital costs, which were much more carefully estimated, accounted for only 10 percent. A small percentage change in recurrent costs, which could have easily been misestimated, would result in larger percentage changes in the rate of return than if the capital costs had been misestimated.

These difficulties encountered in careful system estimates are often a result of poor information systems. This was particularly evident in a case study of technical education in Chile (Arrigazzi and de Simone 1972). A policy decision was made to increase enrollments by 17 percent while reducing the instructional load of teachers. No budget increase was provided for these two policy objectives, which both apparently would result in increased costs. However, when facts were gathered concerning the number and size of classes and the manner in which teachers spent their time, many small classes and underutilized teachers were found. The problem was solved by rescheduling the students. Due to the lack of information and any continuing cost analysis, the system obviously had been overspending.

Good data in a complicated model do not necessarily result in complete results. In Norway (Magnussen 1972), a multiequation model was utilized to evaluate several strategies for the expansion of primary education. Two of the most significant problems in this analysis came from ignoring capital costs (on the assumption that the alternatives would not affect capital costs) and ignoring shifts in the structure of the teaching supply. Of interest to developing countries engaged in planning extensions of compulsory education was the fact that projections for the demand for teachers were found to be so high that it became evident that some form of technology would be necessary. The rapidity with which a given population may be reached with a technology system is often cited as one of the benefits of relying upon technology as opposed to teacher training for expansion of an educational system. However, this possibility may be more relevant to Norway, which may be better endowed with communication facilities than a typical developing country. Of additional

interest is that the policy variable found to be most sensitive to costs was class size owing to the large percentage of educational budgets that go to instructional salaries.

Nigerian educational television (Lyle, Chesswas, Kahnert, and Griffiths 1967) was characterized by rapid implementation, and extensive planning was not undertaken. Clear goals and objectives were not stated, resulting in a lack of identifiable objectives for evaluation purposes. As noted, sufficient time to develop plans adequately is an important resource, and in Nigeria, the lack of time also contributed to a poor organizational structure, which further hindered the project.

Planning Agency Problems

G. Benveniste (1972) has discussed many of the problems of planners and planning agencies. While he does not question the need for planning, he delineates the political aspects of the planning process that may divert it from its proclaimed purpose of choosing objectively a socially optimal path of development. One reason for this diversion is the need to evaluate subjectively the relative importance of various criteria for choosing among alternatives. When we move away from economic matters, it is not a simple matter to choose between literacy training for adults and extended schooling for children or between increased primary participation and higher education participation. The subjective judgments are made by the planners, and, as Benveniste points out, their thinking is likely to be influenced by the persons who employ them or persons who are politically influential and powerful. Participation in the planning process often is restricted and access limited to those who are the alleged beneficiaries of policy decisions.

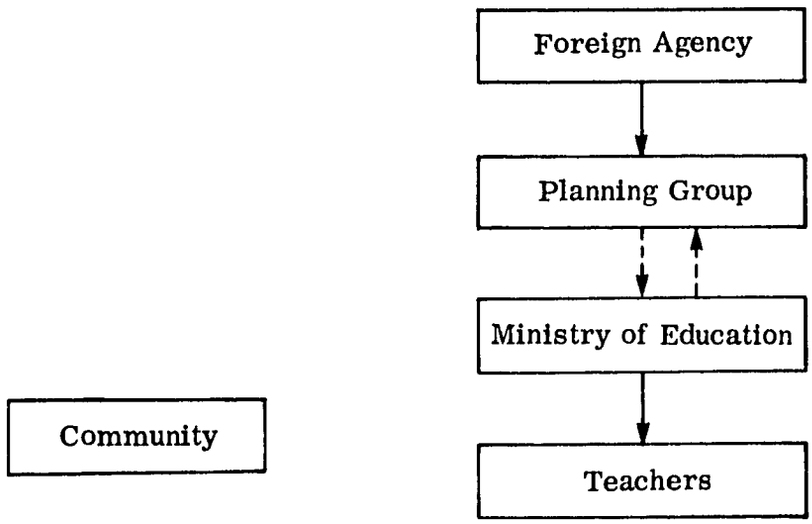
Benveniste stressed a secondary function of planning: to legitimize the function of planners, agencies, ministers, or key officials. In order to legitimize their function, often there is more concern with continuing functions or justifying previous choices than with evaluating new opportunities. When these vested interests exist, major change is often difficult to accomplish. For example, the television project in El Salvador was not seriously planned until Benecke, a supporter of the television system, became minister of education (Mayo and Mayo 1971).

Benveniste also pointed out that pilot projects are often used to delay decision making and to reduce conflict among agencies and that these projects often are not expanded. In Niger (Le Franc 1967b), a pilot project for television was introduced, its expansion has never been fully supported, and it has never gone beyond serving 800 students. This has made the project extremely expensive on a per student basis.

Some of the potential problems associated with authority of planning agencies may be more easily discerned if one examines possible organizational arrangements of domestic ministries, foreign agencies, teachers, and communities in relation to the planning agency. (Foreign agencies are included as they often have involvements in educational projects that utilize technology.) The term "communities" is really ambiguous, as one would not expect individuals in communities to have homogeneous interests. However, it is used here to represent any direct input from community groups in the planning process. If community groups are not included, then one must optimistically hope that their interests are considered by the groups controlling the planning process. Teachers are typically associated with formal educational projects. For nonformal projects, one may replace teachers with discussion leaders. There is no reason to expect the following analysis to be affected by the particular alternative chosen.

There are many possible organizational arrangements among the groups, but only three of these relationships will be discussed to highlight some problems that may exist. In the first arrangement, authority for planning is directly in the control of foreign agencies and the decision is transmitted to the ministry of education. Community groups are not included in the planning process. Figure 2.1 shows a chart for this structure (the solid arrows represent authority relationships and the broken arrows represent information flows).

FIGURE 2.1
Foreign Control of Planning



At first glance, it may seem impossible for planning to be solely directed by foreign agencies. However, it is not unlikely that foreign consultants will analyze a problem, choose an alternative, and present a decision to the ministry of education, which may then choose to implement that decision. In the case of El Salvador, the U.S. government had decided to fund a television project for formal elementary schooling in Latin America. When El Salvador chose to accept the funding, the planning decision was also accepted, although authority for implementation decisions was jointly shared by the government of El Salvador and agencies of the U.S. government.

The obvious danger in such a situation is that planning will be undertaken in a vacuum removed from local inputs, as the planners will feel more obliged to react to the criteria of the foreign agency. However, the incentive for the ministry of education to accept the decision may be very low. If the ministry were a slow moving bureaucracy, unwilling to change, then its resistance would probably be intensified by an attempt to remove responsibility for change from the ministry.

The incentive problem of the ministry of education may be alleviated when responsibility is shared, as diagramed in Figure 2.2. However, local input may still be ignored and the teachers have not participated in the planning process. A decision is more likely to be made in this situation with more potential resistance in implementation than for the structure shown in Figure 2.3. In this situation, however, the problem is that a decision may never be derived from a group with such diverse authority, although, once an alternative has been chosen, it will be easier to implement as conflicts will have been resolved in the planning phase.

FIGURE 2.2
Education Ministry and Foreign Control of Planning

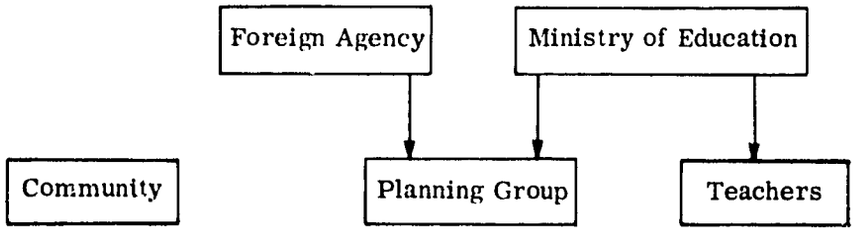
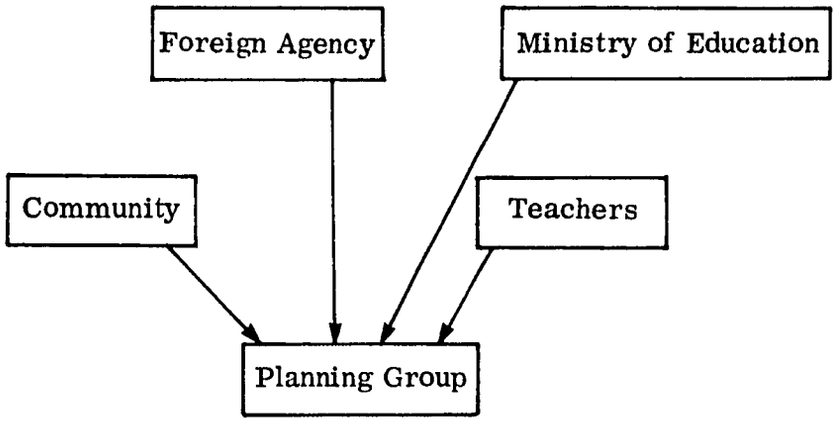


FIGURE 2.3
Shared Control of Planning



SPECIAL ASPECTS OF PLANNING FOR TECHNOLOGY PROJECTS

Some special aspects of technology systems should be considered in the planning phase, although actual decisions will probably occur during the implementation phase. The major differences for technology choices come from three important aspects of a technology system: production, transmission or distribution, and reception. In addition, there are other technical aspects of technology systems that must be considered. Finally there are some major advantages and disadvantages to technology systems that may well influence choice but have not been considered under criteria related to goals.

Production

Production decisions are related to the types of courses or elements of courses that will be undertaken. Content or curriculum planning is an important issue for any educational system and is discussed in more detail as an implementation decision in Chapter 3. For example, learning tasks that are divisible and sequential have been taught in the United States with computer-

assisted instruction (CAI). In a survey of its uses, D. Jamison, P. Suppes, and S. Wells (1974) discussed CAI in elementary mathematics, English, and college language courses. Radio and television may make use of straight talk presentation, dramatization, or, in the case of television, animation and demonstration of experiments. Hagerstown, Maryland (Wade 1967, Wells and Klees 1976), makes use of a variety of presentation styles. The archdiocese of the San Francisco Bay area utilizes materials purchased from several different sources. As the production becomes more complex, one would expect the costs and demands for skilled personnel to increase.

In the simplest form of a straight talk presentation, as undertaken at Stanford (Wells 1975a), only three persons are actively involved: the teacher, a camera operator, and a person for master control. The teacher presents the course as if teaching a regular class, and the camera may be used to broadcast handwritten notes and diagrams to the audience. As the production grows, more complex graphics departments may be added to produce special charts or displays; a printing department may produce materials to be distributed to program participants; a director and other stage personnel may be added to make the presentation more effective; a team of teachers may be used to plan carefully the content of the course and coordinate the written and transmitted materials; actors may be used to present the course materials; and professional writers may be added to make the presentation more effective. With this growth in complexity, even camera operators will need to be better trained. In the simplest case, only a person who knew how to point the camera and focus it would be needed. In the more complex case, care would be given to camera angles and lighting. The one other skilled group that is important to have is maintenance personnel. The degree of training is more a function of the equipment (hardware) used than the complexity of the production (software).

Transmission

The effect of transmission facilities is basically limited to the costs of the project and the length of implementation time, whereas the production and reception arrangements and facilities may also affect on the effectiveness of the presentation. Transmission facilities are simply the means used to move the information from the production point to the reception point. As education is one form of a communication process among different parts of the country, it would be beneficial for the country to consider its full range of communication problems and integrate the planning of the technology system (if that is the choice) with planning for other communication networks. Integrated planning can avoid waste and duplication. For example, suppose the ministry of education analyzes the educational needs and chooses a television project. It

may find that ground stations with microwave relays are the most economical choice for transmission, as only a few channels are needed for education and the transmission is directed to a set of specified points (designated school buildings). However, after analyzing the total communication needs of the country as a whole, a satellite system may be found to be superior, as it provides the opportunity for many more channels. The education sector should only be interested in ensuring that channels exist for its broadcasts. If channels would be available from a satellite system, it would be wasteful to duplicate transmission facilities.

Satellite systems are in operation or being planned for the Rocky Mountain area and Alaska in the United States and in Brazil, India, and Iran. The feasibility of a satellite system is being investigated for Indonesia. While this is the most technologically advanced and expensive transmission system available, it is a reasonable choice for a country with severe communication deficiencies.

Many technology systems utilize single-purpose transmission systems. In Hagerstown, the telephone company leases cables, which were specifically installed for school use, to the school system. Many of the university television systems for continuing education in the United States broadcast over open air but at higher frequencies than normal television sets receive in order to control access by nonpaying users. With an established road and postal system, distribution of videotapes also has been undertaken in the United States. Videotapes are produced and reproduced at a central facility and then distributed to users, who keep the videotape for a specified time period and view it according to their own schedule. This avoids some of the scheduling problems and coordination difficulties that arise through broadcast of materials.

Reception

At reception sites, equipment must be available to receive the broadcast and distribute the signal to sets (television or radio). If more than one signal is broadcast, additional reception equipment is necessary to aid in channel selection. The major problems facing developing countries in terms of planning for reception sites are maintenance and power. Personnel must be available to maintain the equipment and they must be able to reach the reception points; an adequate supply of spare parts also must be available. Power for the reception point is also an important problem in many countries. Rural areas often lack electricity, so it is not possible simply to plug a television set into a wall outlet. In the Ivory Coast (Klees and Jamison 1973), batteries are used for reception power and greatly increase the cost of the system. Here, too, it would be best to coordinate the power needs for education with general needs for power. However, electrification of rural areas is probably a long-term prospect

for developing countries, and short-term solutions are often necessary. Alternative low power sources include gas and diesel generators and animal power.

Other Technical Aspects

Some other important technical aspects of planning for technology systems include area of coverage of the broadcast, geography of terrain (which creates problems for ground transmission systems), climatic conditions (which could cause more maintenance difficulties and problems in reaching villages or require more expensive design for protection against climate), number of channels necessary, frequency of transmission (to exclude "unofficial" students from receiving transmissions on home sets or to ensure availability of transmissions), desired resolution quality of the broadcast (students would quickly lose interest if reception were poor or subject to frequent interference), and power sources for reception sites (many countries do not have mainline electric power to all areas of the country and may need alternative power sources, as in the case of the Ivory Coast).

Advantages and Disadvantages of Technology Systems

Schramm (1973a) has suggested several advantages of instructional television, mentioning that television requires a major commitment to change, impose rigid schedules, forces revisions of curriculum, catches the interest of the pupils, and facilitates the generation of outside finances. The most interesting of these advantages is the commitment to change, as it implies an interaction between the results of the planning process and the planning process itself. Television systems require major capital investment, and with scarce resources available for development, the decision to undertake the project needs to be carefully considered. Once the project is begun, it is difficult to reverse the decision: abandonment of the project could represent a substantial waste of resources and embarrass the decision makers. Furthermore, with such a large investment involved, there is a further incentive to attempt a more rapid and comprehensive utilization of the system.

The imposition of a rigid schedule may be an advantage, but, as Carnoy (1973) has argued, the rigid schedules imposed by the television system and the concurrent use of monitors who follow program materials may inhibit development of initiative and decision making and therefore hinder the development process. Rigid schedules may also impose organizational problems (discussed in Chapter 3).

The advantage of obtaining foreign financing is that it may reduce the cost of the technology. However, if the funds are only available if the country

chooses to broaden or revise the educational system, then one might expect that other conditions could be attached to the funds. For example, the financing arrangement could include substantial involvement of foreign personnel in administration or evaluation. While the country may enjoy advantages from the use of skilled personnel, the potential disadvantage of increasing reliance on foreigners needs to be considered. If the financing is in the form of a loan, then the country must consider the impact of repaying the loan in later years. Data derived from Jamison, Klees, and Wells (1976) demonstrate the impact of a loan for El Salvador's television system. With the specified payback of a delay in loan repayments, the costs to El Salvador are lower than total project costs in early years of the project but higher in later years of the project. Even if the funds are in the form of a grant and provide a substantial portion of initial capital requirements, a substantial financial burden may still be experienced by the developing country for maintenance and equipment replacement.

A disadvantage associated with the choice of a technology system is the relatively passive nature of the medium. Usually, students passively view or listen to the program and do not have time to question the presentation. If the students have classroom materials available, then they may become involved by following the presentation. Perhaps the most dramatic example of the passive nature of the televised medium is the author's observation of a televised science lesson in the United States. The classroom was well equipped with basic experimental equipment for each child, yet the children sat and watched the television teacher perform an experiment with equipment identical to the equipment only 10 feet away from them.

A student who misunderstands some aspect of the presentation must wait to question the teacher or monitor after the presentation and may have difficulty in understanding the remainder of the broadcast. To minimize this problem, it is extremely important to test and revise materials prior to classroom broadcast. While this will increase production costs, it will also increase the effectiveness of the presentation.

Several advantages were suggested by McAnany (1973) for radio. He argued that radio could be made more quickly available to large portions of the population, had a cost advantage relative to television, and could be used for more localized programming. If transmission facilities need to be built, then the implementation time advantage is reduced. The major advantage in time comes through the fact that many people already own portable AM radios. A cost advantage derives from the fact that local power requirements are reduced, as radios can be operated on inexpensive batteries. In terms of the cost advantage localized programming advantage, P. Bourret (1973) has discussed low-cost television systems that could be used for small populations. Local areas could also use videotaping equipment with battery packs to facilitate local programming.

In planning for technology projects, one also must be concerned with the

effect of the technology system on the social and cultural patterns of the country. J. C. Mathur (1972) felt that the use of media tended to break the cultural links between mobilized individuals and settled people in the villages. This may be true when media are concentrated in certain areas and not available in villages. However, R. F. Arnove (1973) thought a more serious problem was that the curriculum in television systems tended to reflect urban values and the language and curriculum of foreign donor agencies (often the former colonial power). As Benveniste (1972) points out, this type of curriculum planning reinforces the attitudes and beliefs of those in the center of power. Mathur (1972) also felt that radio programs for agricultural development would not be successful if they were not related to agricultural activity and that planning a radio program with successful demonstration of the new technique was important.

L. Masland and G. Masland (1973) concluded that many of the difficulties of the television project in Samoa were related to the cultural differences between the United States and Samoa. The Samoans' emphasis on past and future conception of spatial relationships was not taken into account in planning for the educational television system. These cultural differences could easily reduce the effectiveness of the system. Masland and Masland and other writers have concluded that it is extremely important in planning technology systems that tend to be highly centralized to identify carefully attitudes and values of the recipients of the service and to plan for an instructional system that utilizes these values rather than undermines them.

In his survey of radio in rural development, McAnany (1973) identified many planning problems in radio projects. One major difficulty he noticed was that the radio projects tended to be fragmented, small, and unrelated to larger development efforts. The projects tended to be distinguished by a lack of identification of objectives and emphasized their own survival. He further noted a lack of coordination with other rural development efforts. All of these deficiencies in planning efforts that seriously lessen the potential effectiveness of the projects may be related to the rationale for pilot projects that Benveniste (1972) identified as interagency conflict avoidance. The tendency toward a pilot project may result from a lack of strong support for the technology project. For most of the projects discussed by McAnany, the impact of the project on development efforts of the country was small and might have been improved if more care had gone into the planning.

Essentially, one can see a trade-off occurring in many situations between care in planning and likelihood of instituting the project. If a conflict among agencies is likely to exist, then careful planning by focusing on the project is likely to aggravate these difficulties. However, the absence of coordinated planning, while leading to the institution of a pilot project, may be socially wasteful in that a successful project is not "implemented."

The project in El Salvador has not been problem-free, even though planning activities were extensive. Television was part of a major national reform of the educational system, which included revised curriculum, reorganization of the ministry of education, extensive teacher retraining, and extensive expansion of the system. A project of this magnitude requires careful attention to planning and, even without television, is likely to generate conflict among participants in the process.

There are other problems, in addition to a lack of coordination with other development efforts, that are likely to occur when a technology project is not carefully planned for. The production of instructional material is obviously an important element for a successful project. Sufficient time should be provided to develop and pretest materials, and provisions should be made for feedback and revisions of the materials. Careful planning with clear objectives is necessary to focus the presentation. A successful project such as the Japanese correspondence school using radio and television (Tsuji 1964) is an excellent example of the care involved in planning for materials. Planning is undertaken in March for April of the following year. Plans and lectures are distributed to the schools in December for comments. In February, production is undertaken, and detailed plans are distributed in March. Extensive evaluation of the materials is done from October to June during the year when the program is being broadcast to the schools. This careful planning of program content is important as research, such as that of Hornik, Ingle, Mayo, McAnany, and Schramm (1973), demonstrates that effectiveness improves as program quality improves.

CHAPTER

3

IMPLEMENTATION

INTRODUCTION

In Chapter 2 the process of choosing an alternative in the context of planning was described. This chapter contains an analysis of the process of implementing that choice. The planning phase involved a decision of the type of educational system to be implemented. In the implementation phase it becomes necessary to make decisions with respect to certain aspects of carrying out the original choice. These decisions constitute the process of implementation discussed in the next section and include implementation timing, degree of centralization of decision making, control of decision making, and curriculum planning. How organizational models affect the organizational structure charts is discussed in the next section. While learning models should affect curriculum decisions, the main item to be discussed is the personnel relationships in making curriculum decisions. Problems and successes in implementation decisions will be analyzed through examples of instructional technology projects. Finally, there are special implementation decisions connected with technology projects, including control of communication facilities and provision of technicians and maintenance.

While the topics of process, models, problems, and application to technology projects are covered in this chapter, they are not discussed in the same manner in Chapters 2 and 4. It is more convenient to discuss the first three topics in the context of the various implementation decisions that must be considered. These more general implementation decisions are the subject of the next section and draw on examples from instructional technology projects. The final section contains an analysis of the more specific implementation decisions necessary for instructional technology projects.

It is important to realize that most of the aspects of implementation involve individuals and groups, as it is people who implement policy, are affected by policy, and can constrain policy. Much of the analysis in the rest of the chapter depends on evidence from case studies of technology projects. Unfortunately, many implementation decisions involve personnel relationships and are likely to be sensitive areas. Many problems that have occurred, therefore, are probably not reported in the case studies.

IMPLEMENTATION DECISIONS

The more general implementation decisions of timing, centralization, control, and curriculum are discussed in this section. Timing involves a decision that will determine the speed with which a project is implemented. Centralization is a crucial issue: the more centralized the process, the more likely it is that overall national development needs as opposed to local needs will be emphasized. As far as control is concerned, one would expect the ministry of education to have major responsibility for education projects. However, this has not always been the case. Control is also affected by the nature and extent of foreign influence. Finally, in curriculum planning, the crucial issue is the extent of involvement of teachers in the process. Curriculum decisions are very much related to the degree of centralization of the structure, as one would expect a more centralized approach to tend to limit the involvement of teachers.

Timing of Implementation

An important decision in establishing the organizational structure and relationships to implement the decision to undertake a large-scale project is the determination of the amount of time to be allocated to achieve full implementation of the project. Three alternatives are possible: a pilot project, an incremental approach, and full-scale implementation. The implementation plan may start with the institution of a pilot project, continue with an evaluation, and end with a decision to expand the system. The implementation may be designed to be an incremental process with the system expanded each year, with possible dimensions of expansion being grade levels, regions of the country, or subject area. The final type of implementation may be a whole project approach. Each approach to timing has advantages and disadvantages.

The pilot project allows a test of the project and materials, but may, as in the case of the Niger system (Le Franc 1967b) never expand beyond the pilot stage regardless of how successful or well planned the pilot project was. The

pilot project may be chosen to reduce conflict and may never gather sufficient support to grow beyond its initial stage. With high capital investment in a pilot project, the decision not to expand can mean a very expensive test. A pilot project generally may be ruled out for technology projects because of the large initial investment in equipment and programming involved. It is better to use analyses of the experiences of other countries than to structure a pilot project to gather additional information to expand the system.

Pilot projects are more likely to be used when the investment is small. These situations may be characterized by equipment with a small transmission range and programming of a highly localized nature. The pilot project approach is convenient in these situations as facilities will probably have to be duplicated to extend the system. This situation probably typifies many of the uses of radio for rural development as new transmission facilities must be added to extend the coverage to other areas.

The incremental approach allows for consideration of problems and successes of early stages rather than duplicating the same mistakes in many areas. One would assume that the rational process would be to evaluate the previously instituted programs, analyze the cause of errors, and avoid them in the future. The incremental approach would mean that the planning process had resulted in a commitment to undertake a decision but a full-scale implementation in the initial phases would be difficult.

With full-scale implementation more students may be reached by the system in less time. If the existing structure is outmoded or unproductive, a rapid change, which is also likely to be disruptive, will be more successful in accomplishing change by limiting the time for opposition to form at levels of the educational system that may not have been affected in the early stages of an incremental process. However, there is the obvious disadvantage of duplication of errors. In addition, the disruption of the current system may result in a reduction of effectiveness of the change, and the desire to implement the program rapidly may reduce the care in administering the implementation. One of the major advantages cited by Schramm (1973a) of a television project is that the large-scale investment entails a greater commitment to change. Although that commitment may be somewhat difficult to obtain, once established, the project is more likely to continue. Unfortunately, full-scale implementation of a technology project is often impractical because resources are lacking and it is impossible to analyze all elements of the project in advance to determine potential problems.

In El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), a well-structured implementation plan was used combining an incremental strategy for system expansion and a pilot approach for new material. Television was to be used in seventh, eighth, and ninth grades. In the first year of the project,

television was available to only 30 classes in the seventh grade. In the second year coverage was extended to all seventh-grade classes, and programs were introduced to 30 of the eighth-grade classes. This procedure was followed until all grades were covered. The decision was then taken to extend television classes to primary grades. Concurrently with the gradual implementation of the television programs was a nine-month program of teacher retraining. Prior to being in a class with televised courses, the teacher received training with respect to the new curriculum and utilization of the television programs.

The strategy used in El Salvador appears to be sensible. The decision to invest in the equipment was a major one and could not be undertaken without a firm commitment to proceed. The tryout period for programming provided a useful first step to introducing the material so that it would be reviewed.

The Ivory Coast (Klees and Jamison 1973) has adopted an incremental approach and is adding one grade per year at the primary level for the television broadcasts. In Samoa (Schramm 1973b), 12 grades were included in two years, but the population is very small relative to other school systems. In Washington County (Wells and Klees 1976) the implementation was relatively rapid, with all 12 grades covered in two or three years. In Samoa and Washington County, the schools were in a relatively small geographic area. Adding another school in Washington County would merely mean a new cable for transmission and additional television sets, all of which were donated in this project.

Centralization

A major item of consideration in determining the organizational structure of a project is the degree of centralization of authority in the educational system. The number of potential relationships between communities and project management is small. Communities may share control with other agencies, provide input (with no control) to project management (either directly or indirectly), and have no relationship. These three possibilities are represented by the organizational charts in Figures 3.1, 3.2, and 3.3. The relationship in Figure 3.3 is probably the most likely and is the centralized form. The relationship in Figure 3.1, where communities share control, may also be centralized but is more likely to be decentralized with communities controlling daily operations of the project. The extent of community control is a crucial issue in developing countries, as the communities are likely to be the rural areas.

FIGURE 3.1
Shared Control of Implementation

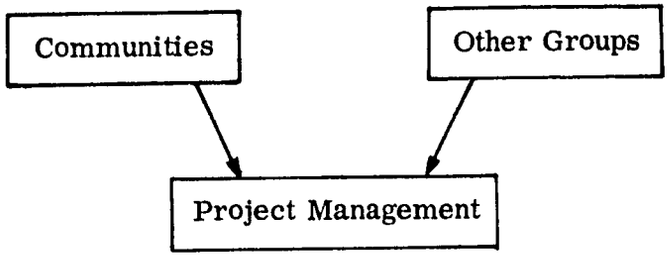


FIGURE 3.2
Community Input to Implementation

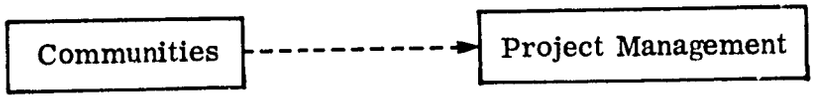


FIGURE 3.3
No Community Influence on Implementation

A centralized control structure has the advantage of providing better coordination of educational overall development plans for the country. The central government will more likely recognize the trade-offs for the country in terms of the amount invested in education vis-a-vis other investments.

A total lack of involvement through local participation may result in a failure to mesh national development needs with local needs and desires. There may also be a lack of recognition of local problems. A decentralized structure, on the other hand, is advantageous for increased responsiveness to local needs since greater consideration is likely to be given to local communities.

A conflict of objectives may always exist between national development needs and rural development needs. For example, Russian peasants in the late nineteenth and early twentieth centuries had a desire to own their own land. However, three major peasant land reforms under a czarist regime, a more liberal government, and Lenin's government did not result in distribution to small landowners since the central governments considered that this would not aid national development.

