

**Comparing the Effects
and Costs of Different
Approaches for
Educating Primary
School Teachers:
the Case of Sri Lanka**

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Basic Research and Implementation in Developing Education Systems



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

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

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Foreword

This paper completes the BRIDGES collection on teacher training and teacher performance. The first paper in the series focuses on the interaction between the teacher and child, and presents a theory of learning that can be used to organize instructional technologies.¹ The second paper, on teacher performance in classrooms, discusses the central importance of "time on task" or, time spent teaching and learning the curriculum.² This was followed by an analysis of those teacher practices most highly associated with student learning in Pakistan.³ The fourth paper presented comparative research on the costs of Distance Education as a method for training teachers in Indonesia and Sri Lanka.⁴

The current paper presents a comparison of the three best-known approaches to teacher training in Sri Lanka: the Colleges of Education's pre-service, residential approach; the Teachers' Colleges' in-service, residential approach; and the increasingly popular Distance Education in-service approach. Tatto, Nielsen, and Cummings make a unique contribution to our understanding of the comparative costs and benefits of these three approaches to teacher training.

The results are clear. First, teacher training changes how teachers behave in classrooms. In Sri Lanka, trained teachers teach differently than untrained teachers, and the results of their teaching are seen in higher levels of student achievement. Second, the impact of training on teacher behavior, and eventually on student learning, varies with the kind and quality of training received.

The second finding conditions the first, and can account for studies in other countries that report that teacher training does not contribute to higher levels of student achievement.⁵ The effectiveness of training depends on the quality of the candidates and the quality of the program. Good training programs emphasize subject knowledge mastery, teaching skills, opportunities to practice what has been learned, frequent supervision with feedback about performance, and links with the community in which the teachers will work. In Sri Lanka each program was of moderate to high quality and had positive effects on the teachers trained.

But the study also shows that, which kind of training is best depends on circumstances. This result reinforces our conviction that effective educational planning requires local policy analysis. Research in other contexts can define the issues and frame the questions, but answers depend on the goals and conditions of the particular system. What works depends on what you hope to achieve, and on local resources and constraints. The effectiveness of a given policy is conditioned by its technical characteristics, and by the context in which it is applied. For example, countries that have not yet been able to enroll all their children may want to train (even minimally) large numbers of new teachers. Another system that has already achieved universal enrollment may seek to improve the skills of the current teaching force.

The selection of which kind of teacher training to implement depends on the conditions in the particular context. In some countries universal primary education is unmet and conditioned by a shortage of

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teachers. If this shortage is a result of a lack of teacher candidates, then one kind of teacher training program may be preferred. If there are adequate candidates, but too few actually teach after completing training, then another kind of program may be preferred. Yet another approach may be appropriate if all children enroll, but too few complete the primary or compulsory cycle.

Using the research from Sri Lanka reported in this paper, we can offer a general model for decision making, but specific answers to questions about teacher training are to be found in research carried out in the specific contexts where decisions about teacher training need to be made.

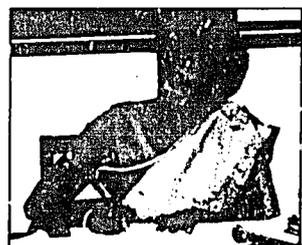
Through the BRIDGES Project we have learned that, although it is possible and useful to develop a general model of education, and to model the various aspects of the education process, we are not in a position to offer general recommendations about "what works" in education. Through BRIDGES we have learned that local circumstances demand local answers. We have found that some questions in the small universe of our endeavors strike common chords, but that none of these common chords should drown out the song of local circumstances. We have learned that harmony may be achieved by making these common chords available for local mixing.

Noel F. McGinn
October 1991

Notes

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2. Montero-Sieburth M., "Classroom Management: Instructional Strategies and the Allocation of Learning Resources." BRIDGES Research Report Series No. 4, Cambridge, MA: Harvard University, 1989.
3. Rugh A., "Teaching Practices to Increase Student Achievement: Evidence from Pakistan." BRIDGES Research Report Series No. 8, Cambridge, MA: Harvard University, 1991.
4. Nielsen H. D. and Tatto, M.T. "The Cost-Effectiveness of Distance Education for Teacher Training." BRIDGES Research Report Series No. 9, Cambridge, MA: Harvard University, 1991.
5. Forthcoming BRIDGES report on determinants of learning in Pakistan.

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Executive Summary

For many years, and particularly since the 1950s, the main priority of educational policymakers in developing countries has been to increase access to basic education. In almost every country, quantitative expansion came at the expense of educational quality. In recent years, improving the quality of education has become just as important as increasing access.

Educational quality, as measured by pupil achievement, has been shown to be largely a function of teacher quality (Fuller, 1986; Avalos and Haddad, 1981). Teacher quality is, in turn, a function of teachers' mastery of subject matter, knowledge and use of appropriate teaching skills, and positive professional attitudes. At the early stages of educational expansion it was assumed that such knowledge, skills, and attitudes were in part developed during general education and were in part the result of natural aptitude. There is now, however, conclusive



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evidence for the importance of professional teacher training (Chapman and Snyder, 1989; Fuller and Snyder, 1991; Lockheed and Verspoor, 1989). The rapid quantitative expansions that were required to increase access were accomplished by recruiting large numbers of teachers with little or no professional training. Judging from a recent revival of interest and investment in teacher training programs in developing countries, it is clear that policymakers are now intent on influencing educational quality through teacher training (Dove, 1986; Levin, 1983; Lockheed and Verspoor, 1989; Psacharopoulos and Woodhall, 1985; UNESCO, 1986a).

Although all teacher training programs attempt to influence the knowledge, skills, and attitudes of teachers, research has shown that not all are equally effective in doing so (Dove, 1986). Moreover, it is not clear that all program outcomes justify their costs. Some of the most expensive programs may be among the least effective and vice-versa (Levin, 1983).

This paper examines the effectiveness and costs of three different approaches to elementary teacher training in Sri Lanka: pre-service, conventional in-service, and distance in-service. It assesses the effectiveness of the various approaches as measured by teachers' theoretical knowledge, their actual classroom performance, and pupil achievement. It assesses costs from the point of view of both the sponsoring institution and the trainees.

Data

The data on which this report is based were collected in Sri Lanka between March 1988 and October 1989 from three different but comparable groups of teacher candidates at the entry, exit, and post-program levels in their programs. An additional group of untrained teachers was measured at the post-program level (classroom teaching). Achievement tests were developed in knowledge and teaching skills in mathematics and mother tongue. An attitude questionnaire was developed as well. Teachers' achievement level was measured at the entry, exit, and post-program levels. A two-day classroom observation study measured teachers' classroom performance, use of teaching skills and resources, and teacher-pupil interaction. Information about teaching practices was collected through a self-administered teacher questionnaire. This questionnaire included questions about the teachers' role in the school, their career path, support provided to them by the school, and their motivation. School support of teachers was measured by a questionnaire exploring the role of the principal, other sources of teacher support in the school, availability and use of resources, school status (i.e., whether a difficult or congenial school), and more general information about the school.

We also measured achievement for pupils being taught by the teacher training graduates in this study. Information about a program's history, philosophy, goals, and practices was obtained through interviews with program directors and faculty, as well as from documents provided by them. The institutional, private, and overall costs of the different approaches were also measured through interviews with program directors, questionnaires applied to trainees, and document analysis.

Findings

The data reported here point to four important findings:

- Teacher training seems to change what the teacher does in the classroom in a way that is positively correlated with pupil achievement.
- Although some features of teacher training programs studied have proven more effective than others, we found that in terms of pupil achievement, any type of training is better than none at all (Saha, 1983).
- Trainees in the Colleges of Education and in Distance Education are stronger both in subject matter and pedagogy than those in Teachers' Colleges.
- The Distance Education approach demands attention because the costs are very low and given support it could maintain effectiveness at the post-program level.

Policy Implications

These findings have important implications for future policies on teacher training as a vehicle to increase the quality of education in developing countries. The following features had a positive effect on program success:

- clearly established standards/strategies for recruiting and selecting excellent qualified candidates to be trained;
- curriculum and teaching strategies based on current international research on teacher training;
- inclusion of a strong subject matter component in a balanced program that combines subject matter mastery with innovative teaching techniques;
- classroom application of what is being learned in the training program;

Colleges of Education approach works best:

- where the purpose is to train few but excellent teachers;
- where there are highly qualified recruits and available resources;
- where training large numbers of teachers is not urgent;
- where the purpose is to strengthen the effects of teacher training once graduates are teaching; and
- when support is provided through a third year internship.