Spain (1973) and Schmelkes de Sotelo (1973) have reported that one of the major failures of the radio schools in Mexico has been their lack of coordination with rural development and problems. There was no community participation in planning for the programs and the apparent irrelevance of the curriculum to local communities contributed to high dropout rates. Students also dropped out because of lack of supplies and high opportunity cost (in terms of forgone income) for attendance. Schmelkes de Sotelo (1973) recommended a reorientation of the program along the lines suggested by Freire (1970). The reorientation would be not only to involve rural citizens in design of the programs but to relate the programs to community action. Freire, as others, feels that education gains more meaning when tied to development problems of local areas. The potential problem with this approach and its possible rationale for larger scale programs is that progress for the country may be slower and more disjointed without overall coordination.

There are two other problems associated with the decision on the degree of centralization. One problem of dictating solutions from centralized structures is a reduction of incentive to develop local initiative and creativity, which may prove important to the future of the country. The other problem is rural-urban migration. One of the reasons for extending schooling to rural areas is to reduce rural-urban migration by providing higher quality schooling in rural areas. The experience in the Ivory Coast with the television project is that there has been no reduction in migration patterns, as the curriculum developed by a centralized structure is more relevant to urban living and employment.

The extent of local participation is an issue that arises in any development project or any educational project not involving technology. These rural problems will tend to be magnified with technology. A technology project may involve large-scale investments and the need for national financial resources by local communities. While there have been proposals and discussions of low-cost technology projects, such as Bourret's analysis of local television arrangements (1973), that would make local control economically feasible, it should be realized that major technology projects throughout the developing world have been controlled at the national level.

In the case of technology projects, some central structure is necessary in order to attain the levels of economies of scale needed to justify a technology system. Spain (1972), in an analysis of satellites for Africa, discussed many of

the problems and necessities for coordination among countries if satellites are to be considered a viable transmission alternative. Centralization is also useful when the technology system is part of a larger scale national educational reform and a strong national commitment is necessary.

The major television investments in Samoa (Schramm 1973b), Ivory Coast (Klees and Jamison 1973), South Korea (Morgan and Chadwick 1971), and El Salvador (Mayo and Mayo 1971) have all been centralized national projects lacking organizational structures designed to incorporate local influence. In Italy (Lyle, Kahnert, Benton, and Bertola 1967), the television project was designed to fill temporary educational needs. The organizational structure was designed to retain control at the national level through joint cooperation of the ministries of education and radio and television and to avoid the influence of local education departments.

Many systems, such as the television system in Washington County and the radio system in Thailand (Ratanamungala 1972), have been instituted to fill special educational needs for which available teachers did not have the necessary skills. The radio clubs of Niger (Le Franc 1967a) had a mixed approach to development. The broadcasts had two major elements. One portion of the program was a response to problems and needs recognized at local levels. It was expected that local problems would have many similarities throughout the country. The radio clubs served as a means for sharing information on these problems. The other portion was devoted to national programs. The purpose was to air those development problems of the whole country that would require the understanding or cooperation of local groups and to disseminate information related to different techniques that had been found to be successful.

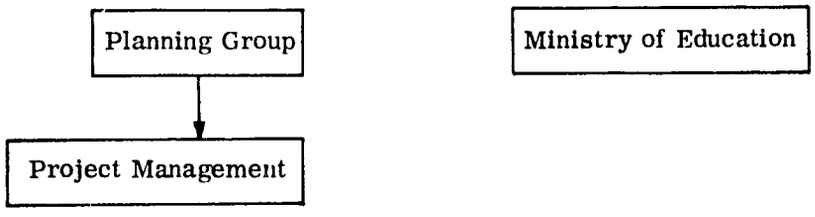
Control

There are many possible organizational structures for control of a project. In addition to the ministry of education, other domestic agencies and foreign agencies may be involved, as education affects many aspects of national development. One might expect that in a technology project that involves major communication facilities and large amounts of funding that influence over control of the project would extend beyond the ministry of education. In addition, one must consider the potential creation of a separate agency for control of a new project. A separate agency may be set up if the present bureaucracy in the ministry of education is not amenable to change. However, separate agencies often become isolated and possess no real authority.

Figures 3.4, 3.5, and 3.6 represent some of the potential control arrangements. There are many structural possibilities but the main ones to be discussed are separate agencies, shared responsibility among domestic ministries, and foreign influence (through control and advisory capacities). In these fig-

ures the degree of community involvement is ignored, as are teachers (assumed to be under the control of project management and/or the ministry of education). In Figure 3.4 a separate agency is shown to be created by the planning agency.

FIGURE 3.4
Separate Agency from Education Ministry Controlling Implementation



A separate agency may be created when planning does not take place in the ministry of education, although the ministry of education may eventually gain some degree of control. In analyzing the likelihood of change and acceptance of a technology project, Benveniste (1968) felt the ministries of education that have become centralized would be unlikely agencies of change. Ministries, as other bureaucratic structures, would tend to minimize conflict by routinizing practices, and a technology project would upset these arrangements. Innovations would be likely to originate in departments where the structure was not threatened. For this reason, one might expect the original decision to undertake or plan for a technology project to be made outside the ministry of education. However, as the chances for technology project increased, one would then expect the ministry of education to attempt to move to the central position.

The case of the television project in El Salvador, analyzed in an administrative history by Mayo and Mayo (1971), is an interesting example of changes in administrative authority. The original impetus for instructional television came from Walter Benecke, who was not then a top administrator in the Ministry of Education. He had observed the Nippon Hoso Kyokai (NHK) system in Japan in 1960 and thought that television might be practical in El Salvador. The project was pursued to the point of having NHK engineers design a project for El Salvador and sending Salvadoreans to Japan to receive technical training. However, there was no support for television within the Ministry of Education and there were no jobs for the trainees when they returned.

Interest revived when it was learned that the United States was interested in funding an educational television project in Central America. A department within the Ministry of Education was analyzing the possibility of a project but wanted to be separate from the ministry because of the lack of support. The divergence of opinion was alleviated when Walter Benecke became minister of education, although, as Benveniste (1968) pointed out, the new minister inherited the old bureaucracy, which was not totally amenable to the television project. However, for El Salvador it would have been irrational to have the television project separated from the Ministry of the Education: as television was part of an integrated wide-scale reform of the educational system that included a major emphasis on curriculum revision and teacher retraining. A separate agency would have complicated greatly coordination of elements of the reform. While a separate administrative structure may have had negative impacts on the entire educational reform, the television project could not have been successfully integrated into the educational reform without the strong support provided when Benecke was appointed minister of education.

In the larger scale television projects that have been successfully expanded, the common approach, however, has been to incorporate the television project into the ministry of education. In the Ivory Coast, the television project for primary education has been an integral part of the Ministry of Education. The expansion of the television system is a central feature of the expansion of the educational system. In Samoa, the television project is also part of the Ministry of Education. The Samoan project was originally controlled by Americans. Authority is now in the hands of the Samoans and production of television programs has declined from an unrealistic 6,000 hours per year to 2,300 hours per year. The Ivory Coast project is still controlled to a large extent by foreign personnel.

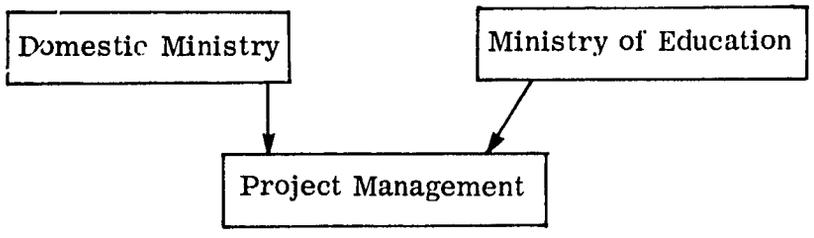
In Washington County, Maryland, the television system has always been part of the education department of the county, although individuals within the administrative structure are either part of the television project or part of central administration.

With radio schools, administrative structure has varied. In Colombia (Schramm 1973a), Radio Sutatenza is under the control of the Church, with Father Salcedo, the founder of the system in 1947, still in charge. The Church operates outside the governmental structure and its radio project probably owes its continuing existence to avoidance of an association with any particular power group within the government. The network has many radio stations and broadcasts literacy, general, and religious programs as part of its schedule. Another reason that the separate administrative structure succeeded in this case may be due to the fact that Radio Sutatenza is concerned with out-of-school people and does not threaten the authority structure of the Education Department, which concentrates its efforts on formal schooling.

In uses of radio for schooling in Mexico the projects, although localized, have involved the Ministry of Education. The reports by Schmelkes de Sotelo (1973) and Spain (1973) on radio schools were not concerned with descriptions of administrative structures, but both noted a lack of distinct goals and objectives.

McAnany's observation (1973) that rural radio projects tend to be small, fragmented, and uncoordinated with other development activities would seem to indicate that regardless of which agency has control of these projects, the projects have not been incorporated in overall plans. Separate departments also may have been established to control these projects. However, this would increase their visibility and might increase potential conflicts. One could speculate that the projects have been established by groups within ministries and have not been integrated since visibility might lead to administrative conflict over the proper locus of control. Figure 3.5 illustrates shared responsibility among ministries. The other ministry may be any other department in the central government.

FIGURE 3.5
Shared Domestic Responsibility for Implementation



As an example of authority arrangements, consider a radio rural development project. One can quickly conceive of three governmental groups that are likely to desire to be or find themselves the center of authority: the ministries of agriculture, education, and communications. The determination of the relative authority of the ministries may be related to the relative emphasis placed upon agriculture, education, and communications within the project. The ministry of agriculture is apt to have the most knowledge on the type of information necessary for agricultural development, persons within the ministry of education may possess the expertise for delivering the information, while persons within the communications group may be best equipped to coordinate the radio project with other communication needs of the countryside. The basic goals and concerns of the ministries probably differ also. The ministry

of agriculture is interested in agricultural output and productivity and distribution within the country. The ministry of education is concerned with increasing knowledge and having this knowledge tied to activities of the group involved. The ministry of communication is concerned with the process of information flow among sections and regions of the country.

Any of these ministries may be best equipped to have central authority for a radio rural development project. However, if the expertise in other ministries is ignored, there may result a duplication of talents, or worse, an improperly planned and implemented project. In Italy (Lyle, Kahnert, Benton, and Bertola 1967), dual management by the Ministry of Education and Ministry of Radio and Television for the national network was probably successful because the television system for secondary schools was always viewed as a temporary solution to the teacher shortage. Temporary cooperation may be successful when the project is expected to terminate in a limited period of time.

Dual management has not been successful for the Nigerian television projects (Lyle, Chesswas, Kahnert, and Griffiths 1967). Here, the conflict of interest between the Education Department and the Radio and Television Department has operated to the detriment of the educational system. In addition to the departmental conflicts, the projects in Nigeria were set up on a regional basis with no overall national coordination. The lack of national coordination meant that resources for programming were not pooled; each region placed heavy reliance on purchased programs, which are often subject to delays in shipping and had to be picked without previewing. (A more detailed discussion of potential conflicts with an instructional technology project and control of communication facilities is presented later in this chapter.)

FIGURE 3.6
Foreign Influence on Implementation

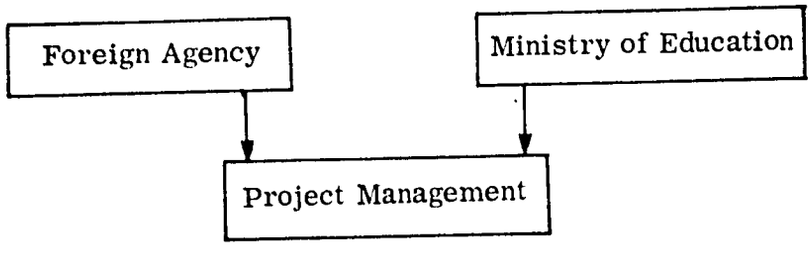


Figure 3.6 depicts a foreign agency sharing control with the ministry of education. Another possibility is to have foreign personnel serving in an advisory capacity directly to project management or indirectly through the ministry of education or the planning group.

Foreign influence in education in developing countries is pronounced and associated problems have been discussed in the general context of planning (see this chapter and Chapter 4). Foreign influence is even more pronounced in technology projects, as expertise and equipment are readily available in developed countries and grants and loans are readily available. Carnoy (1973) has written that the impact of foreign financing needs more study. He felt that the funds could have two effects in addition to monetary flow: a creation of markets for the technical equipment and a distribution of income in the donor countries from the general public to producers of the equipment.

Foreign funds also effect the organizational structure in developing countries. In the Ivory Coast, the television project is controlled by French personnel who are responsible for administrative and curriculum decisions. The eventual goal, however, is to train Ivorians to control the system. In Samoa, the system was controlled by Americans and eventually control shifted to Samoans.

During the mid-1960s, the United States had made a commitment to support a large-scale technology project in Central America (Mayo and Mayo 1971). The country decided upon was El Salvador. However, the money was not transferred without strings. The major impact on organizational structure in El Salvador derived from strong U.S. pressure to have the educational television project within the Ministry of Education. The Salvadoreans wanted a separate agency. As stated previously, the problem was eliminated when Benecke became minister of education. The United States may have wanted an administrative structure that appeared "rational" in the context of "proper" authority relationships, whereas the Salvadoreans desired an administrative structure that would relate best to current structures.

There were other effects of U.S. aid on the decisions of the Salvadoreans. The Americans insisted on utilizing an unused teacher training institution (built with U.S. assistance), located 15 miles from the capital, as the production center of the educational system. Severe communication problems with a facility in this location resulted in a move to the location originally desired by the Salvadoreans. The United States was also originally interested in supporting a primary educational project, but the desires of the Salvadoreans eventually prevailed and the project was directed at middle school students.

In Samoa, strong resistance to implementation of the technology project came from the American teachers. The centralized nature of the educational system allowed for an expeditious handling of the opposition: the teachers were fired.

In Colombia (Comstock and Maccoby 1966), foreign influence was particularly evident in the television project, which was a project of the U.S. Peace Corps. The project was kept separate from the Colombian Ministry of Education, which led to some degree of resentment. The problem of the separation of the project from the ministry was not necessarily attributable to foreign

control but to the bias of the people who controlled the system. The expertise of the director of the program was in technical aspects of broadcasting, and Peace Corps volunteers were given more training in technical than educational aspects of the program. This bias reduced the educational value of the broadcasts; it was more a result of the orientation of the director rather than his nationality. This was borne out in the analysis of Comstock and Maccoby. They revealed that teachers in the network who needed assistance had a greater propensity to demand the aid of Peace Corps volunteers than Colombians. However, teachers who had already received Peace Corps volunteer assistance were more likely to request Colombians.

The television project in Niger (Le Franc 1967b) never expanded beyond 800 students. Perhaps the single most important reason for this lack of expansion has been the administrative structure of Niger. The television project has never been part of the Ministry of Education and has always been regarded as a French experiment. One can only speculate on the reaons for the limited nature of the project. The failure to expand could be due to an unwillingness to dilute authority in the Ministry of Education, an unwillingness to increase foreign influence, or a lack of belief in the capabilities of the system. Whatever the underlying cause for the lack of expansion, the pressure to restrict the system must be powerful, as expansion could take place at relatively low cost. The production and transmission facilities are already in place and expansion would only involve the purchase of more receivers. The average cost of the system would decline substantially with increased utilization. However, the pilot project costs are being borne by the French, while expansion costs would probably be borne by the government of Niger.

Curriculum and Teachers

Curriculum planning is affected by all of the decisions discussed. A centralized administrative structure will tend to result in a curriculum that stresses national development goals. These goals are often urban-based and cause the curriculum to be poorly related to rural development needs resulting in failure to improve rural areas and a consequent increase in rural-urban migration. When more than one ministry controls a project (for example, ministries of agriculture and education for rural development programs), conflicts may arise over appropriate content. The alien cultural values of foreign personnel also may have adverse affects on curriculum.

Curriculum design is a crucial issue, as, in the final analysis, the student does not learn from the structure of the system or the sophistication of the technical equipment but from the content of the presentations. Careful attention to quality is important and requires extensive analysis that is not within the scope of this book. However, some of the research studies discussed in Chapter 5 do reveal an advantage to learning from improved content quality.

The main item to be considered in this section is the involvement of teachers in curriculum planning and the related problems of qualification levels of teachers, selection of television teachers, and relations between classroom and television teachers. In traditional educational processes, most of the resources are within the control of the educational system. Teachers receive their training within the system and decisions made in the system can result in a determination of minimum requirements for teaching positions and the control of the flow of student teachers through the teacher training institutions. Once teachers have been trained and hired, the central administration is bound to lose some control of the communication process in the classroom. It may influence content by setting curriculum standards and making available some set of educational materials, but the process by which the communication takes place between teachers and students and the methodology employed by the teacher are difficult if not impossible to influence.

One of the major impacts of the utilization of technology is standardization of the content of the educational process. The rationale for the standardization is the dispersion of qualified teaching talent to areas that have deficiencies. As the percentage of school time devoted to instruction via television or radio increases, the extent of content control that can be exercised by the central administration also increases. Teachers are apt to have their own approaches and ideas and some sense of authority over their own environment. The technology system might create feelings of insecurity or might undermine the authority or flexibility of the classroom teachers by centralizing curriculum planning and distributing plans to them without their input. As the classroom teacher must be the advocate of the technology program, it may be useful to involve the teacher in planning the curriculum. This has not always been done and many technology projects have resulted in negative reaction from teachers and, in some instances, teacher strikes (for example, El Salvador and Mexico).

In addition to potential resentment from a lack of participation in the planning process, the teacher may also resent the intrusion into the classroom of the television or radio teacher. Teacher reluctance to utilize technology or share responsibilities with the media teacher is not necessarily a reaction based on ignorance but often against utilization of materials that have not been proven to be successful. It should be obvious that resentment will increase as the involvement of the teacher in curriculum decisions (whether during initial planning or through revisions) decreases, the ability of the teacher to preview materials decreases, and the attitude of the teacher that the technology is replacing her or him increases.

If the teacher is not included in the curriculum planning stage, then some feedback mechanism is probably useful. The best approach might be the one utilized in Japan where materials are centrally planned, distributed to classroom teachers, and revised and produced in detail with teaching guides prior to the first broadcast.

In Mexico varying reactions of teachers to the radio school programs have

been reported. Schmelkes de Sotelo (1973) reported that teachers generally had a lack of commitment to the programs, whereas Spain (1973) reported basically positive reactions. He noted that 72 percent of the teachers brought their own radios to class and that 70 percent felt the use of radios should be expanded, although the broadcasts were too fast and there were too many breakdowns. The generally positive reaction of the teachers, given the apparent lack of interaction on curriculum and the apparently poor implementation of the project, is surprising.

The analysis of the El Salvador project (Hornik, Ingle, Mayo, McAnany, and Schramm 1973) provides an interesting insight into the reaction of the classroom teacher to an extensive television project that was part of a general educational reform. Although favorable opinions generally declined from 1969 to 1972 (there was a long teacher strike in 1971), the teachers still appeared to be favorably disposed to the system. In 1972, 56 percent of the teachers felt that students learned more with television, 63 percent felt that viewing the television teacher improved their own teaching method, only 16 percent felt that the television reduced the importance of the classroom teacher, and only 14 percent felt that television reduced the attention given by the student to the classroom teacher. On the negative side, 32 percent felt that television led to greater student passivity, 59 percent felt that the television schedule reduced teacher flexibility, 59 percent felt that the lack of opportunity to ask questions during the program was a serious drawback, and only 23 percent felt that students learned to study better on their own when they received television instruction.

One must consider the attitudes of the teacher to be generally positive. A major factor contributing to these positive attitudes was probably the extensive retraining of teachers that was undertaken as part of the reform. These positive attitudes toward the television system prevailed after a strike for higher salaries when class size was increased and salaries were not increased proportionately and despite the existence of generally negative attitudes of teachers regarding teaching and the educational system. Of the 137 teachers surveyed in 1972, 37 percent felt teaching was a profession that did not give much satisfaction, 16 percent felt teachers were respected in El Salvador, 55 percent felt that increased enrollment had diminished quality, and 20 percent would encourage their best students to become teachers.

A selection of television teachers must be made. A common procedure has been to choose television teachers from the available supply of classroom teachers. The choice of former classroom teachers may help to dissipate resistance by the other teachers as well as bring classroom experience and knowledge of student problems to the planning of television lessons.

In El Salvador, many of these problems were considered in planning the system. The television teachers were selected from the best applicants with current teaching positions. Selection was based on knowledge of the subject

and appearance. The original plan was to rotate teachers through the television teaching process, but, as has happened in so many other projects, the television teaching staff has become permanent. Apparently, the benefits of reducing the disruption caused by constant changes of television teachers and the costs of extra training for new teachers on television exceeded the costs of reducing the participation of classroom teachers in the planning process.

In Washington County, the same situation has occurred. The original plan was to rotate the television teachers and avoid the establishment of a separate structure. Television teachers also have the benefit of a greatly reduced teaching requirement and prepare approximately one fourth as many lessons as classroom teachers. However, the television teaching staff has become permanent; many of the teachers have taught on television since the beginning of the television project. The television facility is located in the same building as the administrative offices for the whole district, and it is probably true that the television teachers identify more closely with the administration than with the classroom teachers.

As the tendency to keep the television teachers on permanently has grown, the involvement of classroom teachers in the planning process has declined. In El Salvador, curriculum decisions have been made centrally: there was a strong desire to move away from the rote learning process used by teachers. Although classroom teachers at first resented this change, they have gradually accepted it.

Workshops during summer months have been used in Washington County, the radio project in Thailand, and the television project in the Midwest of the United States. It is not clear whether workshops were used to plan curriculum or to solicit opinions of classroom teachers, but after the summer workshop communication with classroom teachers often declines.

When a technology project in a developing country involves an expansion of the system, a variety of choices may be made with respect to the number of instructional hours for technology and the level of teacher training. Teachers may feel that the technology project, as a consequence, will place the teacher in a lower skill category.

In El Salvador, Samoa, and the Ivory Coast, the requirement was to have qualified teachers in the classroom, with retraining and in-service training via television provided. In Mexico, the television system was used in secondary schools in conjunction with teachers trained only to the primary level. In South Korea, the plans for the educational system with television called for teaching teams using teachers qualified at different levels. There was to be a higher ratio of students to more qualified teachers than to less qualified teachers. In Niger and Italy, classroom monitors with low levels of training were used.

The degree of experienced supervision in rural radio projects has also varied. The structures may vary from open broadcast with no organized audience and hence no supervisors, through supervisors picked locally, to

supervisors selected and trained centrally, and then made available to local groups. An important factor in the choice is the degree to which planners wish to ensure some activity inspired by the program and the relative trade-off between local initiative and problems and national development problems. Niger makes use of leaders chosen locally. Dahomey and India (McAnany 1973) had inadequate supervision for their radio clubs, which led to a difficulty in following up the broadcasts and seeing if decisions made by listening groups were implemented.

SPECIAL ASPECTS OF IMPLEMENTATION FOR TECHNOLOGY PROJECTS

While many of the other implementation decisions are related to the particular alternative chosen, there are two specific areas of implementation directly related to the choice of instructional technology: control of communication facilities and provision for technicians and maintenance.

Communication Facilities

Administrative control problems become particularly evident when one examines the control of the production and transmission facilities. The conflict occurs when the facilities are utilized for more than educational purposes. In the decision to undertake a technology project in education, an element that will influence the decision is the availability of current facilities or the potential of sharing proposed facilities with other users. Shared facilities, if the investment cost is apportioned among the users, will lower the cost of the technology choice for the educational system. Where facilities exist, time may be purchased or donated.

The Washington County, Maryland, project (Wells and Klees 1976) has a transmission service that is only used by the school system. Because of the small land area in the county, all schools are connected to the school production facility by cables installed by the telephone company. All costs are borne by the school district, but there is no problem with time availability. Many university continuing education programs in the United States (Wells 1975a) have established their own television systems and there is no problem with control of the facilities.

In the Ivory Coast (Klees and Jamison 1973), with the lack of electricity in villages and consequent lack of television receivers, there was no incentive to establish commercial networks. Transmission, production, and reception facilities have been developed for the use of the educational system and a control problem has not arisen.

The important feature of the establishment of facilities for the educational system is that control will usually reside within the education department. This can have beneficial or detrimental effects, depending upon how the education department views its function. In the case of the Ivory Coast, the facilities were established for formal schooling programs, normally a daytime, five-day-per-week activity. However, once the facilities exist, the cost of utilization of unused capacity is extremely low. The possibility of nighttime or weekend use when schools are not in session exists. The facilities may be used for information dispersion from the central government, out-of-school programs, and entertainment. When the education department controls the facilities, the decision to utilize the facilities for other time periods is also controlled by the department. While educational needs may be met, other communication needs may not.

It is just the opposite when the education department must make use of facilities controlled by others. In Peru (Lyle, Germancos, Kahnert, and Torfs 1967), the education department had to negotiate with a commercial network controlling the transmission facilities to determine the hours that would be available for instructional television programs. The final decision was to allow commercials between the school broadcasts.

In El Salvador (Mayo and Mayo 1971), production facilities were at first shared with a commercial network. Problems existed between personnel on the commercial network and personnel in the educational system. Difficulties were probably magnified by the inadequacy of the facilities, as the commercial network relied to a large extent on imported programs.

Problems with facility use were also severe in the Nigerian project (Lyle, Chesswas, Kahnert, and Griffiths 1967). Commercial networks were also used, but the educational system experienced difficulty in obtaining daylight hours. This problem was basically due to the fact that, in order to maximize its revenues, the commercial network relied mostly on evening broadcasts and used daylight hours for equipment maintenance. In Italy (Lyle, Kahnert, Benton, and Bertola 1967), any problem of separate management of the communication facility was not evident since the television network was not privately controlled but government controlled.

The same situation also exists in radio projects. Radio Sutatenza does not have any problems, as the network is controlled by the Church. In Honduras, even though literacy programs were broadcast over Church-operated stations, they were still confined to daylight hours, as the evening hours were commercially profitable to the Church.

In planning for the organization of a technology project in education, it is not sufficient to establish the structure in some ministry. Careful consideration must be given to control of the communication facilities. Obviously, control within the education sector will reduce problems of accessibility. However, a difficult problem exists when facilities are available. When the facilities

are commercially controlled, an obvious conflict of interest exists. It may prove desirable to purchase time from a commercial network and thus eliminate the low status often given to educational programs on these networks.

Technicians and Maintenance

A technology project involves a whole new set of individuals in the educational system. These personnel must be available to handle the technical aspects of programming and to maintain the equipment in the production, transmission, and reception facilities. It is insufficient to write a good television lesson. Knowledge of lighting, sound systems, camera angles, and so on also must be available. The technology project involves sophisticated equipment that requires periodic maintenance; service personnel must be available.

Lack of trained personnel can be a serious handicap for a program. In Nigeria (Lyle, Chesswas, Kahnert, and Griffiths 1967) the lack of personnel for production purposes led to a need to import programs. The importation of programs from other countries only magnifies the disparities between national and local goals. Additionally, the educational problems of two countries will differ. The cultural basis on which relatively objective subjects, such as mathematics and science, are built, may be sufficiently divergent to cause difficulty to students in relating to and understanding the presentation even though the basic content may be useful.

It is possible that deficiencies in trained personnel may be derived from different approaches toward the amount of general education an individual needs prior to learning a task. In Senegal, P. Fougeyrollas (1967) reported that time periods of a few weeks were used to train people to operate equipment and undertake programming and administrative tasks. Unfortunately, he did not report on the amount of previous education these individuals had.

A particular problem with respect to training arose in El Salvador. The training of graphics personnel brought them up to such high standards that they received commercial job offers. While it was not reported whether these offers were accepted, a three-month delay in pay for technical staff, combined with the unrealistically high demand placed upon the graphics department, may have induced them to leave the educational system. In El Salvador, an additional problem occurred because members of the technical staff felt that they were underpaid relative to other staff members.

The lack of trained domestic personnel and the crucial need for these types of talents have led to heavier reliance on foreign personnel. While training of domestic people may still take place, the disadvantage of reliance on foreign personnel in initial phases of the project is that a hierarchy of authority may be established, with domestic people at the bottom of the ladder.

The crucial need for technical training in these projects can also be appreciated from the maintenance difficulties that have occurred on many projects. In Nigeria, (Lyle, Chesswas, Kahnert, and Griffiths 1967) 75 percent of the television sets were not functioning. In Mexico (Schmelkes de Solelo 1973) less than half of the radio sets were functioning. In Thailand, (Schramm, Nelson, Odell, Vaizey, and Spaulding 1976) long delays were experienced in maintenance as the sets were repaired centrally.

In addition to providing sufficient numbers of people to maintain equipment, the entire maintenance operation must be organized. Communication between reception sites and central repair facilities must exist so that technicians can be notified when sets are not functioning. A system must be established to bring the sets to the technicians or vice versa and to have extra sets available so broadcasts are not missed. In addition to considering the stock of replacement sets, one must also consider the stock of replacement parts.

CHAPTER

4

EVALUATION

INTRODUCTION

In the previous two chapters aspects of the process of planning (undertaking a decision) and implementation (carrying out a decision) were discussed. In this chapter the focus is on the process of evaluation. Results of evaluation studies of technology projects are discussed in Chapter 5.

This chapter contains an analysis of the process of evaluation, including a discussion of reasons for initiating an evaluation, the timing of an evaluation, and responsibility for the evaluation process. Then descriptions of several models are discussed that are typically used in evaluation studies, as well as the kinds of criteria that are used to evaluate educational systems. There is also a discussion of some of the problems that may occur in evaluation, such as those associated with control of the evaluation study and with selection of evaluation criteria. (Analytical problems in evaluation are discussed in Chapter 5). The last section of this chapter is a description of some special aspects of evaluation for instructional technology systems.

THE PROCESS OF EVALUATION

Initiating an Evaluation

There are many reasons for initiating an evaluation of an educational system. Among these reasons are the information needed for a decision regarding a change in the system, the requirements of funding, the justification for

a system structure or organization, the reward system for teachers, and the advancement of students.

Information may be needed for a variety of decision processes, including choice of a system, evaluation of a continuing program for revisions, or evaluation of a project for future decisions. An analysis of the potential costs and benefits of additional information is an important component in determining how much information will be sought. With the exception of bureaucratic self-justification for activities, additional information only has value to a decision maker if it reveals changes in benefits or costs of alternative solutions that are large enough to change the decisions made prior to the receipt of the additional information.

For example, if a country is utilizing an instructional television system with a given distribution of production and transmission resources among grade levels and courses, an evaluation of the effectiveness of each of the television courses would be beneficial if there were some likelihood that the evaluation information would reveal a different allocation of resources that would have higher benefits or lower costs.

Naturally, these potential increased benefits or reduced costs must be balanced against the costs of conducting the evaluation and gathering the information. Evaluation studies for the television system in the Ivory Coast (Klees and Jamison 1973) have been approximately $200,000 per year, or 1 percent of annual costs.

There is an additional cost that is important to consider in gathering information: the cost of delaying the decision. This cost is obviously an important consideration in the planning process. As more time and resources are devoted to gathering information prior to the decision, longer delays in implementing the decision will be incurred. In practical terms, in developing countries, this means fewer students served, at least in the shorter run, by the educational system. The delays also can result in higher project costs if equipment prices or other costs increase. The decision maker must determine whether or not the potential system improvements from the new information are justified by the potential delay costs.

Evaluation studies may be one of the requirements of foreign funding agencies. When these agencies establish loans or grants for educational systems in developing countries, there are two important explicit purposes: to aid the development of the beneficiary and to provide information for other countries. Information for future decisions to be made in these other countries is derived from the evaluation study. While the evaluation study may not reveal changes in the system that would be beneficial to the country currently utilizing the system, it may help another country in planning for a system. The reason for the divergence of benefits to the different countries is that funds already have been committed in the country being analyzed and, hence, are treated as sunk costs.

An additional reason for undertaking an evaluation is to provide a justification for the system choice. This justification is related to the legitimization of bureaucracies discussed by Benveniste (1972). It may be necessary to defend a system by providing positive reports with respect to its current functioning. These reports may not be helpful to the decision maker in suggesting alterations in the system design but may be important in justifying the continued existence of the system or retention of its organizational structure.

The final two reasons for evaluation of systems involve analysis of the performance of participants in the system. This analysis may be used for a reward system for teachers or managers and for an advancement system for students. An item such as student achievement may be used to determine the effectiveness of both the system and the teacher and to determine whether or not the student should be advanced to a higher grade level.

If a new system such as television or radio is implemented concurrently with changes in teacher training, it may be difficult to show which change contributed most to the better effectiveness that followed. In El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), a major educational reform involving curriculum changes and teacher training was introduced at the same time that a television system was begun. However, it was possible to compare classes with the reform only with classes with both the reform and the television system and determine separate effects for each of these.

Timing of Evaluation

Evaluations take place at three different points in time: prior to undertaking a choice regarding the type of project to be implemented, during the operation of the project for the purpose of altering it, and at the conclusion of a project or a phase of the project. An analysis of analogous systems will have been undertaken during the planning process to formulate expectations regarding system performance. These expectations are an important component of system choice. Once a choice has been made, funds have been committed to the new system. If an evaluation during the operation of the project reveals a lower performance than expected, it could mean that the decision would not have been undertaken if a better estimation of the performance had been made. However, this deviation from expected performance, while unfortunate, is not necessarily important for future decisions. Much of the incurred costs must be treated as sunk costs and future decisions must be based on future costs. This situation is particularly true for technology systems, as large commitments of funds for equipment purchases may be undertaken in the early years of the project. The planning evaluation must be carefully undertaken, as a gap between expected and actual performance will be especially expensive.

The evaluation of the expected performance of the system is particularly important in a developing country. This evaluation takes place prior to implementation and during the planning process and is derived from information drawn from evaluations of other projects. Rational choice involves an understanding of relative or absolute impacts of different alternatives according to a well-defined set of criteria. While one can analyze the effectiveness of the current system, the only way to determine the effectiveness of proposed changes is to examine other projects, systems, or countries where similar changes have been implemented. It is important to determine if the information from these sources is applicable to the current situation, as expectations of system performance will be based on this information.

Evaluations also take place during the operation of the system. These evaluations of the system under study are often termed "formative" evaluations. The most frequent reason for undertaking a formative evaluation on a continuing basis is to consider revisions of program materials and to diagnose program problems. A crucial component of a technology system is the software, or program. Regardless of the technical sophistication of the equipment used in the technology system, a poor program will not be a good contribution to learning. Evaluation of the project to help determine the effectiveness of these programs is important as they are presented to the student with little opportunity for the student to ask questions if she or he misunderstands any portion of the program. As Chu and Schramm (1967) noted, testing and revision are useful in improving the quality of the program. However, it is necessary for the decision maker to compare the potential benefits from program revisions with the evaluation costs and the revision costs.

"Summative" evaluations are initiated at the conclusion of a project or a phase of it to determine whether or not the actual performance of the system is matching expectations. A summative evaluation is instigated for major decisions related to continuation or expansion of the project. Foreign funding agencies that desire to provide information for educational administrators in other countries may also initiate summative evaluations.

Responsibility for Evaluation

A final consideration in the process of evaluation is a determination of the responsibility for conducting the evaluation. This decision may be related to the timing of the evaluation and the criteria selected. Planners may be involved in evaluations at both the planning stage and any major decision point. During the planning stage, one might expect that some attention would be concentrated upon the potential economic and social benefits of education to determine whether or not any new investment would be worthwhile. In addition, some analysis would be directed toward effectiveness criteria, for example,

academic scores and participation rates, to determine which system alternative would be the best choice. At major decision points such as determining whether the system should be continued or expanded, the planner would tend to analyze the effectiveness criteria. However, at this point, it is still important to consider longer run benefits.

Managers of the project or system will tend to be involved in formative evaluations to determine if program revisions are necessary or if educational resources need to be reallocated. These evaluations will usually concentrate on effectiveness criteria. The manager typically is not concerned with longer run benefits, although he may have a vested interest in continuation or expansion of the system. Analysis according to effectiveness criteria will help to identify weak programs that could benefit from further revisions. This analysis will also help to find out whether a transfer of resources from one course to another, one grade level to another, or one school to another would be beneficial.

It should be realized that in making these reallocation decisions, the manager is implicitly creating trade-offs among the values to society of increasing or decreasing test scores at different grade levels and in different courses. For example, suppose the evaluation reveals that "too many" hours are devoted to mathematics and "too few" hours to language. A reduction of 10 hours of mathematics teaching might reduce student test scores by an average of only 5 percent, whereas if the resources used to produce 10 hours of mathematics teaching can be reallocated to produce 10 additional hours of language training, student test scores might increase by an average of 20 percent. Obviously, if this resource transfer is undertaken, there is an implication that a 20 percent increase in language skills has more value to society than a 5 percent decrease in mathematic skills.

Outside consultants associated with foreign funding agencies are the final group that may be involved in evaluations. As these agencies are interested in affecting a given country's development pattern and in providing information for other countries, one may expect them to be involved both at the planning stage and in summative evaluations. These evaluations may be directed toward effectiveness criteria and longer run benefits. As the participation of outside consultants increases, the likelihood of a conflict with local managers over objectives and relevant evaluation criteria also increases since each group may have a different reason for conducting the evaluation.

MODELS IN EVALUATION

This discussion is divided into two subsections: models and criteria. Two basic sets of models are discussed: evaluation models, which compare systems according to different individual criteria, and choice models, which combine the analysis of many criteria for decision purposes. Criteria for evaluation of educational systems include cognitive (a variety of measures for academic

achievement) and noncognitive (attitudes, participation rates, dropout rates, and so on) criteria.

Models

Comparisons of two alternative systems usually have one basic form: a determination of whether there is a statistical difference between average scores or a given criterion for students being educated in the two systems. This determination may be accomplished by comparing mean scores under each system, the typical analysis, on the criterion used or analyzing an equation where the score of the criterion is a function of a variety of inputs and a dummy variable that differentiates between the average criterion score of students in the two systems. Equation 2.4 is an example of the latter analysis:

$$0 = a + b_o T_D + \sum_{j=1}^{n} b_j I_j \tag{2.4}$$

where 0 is the score on the criterion;
- a is a constant;
- I_j is a vector of inputs;
- T_D is a variable with the value of 1 if the student is in a classroom using television and 0 otherwise
- b_o is the average difference in criterion score between students in the television system and students in the other system; and
- b_j is the increase in criterion score from an additional unit of input j.

If b_o is positive and statistically significant, then the television system is more effective according to the given criterion.

One may also estimate the impact of increasing the exposure to a given system. For example, equation 2.5 may be used to help determine if students currently in the television system would be better or worse off with more instructional hours devoted to television.

$$0 = c + d_o T + \sum_{j=1}^{n} d_j I_j \tag{2.5}$$

where T is the number of hours of television;
- d_o is the marginal effect on the criterion for a one-hour increase in television exposure; and
- is the marginal effect on the criterion from an additional unit of input j.

The models presented above have linear functional forms. It is quite possible that the actual relationships between inputs and criterion may have nonlinear forms. As these types of models may be used for a wide variety of criteria, there is no reason to assume that a single type of functional relationship would be appropriate for all criteria. In fact, one may have one equation for each criterion for students at different grade levels and in different courses.

In general, evaluation models of the comparison type (equation 2.4) are used for planning and for summative evaluations if students have been educated under two different systems in a given country. For purposes of a formative evaluation when a resource reallocation is possible, models of the form of equation 2.5 would be preferable as they would provide information about the impact of increasing or decreasing the utilization of any particular resource in a given course at a given grade level.

The evaluation studies reported in Chapter 5 predominantly involve a simpler comparison model than equation 2.4. The typical technique is to compare average criterion scores for students taught by television or radio with scores for students taught without these media. Often, there is no attempt to control for the effects of variations in values of other inputs between the groups of students.

Evaluation models merely provide information on the relative effectiveness of different systems or inputs for a variety of criteria. Choice models are used in making a decision. There are three major classifications of choice models: cost-effectiveness, cost-benefit, and alternative-criteria decision. Cost-effectiveness models are used to determine which system will have the highest value of some criterion, for example, academic achievement, for a given cost or, alternatively, which system will achieve a given criterion value for the lowest cost. In a situation where more than one criterion is considered, a decision must be made with respect to the relative value to society of changes in the different criteria.

Cost-benefit models are used to compare the economic and social benefits of a system with the cost of achieving those benefits. These models are more appropriate for decisions involving multiple criteria; one converts the criteria values to dollar terms to assist in their comparison.

The alternative-criteria decision model is also used for multiple-criteria decisions. Scores on all of the criteria are converted to a common scale and the criteria are then weighted on the basis of the values assigned by the decision maker or other participants. In this model, by taking explicit account of weights, different results may be obtained than with a cost-benefit analysis. For example, in a cost-benefit model, it is usual to choose that alternative which results in the highest net benefits or benefit-cost ratio. In the alternative-criteria model, one may place a heavier weight on one group of participants such as rural people than another and be willing to choose an alternative that has lower

total net benefits but effects a transfer or redistribution of benefits to that group.

Criteria

These evaluation models may be utilized for a wide variety of criteria. The most common differentiation is between cognitive and noncognitive criteria. Cognitive criteria are based upon student learning and are usually measured by some type of test. In elementary grades, tests are often formulated to determine a student's mathematical or language ability.

While learning is often tested with respect to knowledge of subject matter, little attention is paid to the type of level of the learning task. For example, R. M. Gagne (1965) theorized that learning proceeds according to a hierarchy of learning tasks from signal learning (a diffuse response to a signal) to problem solving (the ability to use two or more chains of concepts to produce a new capability that can be shown to depend on a "higher-order" chain). B. S. Bloom (1956) also theorized a taxonomy of learning. His taxonomy is divided into six basic categories moving from knowledge (recall ability), the lowest level, to evaluation (the ability to assess the value of materials), the highest level. It may be useful and necessary to determine the type of learning that is taking place rather than simply the "amount" of learning, as it is quite possible that different systems may be better for different elements of either of the learning hierarchies.

Another crucial item in evaluation with cognitive criteria is consideration of the time the evaluation is conducted relative to the time the material is presented. Very different effectiveness results may be encountered if one tests immediate knowledge of a concept, overall learning at the termination of the course, or retention of knowledge after some period of time. An individual's knowledge may be different at these different times, and it is possible that a change may be correlated with the type of system used.

Cognitive criteria should also be related to acquired skills if the system is designed to train students for specific tasks. For example, programs designed to train technicians or skilled laborers should be evaluated on the basis of the student's ability to perform the task in addition to the student's knowledge of the area. Unfortunately, ability to perform tasks is not analyzed. Evaluations of radio rural forums have however, involved decisions to act.

Noncognitive criteria are typically associated with attitudes. The most common noncognitive criteria are attitudes of students and teachers toward the system and its performance. However, educational systems are also designed to influence attitudes of the student's with respect to themselves and society. D. Krawthohl, B. S. Bloom, and B. Masia (1964) delineated a taxonomy in the affective domain that is structured in a manner similar to Bloom's (1956) cognitive domain. The taxonomy is quite complex and tends

to be ambiguous, but the authors theorized that a hierarchy of development did exist starting from sensitivity to phenomena and ending with consistent behavior with respect to a set of values. Again, it may be useful to analyze attitudes according to the elements of this taxonomy to determine the differential impacts of different systems.

For developing countries, other important noncognitive criteria for evaluating the impact of a system would be measured by participation, dropout, repetition, and completion rates. It may not be sufficient to determine attitude or knowledge changes in students participating in the system to determine the importance of the system to the country. A crucial element in the choice of a system is the differential impact on the various rates. If education is important to the development of a country, then the increase in the number of students participating in the system is a logical component of system choice. High dropout rates are a typical problem in developing countries, and a system that reduces these rates would be useful.

Determination of the equity of the system, that is, the difference in impact for students from different social classes or regions as measured by any of the criteria is an additional issue of importance in a developing country. Unfortunately, very few evaluation studies, including those discussed in Chapter 5, have considered equity issues.

While academic achievement, skill learning, attitude change, participation rates, dropout rates, repetition rates, and completion rates may all be impor.ant in the choice of a system, these criteria do not measure completely the benefits to society of an educational system. In evaluating an educational system, some attention should be directed toward benefits related to economic and social development. These benefits may be measured by such items as the probability of satisfying labor force needs, the employment possibilities of school graduates, and the impact on the social and economic mobility of students.

Although many potential criteria for evaluating systems have been mentioned, the major effort in evaluation studies has been directed toward measurement of academic achievement with a test score. Most of the research to be discussed in Chapter 5 analyzes tests of knowledge for a given course. There is virtually no analysis of the type of learning that takes place. With few exceptions, there is no analysis of changes in participation, dropout, repetition, or completion rates. The major emphasis in attitude analysis is on attitudes toward the system rather than social attitudes of the students.

PROBLEMS IN EVALUATION

Evaluation problems fall into two major classes: problems in conducting evaluations and problems in developing data that will demonstrate differences

in system effectiveness. The first set of problems includes the potential organization in initiating evaluations and utilizing the information derived from an evaluation and problems associated with the criteria chosen. The second set of problems is discussed in Chapter 5 in the context of the review of evaluation studies.

Conducting and Utilizing Evaluations

Problems in conducting and utilizing information may derive from two basic sources: a difference in interest between the group conducting the evaluation and the group being evaluated and a difference in interest between the group conducting the evaluation and the group that will utilize the evaluation information. As in the two previous chapters, these differences may be analyzed by examining alternative authority arrangements among the following groups: foreign agencies, ministry of education, project management, evaluation group, and teachers.

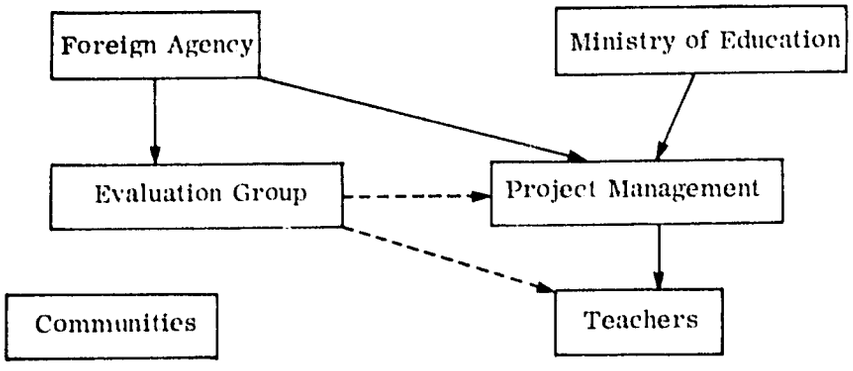
In all of the following figures, it has been assumed that project management authority is jointly shared by the foreign agency and the ministry of education and that teachers are directly controlled by the project management. These assumptions may be altered and other problems will then exist. Solid arrows in the charts represent authority relationships and broken arrows represent information flows. Planners have not been included in the figures as they primarily influence evaluation by desiring evaluation information from other projects prior to making a decision.

The first structure (Figure 4.1) demonstrates a separation of groups controlling evaluations from groups being evaluated and groups utilizing information from evaluations. Evaluation is within the control of the foreign agency. Many technology projects typically have had foreign agencies controlling the evaluation (as in Figure 4.1) or sharing responsibility with the ministry of education (as in Figure 4.2), although some of the problems would be the same if there were a separate domestic agency.

In Figure 4.1, control of evaluation is divorced from control of the project. The fundamental problem that may arise in this situation is that the evaluation criteria established by the evaluators may not coincide with the information needs of project management. Project management may be more concerned with the operation of the system and reallocation of resources within the system, while the evaluators may be more concerned with overall performance of students in the system. This divergence would occur if the evaluators had a more macroscopic view in determining how well a student performs in different systems or how a student's performance in a particular educational setting (instructional technology, differentiated staffing, and so on) affected the student's role of behavior in society. The project management may be expected

to have a more microscopic view and be interested in altering resource allocations among regions, grade levels, or courses in the particular system currently in existence.

FIGURE 4.1
Foreign Control of Evaluation



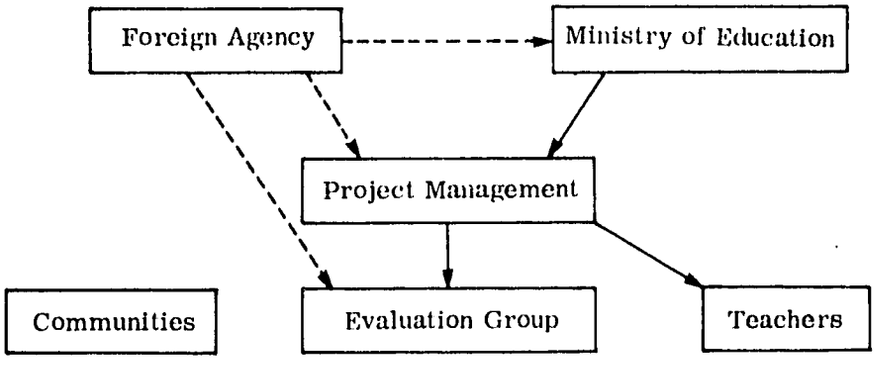
The fundamental problem of separation of control is likely to be compounded when control of the evaluation group, as depicted in Figure 4.1, is held by a foreign agency. The foreign agency may be interested in generating information that will be useful to other countries or in maintaining a comparative evaluation between two different systems within the same country. For example, the foreign agency may be interested in comparing the academic performance of students in schools equipped with television and that of students in schools without television. However, this comparison may be of less importance to the country as funds have already been committed to a transition of systems.

Foreign agencies may also disagree with project management over timing of evaluation. As mentioned earlier, foreign agencies may desire a summative evaluation while managers may desire a formative evaluation.

An additional problem that may arise from foreign agency control is the impact of different cultural values. The instruments that are established for evaluation by the foreign agency will reflect its own cultural background and thought patterns, and these biases would be inappropriate for measuring performance of students in the educational system. (This problem is discussed in more detail for Samoa in Chapter 5.)

The problem of separation of control is alleviated in the structure designated in Figure 4.2, although the foreign agency still may influence the evaluation, and the problem of the separation of evaluation control from the persons being evaluated still remains. The foreign agency in Figure 4.2 is shown in an advisory capacity only. However, as in Figure 4.1, the teachers, who are one of the subjects of the evaluation, do not have any influence on the evaluation. The teachers may feel threatened by the evaluation as the evaluation is structured to determine a superior instructional methodology and/or the resources (including teachers) to be reallocated to improve the operation of the system. The teachers may also dislike the evaluation for pedagogical reasons. The evaluation may be structured for criteria that teachers feel are inappropriate for the types of learning they wish to emphasize or the teaching style that individual teachers have adapted.

FIGURE 4.2
Education Ministry Control of Evaluation



Criteria

As just mentioned, problems may arise because of disagreement regarding the criteria appropriate for measuring the performance of students. This problem may arise even if all groups participate in control of the evaluation group.

One other important problem in evaluating projects is the general tendency to ignore hard to measure objectives. For example, academic achieve-

ment is relatively easy to measure, whereas attitude change is much more difficult. In all societies, individuals are socialized to conform with behavioral norms and this behavior may be crucial to the country's development. It would be unwise to concentrate an evaluation upon the easier to measure criteria if this evaluation were to lead to a choice of an alternative with negative impacts on the hard to measure criteria.

The final issue that must be addressed at some stage in relation to criteria selection is a determination of the contribution of education to economic, social, and cultural development. A tendency to ignore larger social goals may involve more efficient allocations of resources within the educational system but less efficient allocations between education and other forms of investment.

This problem of attainment of social goals is manifested in another way. As shown in the figures in the previous section, the community is not included in the evaluation process. This is another aspect of the problem of a failure to consider rural interests. If the evaluation control is centrally based, an implicit assumption for the organizational charts, then criteria that measure goals of importance to rural areas may not be considered.

SPECIAL ASPECTS OF EVALUATION FOR TECHNOLOGY PROJECTS

Evaluations are often necessary to determine whether or not a system is functioning properly. In these situations one monitors criteria that will provide information on whether or not students are actually receiving the instructions intended for them. In technology systems, this type of evaluation may be crucial, as the technology system will involve a departure from customary classroom arrangements and the utilization of new equipment.

One item to be evaluated is the manner in which the classroom teacher utilizes the broadcast course. If the teacher treats the course as an infringement on her or his control of the classroom, then the technology system will probably be less useful than when the teacher integrates the broadcast course with in-class material.

Another important item in evaluating the proper functioning of a technology system is the physical condition of classrooms and equipment. Physical condition is affected by equipment maintenance schedules, audio, and video quality of the broadcast, and characteristics of the classroom that affect a student's ability to hear and/or view the broadcast.

CHAPTER

5

EVALUATION STUDIES OF INSTRUCTIONAL TECHNOLOGY

INTRODUCTION

This chapter contains a survey of studies evaluating instructional technology. Most of the studies discussed in detail are from developing countries: television in Mexico, Samoa, El Salvador, Senegal, India, and Colombia and radio in Mexico, India, Ghana, Thailand, and Colombia. However, there are many studies from the United States. The main reason for mentioning the U.S. studies is that instructional technology has been widely used in the United States for many years and provides more information for decision makers on the effectiveness of instructional technology in a culture that may be more attuned to these methodologies.

For cognitive criteria, a very simple evaluation model has been used in the vast majority of the studies: a statistical comparison of mean test scores for students receiving conventional instruction and students receiving some form of instructional technology. For noncognitive criteria, comparisons with conventional instruction typically have not been undertaken. The exceptions are an analysis of dropout and repetition rates and educational and occupational aspirations in Mexico's television project (Mayo, McAnany, and Klees 1975). These aspiration levels are critical to development objectives, as low aspirations may lead to slow growth and high aspirations may be frustrated if unemployment and limited higher education enrollment exists.

For most of the television projects, attitude surveys of students and teachers have been undertaken to determine the acceptance of the system and the potential problem areas. In radio projects, studies of attitude change also have been undertaken. As radio is also used for rural development, there has been some analysis of activities that were planned or undertaken as a result of the broadcasts.

Studies of other instructional technologies have not been analyzed in detail. However, in studies in the United States, there has been a consistent finding that students using programmed instruction (Hughes and McNamara 1961; Hughes 1962; Hough 1962; Attiyeh, Bach, and Lumsden 1969) and computer-assisted instruction (Axeen 1967; Bitzer and Boudreaux 1969; and Homeyer 1970) learn as much as students exposed to conventional instruction but in considerably less time. Time savings of 20 to 47 percent were mentioned in these studies.

The second and third sections of this chapter contain analyses of television and radio, respectively. In each of these sections, cognitive and noncognitive criteria are considered separately. The final section contains an analysis of inferences drawn from the results of the studies, including pitfalls in evaluation.

INSTRUCTIONAL TELEVISION

The research into the use of television for educational purposes has been voluminous and there have been several excellent surveys of this literature. These surveys predominantly concentrate on utilization in developed countries (the United States in particular) and a simple comparison of mean scores of students in conventional instruction and television instruction. The major conclusion is that instructional television is as effective as conventional instruction.

E. F. Pflieger and F. C. Kelley (1961) reported the results of a three-year study that involved over 200,000 students in 800 public schools. The majority of the comparisons resulted in no significant differences; there were significant differences favoring the television-taught students in 119 cases and the conventionally taught students in 44 cases. Kelley (1964) evaluated over 300 matched achievement test comparisons from 1956 to 1961. He found significant differences in favor of television in 25 percent of the cases.

Schramm (1962) evaluated 393 studies and found no significant differences in 255 of the studies, significant differences favoring television in 83 cases, and significant differences favoring conventional instruction in 55 cases.

Chu and Schramm (1967) evaluated 207 studies that involved 421 separate comparisons. There were no significant differences in 308 of these comparisons. Significant differences favoring televised instruction were found in 63 comparisons, while 50 cases favored conventional instruction. Chu and Schramm also analyzed program format and generally concluded that effective television teaching was more a result of attention to the basic requirements of good teaching than the use of fancy production techniques.

D. W. Stickell (1963) analyzed 250 comparisons. He applied strict restrictions to experimental design and determined that 217 were not interpretable.

Of these 217 comparisons, significant differences occurred in 59 cases and were evenly divided between televised instruction and conventional instruction. Twenty-three studies were only partially acceptable (usually because of non-random assignment) and of these there were significant differences in favor of television in three cases. The ten acceptable studies were all undertaken by Carpenter and Greenhill (1955, 1958) at Pennsylvania State University and resulted in no significant differences. The restrictions were experimental and control groups of at least 25 that had been randomly assigned from the same population. They were taught by the same instructor, either by two instructors exchanging classes in the middle of the term or by seating one group in the room from which the class was being televised to the other groups, and were evaluated by acceptable statistical procedures. While Stickell's technique eliminates many of the potential difficulties encountered in comparison studies, it does not provide information regarding potential unique advantages of televised or conventional instruction.

R. Dubin and R. A. Hedley (1969) surveyed research on college television instruction. In order to be included in their survey, a study had to be of an American college course for credit of at least one term duration and include a report comparing group mean scores of students in a televised course with students in a conventional course. On this basis, they found 102 studies that favored televised instruction, 89 that favored conventional instruction, and 2 with no significant differences.

Cognitive Criteria

There have been many major long-term implementations of television projects in school systems throughout the world that have had detailed evaluation studies of both academic test scores and attitudes of students and teachers toward the use of television in the classroom. These studies, discussed below, were not included in any of the surveys cited above.

In Japan (Tsuji 1964), students in classrooms receiving one 20-minute broadcast per week for a year had significantly higher scores in science and social studies than students in nontelevision classrooms.

In India (Neurath 1968), there were significant advantages for the television students on visual abilities (experiments and diagrams), some advantage on understanding and application, and no advantage on factual questions for physics and chemistry courses. This result is consistent with one of the conclusions drawn by Chu and Schramm regarding ITV: "The use of visual images will improve learning of manual tasks as well as other learning where visual images can facilitate the association process. Otherwise, visual images may cause distraction and interfere with learning" (1967, p. 162).