Teachers' Colleges approach works best:

- to update teachers' knowledge and skills;
- to motivate teachers for long years of service;
- where training large numbers of teachers is not urgent;
- where teachers need to develop pedagogical knowledge and skills; and,
- where there are resources available for selected groups of teachers.

Distance Education approach works best:

- when program materials are used in conjunction with tutorial visits;
- when there is constant face-to-face interaction among tutors and trainees;
- when the purpose is to do "on-the-job" training; and
- where large numbers of unqualified teachers need to be trained at a low cost.

-
- **tutorial and collegial interaction between teacher educators and teacher trainees, and interaction among teacher trainees themselves;**
 - **integration of the program's curriculum with the community where the teachers will work;**
 - **high levels of effectiveness per unit of expenditure; and**

- **financial arrangements in which a relatively high proportion of overall costs is borne by the trainees.**

The development of affordable and sustainable systems that fill future needs for trained teachers could use the best features of existing Colleges of Education pre-service, and Distance Education in-service approaches.

Section I: Introduction

For many years, and particularly since the 1950s, the main priority of educational policymakers in developing countries has been to increase access to basic education. By the 1980s many such countries, including Sri Lanka, had in fact attained nearly universal primary education. As impressive as this accomplishment was, it is now apparent that in almost every case quantitative expansion came at the expense of educational quality. In recent years, improving the quality of education has become just as important as increasing access.

Educational quality, as measured by pupil achievement, has been shown to be largely a function of teacher quality (Fuller, 1986; Avalos and Haddad, 1981). Teacher quality is, in turn, a function of the teacher's mastery of subject matter, knowledge and use of appropriate teaching skills, and positive professional attitudes. At the early stages of educational expansion it was assumed that such knowledge, skills, and attitudes were developed during general education and were in part the result of natural aptitude. There is now, however, conclusive evidence for the importance of professional teacher training (Chapman and Snyder, 1989; Fuller and Snyder, 1991; Lockheed and Verspoor, 1989). The rapid quantitative expansions that were required to increase access were accomplished by recruiting large numbers of teachers with little or no professional training. Judging from a recent revival of interest and investment in teacher training programs in developing countries, it is clear that policymakers are now intent on influencing educational quality through teacher training (Dove, 1986; Levin, 1983; Lockheed and Verspoor, 1989; Psacharopoulos and Woodhall, 1985; UNESCO, 1986a).

Teacher training has taken a variety of forms: pre-service for the induction of new teacher recruits; in-service (campus-based or on-the-job) for "upgrading" practicing teachers; certificate or degree programs and "non-credit" courses; long and short programs. Some programs have required heavy investments (building campuses and hiring staff), and some not so heavy (providing self-instructional materials). In many cases such programs exist side-by-side but are

unrelated, having been developed in an uncoordinated manner.

Although all teacher training programs have been established in order to influence the knowledge, skills, and attitudes of teachers, research has shown that not all are equally effective in doing so (Dove, 1986). Moreover, it is not clear that the costs expended on the programs are justified by their outcomes. Some of the most expensive programs may be among the least effective and vice-versa (Levin, 1983).

This paper examines the effectiveness and costs of three different approaches to elementary teacher training in Sri Lanka: pre-service, conventional in-service, and distance in-service. It assesses the effectiveness of the various approaches as measured by teachers' theoretical knowledge, their actual classroom performance, and pupil achievement. It assesses costs from the point of view of both the sponsoring institution and the trainees.

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General Issues in Teacher Training

The Study of Teacher Training

The quality of teaching is recognized as one of the most important elements in the improvement of basic education in developing countries (Fuller, 1985; Henderson, 1978; Sharpes, 1983; UNESCO, 1986b). What happens in the classroom explains more of the variance in pupil achievement than other school-related factors such as the quality of buildings and facilities, the availability of textbooks, or the nature of school management and supervision (Chapman

and Snyder, 1989; Fuller, 1985; Fuller and Snyder, 1991).

High quality teaching involves:

- effective use of time;
- command of the subject matter;
- ability to present the subject matter to pupils in a way they can comprehend;
- the frequent use of tests and quizzes to monitor pupil progress;
- systematic attention to weak spots in the pupils' learning patterns;
- empathy with pupil concerns that often extend far beyond the formal curriculum; and
- effective communication with fellow teachers, school officials, the broader school community, and especially parents (Fuller, 1986; Montero-Sieburth, 1989; Tillema and Veenman, 1987; Rugh, 1991).