In Colombia (Lyle, Germancos, and Torfs 1967), there were 30 15-minute

broadcasts to each of the first five grades of elementary school. While there were significant differences for students in the ITV classrooms for some tests, there were insignificant differences for most of the tests. Comstock and Maccoby (1966) reported that cognitive tests given to 8,500 students in Colombia revealed a significant advantage for students exposed to television teaching.

Achievement results for students in the earlier years of the Hagerstown project were reported in Washington County Board of Education (1963) and repeated in Wade (1967). In the first year of utilization (1956–57), fifth-grade students gained an average of 1.9 grade equivalents on a national test. Achievement gains for both rural and urban students in mathematics in the third, fourth, and sixth grades also exceeded the national norm gain of 1.0 grade equivalents. This achievement gain for rural students is of great importance to developing countries as the most severe educational problems are in the rural areas. Additionally, within Hagerstown, students in a given grade had higher average test scores than their predecessors at that grade level with less exposure to television. For example, students in rural schools in fifth-grade mathematics in succeeding years scored 5.34 in May 1958 with no television, 5.71 in May 1959 with one year of television, 6.03 in May 1960 with two years of television (fourth and fifth grades), and 6.11 in May 1961 with three years of television (third, fourth, and fifth grades). This finding of increased learning with more exposure was also found for preschool students viewing the "Sesame Street" broadcasts in the United States (Bogatz and Ball 1971).

Major studies have been undertaken in Mexico, American Samoa, and El Salvador. The Telesecundaria system in Mexico is an interesting application of television systems, as the prime motivation for the system was to extend secondary schooling to rural areas. Most of the students in the television system are rural students, while most of the students in the traditional system are urban. The teachers in the Telesecundaria system are trained for teaching fifth and sixth grades only and must supervise all courses in seventh, eighth, and ninth grades, while teachers in the traditional system are trained to teach specific courses at the secondary level. Yet, with all these deficiencies, Mayo, McAnany, and Klees (1975) report significantly higher gains for Telesecundaria students in mathematics, Spanish, and chemistry. Table 5.1 shows that, although the pretest scores were the same for both groups of students, the post-test scores were higher for Telesecundaria students. Klees (1974) compared the two systems through regression analysis, controlling for a large number of variables, including community characteristics; student background, attitudes, and aspirations; teacher education, experience, and classroom behavior; and class size, and found that television contributed significantly to learning. He found that this was true for low, middle, and high ability level students, although the effect was the strongest for the middle level students. The results of these studies on the Telesecundaria system are especially important as they provide evidence that television combined with other

resources of lower quality can substitute for the normal quality levels of traditional systems.

The evaluation study of American Samoa is interesting as it provides many examples of potential pitfalls in evaluation studies. In 1964, a major curriculum reform was undertaken that included utilizing television. There is a heavy emphasis on learning English in Samoan schools, although this is not the primary language of the students and is not used in the homes of the students. Yet all testing is undertaken in English. The researchers recognized this problem (Institute for Communication Research 1972): "in Samoa, every test is a language test." The researchers also stated that there may be cultural and curriculum problems with tests. Cultural difficulties arise because the culture represented on the test differs sharply from the culture of the students; for example, questions on the science test refer to trains, which do not exist on the islands and are not part of the children's background. The difficulties with curriculum arise because the course work may not be structured to meet the needs of the students. The heavy emphasis on English in the

TABLE 5.1

Results of Before and After Achievement Testing for Telesecundaria and Ensenanza Directa (Traditional Schools)

Subject Matter	Means	Standard Deviation	Gain Scores[a]	Number of Students[b]
Telesecundaria				
Math 1 (February)	20.24	4.84	—	1,151
Math 2 (June)	25.92	6.74	+5.68	—
Spanish 1 (February)	26.39	6.62	—	1,110
Spanish 2 (June)	31.50	8.44	+5.11	—
Chemistry 1 (February)	18.06	4.25	—	1,132
Chemistry 2 (June)	24.31	6.15	+6.25	—
Ensenanza Directa				
Math 1 (February)	20.15	5.02	—	836
Math 2 (June)	22.76	5.86	+2.61	—
Spanish 1 (February)	24.54	6.72	—	781
Spanish 2 (June)	27.19	6.84	+2.65	—
Chemistry 1 (February)	18.49	5.02	—	713
Chemistry 2 (June)	22.70	6.27	+4.21	—

[a]The authors report that the gain scores of students in the two school systems are significantly different at the 95 percent confidence level.

[b]Number of students are those who took both tests.

Source: Mayo, McAnany, and Klees 1975.

schools is derived from a policy of preparing students for careers on the mainland. Yet, on the islands, English usually is not used outside the schools.

Even with these test problems, one might feel some confidence in using the results to measure differences among Samoan students since one would expect the impact of the disadvantages to be randomly distributed among all students. The major success of the television system has been to improve the ability of the students to use English. W. Schramm, L. M. Nelson, W. R. Odell, J. Vaizey, and S. Spaulding (1967a) reported that an 82-item English test given to fifth and sixth graders in two television schools and one nontelevision school resulted in an average of 33 correct responses in the nontelevision school and 63.5 correct responses in the television schools.

Table 5.2 contains results for another test that demonstrates the English-speaking advantage of students in the television schools. These results for language ability are not surprising: the English-speaking ability of the classroom teachers was often of poor quality while the television system utilized native English speakers. Schramm, Nelson, Odell, Vaizey, and Spaulding (1967a) also mentioned a standardized mathematics test constructed for fifth and sixth graders and administered to 106 television students and 229 nontelevision students in the eighth and ninth grades in Samoa. The results revealed an advantage to the television students that was significant at the 90 percent level.

Although these test results do indicate some advantage to the use of television in the school system, one may still suspect that some of the differences can be attributed to other characteristics of the television and nontelevi-

TABLE 5.2

English Test Scores for Samoan Students

	Understanding Number Correct of 50 Questions	Speaking Number Correct of 114 Questions	Reading Number Correct of 32 Questions	Number of Students
Nontelevision	18.5	n.a.	4.9	10
Grades 4, 5, 6	(4.46)*	n.a.	(3.3)	—
Television school	32.6	69.6	12.0	14
Grade 3	(4.28)	(15.30)	(4.52)	—
Television school	32.4	61.1	10.6	8
Grade 4	(3.22)	(9.58)	(2.80)	—
Television school	42.1	102.7	21.9	15
Grade 6	(2.28)	(12.07)	(4.12)	—

n.a. = Not available.

*Standard deviation of test score is in parentheses.

Source: Institute for Communication Research 1972.

sion schools. This suspicion is raised by an examination of test scores of students in the Samoan educational system prior to the introduction of the television system (1964) with students currently in the school system (1970–72). This comparison led researchers (Institute for Communication Research 1972) to conclude that there was little difference in language scores: the earlier students had some advantage in reading and the later students had some advantage in arithmetic. The results of the language examinations are interesting. While a comparison of present television and nontelevision schools reveals an advantage for the television schools, a comparison of overall test scores between the past and the present does not indicate that the addition of television has added to the amount that students learn.

The final case of television for formal education to be examined is the project in El Salvador. This system was also instituted at the same time as major change in the educational system. The reforms, according to Hornik, Ingle, Mayo, McAnany, and Schramm, included:

1. Reorganization of the Ministry of Education
2. Extensive teacher retraining
3. Curriculum revision
4. Development of new study materials
5. Modernization of the system of school supervision
6. Development of a wider diversity of technical training programs in grades 10–12
7. Extensive building of new schoolrooms
8. Elimination of tuition in grades 7, 8, and 9 (in 1971)
9. Use of double sessions and reduced hours to teach more pupils
10. A new student evaluation system incorporating changes in promotion and grading policies
11. Installation of a national instructional television system for grades 7–9 (1973, pp. 8–9).

The evaluation of the system has been extensive and as the evaluation results reported in Table 5.3 show, there is no clearly established advantage for the instructional television system. In the table, traditional classes are classes that do not have television and have not been part of any of the reforms. Test scores are reported for general ability, reading, mathematics, science, and social studies. The pattern for all of these scores is fairly consistent. There appears to be an advantage to the students in the television classrooms over students in the traditional classrooms or reform classrooms without television for the seventh grade. However, in the eighth and ninth grades, the test advantage is often for the students in the nontelevision classrooms and traditional classrooms.

Hornik, Ingle, Mayo, McAnany, and Schramm (1973) attribute this diminished effect to the "novelty" of the television system. When the students

TABLE 5.3

Test Scores for El Salvador

	Group A[a]		Group B[b]		Group C[c]	
	ITV	Traditional	ITV	Reform (No ITV)	ITV	Reform (No ITV)
General Ability						
Beg seventh	86.99	85.56	57.93	54.60	51.62	49.70
Gain (seventh)	−12.38	−12.24	12.83	8.10	n.a.	n.a.
Gain (seventh through eighth)	n.a.	n.a.	n.a.	n.a.	13.61	10.25
Gain (seventh through ninth)	0.811	−2.25	24.62	19.06	n.a.	n.a.
Number of students	419	156	298	87	343	130
Reading						
Beg seventh	63.32	64.79	37.90	33.00	32.25	30.01
Gain (seventh)	−15.29	−16.26	8.71	7.81	n.a.	n.a.
Gain (seventh through eighth)	−11.56	−9.19	n.a.	n.a.	10.71	11.69
Gain (seventh through ninth)	n.a.	n.a.	18.08	17.56	n.a.	n.a.
Number of students	468	160	298	87	343	130
Mathematics						
Beg seventh	11.97	12.44	15.33	15.26	14.23	13.75
Gain	6.26	4.41	3.68	1.60	3.06	4.19
Beg eighth	16.13	15.58	13.81	12.94	16.65	16.56
Gain	2.20	1.20	2.20	3.97	3.25	1.29
Beg ninth	15.51	15.37	18.44	17.07	n.a.	n.a.
Gain	3.15	0.69	4.95	3.76	n.a.	n.a.
Minimum number of students	537	175	413	90	434	124
Science						
Beg seventh	18.06	19.28	20.72	21.07	19.47	19.15
Gain	6.71	2.13	5.25	2.24	4.22	3.45
Beg eighth	25.19	21.22	22.41	20.03	22.52	20.78
Gain	1.60	2.36	2.56	3.38	0.07	0.44
Beg ninth	21.37	18.07	25.92	22.85	n.a.	n.a.
Gain	2.02	2.09	2.77	5.05	n.a.	n.a.
Minimum number of students	527	178	425	94	444	129
Social Studies						
Beg seventh	26.63	27.99	24.31	23.68	22.23	20.05
Gain	8.93	2.24	7.41	3.36	6.10	3.90
Beg eighth	26.18	20.11	23.84	19.69	23.56	22.30
Gain	2.74	2.11	2.58	4.15	5.05	3.38
Beg ninth	20.52	18.59	25.60	23.98	n.a.	n.a.
Gain	1.22	3.16	1.13	0.73	n.a.	n.a.
Minimum number of students	529	179	425	94	439	123

n.a. = Not available.

[a] Entered seventh grade in 1969.

[b] Entered seventh grade in 1970.

[c] Entered seventh grade in 1971.

Source: Hornik, Ingle, Mayo, McAnany, and Schramm 1973.

were first exposed to the system, it was new and exciting and might have motivated them to work harder, but, by the second year, they adapted to its use and were no longer motivated to perform at higher levels. However, this conflicts with the positive results of increased exposure to television uncovered in the Hagerstown and "Sesame Street" evaluations. A more likely reason for the decline is the administrative difficulty mentioned by Hornik, Ingle, Mayo, McAnany, and Schramm (1973) that occurred in the project and prevented the programs designed for the eighth and ninth grades from undergoing the review and revision procedure that was applied to the seventh-grade program. The quality of a program has been demonstrated to be correlated with the learning effect from that program. Thus, a neglect of program revisions will contribute to the development of a poor teaching instrument.

One important advantage to the television system discussed by Hornik, Ingle, Mayo, McAnany, and Schramm (1973) is the apparent advantage for rural students with the television system. They claim that in the traditional system rural students fell further behind their urban counterparts, while rural students in the television classrooms, although still behind the urban students, gained approximately the same amount as the urban students.

In an evaluation of television in a nonformal context in Senegal (Fougeyrollas 1967), television was used to provide health and nutrition information for illiterate women. While the programs increased the knowledge of the women with respect to causes and treatment of diseases (the effect was reduced when a conflict existed with traditional treatments), there was little change in behavior (food storage and types of food eaten). While awareness may be the first step to action, this study reveals that tests of knowledge (especially in nonformal settings) may be insufficient to determine whether or not a real impact will be made on the lives of people in developing countries.

When one weighs all the evidence on the effectiveness of television as an instructional aid, one cannot conclude that television will always add to the learning of the students. The results seem to point to the general finding of no significant differences, although there are some interesting conclusions. The one consistent advantage for television seems to be in improving the test scores of rural students. One of the reasons for this improvement is that the technology provides for the distribution of the scarce resource of high quality teaching ability. However, as Carnoy and Levin (1975) noted, one must question whether or not a centralized, urban-based curriculum is amenable to rural development. The studies reviewed here also indicate that attention to content quality of the broadcast may improve performance of the students.

Noncognitive Criteria

While test scores are an important component of measuring a system's effectiveness, one may also examine dropout and repetition rates. Again, however, there is no advantage to television systems. In Mexico (Mayo, McAnany,

and Klees 1975) and El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), there was no difference in these rates between students in television classrooms and students in nontelevision classrooms.

The degree of acceptance of the television system, measured by the attitudes of teachers and students, also helps one understand its effectiveness. These attitudes help gauge whether or not the system will be effective in improving learning, as dissatisfaction may hinder the implementation of the system and its teaching effectiveness. In examining attitude surveys from Hagerstown, Mexico, Samoa, and El Salvador, one may draw the following conclusions: the acceptance of television by both teacher and students tends to decline for higher grade levels and as time progresses, classroom teachers and television teachers have different perceptions of the effectiveness of the presentations, and mechanical problems are prevalent in the developing countries.

Another point should be made clear in discussing results of attitude surveys. Surveys do not represent majority voting, that is, 60 or 70 percent agreement by survey respondents with a statement that television is useful to improve learning does not imply acceptance. There may be serious problems realized by the minority that could limit the usefulness of the system.

In Hagerstown, surveys reported by Wade (1967) indicated a general decline in favorable opinions from primary to secondary teachers. For example, 76.9 percent of primary teachers and only 40.9 percent of secondary teachers felt that television provided help in instruction; 98.4 percent of primary teachers and 76.3 percent of secondary teachers felt that television provided a richer experience; and similar numbers felt that television enriched and expanded the curriculum.

Criticisms of the system in recent years led to a county report (Washington County Instructional Television Evaluation Committee 1973) on the attitudes of parents, teachers, and students toward the system. It is unclear what sampling procedure was used for the attitude surveys, but the results, published in the local papers, have been rather negative. For example, among students, 2,439 felt that they learned more from the classroom teacher, while 707 felt that they learned more from the television teacher; 2,[illegible] of 3,360 students felt that television did not motivate them to learn and 2,[illegible] of 3,244 students felt that they would rather learn without television. A total of 180 responses was obtained from the general public. Approximately 60 percent of this sample felt that television did not contribute to learning, did not motivate students, and did not belong in the classrooms. The use of television was more favorably viewed by teachers, although their opinions were far less positive than in the earlier survey. Approximately 50 percent of elementary and secondary teachers responding to the survey felt that ITV did not improve the quality of instruction. Additionally, 50 percent of elementary and 75 percent of secondary teachers felt that their students were worse off with television.

TABLE 5.4

Educational and Occupational Aspirations of Students in Mexico (in percent)

	Telesecundaria	Ensenanza Directa
Educational aspirations:		
level of schooling desired		
Finish secondary	13.8	4.8
Finish normal or short vocational/professional course	50.5	35.0
Finish preparatoria (senior high school)	9.4	6.0
Finish university or politechnic institute	26.3	53.8
Occupational aspirations:		
general occupational level		
Lower level occupations	9.2	3.0
Middle level occupations	51.6	33.1
Higher /professional level occupations	39.2	63.9

Source: Mayo, McAnany, and Klees 1975.

In Mexico (Mayo, McAnany, and Klees 1975), a survey of student attitudes revealed that 19 percent of the students had difficulty seeing the broadcast, 14 percent felt the television lessons were too difficult, and 37 percent felt they did not have ample opportunity to ask questions. The more interesting questions of student attitudes in Mexico relate to occupational and educational aspirations of the students. As shown in Table 5.4, the distribution of aspirations for Telesecundaria and traditional school students is very different. While only 26 percent of the Telesecundaria students aspire to move on to higher education, 54 percent of the traditional school students aspire to this level. In terms of occupational aspirations, 64 percent of traditional school students aspire to professional level occupations, while only 39 percent of the Telesecundaria students have this desire. The system is clearly not creating an equality in aspirations. This is a very important result, as education should be an investment for both the student and society. A developing country can ill afford to raise test scores and not occupational aspirations. However, the other side of the problem is a lack of opportunities to fulfill these aspirations. In El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), although students have high occupation aspirations, there are high unemployment rates,

so their aspirations are going to be frustrated. Their educational aspirations will also be frustrated as there are fewer places at universities than students desiring to enter them.

In Samoa (Institute for Communication Research 1972), 1,915 elementary students, 1,581 secondary students, 263 elementary staff, and 51 secondary staff were surveyed. The decline in favorable attitudes for the higher grade levels was dramatic. For example, 80.6 percent of the elementary teachers but only 37.5 percent of the secondary teachers felt that the children learned from television. This attitude was also prevalent among the students. In elementary levels 5, 6, and 7, 70.6, 50.8, and 46.4 percent, respectively, of the students felt they had learned from the television lessons. These percentages declined to approximately 22 percent for secondary students. Similar percentages of students said that they wanted the television lessons to continue.

Distributions of attitudes among teachers in Samoa toward how television should be used also varied dramatically between elementary and secondary teachers. For example, in mathematics, only 6.6 percent of the elementary teachers felt that television should not be used, while 28.6 percent of the secondary teachers held this attitude. For science, the proportions were 4.3 and 20.4 percent, respectively. Nearly 60 percent of the elementary teachers felt that television should be used to present and develop the main parts of the course (the arrangement adopted in Samoa), while an additional 29 percent felt that television should introduce basic skills and concepts. Secondary teachers were approximately evenly divided between these two choices and the additional choices of using television for enrichment purposes only or not using television at all.

The classroom teachers were also asked questions about the reasons for their criticisms (the survey of television teachers revealed that they did not share the opinions of the classroom teachers). For example, 65 percent said that television teachers did not visit classrooms frequently enough and did not know the level of understanding of the students; approximately 30 percent felt that the production was of poor quality; approximately 42 percent said that students were bored; and approximately 50 percent felt that the sound was of poor quality.

Many of these same problems were also regarded as serious by the teachers in El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973). In this survey, 48 percent felt that the lack of printed materials was a serious problem and 37 percent felt that the lack of communication between classroom teachers and project administrators was a serious problem. The survey of teachers in El Salvador also revealed a decline in favorable attitudes as the years progressed. For example, the percentage of teachers agreeing that students learned more with television than without it declined from 73 percent in 1969 to 56 percent in 1972. In 1969, 78 percent of the teachers felt that they improved their teaching methods by viewing the television teacher. This percentage, although still high, declined to 63 percent in 1972.

Generally, the attitudes of teachers appear to be favorable although in each case many problems are mentioned by the teachers. As elementary teachers are more favorable toward television than secondary teachers, it may be wise to increase utilization at elementary levels with respect to secondary levels. Furthermore, it is important to reemphasize that administrators in these countries must understand why there is disenchantment with television classes among students and teachers, even if they are in a minority. An understanding of the causes of the disagreements and complaints may lead to their disappearance.

INSTRUCTIONAL RADIO

Instructional radio was used fairly extensively in the United States in the past; in the present, it represents a potentially good investment for developing countries. As with the evaluation research for television, there is little research support for concluding that radio is uniformly more successful than conventional instruction or vice versa. However, for developing countries, the lower costs of radio compared with television (analyzed in Chapter 6) make it a viable alternative. In addition, radio systems are more adaptable to localized programming control than television. Radio has played a larger role in nonformal educational programs than television in developing countries and there are some studies cited below that contain evaluations. For evaluations on noncognitive criteria, there are studies that have concentrated upon attitude change rather than attitudes toward radio.

Cognitive Criteria

In their survey of instructional television, Chu and Schramm (1967) concluded that radio supplemented by appropriate visual material could teach as effectively as other media. R. O. Forsythe (1970), in a survey of the use of radio, reached a similar conclusion. Furthermore, he concluded, as did Chu and Schramm, that visual messages are not always helpful to learning and may, if not directly related to the subjects to be learned, prove to be a hindrance. Jamison (1971) and Jamison, Suppes, and Wells (1974) also analyzed several studies in the use of radio and concluded that radio was as effective as conventional instruction.

C. Atkinson (1942) reported on a study of the use of radio in the Cleveland, Ohio, school system in the 1920s for mathematics education. Tests revealed an advantage to second- and third-grade students in the radio classes (one 15-minute program per week) over students in nonradio classes who used identical printed materials.

V. E. Dickson (1926) reported on an experiment in the use of radio in the 1920s in Oakland, California, where radio was used for a variety of subjects in grades 5 through 10 in place of a teacher. Test results did not reveal any significant differences between students in the radio classes and students in conventional classes.

In Wisconsin (Wisconsin Research Project in School Broadcasting 1942), radio was used for several different courses. The one course that resulted in significant differences for radio-taught students was the music class. The more interesting results from this and a related study (E. E. Willis 1940) are concerned with changes in social attitudes.

In Japan (NHK 1956), students received radio instruction in English and music and scored at the same level or above as students in traditional classrooms.

Radio was also used to teach English and music in Thailand (Schramm, Nelson, Odell, Vaizey, and Spaulding 1967b). Students in grades 2 and 3 who received music instruction via radio scored significantly higher than students who did not. The English results were mixed. Sixth graders in nonradio classes scored higher on writing ability than radio class students, whereas the results were reversed in the seventh grade. Interestingly enough, while one would expect an advantage for the audio medium, as in the case of the music classes, there was no significant difference in oral ability in English.

For the radio school in Mexico (Spain 1973), there were no significant differences in gain scores between radio school students and nonradio school students in mathematics or Spanish achievement. However, in this case, the radio school students (primarily rural students) started at lower achievement levels than the other students. Their score gains were higher but not statistically significant. One must regard this result to be beneficial. Similar gains in test scores of radio and nonradio students will prevent an increase in the advantage of nonradio students.

In a nonformal use of radio in India, Mathur and Neurath (1959) reported that radio rural forum members learned more than nonmembers. In Ghana, H. C. Abell (1968) reported that students listening to radio with a forum learned more than students with a radio and no forum and individuals without a radio or participation in a forum.

Finally, there is the extensive project in Colombia, Radio Sutatenza (Schramm 1973a) which involves a wide variety of subjects for individuals outside a formal school setting. The schools for the broadcasts are formed with six to ten members who meet, listen, and discuss. There was a decline in participation from 28,000 schools and 230,000 students in 1965 to 20,000 schools and 167,000 students in 1968. The reason for the decline is unclear and may either be a positive or negative attribute for the system. It is positive if it represents the fact that there are fewer individuals requiring the service of these broadcasts and negative if it means that the broadcasts have lost their

attractiveness to potential listeners. While no comparisons have been made with nonlisteners, Schramm (1973a) reported the following results for 1968:

1. Literacy training (six-month program, one 30-minute broadcast each day) —75,000 enrolled, 27,500 took an exam, 20,180 passed the exam
2. Progressive course (two-year course on health, nutrition, and so on with a one-hour broadcast each day)—92,000 enrolled, 20,000 took an exam, 15,200 passed the exam

While the number of individuals passing an exam for the course is only 30 percent for the literacy course and 17 percent for the progressive course, one must still find these results encouraging for a nonformal educational program.

Noncognitive Criteria

The Mexico study also contains some attitude data of teachers. The teachers were evenly divided: 43 percent felt that the schools were better without radio and 45 percent felt that schools were better with radio. These negative attitudes may be caused by administrative and functional difficulties and content problems. A high percentage of teachers felt that there were too many breakdowns and that the programs had too much content and went too fast.

In the area of attitude change, the Thailand study revealed that the students in radio classes had significantly higher agreement with desirable social attitudes on 16 of 28 items in the second grade and on 12 of 28 items in the third grade. There were insignificant differences on the other items.

Radio also was successfully used in Wisconsin to change social attitudes. High school students in Wisconsin receiving radio instruction via radio had significantly higher changes than nonradio students in the direction of program goals, which were to increase:

1. Tolerance toward the interests of various economic groups
2. Cooperation with the members of one's own group in solving common problems
3. Cooperation with other groups in solving common problems
4. A sense of responsibility in furthering the interests of one's own group (Wisconsin Research Project in School Broadcasting 1942, p. 90)

In related work on attitude change, E. E. Willis (1940) compared the relative effectiveness of three forms of radio presentations: straight talk, dramatization, and a combination of talk and dramatization. The subject areas treated were the treatment of criminals, freedom of speech and press, and the

attitudes students should hold toward the German people. An attitude test was administered to high school and college students prior to the program, at the conclusion of the program, and two weeks after the conclusion. There were nonlistening control groups for each education level. The following general conclusions were noted:

1. A 15-minute radio program significantly shifted the attitudes of high school and college students.
2. The attitude changes were still significant after two weeks although there was more of a tendency for the attitudes of the high school students to return to original attitudes.
3. For high school students the dramatization was more effective, the combined form next, and the talk the least effective in changing attitudes (all methods produced significant attitude changes).
4. For college students all three methods were equally effective.

An important use of radio in developing countries is its use for literacy training, agricultural information, health and nutrition information, and so on in a nonformal setting. The arrangements for listening to these broadcasts range from individuals listening at home to group listening with group discussion and decisions. N. C. Jain (1969) analyzed several alternative types of rural forums to determine which would have the greatest effect on attitudes and behavioral intentions of the participants. His data indicated the following: group listening plus group discussion was more effective than group listening only; group listening plus group decision (no discussion) was more effective than group listening only; group listening with discussion and decision was more effective than group listening and decision; and public commitment to action following discussion was more effective than when it followed listening only. Not surprisingly, his results indicated that the most effective format for radio forums is one that involves group discussion with public commitment to action.

Unfortunately, Jain did not discuss in his study one very important variable: action by the radio groups. While public commitment to action may be more effective in changing attitudes and behavioral intentions, it may still not translate into any activity. In India, Mathur and Neurath (1959) reported that rural forums led by trained discussion leaders who engaged in group discussion and decisions resulted in greater acceptance of innovations and more rural improvements than individual listening or unguided group listening. However, this experiment was only carried on for a small number of villages and it was never possible to extend the concept throughout the country. This failure may be attributed to a lack of enthusiasm on the part of new discussion leaders.

In Ghana, an experiment involving 80 villages to determine the impact of rural forums was reported by Abell (1968). In this experiment, 20 villages

TABLE 5.5

Results in Ghana Radio Forums

Question	Percentages by Type of Village			
	Radio/One Forum	Radio/Two Forums	Radio/No Forum	No Radio/No Forum
Action taken to increase production?	60	53	42	35
Production cooperatives planned or formed?	17	13	7	2
Action to improve marketing of crops?	25	23	21	9
Marketing through a group or a cooperative?	19	19	18	7
Action to improve harvesting, storing, transporting crops?	27	24	8	13
Joined a cooperative within six months?	16	19	5	6
Able to name cooperative started somewhere within six months?	55	43	35	28
Correct ages for introducing different protein sources to baby's diet?	51	46	41	36
Now saving on a personal basis?	70	60	57	50

Source: Abell 1968.

had radio and one forum, 20 villages had radio and two forums, 20 villages had radio and no forum, and 20 villages had no radio or forum. Abell mentioned that some of the villages involved were resettlement villages, that is, the inhabitants had been relocated there prior to the flooding of their lands for a dam project. There is no easy way of predicting how these people would respond to further development information and it is not clear if these villages were distributed among the four groups. A field organizer was sent to each village and told to form a forum consisting of 50 percent males with no formal education and employed in farming, 25 percent males with formal education and not employed in farming, and 25 percent females with no formal education and involved in farming. Several questions were asked to determine the relative effectiveness of the four presentation styles. As can be seen in Table 5.5, while no tests of significance were conducted, the results seem to indicate an advan-

tage in group action, individual action, and individual knowledge for participants in the radio forum groups. The surprising result is that one forum seemed to be more effective than two forums.

INFERENCES DRAWN FROM THE RESEARCH

The major conclusion of this survey of the effectiveness of instructional technology is similar to that of many previous surveys (Chu and Schramm 1967; Dubin and Hedley 1969; Jamison, Suppes, and Wells 1974): there are apparently no significant differences on a variety of test scores for students receiving conventional instruction and those receiving instruction via technology. Yet, if one examines the surveys, this conclusion is based on an overall view of many projects. There are individual instances where conventional instruction is superior and other instances where instructional technology is superior. Future research must be directed toward a determination of the factors that lead to one system being superior to another system.

There are many possible reasons for a finding of no significant differences among alternative instructional methodologies, including a failure to ensure comparability of projects and a failure to differentiate between project organizations, material quality, and students. An explanation of each of these analytical problems is discussed below. This discussion is followed by an analysis of the importance of continuing evaluations and a brief discussion of some of the more interesting results of the developing country projects considered in this chapter.

Comparability of Projects

To determine the relative cognitive effectiveness of instructional technology, comparisons are usually made with conventional instruction. Unfortunately, there is no clear definition of conventional instruction. It is also difficult to specify precise experimental controls for the studies. For example, in a comparison of televised and conventional classroom instruction, should the same instructor with the same materials in both settings be used? Or should total flexibility in course construction to utilize the differences in the media be allowed? What class size should be permitted for the conventional instruction alternative? Briggs et al. (1967) pointed to other difficulties in comparison studies, including the use of intact classes and the failure to assign randomly students to instructional methodology, the use of investigator-constructed evaluation tests and the subsequent lack of attention to reliability and validity, the possibility that the test was not powerful enough to uncover differences,

and the frequent absence of control for teacher effects. For example, F. Costin, W. T. Greenough, and R. J. Menges (1971), in a survey of student ratings, reported that the most frequently cited teacher success criteria were knowledge level of teacher, organization of course content, interest in students and course, and ability to motivate.

One might feel that a successful use of technology would take advantage of the unique capabilities of the various media (for example, color television and animation). However, in analyzing a variety of program formats for instructional television, Chu and Schramm (1967, p. 180) generally concluded that:

> effective use of television grows out of attention to the basic requirements of good teaching, rather than to any fanciness that might be peculiar to television. . . .
>
> . . . qualities like simplicity, good organization, motivation, practice, knowledge of results, rest pauses at appropriate points, cues that direct the pupil to the essential things he is to learn. . . .

One potential explanation for the difficulty in comparing technologies may be the relative advantage of one technology for some elements of instruction. As Briggs et al. (1967, p. 24) stated:

> When a lengthy course or sequence, representing several kinds of learning, is prepared in two different media and the results analyzed, the most frequent result is a failure to demonstrate a significant difference. One reason for such a finding could be that each of the media compared was more effective for some elements of instruction and less effective for other elements, so that the differences in effectiveness among media were cancelled in the overall analysis.

The opinion that new research should be directed toward uncovering specific instances for which a particular technology might be significantly effective is not new:

> The problem that must be solved is not the question "Is Method A better than Method B or Method C?" but rather, "What are the conditions under which Method A produces more effective results? What are the situations where Method B is best, etc." (Spence 1928, p. 462).

In quoting this remark, R. Dubin and T. C. Taveggia (1968, p. 17) further concluded that "It is notable that his question persists through the literature and always remains unanswered in terms of empirical data."

Organization of Project

Other favorable conditions that might ensure the success of a technology project relate to the organization of the project. J. W. Armsey and N. C. Dahl (1973) stressed organizational objectives such as the existence of a recognized and generally agreed upon need and the desire to meet the need through the use of technology, the participation and support of teachers in the project, and the provision of adequate resources for the duration of the project. Earlier in this book, problems associated with the failure to include teachers and communities in planning, implementation and evaluation, and the inclusion of foreign agencies in these processes have been discussed. The major point to be made is that a technology project or any educational project will fail if the needs and desires of communities are not considered, if teachers have a new system imposed upon them, and if cultural and social conflicts exist with representatives of a foreign agency. Teacher strikes occurred in Mexico and El Salvador and probably limited the effectiveness of the technology project there. The interests of Peace Corps volunteers in Colombia conflicted with those of the teachers and may have limited the effectiveness of the television project.

In addition to the problems of agreement on more macroscopic objectives for a school system, one must be concerned with the microscopic objectives of determining precisely what should be accomplished in the classroom. Briggs et al. (1967) suggest four basic steps in the planning of a course using multimedia presentation: identify each behavioral objective, relate behavioral objective to type of learning (according to Gagne's hierarchy), choose media that provide the best stimuli for types of learning, and look at overall choices to determine the most effective sequencing for multimedia use. R. Bretz (1971) mentioned several objectives for determining appropriate technology: motivating learner, reinforcing learning, stimulating discussion, providing for drill and practice, and inducing teacher-learner interfaces.

The importance of stating instructional objectives cannot be underestimated. This step is critical in evaluating the relative effectiveness of instructional technologies. For example, Forsythe (1970) mentioned a highly successful creative arts program that was originally broadcast on radio and later transferred to television. The program was returned to radio when it was discovered that its effectiveness had diminished when students were copying the artist. It is evident in this instance that creativity was the instructional objective. Had the objective been technical competence in drawing, television might have been the more effective medium.

Quality of Material

The quality of the instructional material is also an important dimension in measuring the success of a given project. Chu and Schramm (1967) con-

cluded that showing, testing, and revising an instructional program could substitute for the lack of feedback and improve the quality of a televised course. Wells (1973), in a survey of economics education, discussed two studies on programmed instruction that demonstrated the need to account for differences in quality. R. Fels and D. R. Starleaf (1963), in a comparison of lectures and programmed instruction, reported significant differences favoring the lecture students in their first experiment but no significant differences in the second experiment when the programmed materials had been revised. R. Attiyeh, G. L. Bach, and K. G. Lumsden (1969) conducted one of the largest studies of programmed instruction to date, involving over 4,100 students at 48 colleges. Two different programmed books were used and the students were divided into five groups: programmed book only (one group for each book), conventional instructional only, and conventional instruction supplemented by the programmed book (one group for each book). Students using one of the programmed books as the only source of instruction performed significantly worse than all other groups, indicating a difference in quality of programmed material. Wells (1974) found significant differences in achievement of economics students in the United Kingdom depending upon the textbook used, indicative of a difference in quality between the textbooks.

The relative success of television for seventh graders in El Salvador compared with the lack of success for eighth and ninth graders may be caused by the extensive revision of seventh-grade materials combined with a lack of revision of other materials.

Student Characteristics

There is a possibility that instructional technology has differential impacts on different students. These differential impacts might be the result of certain characteristics of the learner, such as basic intelligence or ability, initial knowledge of the subject, family background, or personality. Unfortunately, the results of research studies in this area do not reveal any consistent findings, and we have not yet reached the point of recommending a particular type of instructional methodology that would be best suited for given student characteristics.

In terms of ability level of the students, a conflict exists. In a U.S. study, R. E. Dreher and W. H. Beatty (1958) found that television was significantly better for students of low and high ability but not for students of middle ability. In Mexico, Klees (1974) reported that television was more effective for students of middle ability level compared with conventional instruction than for students of other ability levels. He also found that television was the only educational resource with a positive impact on students of low ability.

Studies in the United States (Doty and Doty 1964; Lublin 1965; Kight

and Sassenrath 1966; MacPherson 1967; Shrable and Sassenrath 1970) show varying effectiveness for programmed instruction based on a variety of personality characteristics of students, including creativity, need for autonomy, social need, achievement need, anxiety level, and fear of failure. These studies did not reveal consistent findings, and we may still not be at the point of determining the appropriate instructional methodology for a given student.

With respect to students, perhaps one of the most important reasons for findings of no significant differences has been ignored: the allocation decisions of students with respect to their own time. This is a separate issue from the time savings that has been demonstrated in some studies of programmed instruction (see introduction to this chapter). If the student determines a deficiency in his classroom instruction (regardless of the technology used), he or she may decide to compensate by increased studying and reduced attendance. In a further study of economics education in the United Kingdom, Wells (1975c) found that students in classes with lower quality lecturers (measured by status and experience) tended to attend fewer classes and study more hours than students in classes with higher quality lecturers. Students in lectures with higher enrollments studied more often and attended fewer lectures than students in lectures with lower enrollments. As this study indicates, a lack of information regarding student activities and decisions may lead to a conclusion of no significant differences when, in fact, there are very real differences in the productivity of two instructional methods of technologies.

Need for Continuing Evaluations

A particular problem in evaluation occurs when there is a lapse in continuing evaluation studies. In El Salvador (Hornik, Ingle, Mayo, McAnany, and Schramm 1973), the evaluation that continued over a period of several years revealed that the initial advantage attributed to the television system declined, and the major advantage in student learning appeared to be associated with the educational reform (curriculum changes and additional teacher training). If the evaluation had been discontinued at an early stage, information regarding the effectiveness of television would have been incorrect.

In Hagerstown (Wells and Klees 1976), a discontinuation of the evaluation of the project led to substantial problems for the project. In the early years of the project, when television was used in some classes in Hagerstown and not in others, a substantial improvement in test scores was demonstrated for students in television courses (Wade 1967). However, in later years, when all students were in television courses, no evaluations were conducted, as administrators of the project felt that there were no comparable groups not using television in Hagerstown (test scores could have been compared with national averages). Additionally, evaluations of attitudes toward the programs

to aid in monitoring program acceptance were not continued. In 1973 (Washington County Instructional Television Evaluations Committee 1973), in response to apparent undercurrents of dissatisfaction with the system, a survey of attitudes was conducted by voluntary response to a newspaper questionnaire. The results of the survey of attitudes of students, teachers, and the general public were published in the newspaper and revealed basically unfavorable responses. If a continuing evaluation had been conducted, a more random sample of opinions might have been utilized and dissatisfaction might have been identified in earlier stages.

Results

Some interesting results do emerge from some of the projects that were analyzed. The most consistent finding is the relative success of instructional technology for rural students. In Hagerstown, rural students gained more on achievement tests than their urban counterparts. Comparing rural students enrolled in the fifth grade in succeeding academic years, one observes a steady increase in mathematics scores from one year to the next as students in successive years had additional exposure to television.

In both the radio project in Mexico and the television project in El Salvador, rural students gained as much in test scores as urban students and the trend of falling farther behind was halted. In Mexico, students in the Telesecundaria outperformed students in the conventional system. The students in the Telesecundaria system were rural students with teachers trained to teach only at the elementary level and the students in the conventional system were mostly urban students with teachers trained to teach at the secondary level. However, as both groups of students had the same pretest scores, it is likely that the Telesecundaria students were among the more advanced rural students, as the typical pattern is for rural students to have lower scores than urban students.

In Samoa, a comparison among students in classes with television in two schools and students in another school without television revealed a consistent advantage for the television-taught students on English tests. This result is not surprising as the television teacher was a native English speaker and the classroom teacher was not. In addition, a comparison of Samoan students in the system before television was introduced with Samoan students in the system when every school received television did not reveal any difference in language ability.

In El Salvador, the success of the television programs, which were carefully planned and revised for the seventh grade, revealed the importance of concentrating upon quality. Programs for the eighth and ninth grade that were not revised were not successful.

Attitude surveys of students and teachers in several countries revealed a general pattern of declining favorable attitudes as grade levels increased. The surveys were useful in signaling potential problem areas, although there is no evidence to indicate whether or not there was a response to these signals on the part of administrators. There is also the danger that a potential problem may be ignored if a large majority (70 to 80 percent) of survey respondents do not feel the problem exists even though the minority may be greatly affected.

The most interesting type of survey that has been conducted was for educational and occupational aspirations. There is a two-edged problem with aspirations. In cases where aspirations are low, as in Mexico (see Table 5.4), the investment in education may have limited social value. However, when aspirations are high, as in El Salvador, frustrations are likely to arise when there is widespread unemployment and limited space at higher education levels.

For nonformal programs, there is evidence that instructional technology (television in Senegal and radio in India and Ghana) improved learning of agricultural techniques, nutrition, and health care. There was less evidence that knowledge was translated into action. It is quite likely that the attainment of knowledge from instructional technology is insufficient to induce the motivation necessary to act, and more directed personal leadership may be needed to translate knowledge into action.

CHAPTER

6

COSTS OF INSTRUCTIONAL TECHNOLOGY

INTRODUCTION

Cost analysis should always be a major component of any decision process involving a commitment of funds. As explained in Chapter 2, the cost of an alternative is one of the main criteria for judging the value of that alternative in relation to the other alternatives generated to solve a problem. From the evidence of the evaluation studies of the previous chapter, cost analysis holds a special importance as, with few exceptions (such as instructional technology for rural students in formal educational systems), there does not appear to be a consistent advantage of one alternative over another.

This chapter contains information gathered from many sources on costs of instructional technology systems and presented in the context of four different cost methodologies. The major sources of information are manufacturers' equipment costs, planning studies, and actual project costs. Unfortunately, there is a relative paucity of information on costs of instructional technology in nonformal education. For example, of the television projects summarized in Table 6.4, only one out of nine is for nonformal education and, in that project, utilization had to be estimated to determine average costs. There are more radio projects for nonformal education—two out of six in the cost summary table (Table 6.4).

The next section contains definitions of the different cost concepts that are used in the cost analyses, and is followed by a discussion of problems and limitations of cost analysis. Perhaps one of the more important problems associated with technology projects is that of determining the proper costs to associate with the instructional technology project. Difficulty in making this decision arises because technology projects are often a part of a larger educational system, and it is not always evident whether central administration,

building, and other similar costs should be wholly or partially included in the estimation of technology costs or whether these costs should be excluded.

The fourth section of the chapter is a presentation of the cost analysis using four models: component cost analysis, annualized cost estimates, time structure of costs and utilization, and opportunity cost analysis. The first model relies solely on manufacturers' costs and hypothetical school systems. The second model analyzes actual project experiences, although examples of a detailed procedure for this cost analysis for radio and television include both project and manufacturers' costs. The third model involves project costs and projections of these costs. The fourth model also involves project costs, but its purpose is to demonstrate what other resources could be purchased with the money spent for the instructional technology system.

The final section of the chapter is a brief summary of the cost information and the limitations of the analysis.

COST DEFINITIONS

Several different types of costs are used in cost analysis: capital, recurrent, fixed, variable, total, average, marginal, sunk, and opportunity costs.

Capital cost is the cost incurred to purchase some piece of equipment or other material that has a useful life beyond the time of its purchase. Recurrent cost is a cost incurred for some item that is used at the time of purchase. For convenience and in accordance with standard accounting procedures used in school systems, a one-year period is often considered to be the dividing line between recurrent and capital costs. Therefore, any cost incurred for an item that is used during the year (regardless of whether or not the payment is made during the year) is a recurrent cost. The salaries of teachers, administrators, and other personnel are obvious examples of recurrent costs, as are maintenance and service costs. Capital costs are usually associated with equipment, such as production, transmission, and reception facilities and buildings, that is, those items whose useful life extends beyond the period of one year.

Another distinction between costs that is often confused with the distinction between capital and recurrent costs is that between fixed and variable costs. Fixed costs are those costs that do not change with the level of system utilization (number of course hours produced or number of students in the system). For example, for a technology system, the costs associated with production and transmission equipment do not vary with the number of students utilizing the system or the number of course hours produced and are fixed costs. Administrative and building costs are also fixed costs. Variable costs are those costs that change with the level of utilization, such as cost of reception equipment and printed materials. Fixed costs are often confused with capital costs since they are often associated with equipment purchases. However, some costs that are fixed, such as administrative salaries and mainte-

nance, are also recurrent, while some costs that are variable, such as for reception equipment, are also capital costs. Printed materials may vary: textbooks may be capital items, while workbooks may be recurrent.

Related to the fixed and variable cost distinctions are total, average, and marginal costs. It is usually convenient to establish cost functions for given years of the project so that total cost is the total amount of money spent on a project in a given year and is equal to the sum of the fixed costs (administrative salaries, maintenance, and the annualized cost of fixed capital equipment, such as production and transmission facilities; a methodology for annualizing these costs is discussed in a later subsection of this chapter); the variable cost per student (teacher salaries divided by class size, cost of printed materials, and annualized values of variable capital equipment such as receivers) multiplied by the number of students, plus the variable cost per hour of production (electrical power, videotapes, programming costs, and so on) multiplied by the number of hours of production. That is, TC (total costs) = F (fixed costs) + V_n (variable cost per student) X N (number of students) + V_n (variable cost per hour) X h (number of hours). This equation may be further modified by adding a term for costs that vary by the number of student-hours.

Average costs are total cost divided by the number of students, the number of hours, or the number of student-hours. Marginal cost per student is the additional cost to reach one more student and is equal in the linear model above to the variable cost per student, V_n. Marginal cost is usually a useful concept for analyzing costs. However, for planning that involves expansion for large numbers of students and summaries of the cost experiences of various projects, a discussion based upon average costs is more useful. The cost function given above does not really provide an accurate picture of the true marginal cost, which is probably close to zero: the cost of adding one more student to the system is usually negligible as one would not expect additional teachers or reception equipment to be added to accommodate one additional student.

The variable cost per student is, in a sense, an average cost per student for expenditures that vary with the total number of students served. The convenience of using variable cost per student derives from the fact that different variable items may be shared by different numbers of students. Workbooks may be used by one student, textbooks by one or more students (in a given year), library and other facilities by several classes or grades, teacher services by a class of students, and reception equipment by one or more classes or grade levels.

The linear function is, at best, an approximation of the cost structure and involves an assumption of declining average costs; that is, as the number of students (or hours) increases, the average cost per student (or hour) decreases. Because of the high fixed costs usually associated with technology projects, the assumption of declining average cost is reasonable.

Two other costs concepts that are given more explicit treatment in the discussion of cost methodologies are sunk costs and opportunity costs. Both

types of costs are particularly relevant to decision making. Sunk costs are those expenditures that have already been made and are not recoverable. Future decisions should not reflect these costs. It is not rational to undertake some project because of previous expenditures, regardless of their size, if new expenditures are not justified by the expected result of the new project. Opportunity costs are the value of actions or alternatives that are forgone in order to pursue the chosen alternative. For example, the opportunity cost to an individual attending school is the income forgone that could have been earned had the individual not attended school. To a country, the opportunity cost of increased or continued expenditures on schools may be increased investment in transportation or agricultural development. When resources are limited, as they always are, the concept of opportunity cost is particularly important in an analysis of alternatives.

PROBLEMS IN COST ANALYSIS

There are several problems in cost analysis: the use of average cost, the type of student considered for average cost measurement, the proper costs to include in the analysis, the financing of the project, and the comparability of cost analyses among projects.

Use of Average Costs

Costs are usually discussed on a per student or per student-hour of instruction basis. To some extent, and especially when a country is engaged in expanding its educational system, the number of students served becomes an objective or output of the system. Therefore, while costs are estimated on the basis of inputs (teachers, books, media systems, buildings, and so on) utilized in the educational system, they are analyzed in terms of possible output measures.

A difficulty arises if we consider two systems where the one with the lower average cost per student also serves fewer students. It may seem more desirable socially to choose the alternative with higher average costs per student since more students are served by the educational system. To overcome this difficulty, we may assume that for any expansion, the average cost per student does not increase; that is, for a given percentage increase in the number of students served, the costs increase by the the same or a lower percentage. Therefore, the system with lower average costs will be chosen (assuming no difference in impacts on any other criteria) and expanded to the required size.

Even though average costs will be decreasing, expansion of the system will involve additional expenditures, and the decision not to expand could be

perfectly rational. The original investment is treated as a sunk cost, that is, the money has already been spent and cannot be recovered except by ending the system and reselling the equipment (which may be quite difficult). Further decisions ought to be based upon future costs and utilizations and not upon previous costs. Unfortunately, previous costs are often taken into account for political reasons. Money has been spent, and even though it may seem hopeless more money is often spent in the hopes of reducing the embarrassment of poorly spent money. One of the cost methodologies (time structure of costs and utilization) discussed below involves explicit treatment of the problem of sunk costs, and is a superior methodology for decision making.

It is quite possible that our assumption of equal or declining costs is incorrect. Expansion of the system may also make it necessary to hire more personnel. Depending upon the current situation in the labor market, it may also be necessary to increase salaries to attract more personnel, that is, teachers, administrators, and technicians. Private industry often pays higher salaries for a given individual than the school system. If economy is approaching full employment, higher salaries will be necessary to attract qualified people into the school system. However, this problem is minimized in developing countries, as the much more serious problem of a lack of employment opportunities for school graduates often exists. For example, Blaug, Layard, and Woodhall (1969) estimated that there were 0.5 million unemployed graduates in India in 1967.

Type of Student as Basis for Average Cost Measurement

One other problem in the measurement of costs on a per student basis is the type of student to be considered. Should costs be evaluated in terms of students enrolled, students completing a given grade level, or students completing or graduating from some fixed educational cycle? This problem could be especially acute. Suppose, for example, that there is a choice of two alternatives to reach some objective: one alternative is cheaper in terms of the average costs per enrolled student, while the other alternative is cheaper in terms of the average cost per graduating or completing student. Apparently, there is some factor in the former system that produces a higher dropout rate.

One possibility is to reinvestigate the alternatives and determine if there is a way of modifying the factor that results in higher dropout rates. If modification is not possible, then a decision must be made regarding the worth to society or to the individual of an incomplete education compared with the worth of a certificated complete education. If little value is placed upon the incomplete education, the alternative with the lower costs per graduate is likely to be highly preferable. These relative values may be caused by employer preferences that place undue emphasis on certificates rather than on knowl-

edge. Critics of schooling, such as H. Gintis (1971) and Carnoy (1974b), have argued that future employment opportunities depend upon factors other than course content. Completion of a course may demonstrate a personality trait that employers find more desirable than the student's actual knowledge.

A difficulty in defining student classification was encountered in the analysis of costs of Stanford's television system for continuing education undertaken by Wells (1975a) and Jamison, Klees, and Wells (1976). In this situation, there were students enrolled for the class who would receive credit and auditors who paid a small fee to receive related printed materials and could view the course. Owing to the large number of auditors (approximately 30 percent of total enrollment), the decision on whether or not to include auditors in the cost estimates had profound effects on the costs per student.

This problem of differentiating between types of students is also very relevant and perhaps more important in a discussion of nonformal education and the use of media. In most instances of the use of radio for rural education or information dispersion, there is no formal program. For example, the major purpose of the radio rural forms in India (Schramm, Nelson, Odell, Vaizey, and Spaulding 1967c) was the dissemination of agricultural and other community development information to rural areas, with members of forums discussing the broadcast and possibly deciding upon some action. However, while the impact upon forum members may be measurable, the broadcasts are over open radio waves, and anyone with a set may listen in. If there is any impact upon nonforum listeners, then it may be desirable to estimate costs on some basis other than the number of forum members.

Nonregistered or nonmember listeners probably occur frequently in any situation in which broadcast is over open air waves (television or radio) and segments of the population have access to receivers. However, in those cases where the broadcasts are part of a degree or certificate program, the problems of differentiation are less pronounced since rewards are more likely to accrue to program completers.

Included and Excluded Costs

The selection of costs that adequately represent the project is another problem in cost analysis. One example of this type of problem is teacher costs. In Colombia (Comstock and Maccoby 1966; Lyle, Germancos, and Torfs 1967), Peace Corps volunteers served many functions, including teaching. While the Colombian government did not pay their salaries, a complete picture of the costs of the television system would probably involve some estimation of these costs. This same situation occurs with many of the television systems in the United States used for continuing education. Many of these systems broadcast already established university courses. Since the television students

are added, the cost of teachers is often not included, as it would not be relevant to decision makers at the university in terms of the television system. However, for others wishing to know the costs of the system, it is necessary to include these costs. As Jamison, Klees, and Wells (1976) demonstrated for the television system at Stanford University, the inclusion of teacher costs made a substantial difference in terms of average costs per student. As an example, in one of their estimates, average costs per student hour were $6.11 with teacher costs excluded and $9.06 with teacher costs included.

As Jamison, Klees, and Wells (1976) pointed out, another problem is the choice of a cost to associate with teachers. If there is a shortage of teachers, then the salaries actually paid may understate the true resource cost to society, as persons who could teach are in higher paying employment. If an excess of teachers exists, the salary paid may overstate resource costs.

As technology projects are usually part of larger educational systems, there are many other costs that clearly are not part of the technology project. Costs of buildings and central administration, for example, when excluded from the analysis will result in an understatement of replication costs for countries that must establish an administration and construct buildings.

Financing

An additional problem particularly relevant to developing countries is the financing of the project. While estimates of total costs are necessary, the costs to the government itself are particularly important, especially because of the large degree of outside financing obtainable for some of these projects. In El Salvador, in addition to a grant, a loan was obtained for the television system. An analysis of the costs of the project by Jamison, Klees, and Wells (1976) revealed that, while in the earlier years of the project, the average costs per student were much lower for the government of El Salvador than the average costs per student for the entire project, in the later years, these costs were higher for the government than for the project. This change was caused by financing the project with a loan in the early years of the project and repaying the loan in later years. This indicates the importance to a developing country of taking a long-term view of the project, as financing that may make a large-scale technology project very attractive in the earlier years may turn it into a white elephant in the future if the financing must be repaid.

Comparability

Finally, while the cost experiences of a given country or for a given technology project may be estimated (and the precision of the estimate depends

upon the ease with which cost information may be gathered), these costs only provide a guide to planners in other countries who wish to consider some technology as an alternative means of providing education. Differences among countries in salary structure, availability of personnel, maintenance problems, and geographic disperson of the population to be served all result in significant cost variation from one country to the next.

COST METHODOLOGIES

Four cost methodologies (or models) are discussed here: component cost analysis, annualized cost estimates, time structure of costs and utilization, and opportunity cost analysis. Component cost analysis is undertaken by assuming characteristics of a hypothetical school system and using manufacturers' costs. Annualized cost estimates are calculated by summing the recurrent costs in a given year of a project with an annualized value of capital equipment in use. For this methodology, an interest rate and life of capital must be assumed. The third methodology, time structure of costs and utilization, is conducted by specifying actual expenditure commitments (whether capital or recurrent) and utilization in each year of the project from which projections may be made. This methodology is useful for technology systems, as expenditures are high and utilization is low in early years of the project. The annualized cost methodology would result in overestimation of average costs. The final model, opportunity cost analysis, is undertaken to determine the other educational investments that may be made if the technology project had not been undertaken.

Component Cost Analysis

The first methodology discussed involves estimates of costs of technology systems derived from manufacturers' cost estimates and based upon a variety of system parameters that may not necessarily be related to specific conditions that exist within any country. Most of the analyses in this section were undertaken for the United States and only provide a very rough guide for developing countries. For example, J. G. Miller (1970) provides very rough estimates of costs per student-hour for a variety of instructional media, including conventional instruction in large lecture and small discussion groups, printed materials, radio, four types of television, computer instruction, and standard classroom audiovisual aids. These costs are included in Table 6.1. The ranges provided for these estimates are so wide as to become nearly useless for planning purposes. For example, the estimate for instructional radio varies from $.01 to $1 per student-hour. This is a thousandfold increase from the low

end estimate to the high end estimate and is probably indicative of wide variations in utilization levels. (In one of the other methodologies to be discussed, it will be seen that these high end estimates may reflect the average costs faced by a country if a project is terminated in its early years when investment is high and utilization levels are low.)

While computerized instruction is not particularly relevant to developing countries due to the cost of the system, the estimates provided by Miller appear to be too high. Hayman and Levin (1973) provide more detailed estimates of computerized instruction that are much lower on a per student-hour basis. Interestingly, the costs are fairly consistent regardless of the size of the system. The estimated cost for existing eight terminal systems is $.91 to $1.60 per student-hour, for an existing 32-terminal system, the costs are $.90 to $1.45, and for a 4,000-terminal prototype, the costs are $.84 to $1.44.

In all of these estimates, the average yearly utilization per terminal was assumed to vary from 1,584 to 2,832 hours per year. The average school day in the United States is 6 hours with 180 days in the school year, a total of only 1,080 instructional hours. So it is clear that in these estimates longer school years or days were assumed. If the system were used 260 days per year for 10 hours per day, this would result in only 2,600 instructional hours, which is still

TABLE 6.1

Cost Range Estimates of Different Instructional Media (in dollars)

Medium	Estimated Cost per Student-Hour
Conventional	
Class lecture	0.15–3.00
Small discussion group	0.50–15.00
Printed	
Books and journals	0.05–10.00
Printed programmed instruction	0.05–10.00
Radio	
Instructional radio	0.01–1.00
Television	
Broadcast ITV (live)	0.02–10.00
Closed-circuit ITV (live)	0.03–3.00
Broadcast ITV (taped)	0.01–5.00
Closed-circuit ITV (taped)	0.03–2.00
Other	
Other standard audio visual aids	0.05–8.00
Computerized programmed instruction	2.00–25.00

Source: Miller 1970, p. 1013.

lower than the high estimate. However, these estimates are still in the range of other estimated costs of computer assisted instruction. Ball and Jamison (1973) estimated a range of costs from $.84 to $3.60 (using satellite distribution), which varies with the total utilization.