What Determines Quality Teaching?

Quality teaching does not occur in a vacuum. It is more likely to occur where there is a well-developed curriculum and an adequate supply of textbooks and teaching materials. It is also more likely to occur in settings where pupils are well-fed, motivated, and supported by educated parents. The interaction of these favorable factors enhances the impact of quality teaching. But even when all these conditions exist, some teachers prove to be outstanding while others are mediocre. What makes the difference between these individuals?

The age, sex, and experience of teachers as well as the salary or other "rewards" they receive are factors often discussed in attempts to answer this question (Cummings, 1990). Another factor, often more susceptible to policy impact, is teacher training.

In virtually every profession—health, business, legal, military—the importance of specialized training is acknowledged. Although the importance of professional training for teachers should be self-evident, the majority of teachers in the developing world do not receive adequate training.

Reasons for Inadequate Teacher Training

Why is teacher training so inadequate? Part of the explanation lies in the rapid expansion of educational systems in many countries; part lies in program costs. The demand for teachers has continuously outstripped the supply, and thus it has become necessary to hire many teachers whose sole "training" is their completion of a certain level of school-

ing—as little as one level above the one they are being hired to teach! (Verspoor and Leno, 1986). Given the pressures to rapidly increase the number of teachers and the expense of training, it is no wonder that few have been trained fully and that training has had little impact in improving educational quality on a large scale.

Inadequate Research on Teacher Training

Even more fundamental than the practical difficulties associated with rapid growth, however, is the ambiguous attitude towards teacher training held by many policymakers. In the past, it was generally believed that a teacher was born, not made. This belief was especially characteristic of educational systems developed in the British Empire. Systematic teacher training was introduced relatively late in the United Kingdom, and was rarely emphasized in British colonies, such as Sri Lanka. Educational leaders raised in this tradition tended to elect one or both of two partial solutions for teacher training: offering either (1) small-scale elite courses as one component of university education, with the expectation that the graduates of these courses would, following a short teaching career, move into key administrative positions; or (2) large-scale, short-cycle teacher training courses that frequently lasted no longer than a week and were held at temporary sites such as regional educational offices. The British tradition did not support mass teacher training; in fact, it questioned whether it was really required.

As the age of expansion progressed, educational policymakers were faced with decisions regarding the expansion of teacher training relative to the expansion of places in schools. In some instances, they turned to research for assistance in weighing these options. Interestingly, much of the early research results did not support the efficacy of teacher training in improving the quality of teaching. Thus during the age of expansion, regardless of the particular tradition in which a system began, teacher training was seldom given high priority.

In sum, both traditional beliefs about the natural gift of teaching and the cumulative weight of research have contributed to the lack of confidence in the efficacy of teacher training (Dove, 1986). However, even a casual review of past research would convince the critical reader of its inadequacy. Most studies of teacher training either: (1) attempt to determine how much a teacher changes over the course of a training program, or (2) attempt to determine whether teach-

ers who have been through such programs do better than teachers who have not been through them. It is rare to find a study that joins these two sides—that is, one that attempts to determine whether teachers who have changed the most in the training program are also the ones who demonstrate the best classroom teaching. Usually the measure of teaching performance is inadequate, since it focuses on pupil performance or the quality of teaching rather than on the interaction between the two. Just as often, the studies fail to control for other factors such as the socioeconomic background of teachers, their previous education, their previous teaching experience, the schools where they are teaching, and a host of other factors that influence the quality of teaching (Sharpes, 1983).

A few studies have attempted to synthesize the results from an array of single country studies (Avalos and Haddad, 1981; Fuller, 1985; Husen, Saha, and Noonan, 1978; Simmons and Alexander, 1980). These studies often use very rough criteria of pupil achievement to judge the impact of teacher training rather than using more appropriate measures such as teacher achievement and classroom performance. The argument for this is, that if teacher training is effective, then pupil achievement of trained teachers will be higher than pupil achievement of untrained teachers. This approach fails to capture *how* and *why* teacher training affects classroom teaching, and as a consequence pupil achievement. These overview studies make no effort to evaluate the quality of the training programs in the various single country studies, nor do they make a serious effort to sift out the few good studies from the rest. When program costs are heeded, and they rarely are, they are often perceived as excessive. In conclusion, the effects and costs of teacher training have been poorly evaluated by inadequate research, thus fostering the notion that teacher training is not a viable policy option.