The General Learning Corporation (1968) study summarized by Sovereign (1969) also provides approximate cost estimates for instructional media. In this study, a variety of populations over a variety of areas were assumed. Cost estimates are presented in Table 6.2 for some of the television alternatives and the radio alternative. The variety of television alternatives result from different transmission options. These include airborne television, similar to the system used in the Midwest (see Ivey, Perry, and Bohnhorst 1967); satellite television, currently being used in the United States and being proposed for India and Brazil (see Butman, Rathjens and Warren 1973); Instructional Television Fixed Service, (which broadcasts over very high frequencies and requires some means of downconverting the signal to a standard receiver [see Wells 1975a; Jamison, Klees, and Wells 1976, for an analysis of one of these systems]) closed-circuit television (the Washington County school system is closed-circuit in that all schools are connected to the studio via cables (see Wade 1967; Wells and Klees 1976; Jamison, Klees, and Wells 1976, for studies of this system); and ultra high frequency television. The five districts in the General Learning Corporation study have the following characteristics:

Local—15,000 students in 80 square miles
14 elementary and 4 secondary schools
City—150,000 students in 80 square miles
136 elementary and 46 secondary schools
Metropolitan—600,000 students in 1,500 square miles
546 elementary and 183 secondary schools
State—1 million students in 40,000 square miles
920 elementary and 310 secondary schools
Regional—10 million students in 550,000 square miles
9,200 elementary and 3,100 secondary schools

Costs were estimated separately for production, transmission (distribution), and reception and were based upon an assumption of 1,000 hours per year of broadcast time (approximately 10 percent of total instructional time to an individual student). Costs were presented on an average per student per year measure. For the presentation in Table 6.2, it was assumed that the average student received 100 hours per year.

As would be expected, the production costs are the same for all television transmission choices for a given school population, and as the school population increases, the production costs decrease from $0.18 per student per hour for the local model to $0.005 for the regional model.

TABLE 6.2

Cost Estimates of Instructional Media by Size of Population Served (per student hour in dollars)

	Local	City	Metropolitan	State	Region
Airborne television					
Production	—	—	—	0.02	0.005
Transmission	—	—	—	0.03	0.015
Reception	—	—	—	0.06	0.06
Total	—	—	—	0.11	0.08
Instructional television fixed service					
Production	0.18	0.03	0.025	0.02	0.005
Transmission	0.065	0.015	0.01	0.01	0.015
Reception	0.075	0.065	0.06	0.06	0.06
Total	0.32	0.11	0.095	0.09	0.08
Satellite television					
Production	—	—	—	—	0.005
Transmission	—	—	—	—	0.02
Reception	—	—	—	—	0.055
Total	—	—	—	—	0.08
Ultra high frequency television					
Production	0.18	0.03	0.025	0.02	0.005
Transmission	0.18	0.02	0.010	0.04	0.035
Reception	0.06	0.06	0.06	0.06	0.06
Total	0.42	0.11	0.095	0.12	0.10
Closed-circuit					
Production	0.18	0.03	0.025	0.02	0.005
Transmission	0.10	0.025	0.025	0.06	0.065
Reception	0.06	0.055	0.05	0.05	0.050
Total	0.34	0.11	0.10	0.13	0.12
Radio					
Production	0.035	0.01	0.01	0.01	0.005
Transmission	0.02	0.005	0.005	0.01	0.01
Reception	0.03	0.02	0.015	0.02	0.015
Total	0.085	0.035	0.03	0.04	0.03

Dashes indicate that data were not provided in source.

Source: General Learning Corp, 1968, with assumption of 100 hours per student per year.

Radio is cheapest for any population size but has its biggest advantage for the local model, which is consistent with the increased emphasis on radio for rural development in developing countries (see McAnany 1973; Hornik, Mayo, and McAnany 1973, for more detailed discussions of the role of radio in rural development). However, the estimates for radio for large populations of $0.03 per student hour seem high. Estimates for the radio system in Thailand (Schramm [1973a] estimates an approximate cost of $0.02 per student-hour for 1 million students) are considerably lower.

From a more detailed version of a linear cost function (discussed below), Jamison, Klees, and Wells (1976) estimated costs of 7.17¢ per student-hour for television and 1.96¢ per student-hour for radio. They assumed a population of 200,000 students receiving 120 instructional hours per year and living in an area of approximately 31,400 square miles. These population assumptions are probably more realistic for the nonurban areas of developing countries.

Annualized Cost Estimates

The most common method for analyzing the costs of a project is to estimate the recurrent expenditures in a given year of the project for items such as teacher salaries, maintenance, and so on from ministry of education budgets or to make approximations based upon the given educational structure. A value is placed upon the capital equipment and the buildings, and a yearly charge equivalent to the value of the equipment divided by the estimated life of the equipment is calculated to cover depreciation. In addition, the value of the capital is multiplied by an interest rate to represent the cost to society of keeping financial resources tied up in some piece of equipment.

This interest rate may be considered to be a social discount rate in that it represents a trade-off between future and current consumption. To some extent, the interest rate represents the cost of the financial capital that is tied up, as this interest may be earned on other investments in society. In countries with a private marketplace, the interest rate on alternative investments is more easily calculated. For example, suppose that an interest rate of 0 percent is used. This would indicate that a country would be indifferent between spending $X on a piece of equipment with a life of n years and spending X/n dollars per year for the next n years. This is clearly not the case, as the money could be placed in a bank in the first year to earn interest and withdrawals could be made to cover the yearly payments. In this manner, the capital equipment would be paid for, and due to the bank interest rate, there would be money left at the end of the total time period.

It should be stressed that the interest rate or social discount rate is not related to the existence of a private market economy and is an important policy variable used to determine the relative trade-offs between present and future

consumption, especially for projects where the benefits and costs do not necessarily coincide in the same time period. This is certainly the case for education, wherein the benefits to society from investment in education may not be realized for several years after the investment is made. As the choice of an interest rate is partially determined by alternative investments, decisions on reinvestments of dividends, and social policy, it is usually preferable to undertake the analysis for several interest rates.

The cost analyses in the International Institute for Educational Planning educational technology case studies included a cost for capital calculated by straight-line depreciation of the value of the equipment (as discussed above), plus a national interest rate of 3 percent to cover the social discount rate involved in having the financial capital tied up in the project. However, since the value of the capital is constantly depreciating, applying an interest rate to the original value of the capital equipment will overstate the cost of finance capital in later years of the project. It is preferable to use an annualization factor, as derived by J. G. Kemeny, A. Schleifer, J. L. Snell, and G. L. Thompson (1962), which takes account of the depreciating value of the capital and results in a constant cost to be assigned to each year of the project. The annualization factor a(r,n), where r is the social discount rate and n is the life of the piece of equipment, is given by:

$$a(r,n) = [r(1 + r)^n]/[(1 + r)^n - 1] \tag{6.1}$$

When r approaches zero, the annualization factor approaches 1/n. Table A.1 (see Appendix) provides some of these annualization factors for a variety of interest rates. These annualization factors may be combined with component cost analysis and project information to derive a total cost function for an approximation of the costs of technology systems. This technique was utilized by Jamison, Klees, and Wells (1976), and their analysis is presented below.

Determinants of Total Cost

In constructing the total cost function below, it is assumed that total costs can be written as the sum of central costs, programming costs, transmission costs, and reception costs. This assumption, though convenient, is restricting as it fails to allow for trade-offs between transmission and reception costs. These trade-offs play a central role in assessing the economic desirability of satellite transmission.

Total costs, TC, are then given by:

$$TC = C_C + C_P + C_T + C_R \tag{6.2}$$

where subscripts C, P, T, and R refer to central, programming, transmission, and reception, respectively. Our approach to specification of TC will be to examine each of the component cost functions in turn. For all capital expenses, the annualization factor, a(r, n), is used.

Central Project Cost Function

Project planning and startup costs are important aspects of total costs and should be annualized over the entire project lifetime. Additionally, technology projects may require special administration costs that are distinct from administration costs for the educational system. These costs, the central project costs, are given by:

$$C_C = a(r, n)\, C_{SU} + C_{CA} \tag{6.3}$$

where r is an interest rate;
n is the life of the project,
C_{SU} is the project startup cost, and
C_{CA} is the annual central administration cost.

Programming Cost Function

The programming cost function is a more complicated formulation than the other equations, as the capital expenses for production facilities and equipment are annualized over the life of the program. The function is given by:

$$C_p = a(r, n_p)\, [a(r, n_{PE})\, C_{PE} + a(r, n_{PF})\, C_{PF} + C_{PA}] \tag{6.4}$$

where n_p, n_{pe}, and n_{pf} are the lifetimes of the program, the production equipment, and the production facility, respectively; C_{PE} and C_{PF} are capital costs for the production equipment and the production facility, respectively; and C_{PA} is annual production cost.

It should be recalled that all programming costs are related to the number of programming hours. An alternative technique would be to summarize these costs into a single per-hour production cost, C_{Ph}. We would then have:

$$C_p = a(r, n_p)\, C_{Ph}\, h \tag{6.4a}$$

This equation assumes a target audience with a single language and little cultural diversity. Multiple languages and cultural diversity could require alterations of program content for different groups.

Transmission Cost Function

The transmission cost is given by:

$$C_T = a(r, n_{TE})\, C_{TE} + a(r, n_{TF})\, C_{TF} + C_{TA} \tag{6.5}$$

where n_{TE} and n_{TF} are the lifetimes of the transmission equipment and transmission facility, respectively; C_{TE} and C_{TF} are the capital costs of the transmission equipment and transmission facility, respectively; and C_{TA} is the annual transmission cost.

The costs vary with the size of the region to be served. More detail could be included in the equation by assuming more than one region with different transmission requirements. There would then be a single equation 6.5 for each region and total transmission costs would be obtained by summing the equations for all regions.

Reception Cost Function

In writing the reception cost function, we must take account of receiver capital and maintenance expenses, power equipment and operating expenses, and printed materials cost. The reception cost function is given by:

$$\begin{aligned} C_R = {} & a(r,n_R)\, N/_k\, C_R' + a(r,n_{RE})\, SC_{RE} + a(r,n_{RF})\, SC_{RF} \\ & + a(r,n_{EE})\, eSC_{EE} + [(l\text{-}e)\,(h/2)\, c_p + e(h/2)\, c_p' + C_{RM}]\, N/_k \\ & + a(r,n_b)\, Nb\, C_b \end{aligned} \tag{6.6}$$

where n_R, n_{RE}, n_{RF}, n_{EE}, and n_b are the lifetimes of the receiver, other receiver-related equipment, the reception facility, power-generating equipment for the reception facility and printed materials, respectively,

C_R', C_{RE}, C_{RF}, C_{EE}, and C_b are capital costs of the receiver, receiver-related equipment, the reception facility, the power-generating equipment and printed material, respectively,

c_p, c_p', and C_{RM} are hourly costs of electric power from power lines, electric power from power generating equipment, and maintenance, respectively,

N is the number of students served by the system,

k is the number of students sharing a receiver,

S is the number of reception sites,

e is the fraction of reception sites located in areas not served by power lines,

h is the number of hours of programming each year, and

b is the number of pages of printed material for each student.

More detail could be included in the reception cost equation by allowing for some variation in reception sites. The difference in costs among sites may be small for related equipment but could be larger for power costs.

$$TC = C_p + C_P + C_T + C_R \tag{6.2}$$

$$C_C = a(r,n)\ C_{SU} + C_{CA} \tag{6.3}$$

$$C_p = a(r,n_p)\ [a(r,n_{PE})\ C_{PE} + a(r,n_{PF})\ C_{PF} + C_{PA}] \tag{6.4}$$

$$C_T = a(r,n_{TE})\ C_{TE} + a(r,n_{TF})\ C_{TF} + C_{TA} \tag{6.5}$$

$$\begin{aligned} C_R = {} & a(r,n_R)\ N/_k\ C_R' + a(r,n_{RE})\ SC_{RE} + a(r,n_{RF})\ SC_{RF} \\ & + a(r,n_{EE})\ eSC_{EE} + [(1\text{-}e)\ (h/2)\ c_p + e(h/2)\ c_p' + C_{RM}]\ N/_k \\ & + a(r,n_b)\ Nb\ C_b \end{aligned} \tag{6.6}$$

Table 6.3 presents an example of these functions for a radio and television system. The results of this example are as follows:

Cost Element	Radio	Television
C_C	$ 89,400	$ 109,400
C_P	140,870	383,617
C_T	140,579	408,768
C_R	102,465	821,742
TC	473,314	1,723,527
$TC/_N$	2.36	8.61
$TC/_{120N}$	.0196	.0717

The costs for a television system serving 200,000 students for 120 hours per student are 3.65 times higher than costs for radio serving a similar group.

The total cost function can be put in the simple format of $TC = F + V_N N + V_h h$. Assuming central costs to be fixed, production, transmission, and reception power hourly cost to vary with the number of hours and reception costs (with the exception of hourly power costs) to vary with the number of students, we have the following equations:

$$\text{Radio: } TC = \$\ 89{,}400 + 562.89\ h + 0.51\ N \tag{6.7}$$

$$\text{Television: } TC = 109{,}400 + 1{,}584.88\ h + 4.10\ N \tag{6.8}$$

The total cost equation is a simplistic representation of the actual estimation that must be incorporated into determining a cost function. If we vary the number of hours and amount of printed materials by student type, the equation becomes more complicated. If different geographic regions of the country

require different transmission facilities due to variations in terrain or different receiver equipment due to variations in power availability, the equation becomes more complicated.

Each component, such as the gross figures used for the capital costs, is really made up of several subcomponents, such as technical personnel, installation, operation, and building, which may vary by the type of student served and the quality of a given program. The equation merely provides a guide for the construction of cost functions. The assumption of linearity may not hold for all expansions of the system. As the cost estimates from the General Learning Corporation (1968) study show, the assumption that average cost constantly declines (which is part of the assumption of linearity) does not hold for all expansions with a given means of transmission. For example, the average costs associated with closed-circuit and ultra high frequency television declined and then increased as the number of students to be served increased.

As with the other cost methodologies, it is possible to use the annualized cost method in applications to both formal and nonformal systems. Most of the results reported below are for formal school projects, including those using radio. Estimates of costs of radio and television projects are presented in Table 6.4 with data from the example in Table 6.3, the case studies analyzed by Jamison, Klees, and Wells (1976), the International Institute for Educational Planning series of cases (1967), and other project source material. The following information is included in the table: number of students, number of hours, average cost per student, average cost per student hour, some information regarding the components of the cost analysis, and references of source materials that include much more detailed discussions of the projects.

For El Salvador, it was possible to estimate the total costs of the project and the costs to the government of El Salvador separately. In the table, the costs to the government are less than the total costs. However, this is not the case in later years of the project, and this is the one aspect of the usefulness of the cost methodology discussed in the next section.

The cost estimates taken from Jamison, Klees, and Wells (1976) are based on a social discount rate of 7.5 percent and calculated in 1972 U.S. dollars using the annualization factor, a(r,n). Those additional cases for which annualization is not possible will be noted. Once again, it is important to emphasize that the cost estimates are sensitive with respect to the value used for the social discount rate. Obviously, as the percentage of costs that are capital in nature and hence subject to the annualization calculation increases, the sensitivity of the cost estimate to the discount rate chosen increases.

Only those costs directly associated with the projects are included. Therefore, one could not conclude that if television or radio were used for instruction, the total costs of the educational system could be calculated from Table 6.4 or from the estimates in the Table 6.3 example. Important costs, such as building, transportation, food or housing services for the students, and class-

TABLE 6.3

Example Values of Cost Components

Variable	Assumed Value for Radio	Assumed Value for Television
N (number of students)	200,000	200,000
h (total hours of programming)[a]	500	500
G (area of region)	31,400 square miles (100-mile radius)	31,400 square miles
b (printed pages per student)[b]	200	150
k (students per receiver)[c]	70	70
e (fraction nonelectrified)	—	0.50
S (number of reception sites)[d]	1,430	1,430
C_{SU} (startup costs)[e]	$300,000	$300,000
C_{CA} (annual central administration cost)[f]	$60,000	$80,000
C_{PF} (production facility capital cost)[g]	$230,000	$2,316,000
C_{PE} (production equipment capital cost)[h]	$160,000	$1,571,428
C_{PA} (annual production cost)[i]	$320,000	$540,000
C_{TE} (transmission equipment capital cost)[j]	$480,000	$1,570,000
C_{TF} (transmission facility capital cost)[k]	$25,500	$26,000
C_{TA} (annual transmission cost)[l]	$68,000	$177,000
C_R' (receiver capital cost)[m]	$20	$200
C_{RE} (receiver-related equipment capital cost)[n]	—	$320
C_{RF} (reception facility capital cost)[o]	$40	$1,100
C_{EE} (power generating equipment capital cost)[p]	—	$3,300
c_P (hourly cost of power from power line)[q]	—	$.05
c_p' (hourly cost of power from power-generating equipment or batteries)[r]	$.025	$.186
C_{RM} (annual receiver maintenance cost)[s]	$2	$20
C_b (printed page cost)[t]	$.005	$.005
$n, n_{PF}, n_{TF}, n_{RF}, n_{EE}$ (lifetime of project and production, transmission, reception facilities, and power generating equipment)	20	20
n_p, n_b (lifetime of programs and books)	3	3
n_R (lifetime of receiver)	5	5
n_{PE}, n_{TE}, n_{RE} (lifetime of production, transmission + receiver-related equipment)	10	10
r (interest rate)	7.5%	7.5%

Notes to Table 6.3

[a]Programming is assumed to be provided for 10 percent of the total instructional time of 1,260 hours (35 hours per week for 36 weeks) for students in four different grades.

[b]Radio is assumed to require more printed materials in conjunction with broadcasts than television, due to the lack of the visual channel.

[c]Each receiver may be used by two classes with an average class size of 35.

[d]It is assumed that there is only one class for each of four grades at each reception site.

[e]Startup costs are expected to be the same for both types of systems. The cost includes basic project planning, feasibility study, and cost analysis costs. The startup costs were $335,000 in Nicaragua. These costs were probably unusually high because of the unusual nature of the project (primary school mathematics via radio with 40 to 50 student responses per 20-minute lesson).

[f]Project central administration is costing $60,000 in Nicaragua for radio and $80,000 in the Ivory Coast for television.

[g]The production expenses are based upon El Salvador, which has been

[h]averaging approximately $2,900 per hour for television broadcasting.

[i]Radio production expenses are based upon the recurrent expenses for Nicaragua and an estimate of equipment expenses, which are 10 percent of those required for television. Schramm, Nelson, Odell, Vaizey, and Spaulding (1967b) estimate a cost of $250 per hour for radio in Thailand and the 10 percent assumption will keep the relative estimates for production costs similar to project experiences.

[j]Mayo, McAnany, and Klees (1975) report that a transmission system to cover 100,000 square miles for television in Mexico would cost $2,100,000. R. C. Butman (1972) estimates that under the best circumstances transmission for television would cost $35 per square mile. A figure of $50 per square mile is used. The VERTA project in the Philippines (Bourret 1973) spent $20,000 for a 5-kilowatt transmitter and $20,000 for a 10-gain antenna capable of covering a 50-mile radius. Radio transmission costs are based upon the General Learning Corporation (1968) study. Costs are approximately one third of the costs of television. This is fairly typical even at lower power ratings. For example, Jamison with Bett (1973) quote prices of $2,500 for a 10-watt FM transmitter and $5,000 for a 5-watt television transmitter.

[k]Facility expenses include a building for transmission equipment assumed to be 500 square feet, at $50 per square foot, and installation expenses of $500 for ratio and $1,000 for television.

[l]Annual expenses are assumed to include 10 percent of equipment investment for maintenance expenses and salaries of $20,000 for four engineers and technicians.

[m]Higher prices are assumed to ensure good quality receivers. It is possible that these values should be $10 for radio receivers (Jamison with Bett 1973) and $150 for television receivers (list price for receivers in the United States).

[n]Radio receivers do not usually need any antennas. The figure for television receivers is derived from the expenditure in the Ivory Coast.

[o]Building modifications are assumed to cost $20 per classroom for radio and require $150 per classroom for television (including a stand) and $800 for installation. These estimates are derived from Jamison with Bett (1973).

[p]No electrical power equipment is necessary for the radio system. For the television system, an 800-watt vapor turbogenerator costing $1,500 is assumed to be used. This would be ample power to provide electricity for two sets, as the watt requirement per set is only 60. The extra power could be used for lighting. A 1,000-gallon storage tank would cost $800 and an additional $1,000 is assumed for installation.

[q]Mainline power is assumed to cost $0.10 per kilowatt hour (Jamison with Bett [1973] use $0.06 and the cost in the Ivory Coast [Chapter 10] is approximately $0.11). The power requirement is assumed to be 500 watts per hour of operation.

[r]Batteries for radio are assumed to have a 40-hour life and cost $1 to replace. The hourly operation for the television system includes maintenance at $0.011 per hour and diesel fuel at $0.175 per hour.

[s]Maintenance for receivers is assumed to cost 10 percent of total purchase price.

[t]This number is based upon printing costs obtained from a printer in Taipei.

Source: Jamison, Klees, and Wells 1976.

room teachers' or monitors' salaries, have been excluded. The cost of printed materials also has been excluded. As a further attempt to keep the cost calculations fairly consistent, the following lifetimes were assumed for capital equipment directly associated with the project: 20 years for buildings and development costs, 10 years for production and transmission equipment, and 5 years for receiver equipment. Additionally, cost estimates were adjusted for inflation in the United States. While this procedure may not provide an adequate representation of actual situations in a given country it results in a fairly consistent approach to all of the projects.

Even with all of these controls, one must still be apprehensive of direct comparisons between projects due to variations in population densities and other factors that are exogenous to the technology system. Factors within the control of project management, such as complexity of the broadcast, may also result in large cost variation. One would expect large variations in cost between production that utilizes straight lectures by an instructor and production that involves dramatization, animation, set design, and so on. Jamison, Klees, and Wells (1976) reported hourly production costs ranging from $100 (straight lecture) to $3,700 (professional production) for television and $100 to $1,200 for radio. It is because of these variations in costs for production quality that the archdiocese of San Francisco has decided to lease programs from national supply sources rather than produce its own programs for its Instructional Television Fixed Service system.

Interestingly, most projects rely upon their own production. This procedure has some rationale for different countries where cultural differences make user-directed programming more relevant. Few school districts are engaged in producing their own textbooks, and as utilization of media increases, one may expect to see more production by outside sources. Yet there are subgroups within countries, and locally aimed programming, although more expensive, may be much more useful. Schmelkes de Sotelo (1973) and Spain (1973) wrote of the need to make the instruction utilizing radio transmissions more relevant to rural communities. Costs in some instances may be affected by attempts to vary program content to meet different needs, although this is rarely if ever, the case.

Estimates from different researchers for the same project have been included in some instances in Table 6.4. The information in column 7 hopefully will reveal the causes for any difference in these estimates. In terms of comparability, these problems are further compounded when it is not possible to determine all of the cost assumptions underlying an analysis. This is the situation with many of the International Institute for Educational Planning (1967) technology cases. A cost for production may be mentioned without a complete description of the items included in that estimate. As much information as possible regarding these assumptions has been included in the Table 6.4. However, in situations where the system has not stabilized (for example,

TABLE 6.4

Summary of Average Costs for Several Technology Projects (in dollars)

Country	Year of Cost Estimate	Number of Students	Number of Hours per Student	Average Cost per Student	Average Cost per Student-Hour	Other Information	Reference
ITV Projects							
Example		200,000	120	8.61	0.0717		
Samoa	1972	8,100	145	159.60	1.10	This estimate is close to recent estimate by Schramm (1973b), even though his methodology is different. Based on proportion of time television is used for school, he allocated one tenth of capital cost plus one tenth of interest compounded at 6 percent for 10 years to each year of project. 1965 estimate is based on Schramm, Nelson, Odell, Vaizey, and Spalding (1967a). Data with different handling of lifetimes and amortization. His estimates would be $357/student, $0.98/student-hour.	Schramm, Nelson, Odell, Vaizey, and Spaulding (1967a) and series of recent reports of Institute for Communication Research (1972)
	1965	6,600	365	291.76	0.80		
El Salvador							
Total: secondary	1972	48,000	170	24.35	0.143	Speagle (1972) estimated a cost of $16/student. The difference is due in large part to Speagle's use of a 0 percent interest and exclusion of many startup costs. Carnoy (1973) also reevaluated Speagle's estimates and calculated an average cost of $21.60. (These two estimates are analogous to the 1972 total secondary costs.)	Speagle (1972 and extensive series of reports by Institute for Communication Research (1972). Jamison, Klees, and Wells (1976) provided estimates for planned costs.
Government of El Salvador secondary	1972	48,000	170	17.75	0.104		
Total: secondary and elementary	1980	990,000	170	2.88	0.017		
Government of El Salvador secondary and elementary	1980	990,000	170	2.56	0.015		
Ivory Coast	1980	745,000	170	7.27	0.040		Planning documents summarized in Chau (1972)

(continued)

TABLE 6.4 (Continued)

Country	Year of Cost Estimate	Number of Students	Number of Hours per Student	Average Cost per Student	Average Cost per Student-Hour	Other Information	Reference
Washington County Maryland	1972	22,000	117	54.23	0.46	The estimates presented here are drawn drawn from yearly cost estimate of the reference.	Wells and Klees (1976)
	1965	20,466	145	46.79	0.32	Wade (1967) estimated a cost of $40.82/student and $0.26/student-hour for 1965. However, he used 20,853 students and 3.3 million student-hours and handled capital costs differently. Additionally, the other estimates of total capital and operating costs are slightly higher.	Wade (1967)
Colombia	1965	275,000	50.25	3.13	0.062	The estimate by Lyle, Germancos, and Torfs (1967 is considerably higher at $3.53/student and $0.07/student-hour.	Lyle, Germancos, and Torfs (1967); Comstock and Maccoby (1966)
Mexico	1972	29,000	360	24.85	0.069		Mayo, McAnany, and Klees (1975)
Korea		100,000	70	19.83		Project data for costs and plans for enrollment.	Jamison, Klees, and Wells (1976)
Peru	1965	2,100	78	49.38	0.63	This system provided formal education on primary levels and literacy and community development for adults.	Lyle, Germancos, Kahnert, and Torfs (1967)
Ivory Coast	1965	1,220 (estimate of enrollees)	89 (estimate)	386.55	4.34	A program for literacy training to worker near Abidjan. Very high dropout rates (55 percent).	Kahnert, Capelle, and Navaux (1967)
IR Projects							
Example		200,000	120	2.36	0.0196		
Thailand	1967	800,000	25	0.347	0.014	These estimates are close to estimates by Schramm, although he used different capital lifetimes and seemed to underestimate utilization. For example, in the 1972 estimate, he assumed only 8 hours/student, although the course schedules indicated higher utilization.	Schramm, Nelson, Odell, Vaizey, and Spaulding (1967b)
	1972	1,000,000					Schramm (1973a)

Mexico	1973	2,800	233	13.57	0.058		Spain (1973)
Indonesia	Planning model	1,200,000	100	0.41	0.0041		Jamison (1971)
Nicaragua		10,000	50	21.00	0.42	The estimates are from a planning model. The costs are very high due to high programming costs.	Jamison, Klees, and Wells (1976)
Togo	1965	1,438 (estimate of participants)	120 (estimate)	59.89	0.49	Radio rural forum. This estimate is extremely tenuous since utilization was only approximated and the radio forums were charged a percentage of costs of the radio network.	Kahnert, Capelle, Lyle, and Navaux (1967)
Honduras	1965	6,740	78	12.80	0.16	Radio for rural education—literacy and fundamental.	Lyle, Martins, and Torfs (1967)

Source: Compiled by the author.

expanding student enrollments), these summary costs may be misleading. In those instances, the methodology discussed in the following section is preferable.

As is to be expected, the cost estimates presented in Table 6.4 differ from some of the original cost estimates because of the difference of methodologies used in handling the data.

Some interesting patterns do emerge from the analysis. In looking at the average costs per student for television from several countries, one notices a fairly consistent pattern of declining average costs with increased utilization. This pattern emerges even though the estimates are from several different countries. The higher cost for the Hagerstown project as opposed to the Mexico project is probably due in large part to salary differentials for television teachers and other personnel. These cost differences might have been reduced if some attempt had been made to control for salary differentials among countries.

In looking at the multiple estimate for some of the countries, some other interesting points may be mentioned. In Samoa, the 1965 estimate for 6,600 students and 345 hours per student was $291.76 per student and $0.80 per student-hour. By 1972, enrollments had increased to 8,100 students, but the hourly utilization dropped sharply to 145 hours per student. As is to be expected in a project with high capital costs, the average cost per student declined to $159.60.

In the estimates for El Salvador, there is a sharp decrease in average costs when enrollments increase from 48,000 in 1972 to the planned enrollments of 990,000 in 1980. The cost decreases from $24.35 per student and $0.143 per student-hour to $2.88 per student and $0.017 per student-hour are less than proportional to the increased enrollment because of the substantial amount of costs that vary with utilization. However, the overall costs decline since the fixed costs are spread over more students. The difference between project costs and costs to the government of El Salvador declines from 1972 to 1980 and, by the mid-1980s, the government's costs will exceed the project costs.

The cost estimates for Washington County, Maryland, reveal an interesting phenomenon: increased utilization with increased costs. The enrollments had increased slightly from 20,466 in 1965 to 22,000 in 1972, while costs had risen sharply from $0.32 to $0.46 per student-hour and from $46.79 to $54.23 per student. This increased cost is a result of sharply increased salary expense, which rose 50 percent after controlling for inflation (assumed to be 32 percent between 1965 and 1972).

An estimate for a literacy project using television in the Ivory Coast also is included in Table 6.4. These figures are approximate at best, but one is struck by the extraordinarily high cost. This cost of $386.55 per enrolled student may be expected from such a low enrollment. However, the dropout rate of approximately 55 percent would greatly increase this figure if only program completers were included.

The sharp contrast between formal programs and rural education programs is also evident in the cost analyses of radio. The tentative estimates of $59.89 per participant and $0.49 per participant-hour for the forums in Togo (1,438 participants) and $12.80 per enrollee and $0.16 per enrollee-hour for the rural radio program of Honduras (6,740 participants) are higher than costs for the formal school programs. The main reasons for this are the lower numbers of participants and the lower hourly utilization for nonformal programs. While there are only 2,800 students in schools using radio in Mexico and the average cost per student is $13.57, the schools in Mexico also have greater hourly utilization (233 hours per student during the year compared with 120 hours in Togo and 78 hours in Honduras).

Time Structure of Costs and Utilizations

Several limitations were mentioned in the estimates of costs in the methodologies discussed above: the inapplicability of component cost estimates to specific situations; the lack of transferability of cost estimates from one project to another because of variations in geography, program quality, and transmission quality; and the difficulty in choosing a social discount rate.

An additional problem in cost analysis is the fact that the investments and utilization of the equipment do not occur in the same time period. For this reason, calculation of average costs in the early years of a project results in astronomically high average costs. Since many of these projects involve expanding utilization over several years, it becomes increasingly important to develop a methodology that takes account of the time structure of costs and utilization. Furthermore, it is useful to have a methodology that reveals the average costs to the decision makers at different points in time. For example, heavy investment is usually expected during the first few years, while student utilization may not rapidly expand for several years. Prior to making a decision, it is critical to know how many years the project must continue in order for the costs to decline to levels that the decision maker may find acceptable. After the project has progressed for a few years, a decision on the continuation of the project may be in order. At this point, previous costs are sunk. The administrators need to look forward and determine what the expected average costs will be from the present point in time to the future.

The methodology described by Jamison, Klees, and Wells (1976) is an attempt to provide the framework for this type of analysis. The costs and utilizations for each year of the project are estimated. The costs in any given year are the commitment to expenditures in that year. Capital costs are not annualized but are included at full cost in the year the expenditure is made. Naturally, where these estimates are projected into the future, they are part of the educational plans and bad planning or misestimates (such as those brought out in the International Institute for Educational Planning case stud-

ies on cost analysis [Coombs and Hallak 1972]), and will not be rectified by this type of analysis. Since this methodology is directed more at the decision makers for a given project than the previous methodologies, it requires closer attention to the information that is provided for the cost estimates. The annualization method is really only a summary of a selected year in the project and does not necessarily provide the essential information to the decision maker: what will happen if the project is continued beyond the present point in time?

The cost functions of the previous sections give an approximation for average costs per student for an expansion of the system. However, these functions are approximations and the method described below, although it requires more care in predicting the future, is preferable. A primary advantage is that a specific form of cost function that fits all system possibilities is not necessary, although to derive the estimates in various years of the project it may be necessary to include cost function equations as part of the general planning procedure. Models relating the required amounts of technology inputs and the probable supply of these inputs should be incorporated into general models of student flow. Another advantage over the methodologies that incorporate annualization of capital costs is that it is possible for the administrator to determine what the costs will look like if the project does not last its planned end.

A summary average cost is calculated from the present year, year i, to some year in the future, year j. AC_{ij} is the average cost (per student, however defined, or per student-hour) from year i to year j. If we let C_k equal the cost in year k and N_k the number of students in year k (or number of graduates or number of student-hours), then

$$AC_{ij} = \frac{\sum_{k=i}^{j} C_k d_k}{\sum_{k=i}^{j} N_k d_k} \tag{6.9}$$

where d_k is a discount factor and $d_k = 1/(1 + r)^{k-i}$.

All costs and utilizations are discounted to the present using the social discount rate. This methodology places more emphasis on present than future costs and utilizations. The degree to which this emphasis is placed is measured by the social discount rate, r. If $r = 0$, then $d_k = 1$ for all k, and we are, in essence placing equivalent emphasis on future actions as well as present actions. With a zero social discount rate, the actual pattern of costs and utilization is irrelevant, and a project in which $C_1 = \$1$ million and $N_{20} = 1{,}000$ students is as preferable as a project in which $C_{20} = \$1$ million and $N_1 = 1{,}000$.

Under the present methodology, with some positive social discount rate, a project is preferable in terms of lower average costs, as costs are delayed further into the future and/or utilizations are brought more into the present. For a fixed pattern of costs, that project is preferable that serves the most students in the most rapid manner.

It would be incorrect to discount the average costs from each year of the project to obtain AC_{ij}. If we assume that costs and utilization are constant from year i to year j, such that $C_k = C_o$ and $N_k = N_o$ for all k, then:

$$AC_{ij} = \frac{\sum_{k=i}^{j} C_o d_k}{\sum_{k=i}^{j} N_o d_k} = \frac{C_o \sum_{k=i}^{j} d_k}{N_o \sum_{k=i}^{j} d_k} = \frac{C_o}{N_o} \tag{6.10}$$

As one would expect, the average cost from year i to year j with constant costs and utilization equals the average cost in any year. However, if the average costs in each year were to be discounted, then:

$$AC_{ij} = \sum_{k=i}^{j} \frac{C_o}{N_o} d_k = \frac{C_o}{N_o} \sum_{k=i}^{j} d_k \tag{6.11}$$

There is no reason to expect that the summation of the discount factors equals 1. In fact, the sum is likely to exceed 1, and the average costs will be overestimated.

As will be seen in the case studies presented below, the average costs decline from the beginning of the operation of the project owing to the large initial capital investments and low utilization that usually occur. However, after the first few years, the average costs are lower since the original capital investment is no longer taken into account in the methodology.

There are a few limitations to this methodology that should be mentioned. First, capital costs, once spent, are treated as totally sunk costs. That is, the equipment is assumed to have no recovery value, and it is obviously assumed that there is no market for used media equipment, even equipment that has been used for only one year.

It is possible to modify the methodology by making explicit treatment of these recovery costs. For example, suppose that all capital is purchased in year 1, then all AC_{ij} where $i > 1$ will not include these costs. To accommodate possible recovery costs for A_{2j} for example, we would assume a cost in year 2 equivalent to this recovery cost. The A_{2j}'s would then be higher than the original calculation, which had treated the capital costs as totally sunk. This

same procedure may be applied to other years for which a recovery cost for equipment is assumed possible.

A second limitation involves assumptions regarding the useful life of capital equipment. Traditional assumptions such as those made above are typically 5 years for receivers, 10 years for production and transmission facilities, and 25 years for buildings. In planning the time structure of the costs, it would seem to be necessary to plan to replace equipment after its useful life has been exceeded to obtain a realistic approximation to future costs. However, these are really average lives, and it may be possible to retain older equipment through maintenance. For example, a receiver does not totally wear out after five years, but some parts may need replacement during the second year while other parts may not need replacement for several years. The useful life of an entire piece of equipment is more of an accounting convenience that may be more related to U.S. tax regulations than to actual experience. For example, in the Hagerstown project there is still in existence a significant amount of equipment, including receiver and production equipment, that was purchased in the early years (1956–58) of the project. The transmission facilities are cables that the school rents, and it is likely that the cables do not totally wear out but require some type of maintenance.

However, in planning for the future, it is probably more convenient to assume replacement at the termination of the useful life of the equipment than to attempt to estimate when parts of equipment would need replacement. The latter prediction, while perhaps more difficult to make, will be a better representation of the situation that will occur. However, the danger is that one may become overly optimistic regarding the ability to maintain equipment rather than replace it. It is perhaps best to follow a more conservative procedure (which results in higher average costs) and assume replacement.

A third limitation is that the project is assumed to end in year j. This requires some definite decision as to the planning horizon. Obviously different values of j may be chosen and the AC_{ij}'s calculated. One possibility is to vary the value of j to determine in what year costs reach a level that seems reasonable and in what year the costs begin to reach some constant level. If the costs seem to be approaching a fixed level, then the problem is minimized.

The final limitation is that more information is required than in other methodologies. However, it seems useful to have a methodology that is related to decision making and provides a framework that requires analysis and thought with respect to the future states of the educational system and the project. A methodology that includes estimates of yearly cost and utilization figures can be integrated into typical educational planning models for entire systems, such as student flow models.

The usual procedure for calculating the AC_{ij}'s is to determine the costs and utilizations for all the years of the project and then to calculate the average costs presented in a matrix by allowing i and j to vary for all years of the project. For example, if the project is assumed to have a 20-year total life, then

AC_{ij}'s are calculated for i=1 to 20 and $j \geq i$. There is a simple computer program to calculate these values and print them in matrix form.

Sensitivity analysis for variations in estimates of costs and utilizations and changes in the social discount rate may be undertaken by rerunning the program. However, if one does not have access to the program, a series of tables consisting of discount rates, AC_{ij}'s, and summed values of costs and utilizations may prove useful.

The equation for AC_{ij} may be modified to take account of errors in the estimates:

$$AC'_{ij} = \frac{\sum_{k=i}^{j} (C_k d_k) + \sum_{k=i}^{j} e_k d_k}{\sum_{k=i}^{j} N_k d_k + \sum_{k=i}^{j} f_k d_k} \tag{6.12}$$

This formula would obviously lead to complicated calculations if there were changes in several years for the costs (e_k) and in several years for the utilization (f_k). However, if there is one estimate that may be particularly subject to error, this formulation is useful. For example, suppose that costs in some year ℓ are particularly subject to variation. Then

$$AC'_{ij} = AC_{ij} + \frac{e_\ell d_\ell}{\sum_{k=j}^{j} N_k d_k} \tag{6.13}$$

With separate reporting of the sums of the yearly costs and utilizations, it would be possible to determine the change in AC_{ij} to AC'_{ij} very simply without recalculating the entire matrix of AC_{ij}'s. Clearly, if all costs and/or all utilizations are subject to the same percentage variation, the original values of AC_{ij} may be given and modified by these percentage changes to find limits for the estimates. For example, suppose all cost estimates can vary by 10 percent and utilization estimates can vary by 5 percent. Then average costs could vary between 0.86 AC_{ij} and 1.16 AC_{ij} (assuming the worst case where costs are 10 percent higher and utilization is 5 percent less than estimated in the best case). While this sort of sensitivity analysis was not undertaken for the cases below, a table of discount rates is provided in Appendix Table A.2. If sensitivity analysis is desired for the interest rates, it is best to recalculate the AC_{ij}'s.

The AC_{ij} methodology has been applied to two projects. The projects in El Salvador and Washington County, Maryland, involve the use of television in formal schooling, although the impetus for the utilization varies in each instance.

TABLE 6.5

Costs of ITV in El Salvador: Secondary Schools Only*
(in thousands of 1972 U.S. dollars)

	Year											
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Production												
Facility	0	0	0	0	234	108	36	36	0	0	0	0
Equipment	0	0	50	270	40	966	0	0	0	0	0	0
Operations	0	0	0	300	370	410	490	490	490	490	540	540
Startup	50	50	380	360	260	210	200	200	100	50	0	0
Videotape	0	0	0	51	51	51	0	0	51	51	51	0
Transmission												
Facility	0	0	0	0	26	12	4	4	0	0	0	0
Equipment	0	0	0	0	0	644	0	0	0	0	0	0
Operations	0	0	0	20	20	40	10	0	10	10	10	10
Reception												
Classroom remodeling	0	0	1,090	0	0	0	0	0	0	0	0	0
Equipment	0	0	50	0	120	120	120	53	62	80	13	13
Replacement	0	0	0	0	0	0	0	50	0	120	120	120
Total costs	50	50	1,570	1,001	1,121	2,561	860	843	713	801	734	638
Foreign aid and debt repayment	0	0	(190)	(680)	(300)	(1,980)	(320)	(320)	0	0	0	0
Total cost to GOES	50	50	1,380	321	821	581	540	523	713	801	734	638
Number of students (in thousands)	0	0	0	2	14	32	48	60	72	86	104	107

	Year										
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Production											
Facility	0	0	36	36	0	0	0	0	0	0	0
Equipment	50	270	40	966	0	0	0	0	0	0	0
Operations	540	540	540	540	540	540	540	540	540	540	540
Startup	0	0	0	0	0	0	0	0	0	0	0
Videotape	0	51	51	51	0	0	51	51	51	0	0
Transmission											
Facility	0	0	4	4	0	0	0	0	0	0	0
Equipment	0	0	0	644	0	0	0	0	0	0	0
Operations	10	10	10	10	10	10	10	10	10	10	10
Reception											
Classroom remodeling	0	0	0	0	0	0	0	0	0	0	0
Equipment	13	18	13	18	18	18	13	18	18	22	18
Replacement	103	62	200	133	133	116	80	213	151	151	134
Total costs	716	951	934	2,402	701	684	694	832	770	733	702
Foreign aid and debt repayment	0	0	45	45	45	45	45	45	45	45	45
Total cost to GOES	716	951	979	2,447	746	729	739	877	815	768	747
Number of students (in thousands)	110	113	117	120	124	128	131	135	139	144	148

Notes to Table 6.5

*Cost data are based mainly on Speagle (1972) for 1966 to 1973 and partly on conversations with the Stanford University Institute for Communications Research group responsible for an ongoing study of ITV in El Salvador. The rationale for each projection or alteration from Speagle's estimate is as follows:

Production facility: Ninety percent of the costs of the Santa Tecla facility were allocated to production and 10 percent to transmission, with the life of the air conditioning assumed to be 10 years and the facility life to be 25 years.

Production equipment: This assumes a 10-year life, with the cost of the Santa Tecla equipment allocated 60 percent to production and 40 percent to transmission.

Production operations and startup: These are the same as Speagle until 1974 when startup costs are assumed to decrease over two years to a $50,000 level. After 1975, they remain at this level and are included in the cost of operations, which are based on Speagle's projection.

Videotape: It is not clear whether these costs are included in Table 2.1 of Speagle. They are added here, purchased as needed, under the assumption of a 5-year tape life, 300 hours of programming a year, and a cost of an hour-long videotape of $170.

Transmission facility: This is explained under production facility.

Transmission equipment: This is explained under production equipment.

Transmission operations: This represents the rental charge through 1971 for the use of commercial braodcast time. Beginning in 1972, operations are expected to cost 25 percent of the 1971 rental charge.

Classroom remodeling: This is the same as in Speagle, with an assumed 25-year lifetime.

Reception equipment: Beginning in 1973, this is based on the number of students added to the system, an average class size of 45, and a cost per receiver of $200.

Reception equipment replacement: This is based on the equipment cost stream in the table and an assumption of a 5-year life.

Foreign aid and debt repayment: Through 1973, this represents the actual size of foreign grants and loans. The loan portion of this aid is paid off with a 10-year grace period during which interest accumulates at 2 percent and a 30-year repayment period during which interest accumulates at 2.5 percent. With our assumption of a 4 percent annual rate of inflation, these effective interest rates become -2 percent and -1.5 percent, respectively. If there were no inflation present, value of the repayment amount would be almost three times as large. The repayment is scheduled as if the 40-year period for the total loan began in 1970.

Number of students: This is assumed to grow rapidly from 1972 to 1976 (about 20 percent per year) after which a 3 percent growth rate is accounted for mainly by population growth.

The cost data do not include teacher training (not considered by Speagle as part of ITV costs), the distribution and printing of teachers' guides and student workbooks, or maintenance and power costs for reception equipment. (Speagle says this latter is textemely small.)

Source: Jamison, Klees, and Wells 1976.

In El Salvador, television was introduced at the secondary level as part of a general reform in education. The costs and utilization are taken from the experience in El Salvador for the first few years of the project and for the planned expansion into the future to include elementary school levels. Owing to the loan arrangements between El Salvador and the United States, the estimates are provided for the total costs to the project and the costs to the government of El Salvador (GOES). Table 6.5 presents a breakdown of the yearly estimates of costs and utilization, while Table 6.6 presents the AC_{ij}'s for the total project and Table 6.7 the AC_{ij}'s for GOES. The costs that are estimated are average per student costs. If one wishes to convert them to average cost per student-hour, a value of 170 hours per student may be assumed. In the projected costs, allowance is made for equipment replacement as its useful life ends. However, replacement is calculated at current costs, which may understate the costs if inflationary trends continue.

Table 6.5 indicates the amount of foreign aid available to El Salvador during the course of the project. The loan repayment in future years of the project amount to some 7 percent of total project costs. For these reasons, as can be observed in Tables 6.6 and 6.7, the average per student cost for the project greatly exceeds the average per student cost for GOES in the earlier years of the project. In the later years, as the loan is repayed, the average costs to GOES begin to exceed the average project costs.

The importance of using constant dollars, which compensates for general rates of inflation, is particularly pronounced in these estimates. The interest on the loan is 2 percent during the first 10 years (when no money is repaid) and 2.5 percent for the next 30 years. However, the present analysis assumes a 4 percent rate of inflation, and this is accounted for in the costs in Table 6.5. If there is no inflation, the payments in the latter years would be nearly three times as large. The debt repayment when calculated in constant dollars takes account of the assumed rate of inflation.

The average costs, reported in Tables 6.6 and 6.7, decline until 1980 and then there is a sharp increase, after which the costs again decline. This cost upsurge is caused by the high amount of expenditure assumed to take place in 1981 to replace production and transmission equipment. which was assumed to have a 10-year life. This decline and upsurge is not noticed in the first four lines of Table 6.6 and the first two lines in Table 6.7 since these lines represent cost estimates from year i, where i = 1966, 1969, 1971, 1972 to year j, where $j>i$. The constantly declining costs in these lines of the tables are caused by the fact that the high investments in startup costs and classroom modeling are included in these estimates, yet have long-range effects.

In the early years of the project, with low utilizations and high startup costs, the average costs per student are extremely high. For example, if the project were to be abandoned after 10 years, the result would have been a cost of $29.84 per student or twice that of the result through the 22nd year ($14.97

per student). These cost differences are not as pronounced to GOES. In the present year (1976), the long-range projection facing GOES is an average cost of $7.52 per student if the project continued through 1988. If the project were to be abandoned in 1980, the cost would be $7.16 per student from 1976 through 1980. However, abandonment of the project in 1982 would result in an average cost of $8.73 per student from 1976 through 1982, due to the large cost increase in 1981 for the purchase of new equipment. If one projected costs farther into the future, one would expect to see declining average costs for 10 years followed by an upsurge due to equipment replacement.

In Washington County, Maryland, television was added to upgrade instruction in subjects for which administrators thought that classroom teachers were not sufficient. All costs and utilizations are obtained from actual project experience, from its inception through 1972–73, with estimated costs and utilization for 1973–74 and 1974–75. While there is a constant stream of expenditures on production and reception equipment, it is not entirely clear how much is spent for replacement and how much for additional equipment. Over the entire life of the project, a fairly constant price in current dollars has been paid for receivers. There has been a major increase in teachers' salaries, and as salaries have been approximately 30 to 35 percent of yearly costs, this increase has had profound effects on total costs. When the costs are converted to constant dollars, the receivers have a declining cost. This pattern of a relative decline in equipment costs compared to labor costs represents an advantage for long-term projects utilizing a high level of technology.

Table 6.8 contains the yearly cost and utilization figures. Tables 6.9 and 6.10 contain AC_{ij}'s on a per student and per student-hour basis, respectively. The costs are considerably higher for the Washington County project than for the El Salvador project. This is probably caused by the much lower utilization levels in Washington County, where enrollments have never exceeded more than 22,000 students. Additionally, salary costs are a significantly high percentage of total costs in the project and salaries are undoubtedly higher in the United States than in El Salvador.

When $k = 1$, average costs are calculated from the beginning of the project to different termination dates. This calculation is reported in the first rows of Tables 6.9 and 6.10. As one can see, as the project operates for more years, average costs decline. The steady decline is attributable to the spread of capital costs over increasing numbers of students. As expected, average costs per student would be very high if the project were terminated in earlier years. For Hagerstown, the average costs declined rather rapidly to $60.53 ($AC_{1,8}$) per student in 1962 and then declined to only $53.37 by 1972 ($AC_{1,18}$). This slow decline occurred because of the rather high expenditure each year on recurrent costs; that is, capital costs, although spread over more students, became an increasingly less important portion of total costs.

TABLE 6.6

Average Total Costs from Year i to Year j in El Salvador: Secondary Schools Only*
(in 1972 U.S. dollars)

	To Year j										
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986	1988
From Year i											
1966	∞	254.95	82.72	44.49	29.84	23.11	20.01	18.88	17.14	15.95	14.97
1969		134.63	60.50	34.24	23.71	18.73	16.53	15.96	14.59	13.67	12.89
1971			43.71	24.90	17.75	14.35	13.02	13.00	11.99	11.33	10.75
1972			17.92	13.55	10.95	9.45	9.15	9.80	9.18	8.80	8.44
1973				11.78	9.69	8.46	8.37	9.21	8.64	8.31	7.98
1974				9.75	8.52	7.58	7.73	8.77	8.23	7.92	7.61
1975					8.00	7.12	7.43	8.66	8.08	7.77	7.45
1976					6.95	6.48	7.09	8.58	7.95	7.63	7.30
1977						6.23	7.13	8.90	8.11	7.72	7.34
1978						6.51	7.55	9.57	8.47	7.96	7.50
1980							7.89	11.17	8.98	8.15	7.53
1984									5.21	5.58	5.32
1988											4.74

*Interest rate is 7.5 percent.
Source: Jamison, Klees, and Wells 1965.

To compare the AC_{ij} calculation with the cost function, one should use $AC_{1,18}$, which is the average cost per student for the first 18 years of the project; this cost is \$53.37. The average per student cost from the cost function is \$54.23 at 7.5 percent, which is a comparable figure.

Average costs per student-hour have also been estimated and are reported in Table 6.10. In examining the average costs from project inception, one observes a rather rapid decline from \$1.64 per student-hour in 1956 ($AC_{1,2}$) to \$0.39 per student-hour in 1962 ($AC_{1,8}$). The interesting difference between the calculations for costs per student and per student-hour is found in the different information available to decision makers in the present. The calculations for $AC_{18,j}$ present the expected average costs for continuation of the project beyond 1972. The average costs per student are lower than previously, that is, $AC_{18,18}$ is \$50.11, whereas $AC_{1,18}$ is \$53.37. However, in terms of average costs per student-hour, $AC_{18,18}$ is \$0.43, whereas $AC_{1,18}$ is \$0.35. Continuation costs appear to be higher per student-hour and lower per student than the average costs for the first 18 years of the project. The difference is attributable to the treatment of all previous capital expenses as sunk costs in the calculation of $AC_{18,18}$, but the general decline in student-hour utilization (the last row in Table 6.8) results in an increase in average costs per student-hour.

The costs of the Hagerstown project have remained high because of the relatively low number of students involved in the system and the rather high costs of programming derived from teacher and staff salaries.

The length of the experience of the Hagerstown project allows us to see one important advantage of technology projects that have a long history: the declining relative price of equipment. The success of maintenance in extending equipment life has kept costs lower on this project relative to one in which receivers are replaced every five years.

Opportunity Cost Analysis

The final cost methodology employed is the methodology of opportunity costs. As employed in technology projects, the opportunity cost approach stresses the items that could have been purchased if the technology project did not continue. That is, the approach is to assume a constant budget expenditure and determine how this could be allocated.

Washington County conducted its own survey to determine the needs that would exist and the costs of satisfying them if the television system did not exist. The function served by the television system could be replaced by hiring 83 new teachers at an estimated cost of \$846,600 and building 27 new classrooms at an estimated cost of \$357,500. Assuming a 20-year life for the

TABLE 6.7

Average GOES Costs From Year i to Year j in El Salvador: Secondary Schools Only*
(in 1972 U.S. dollars)

	To Year j										
	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986	1988
From Year i											
1966	∞	177.52	44.19	25.37	18.39	14.93	13.56	13.52	12.51	11.84	11.25
1969		70.79	24.48	16.28	12.96	11.04	10.47	10.92	10.25	9.81	9.40
1971			13.99	11.20	9.85	8.78	8.68	9.43	8.94	8.63	8.33
1972			11.25	9.84	8.98	8.10	8.15	9.03	8.57	8.29	8.01
1973				9.26	8.56	7.74	7.87	8.87	8.40	8.13	7.85
1974				9.75	8.52	7.58	7.78	8.89	8.38	8.09	7.80
1975					8.00	7.12	7.49	8.79	8.25	7.96	7.65
1976					6.95	6.48	7.16	8.73	8.14	7.84	7.52
1977						6.23	7.22	9.07	8.32	7.95	7.58
1978						6.51	7.68	9.78	8.72	8.22	7.77
1980							8.27	11.55	9.33	8.51	7.88
1984									5.56	5.92	5.64
1988											5.05

*Interest rate is 7.5 percent.

Source: Jamison, Klees, and Wells 1975.

classroom and realizing that the county is spending over $1 million per year on the television project, this alternative appears attractive.

Carnoy (1973), in his criticism of the use of television, suggested that the funds used for television may be better spent on teacher retraining. While he did not estimate the effects of the alternatives, he calculated the average amount of money available for the teachers. For example, in Washington County, assuming an average class size of 30 students and a cost of television of only $31 per student per year, he calculated that $930 per teacher per year would be available for increased training. He based his costs on Wade's (1967) calculation. In fact, under present estimates, the cost is $54.23 per student and the amount available for teacher training would be $1,603.20. For El Salvador, this type of calculation seems even more relevant, as the effectiveness studies revealed significant gains to the educational reform, which included large amounts of teacher retraining, and only marginal gains to the use of television in addition to the reform. Assuming 30 students per class and using the 1972 figure of $24.35 per student, this would mean an additional $730 per year per teacher could be available for retraining. Of course, the average cost figure does include capital costs, which may not be recoverable. If the project were terminated, less money would be available. The $730 figure is valid for a decision prior to investing in instructional television.

Recognizing the large percentage of school expenditures allocated to teachers' salaries and the apparent absence of an effect on academic achievement attributable to changes in class size (see Jamison, Suppes, and Wells 1974), one may make estimates to determine the increase in class size required to keep average instructional costs per student constant when some technology is introduced. The importance of alterations in class size to the costs of an educational system was revealed in the planning model for Norway (Magnussen 1972).

The following model may be used to describe these trade-offs. With S equal to the average salary of a teacher, T the average cost per student of the technology, R the average student-to-teacher ratio, and I the increase in class size necessary to keep the post-technology instructional cost equal to the pretechnology instructional cost, the following equation results:

$$S/R = [S + T(R + I)]/(R + I) \tag{6.14}$$

The increase in class size is given by:

$$I = (SR + TR2)/(S - TR) \tag{6.15}$$

Jamison, Klees, and Wells (1976) estimated increases in class size for several different values of technology costs and teachers' salaries and for original class sizes of 25 and 40. These results are given in Table 6.11.

TABLE 6.8

Costs and Utilization for Hagerstown ITV[a]
(in thousands of 1972 U.S. dollars)

	1955	1956[b]	1957	1958	1959	1960	1961	1962	1963	1964
Administration[d]										
General		30	35	40	40	43	47	50	54	56
Audiovisual and subject area		4	4	5	5	6	6	6	6	8
Production[e]										
Facility	409.5									
Television teachers		250	250	300	300	300	300	300	300	300
Engineering, production, technicians		100	100	125	125.0	132.0	139	146	152.0	156
Support personnel		25	25	30	30.0	33	36	39	43.2	44.7
Equipment	461.0				32.4	16.5	0.6	5.2	108.5	6.7
Videotapes	81.4								3.5	1.8
Power		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Other		40	45	50	64.6	65	66	68	69.7	70
Maintenance		5.0	5.0	10.0	10.0	10.0	10.0	10.0	10.9	10.0
Transmission[f]										
Cable rental		50	110	136	136	158.7	181.3	203.8	226.5	215.3
Reception[g]										
Equipment	97.8			20.8	7.3	7.5	9.7	9.1	32.1	16.0
Power		1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Maintenance		1.0	2.0	3.0	3.0	3.0	3.0	3.0	3.6	3.0
Total cost	1,049.7	509.0	629.0	724.3	757.8	779.2	803.1	844.6	1,014.5	892.0
Utilization[h]										
Number of students (in thousands)		6.0	12.0	16.5	18.0	18.2	18.6	19.3	19.8	20.4
Number of student-hours		950	1,900	2,612	2,954	2,844	2,630	2,664	2,718	2,889

TABLE 6.8 (Continued)

	1965	1966	1967	1968	1969	1970	1971	1972	1973[c]	1974
Administration[d]										
General	58	60	60	60	60	60	60	60	60	60
Audiovisual and subject area	9	10	10	10.3	9.3	14.7	11.5	10.5	11	11
Production[e]										
Facility										
Television teachers	285	300	300	329.0	404.2	415.6	415.8	398.3	400.0	400.0
Engineering, production, technicians	160	164	168	172.0	202.4	224.8	236.1	228.5	230	230
Support personnel	46.1	47.5	48.9	50.2	50.3	54.8	57.9	58.6	58	58
Equipment	17.8	79.0	100.5	7.1	2.3	35.1	6.8	7.8	10	10
Videotapes		15.0	28.1	6.8	13.9	9.5	5.7	5.0	6	6
Power	3.0	3.0	3.4	3.3	4.5	4.3	5.1	5.0	5.0	5.0
Other	70	72	73	75.2	89.1	102.3	110.4	147.1	150	150
Maintenance	10.0	10.0	9.6	6.4	8.0	7.5	9.3	10.0	10.0	10.0
Transmission[f]										
Cable rental	201.8	190	180.7	183.7	180.5	163.0	163.4	164.0	164	164
Reception[g]										
Equipment	13.8		7.3	6.2	1.5	8.3	3.1	3.2	3.0	3.0
Power	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Maintenance	3.0	3.0	3.2	2.2	2.7	2.5	3.1	3.0	3.0	3.0
Total cost	879.0	955.0	994.2	913.9	1,030.2	1,103.9	1,089.7	1,102.5	1,111.5	1,111.5
Utilization[h]										
Number of students (in thousands)	20.4	20.7	21.1	21.5	21.9	21.9	22.0	22.0	22.0	22.0
Number of student-hours	2,968	3,314	2,974	3,255	2,859	2,757	2,839	2,588	2,500	2,500

Notes to Table 6.8

[a]The year given in the column is the year of the start of the academic year, for example, 1958 means 1958–59. Detailed records of equipment purchases for all years were available and figures in the table are accurate. A detailed county cost study (Washington County Board of Education 1973) was undertaken for most costs from 1967 through 1972 and the results of that study were used here. A county report (Washington County Board of Education 1963) was also available with some cost information for 1959 and 1963. Wade (1967) was used for cost information during 1965. Other data are estimated by the author. Costs are reported in 1972 U.S. dollars. Current costs were converted to constant costs by using the gross national product price deflator. Current prices for years 1955 through 1974 were multiplied by 1.82, 1.80, 1.76, 1.78, 1.68, 1.63, 1.60, 1.51, 1.45, 1.38, 1.29, 1.21, 1.18, 1.12, 1.10, 1.09, 1.06, 1.00, 0.95, and 0.86, respectively.