Variations in Teacher Training Programs

Policy research questions about teacher training should focus on which programs are most effective in a particular context, given the needs and resources of that context. The areas in which program variations occur are as follows:

- **Duration.** Some programs last only a few days while others extend for two or more years. One would expect that those programs which last for at least a year are the most likely to have some impact.

- **Entry Conditions.** Some programs prepare new recruits (pre-service) and others upgrade the existing teaching force (in-service). Pre-service programs generally have younger trainees who are likely to be receptive to “chalk and talk” lectures. Depending on the prerequisite educational qualifications for the pre-service program, the trainees may be relatively quick in acquiring subject knowledge but naive about how to communicate such knowledge to young pupils. In contrast, in-service programs tend to recruit older trainees who have extensive knowledge of school and classroom environments, and who may prefer traditional methods in mastering subject matter.

- **Content.** Teacher Training programs place varying emphasis on such components as subject matter, pedagogy and administrative practice, professional attitudes, and actual practice. Some programs place almost exclusive emphasis on subject matter while others virtually ignore it.

- **Supervised Teaching Practice and Follow-up.** Some programs do, and others do not, include an element of supervised practice, where the trainee is placed in a classroom under the careful supervision of an accomplished teacher. Even among the programs that do, supervision is often brief and without follow-up. Better programs, however, include ways to keep in touch with teachers long after they are on their own.

- **Training Approaches.** The structure of programs varies in relation to their purposes and goals. In-service programs can be held at a training institution (campus-based) or at the teacher’s workplace (field-based); they can be delivered face-to-face, using the traditional lecture approach, or through Distance Education, using a mix of correspondence, tutorials, and electronic media. Similarly, pre-service programs may rely on practice teaching and hands-on experiences simulating classroom situations, or they may have a more traditional lecture format. Some training programs incorporate research findings on teaching, while others continue unchanged for years.

- **Costs.** Program costs vary widely depending on size, location, approach, duration, and status. High-status, campus-based programs which offer degrees or diplomas can cost as much as any other form of higher education, whereas those which are field-based or delivered from a distance can be relatively inexpensive. In addition, under some circumstances, governments are compelled to cover the full costs of courses; under others they may be able to

share the cost burden with the trainees. In developing countries, donor agencies often support the early years of a program, but eventually recurrent costs and widespread dissemination have to be covered through regular budget allocations. Given such considerations, governments need to seek cost-effective programs and anticipate the resources they will need in order to sustain them.

Teacher Training in Sri Lanka

Teacher training started slowly in Sri Lanka, reflecting the prejudice of the former British colonizers against any systematic effort in this area. The earliest programs tended to be elitist, aimed at training those who would take roles in the top schools or the educational administrative service; thus they tended to be additions to the existing university programs (Dharmadasa, 1988).

As the educational system expanded, however, educational leaders created programs more responsive to local needs. Among the programs that train primary school teachers are the Teachers' Colleges (an in-service program), Distance Education (also in-service), and the new pre-service Colleges of Education (Ministry of Education, Sri Lanka, 1981 and 1982). The Teachers' Colleges program has been in place for over fifteen years and the latter two have operated for at least five years.

Research Conditions

The ongoing debate about the best approach to teacher training in Sri Lanka has fueled interest in research on the subject. Proponents of the various approaches pointed to strengths in their programs and weaknesses in others. Key educational decision-makers pressed for research that would indicate which programs and program components should be retained and how they could be combined into new, hybrid programs.

This debate, however, was taking place during a troubled period in Sri Lanka's history when ethnic confrontation was disrupting the educational process. These conditions changed the research to a smaller scale than had originally been planned and limited it to a relatively brief period of time. Because of this, the study focused on the country's central region and the coastal areas near Colombo. Its design, ideally set up as longitudinal, was cross-sectional, so that data could be collected during a single year. The latter did not prove to be a constraint, however, since by making certain plausible

assumptions, researchers were able to simulate a longitudinal study.

Purpose of the Research

The current study addresses the effectiveness and costs of different approaches to teacher training in Sri Lanka. The specific questions addressed by the study were: (1) What are the characteristics of the different elementary level teacher training programs in Sri Lanka? (2) How effective have these programs been in imparting subject matter knowledge, teaching skills, and professional attitudes to teacher trainees? (3) How is this training manifested in classroom teaching and pupil achievement? (4) What are the costs of the different programs? (5) How do program costs relate to program effectiveness? Answers to these questions would provide valuable information about the current state of teacher training in Sri Lanka, and provide a basis for policy recommendations and further development of the training system.