[b]Costs for years 1956 and 1957 were based upon utilization patterns for those years and the relationship with utilization in 1958. Production costs and administration were assumed to be a higher percentage of 1958 costs than the relative utilizations would indicate, as some startup and planning time must be assumed.

[c]Costs for 1973 and 1974 are slightly higher than 1972 costs with no growth assumed.

[d]Administration: Data were available for total administration expenditures for years 1959 and 1965 and for audiovisual and subject area administration for years 1968 through 1972.

[e]Production: Facility expense is estimated value of buildings assigned to television and is derived from Washington County (1963). Teacher salaries were available for 1965 and for 1968 through 1973. Engineering, production, and technician salaries and support personnel (graphics, audiovisual, photographic, secretarial, and so on) salaries were available for 1959, 1963, and 1968–73. Equipment and videotape expenses are all from county records. Equipment includes cameras, tape machines, and so on. Power expenses were available for 1963, 1965, and 1967–71. Other expenses include salary fringe benefits for all production personnel, travel, custodial service, and workshops. Maintenance expense was known for 1963 and 1967–71 and was allocated 75 percent to production and 25 percent to reception based upon approximate equipment value ratios.

[f]Transmission: Cable rental expenses were known for 1959, 1963, 1965, and 1968–73. County records were available for information for 1960, 1961, 1962, 1964, and 1967.

[g]Reception: All equipment expenses are from county records and represent the purchase of approximately 10.50 black-and-white television sets and 50 color sets. In 1955, 342 sets were purchased. Approximately 200 sets are no longer in use. Power is estimated by assuming 1,000 sets in operation, 100 watts per set, 750 hours per set per year, and $0.02 per kilowatt-hour.

[h]Utilization: Utilization patterns were derived from county enrollments and published production schedules. Enrollments were available for all years of the project and were used to estimate numbers of students receiving televised instruction. A county report indicated that utilization was lower than enrollments for the first three project years and these figures are reported. To determine utilization in terms of student-hours, enrollment levels for all 12 grades were used in conjunction with weekly broadcast schedules by grade level.

Source: Jamison, Klees, and Wells 1976.

TABLE 6.9

Hagerstown ITV Project: Average Costs per Student from Year i to Year j*
(in 1972 U.S. dollars)

	To Year j										
	1955	1956	1957	1958	1960	1962	1968	1970	1972	1973	1974
From Year i											
1955	∞	272.69	129.40	90.57	67.83	60.53	54.25	53.69	53.37	53.27	53.18
1956		84.83	63.74	54.71	48.89	47.26	46.61	46.81	47.05	47.17	47.27
1957			52.42	47.61	44.88	44.42	45.00	45.38	45.74	45.91	46.06
1958				43.90	42.90	43.10	44.36	44.83	45.27	45.47	45.64
1960					42.81	43.22	44.77	45.31	45.78	46.00	46.18
1962						43.76	45.41	45.98	46.49	46.72	46.91
1964							44.47	45.49	46.25	46.56	46.81
1966							45.29	46.51	47.31	47.61	47.85
1968							42.51	46.46	47.66	48.06	48.34
1970								50.41	50.00	50.11	50.18
1972									50.11	50.28	50.34
1973										50.52	50.49
1974											50.52

*Interest rate is 7.5 percent.
Source: Jamison, Klees, and Wells 1976.

TABLE 6.10

Hagerstown ITV Project: Average Costs per Student-Hour from Year i to Year j *
(in 1972 U.S. dollars)

	To Year j										
	1955	1956	1957	1958	1960	1962	1968	1970	1972	1973	1974
From Year i:											
1955	∞	1.72	0.82	0.57	0.43	0.39	0.36	0.36	0.37	0.37	0.37
1956		0.54	0.40	0.35	0.31	0.31	0.31	0.32	0.32	0.33	0.33
1957			0.33	0.30	0.28	0.29	0.30	0.31	0.32	0.32	0.32
1958				0.28	0.27	0.28	0.30	0.31	0.31	0.32	0.32
1960					0.27	0.30	0.31	0.32	0.33	0.33	0.33
1962						0.32	0.32	0.33	0.34	0.34	0.35
1964							0.30	0.32	0,33	0.34	0.35
1966							0.31	0.33	0.35	0.35	0.36
1968							0.28	0.34	0.36	0.37	0.38
1970								0.40	0.40	0.41	0.42
1972									0.43	0.43	0.44
1973										0.44	0.44
1974											0.44

*Interest rate is 7.5 percent.
Source: Jamison, Klees, and Wells 1976.

SUMMARY

Cost information has been presented in the context of four different models. The fourth model, opportunity cost analysis, was designed to demonstrate the alternative resources that could be purchased with the money spent on instructional technology. For example, in Hagerstown, project administrators estimated that the function served by the television system could be replaced by hiring 83 new teachers and building 27 new classrooms. The annual cost of the proposed expenditure would be lower than the annual operating costs of the television system. In El Salvador, if the television system had not been implemented, an additional $730 (using 1972 figures and assuming 30 students per class) would have been available for teacher retraining. Students in televised classes did not have a consistent advantage on academic scores over students in reform classes in which teachers had some additional training. An allocation of more funds to teacher training rather than to television may have been meaningful. Finally, a constant budget in a hypothetical situation was assumed to determine the increases in class size that would release funds for the technology system. Our analysis includes an implicit assumption that some teachers would be fired and the remaining teachers would have larger classes. Assuming a present class size of 25 and an annual teacher salary of $3,000 (not unreasonable in a developing country), a technology system costing $18 per student could be introduced if classes were increased by an average of 4.4 students.

The remaining three methodologies (component cost analysis, annualized cost estimates, and time structure of costs and utilization) resulted in reasonably consistent results. Component cost analysis (General Learning Corporation 1968), undertaken for the United States with manufacturers' cost estimates, resulted in ranges of $0.08 to $0.42 per student-hour for television and $0.03 to $0.085 per student-hour for radio. These estimates included an assumption of 100 hours of instruction and varying assumptions regarding the number of students and the geographic dispersion of the students.

For annualized cost estimates from project experiences, the following cost estimate ranges were obtained: television, $0.14 per student-hour (El Salvador, 48,000 students, 170 hours per student in 1972) to $1.10 per student-hour (Samoa, 8,100 students, 145 hours per student in 1972); and radio, $0.014 per student-hour (Thailand, 800,000 students, 25 hours per student in 1967) to $0.058 per student-hour (Mexico, 2,800 students, 233 hours per student in 1973). For planning studies for television, the following estimates were made: $0.04 per student-hour (Ivory Coast, 745,000 students, 170 hours per student) and $0.017 per student-hour (El Salvador, 990,000 students, 170 hours per student). For a nonformal educational project in Honduras, an estimate of $0.16 per student-hour was obtained (6,740 students, 78 hours per student).

A detailed example of the methodology of annualized cost estimates has also been presented, with information drawn from projects and manufacturers' costs. In this example, a hypothetical region was assumed with 200,000 students and 120 hours per student with consideration of the following costs: startup; administration for technology project; production and transmission facility; modification for reception facility; technicians and production staff; maintenance and equipment expenditures for production, transmission, and reception; printed materials; and electric power. These examples resulted in estimated costs of $0.072 per student-hour for television and $0.0196 per student-hour for radio.

The important point demonstrated by the use of the time structure methodology was the declining average cost over time due to high initial investment expenditures and enrollment growth. For example, in El Salvador, AC_{ij}, the average cost per student from the first year of the project to year j (the end of the project), would be $255 if j were 1970, $30 if j were 1976, and $15 if j were 1988. During this period, enrollment was projected to grow rapidly from 14,000 in 1970 to 104,000 in 1976 and then slowly to 148,000 in 1988.

TABLE 6.11

Opportunity Costs of Technology in Terms of Alterations in Class Size
(S = teacher annual wage)

		Average Cost per Student For Technology			
	T	$750	$1,500	$2,250	$3,000
		Increase in class size (in numbers of students)			
Initial class size					
R = 25					
	$ 1.80	1.60	0.77	0.51	0.38
	4.50	4.41	2.03	1.32	0.97
	9.00	10.71	4.41	2.78	2.03
	18.00	37.50	10.71	6.25	4.41
R = 40					
	1.80	4.25	2.02	1.32	0.98
	4.50	12.63	5.45	3.48	2.55
	9.00	36.92	12.63	7.62	5.45
	18.00	—	36.92	15.24	12.63

Source: Jamison, Klees, and Wells 1972.

There are five major limitations affecting the cost analyses that must be remembered. The first two are related: the use of average costs in comparing projects and the type of student considered in the calculation of average cost. As two alternative systems may have different rates of expansion and different capacities, one must make assumptions regarding the pattern of average costs as enrollments increase. The assumption of declining average costs for technology projects is supported by the project evidence. As there may be many dropouts or grade repeaters in formal systems or "unofficial" listeners for formal and nonformal programs, it is crucial to determine whether average costs should be calculated on number of enrollments, number of program completers, or number of listeners. Enrollments were used in all of the estimations in this chapter.

A third limitation is the ability to compare these cost estimates with estimates for other alternatives. In the estimates for instructional technology, costs such as school buildings and administration for the school system were not included, as the technology project was assumed to be added on to the school systems. A related item was the proper cost to consider for estimates. For example, we may use teachers' salaries or the wage (resource cost) needed to attract persons to the teaching profession. Depending upon the employment situation for teachers, these two figures will be different.

Another important limitation affecting the cost estimates is the financing arrangements for the project. These arrangements affect the difference between project cost and cost to the country. In a loan situation, project costs will exceed cost to the country in early years of the project and be higher in latter years of the projection. In the case of a grant for original equipment purchases, the receiving country must consider the impact of maintenance and equipment replacement costs in later years of the project.

The final limitation on the analysis is the comparability among countries and the applicability of estimates from one country to another. Factors affecting the variation in costs among countries include salary structures, personnel, availability, maintenance problems, and geographic dispersion.

CHAPTER 7 SUMMARY

INTRODUCTION

Utilization of instructional technology in developing countries has been examined. Although radio and television systems have been emphasized, it is important to realize that, although the development of in-class resources, such as printed materials, has not been examined in detail, these resources may be a viable solution to educational problems in developing countries. Radio and television have been utilized throughout the world for a wide range of educational situations, both formal and nonformal. These technologies also have been used for many educational levels from primary to higher education, for technical programs, teacher training, and rural development. In developing countries, the predominant use of television systems has been for formal primary school programs. Television in these circumstances has been used to increase participation in educational systems (particularly in rural areas), to supplement deficiencies in teacher training, to centralize curriculum control, and to substitute for the utilization of highly skilled teaching personnel. Radio also has been used in formal educational programs in developing countries, but compared with television has played a much greater role in nonformal rural development programs.

In summarizing and integrating the information presented in the previous chapters, the suggested approach to planning will be reviewed and the details that have been developed on educational problems, costs, evaluation, and organization will be added.

EDUCATIONAL PROBLEMS

The impetus for planning comes from the realization that there is an opportunity that can be developed or a problem that exists. This recognition

may derive from an existing gap between desired performance and actual performance in terms of a well-specified set of goals. It is extremely important to integrate educational goals with development goals for the country or the planning effort may be doomed to failure. For example, manpower planning models help to predict the occupational requirements in society. These predictions indicate, in turn, the output of graduates from the educational system that will be required. The benefit to increased investment in education is evidenced by studies that show a higher rate of return for investment in education than investment in physical capital.

Much of the criticism leveled against television systems is directed toward the high degree of centralization that often occurs in curriculum planning. This centralization leads to a concentration on values and knowledge that are important to urban and industrial development but may not meet the problems of rural development.

Many problems of education in developing countries have been discussed, including low participation rates, high population growth, urban-rural disparities in terms of better schools and more employment opportunities, high rates of illiteracy, high dropout and repetition rates in the school system, employment problems for graduates, teacher surpluses in urban areas and shortages in rural areas, and a heavy influence of foreign aid and personnel. An additional problem is the high demand for education due to the subsidized nature of education and the high individual rate of return relative to social rates of return.

In analyzing problems, one must be careful to distinguish between symptoms and causes of problems. Eliminating a symptom will not eliminate the problem, for example, the patient may die even though his fever has been reduced. As an example in education, consider the influence of foreign aid and personnel. This reliance is created by a shortage of funds and trained persons in the developing country. While the problems related to the reliance on foreign personnel may be dissipated by refusing assistance, the problems of the resource shortages will reemerge in an inability to meet some of the goals of the educational system.

INSTRUCTIONAL TECHNOLOGY AS A SOLUTION

The decision to use a technology alternative is a possible response to many of the problems. A primary advantage of a technology alternative over traditional systems is the possibility of reducing urban-rural disparities. By using technology, skilled teaching resources may be concentrated on the production of educational programs and then the programs may be distributed to a much larger area via radio or television. While many writers have pointed to the existence of surpluses of highly trained teachers as militating against the use

of technology, one must realize that it is often extremely difficult to induce these teachers to teach in rural areas.

The technology system also has the advantage of being easily adaptable to multiple uses, that is, formal educational programs in the daytime and nonformal educational programs in the evening. The utilization of the technology system for nonformal education further reduces the requirement to induce trained people to work in rural areas.

Student participation rates may also be increased more rapidly with a technology system, as the traditional method requires that teachers be trained before the students can be taught. However, experience in developing countries has demonstrated that the time horizon for fully implementing a technology system also takes several years.

The problems created by a heavy reliance on foreign aid and personnel are magnified by technology systems. The large investment in sophisticated equipment increases the necessity to use foreign capital and foreign personnel. Many donor agencies promote technology systems and insist on the utilization of foreign personnel for program planning and evaluation. Furthermore, much of the equipment in the technology systems must be imported. If the recipient country is responsible for equipment replacement, a drain on resources may be created in the future and result in foreign exchange problems.

There is no evidence to believe that a technology system will be more or less successful than a traditional system in reducing dropout and repetition rates. There is also no evidence in reducing illiteracy rates. The advantage to a technology system in reducing illiteracy rates is due to reduced reliance on trained personnel to teach literacy.

PARTICIPANTS AND ADMINISTRATION

An important component of planning is an analysis of participants and their goals and responsibilities. Teachers often view technology as displacing them and reducing their control in the classroom. Surveys of teacher attitudes have revealed that substantial numbers of teachers have regarded their role as reduced. There are also teacher complaints regarding program content. In planning and operating the system it is important to involve teachers in the production process and establish ample channels of communication during the project to monitor complaints and receive feedback leading to program modifications.

One method of including teachers in the program production process is to draw the television teachers from the pool of classroom teachers. This is often done with the intention of rotating these teachers back to the classroom and selecting new television teachers. However, experience has shown that these teachers remain in the role of television teachers and do not return to

the classrooms. This has led to poor communication between television and classroom teachers and lends credence to the complaint of lack of participation.

The large expenditure on technology systems may also add to teacher demands for higher salaries. Teacher strikes have occurred in some of the television projects in developing countries.

One must also be concerned with the availability of personnel to maintain and operate the equipment. While foreign personnel often serve these functions, it is important to train citizens to fill these roles in the future.

A crucial element in planning is the establishment of control of the system. As technology programs are often highly centralized, authority often rests with the central government. However, within the central government a decision must be made as to which agency will actually control the project. The common approach taken in formal educational projects utilizing television has been to place authority in the ministry of education. In the case of programs for rural development, authority may be part of the ministry of agriculture, education, or communication. In instances such as these a separate agency may be established with participation from all departments. However, this creates a special project that may never have strong established ministry support in the face of adversity.

One other important element of control in technology projects is authority over transmission networks. The transmission facilities may be part of the general communication facilities of the country. In cases where commercial communication facilities exist, education administrators must negotiate for time for the educational programs. In one case, Peru (Lyle, Germancos, Kahnert, and Torfs 1967), it was necessary to broadcast commercials to the schools between the educational programs in order to obtain use of commercial facilities. When transmission facilities are built for the educational system, other communication needs may not be met. Although authority is often placed in the ministry of education, it is important to examine the total communication needs of the country before a large investment is made that will either preclude educational broadcasts or be insufficient for other communication needs.

ALTERNATIVE SOLUTIONS

Instructional technology is only one means of solving the educational problems of developing countries. Among the other solutions are additional teacher training, organizational restructuring (for example, no schools, differentiated staffing), and many incremental changes in the traditional system (such as changes in class size). The instructional technology alternative often is only an incremental change in the traditional structure. The Western model of a formal system, with promotion through grade levels, certification of completion, and an "expert" dispensing knowledge, may still remain.

It may be possible that greater gains will be made in the development of these countries by altering the structure of education. This thought is certainly behind many of the programs in nonformal education for rural development, but has yet to be applied to the type of knowledge that is supposed to be transmitted in formal systems.

Instructional technology is a method of providing information regardless of the particular structure devised for the educational system.

CHOICE

In choosing among alternatives, many different models may be used. The one that will be emphasized here is the one that ranks alternatives according to a set of criteria. Choice among the alternatives is then made on the basis of a clear notion of weights that are accorded to these criteria. We shall not discuss explicit weights for criteria here. Suffice it to say that, when allocations of scarce resources must be made and there are distributions among the populace of benefits and costs, the choice of weights is a complex political process that involves participation or representation in decision making. Among the criteria considered are dropout rates, repetition rates, participation rates, cognitive test scores, attitudes, behavior patterns, costs, and relationship to development.

We must be sure that the items chosen for evaluation are related to the development goals of the country, the goals of the educational system, and the information needs of the decision makers. Unfortunately, there is often a tendency to ignore hard to measure criteria and concentrate on such items as test scores, which are relatively easy to measure.

There is little evidence that an instructional technology will alter dropout or repetition rates. One must conclude that these rates are not related to system choice. While there is reason to expect that participation rates will increase more rapidly with a technology system, there has been no study that investigates this question. Therefore, in making a choice in a given situation, one must carefully estimate the time horizon of system capacity for each of the alternatives. A traditional system will have large requirements in terms of trained personnel. However, it is not sufficient to be sure that the total number of teachers trained meet the total number required but that the trained teachers will be available in the regions in the country where they are needed.

There have been numerous studies comparing instructional technologies with traditional instruction. After carefully reviewing many of these studies, it is not possible to reach a firm conclusion regarding a superior choice. One conclusion, however, is clear from the research: improvements in the pedagogical quality of educational materials improve the effectiveness of the program. While students apparently can learn from any medium, they learn more when the programs are carefully planned according to principles of good teaching.

However, this does not imply that expensive, technically sophisticated production is superior. A student may learn no more from a colorful animated production than from a purely audio presentation. The decision to alter the quality of the broadcast is not a costless decision. Data reported upon in this book reveal expenditure ranges of $100 to $3,700 per hour for television production and $100 to $1,200 per hour for radio production.

Attitude surveys have not been comparative. The attitudes of teachers and students toward technology systems generally have been found to be good. There is, however, a noticeable decline in favorable attitudes as grade level increases and exposure to the technology system increases. Although the attitude surveys do show high levels of general acceptance, it is important to realize that even if 20 percent are dissatisfied, the system may have difficulties.

The attitude surveys of teachers also point to other important criteria. Teachers frequently complain about system malfunction, such as poor reception and low levels of equipment maintenance, poor coordination of their activities with program production, infrequent visits of television teachers to classrooms, poor program production, and poorly coordinated written materials. Many of these administrative problems obviously are peculiar to technology projects. While these problems do exist, they should not be a basis for rejecting a technology project but provide guidelines for important aspects of planning and continuing evaluation. Administrative difficulties, if they do exist, may be expected regardless of the choice for an educational system.

Perhaps a more important aspect of shortcomings of technology systems alluded to in some of the surveys is the fact that students are viewed as being in a passive role with little opportunity to think for themselves and to question the presentations. While these problems may be partially alleviated by careful program production and coordination with classroom activities, they will be more prevalent with technology systems than nontechnology systems.

The cost estimates from the surveyed projects reveal a general pattern of declining per student costs with increasing enrollment. For radio, the costs ranged from $13.57 per student for a system servicing 2,800 students to $0.35 per student for a system servicing 800,000 students. The television systems had costs ranging from $160 for 8,000 students to $50 for 20,000 students to $20 for 100,000 students to $7.27 for 745,000 students. The cost examples derived from project experiences and manufacturers' equipment costs and an assumed coverage of 200,000 students resulted in estimates of $2.36 per student for radio and $8.61 per student for television. These costs are low compared with per student costs of traditional systems, which are in the neighborhood of $200 per year. However, the technology systems do not cover all of the instruction a student receives and the estimates often do not include building and administration costs, which are part of the traditional system. One must consider whether or not the technology system is added to traditional components and hence substitutes for improvements of traditional resources, as in the case

when television is used in conjunction with teachers trained at lower levels of proficiency. If this happens, then the cost calculations are correct. If the technology system is added to the traditional system without substitutions, then the costs obviously increase. One must bear in mind that the evaluation studies that generally reveal no significant differences between conventional and technology-based instruction on cognitive criteria are often conducted when technology is substituted for some other resource. In looking to the future, one must expect that technology will decline in price relative to labor and be cheaper if it is used as a substitute for labor.

In terms of meeting the development goals of the country, one would expect that if the educational goals are properly related to the development goals, then the choice that best meets the educational goals will be preferred. However, technology enjoys a distinct advantage in relation to development goals and suffers a distinct disadvantage. The advantage lies in the relatively shorter time horizon needed for meeting manpower needs. As skill requirements shift in the country, it will be possible to meet these needs more rapidly with a technology system since it will not be necessary to first train a full corps of teaching personnel to teach the persons who will enter the labor market. The disadvantage lies in the tendency toward centralized planning in technology systems and the failure to meet rural development needs. If the curriculum is urban-based, then rural students will learn skills that have greater possibilities of return in urban labor markets. Rural-urban migration patterns will then be aggravated rather than alleviated by increasing the quality of education in rural areas.

In choosing between a technology system and a traditional system, one is forced to say that the choice depends upon the particular circumstances of the country: the existence of communication networks, the availability of teachers for all areas of the country, and educational goals. There is no evidence that any cognitive criteria, dropout rates, or repetition rates would suggest the choice of one system rather than another. Technology is demonstrably cheaper when used as a substitution for other resources. If the technology system is added to the existing system, then to be desirable it must in fact provide course material that cannot be provided in the classroom. The major advantages of technology systems are greater rapidity in responding to manpower requirements and dispersion of higher quality teaching resources to geographic areas that might normally be deprived. The major disadvantages are a tendency to a centralized curriculum, a more passive role for students, a heavier reliance on foreign intervention, and a potential future drain on resources to finance equipment replacement.

IMPLEMENTATION

In planning for any educational system, it is of fundamental importance to determine the relationship of educational goals to development goals. For

technology systems, it is especially important to have careful planning: the investment is large, there is a tendency to be optimistic and overestimate utilization and underestimate costs, financing must be determined, and, if international loans exist, the repayment schedule must be carefully considered. For the implementation phase, funds must be available for maintenance and replacement, staff must be prepared for teaching and technical duties, and coordination must exist between the classroom and television production.

In implementing the technology project, there are several important decisions to be made: control of the technology project, control of the communication facilities, selection of media teachers, and the degree of inputs to the decision-making process from classroom teachers. One other organizational factor is important: the degree of foreign involvement in operation of the system.

Another critical issue is the timing of the implementation process. The choices are full-scale implementation, incremental implementation, and a pilot project followed by an evaluation and a decision on whether to expand the project. The full-scale implementation approach is usually impractical for technology projects, as large investments in complete reception and transmission facilities may be difficult to finance when investment in complete production facilities must also be undertaken. The pilot project approach is also unattractive for those technology systems that involve high initial investment. There is no logical reason to avoid careful planning with information from many sources prior to choosing an alternative and assuming that the investment in facilities for a pilot project will be justified by the addition of new information from the pilot project evaluation. Incremental implementation is probably the best choice. A commitment has then been made to have eventually a full-scale project. Hopefully, this commitment is derived from careful planning and involves an allocation of funds to reach full-scale. The incremental approach may be along two different dimensions: by geographic area or by grade level. The Ivory Coast and El Salvador used an incremental approach by grade level. This approach allows for gradual introduction of new material and time to revise materials to improve the quality of the content.

It is also more important to concentrate upon pedagogical content in program production than on sophisticated media production. Additionally, increased local input, especially where rural development is important, will act to increase program effectiveness.

Finally, one must insist upon continuing evaluation, not to determine if television or radio is more effective than traditional instruction, but to monitor the system. To improve the success of a system, it is important to know when components malfunction, to find out when participants are discontent and why they are discontent, and to determine whether or not goals are being met and whether or not resources within the system should be reallocated.

APPENDIX: COST CALCULATION FACTORS

TABLE A.1

Value of the Annualization Factor, a(r, n)

n	0	5%	7.5%	10%	15%
1	1.000	1.050	1.075	1.100	1.150
2	0.500	0.537	0.557	0.576	0.615
3	0.333	0.367	0.385	0.402	0.438
4	0.250	0.282	0.299	0.315	0.350
5	0.200	0.231	0.247	0.264	0.298
6	0.167	0.197	0.213	0.230	0.264
7	0.143	0.173	0.189	0.205	0.240
8	0.125	0.155	0.171	0.187	0.223
9	0.111	0.140	0.157	0.173	0.210
10	0.100	0.130	0.146	0.162	0.199
11	0.091	0.120	0.137	0.154	0.191
12	0.083	0.113	0.129	0.147	0.184
13	0.077	0.106	0.123	0.141	0.179
14	0.071	0.101	0.118	0.136	0.175
15	0.067	0.096	0.113	0.131	0.171
16	0.062	0.092	0.109	0.128	0.168
17	0.059	0.088	0.106	0.125	0.165
18	0.055	0.085	0.103	0.122	0.163
19	0.052	0.082	0.100	0.119	0.161
20	0.050	0.080	0.098	0.117	0.160
25	0.040	0.070	0.089	0.110	0.154

TABLE A.2

Present Value Factors

Years	5%	7.5%	10%	15%
1	0.9523	0.9302	0.9090	0.8095
2	0.9070	0.8653	0.8264	0.7561
3	0.8638	0.8049	0.7313	0.6575
4	0.8227	0.7488	0.6830	0.5717
5	0.7835	0.6965	0.6209	0.4971
6	0.7462	0.6479	0.5644	0.4323
7	0.7107	0.6029	0.5131	0.3759
8	0.6768	0.5607	0.4665	0.3269
9	0.6446	0.5215	0.4241	0.2842
10	0.6139	0.4852	0.3855	0.2471
11	0.5846	0.4513	0.3504	0.2149
12	0.5568	0.4199	0.3186	0.1859
13	0.5303	0.3905	0.2896	0.1625
14	0.5050	0.3633	0.2633	0.1413
15	0.4810	0.3379	0.2394	0.1228
16	0.4581	0.3143	0.2176	0.1068
17	0.4363	0.2924	0.1978	0.0929
18	0.4155	0.2720	0.1798	0.0808
19	0.3957	0.2530	0.1635	0.0702
20	0.3768	0.2354	0.1486	0.0611

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