Policy Framework

The development of teacher training during the post-colonial period was marked by the country's ongoing attempt to establish and maintain its own educational and cultural identity.¹ British colonialism and Sri Lanka's continued contact with the West during the post-colonial period have prompted acceptance of Western models which view primary education and the primary school teacher as the facilitator of modernization and socio-economic change. Within this tradition, teachers help pupils acquire problem solving skills and the ability to contribute to the economic growth of their communities. However, the indigenous educational systems promoted by the country's main ethnic (Sinhalese, Tamil) and religious (Buddhist, Hindu, and Muslim) groups, have viewed basic education and teachers as an important means for religious, cultural, and linguistic preservation. Within this basically Eastern tradition, cultural-religious values are transferred through a close personal relationship between the teacher and the pupil: "there is not true education except within the bond between the teacher and the taught, whether in school or at home." (MOE, Sri Lanka, 1982). Sri Lanka has resolved the tension between these two basic educational orientations by requiring that modernization and cultural preservation be given equal emphasis. For example, the country's Education Reform Committee (1979) made this assertion

about the role of the teacher in Sri Lanka:

"It is the teacher who mediates education... It thus becomes of crucial importance that the country should know from where he comes and what he has to give; should watch his progress and help him improve himself; should build up and keep alive a genre of men and women who will preserve all that is best in culture and traditions and at the same time forge ahead as agents of change." (MOE, Sri Lanka, 1982).

Similar considerations permeated the Committee's statements about teacher training:

"[While] there is much that we have learned and can learn from the developed West, let us at the same time look towards our own culture and, before it is too late, identify, appraise and adapt it in enunciating our philosophy of education, in shaping our schools and in formulating programs of training for our teachers." (MOE, Sri Lanka, 1982).

In more recent years, teacher training program development has been marked by a concern with quality improvement. While teachers have always been viewed as the central actors in preserving culture and promoting change, it is now generally recognized that they have not been well equipped to play those roles. Sri Lankan educators have suggested that one reason for the inefficiency of the educational system could be found in the quality of the teachers.

"In Sri Lanka the teachers of the olden days occupied a place of honor in the society and designated Guru in national languages, were almost looked upon with reverence by the common folk. This honor was bestowed on them because of the dedication with which they performed their tasks of imparting knowledge and skills. Our teachers held this revered position until a few decades ago. But in recent times we have witnessed a gradual deterioration of the status of the teacher, with the result that the teaching profession today has failed to attract people of the right calibre... [I]f the teaching profession is gradually drained of teachers of good quality, it has to be considered a major disaster, especially

for a developing nation, because national development is dependent to a very great extent on education." (Samarakoon and Rajapakse, 1985).

Until the early 1980s most teacher training was conducted by between 16 and 20 Teachers' Colleges. These were residential programs where practicing teachers could earn a Trained Teachers Certificate after two or three years of training. Low admission standards, the limited number of training institutions and places in them, outmoded and irrelevant curricula, high program costs, and political interference were some of the factors which adversely affected the quality and output of these programs.

In the early 1980s concern over the quality of teacher training led to the establishment of two new institutions, the Colleges of Education and the Distance Education program. The Colleges of Education were established as pre-service training institutions to recruit bright young high school graduates into the teaching profession, to give them a total immersion program in the knowledge, techniques, and values of effective teaching, and then to place them in relatively secure jobs, albeit in difficult or unattractive locations for at least the first three years. The Distance Education program was established to accelerate the upgrading of existing primary school teachers in order to increase their effectiveness, their status, and their pay grade (and, presumably, their commitment to the teaching profession). This goal had previously been entrusted to the more conventional Teachers' Colleges, which as residential, campus-based programs, could upgrade limited numbers per year.

By the late 1980s it became apparent to the National Institute of Education (NIE), Sri Lanka's premier institution of educational research and development, that teacher training programs had been constructed in an ad hoc manner without an overall long-term plan or internal coherence. Assisted by researchers from the United States under the BRIDCES Project, the NIE decided to mount a policy-oriented research project to examine the cost-effectiveness of the three programs in elementary school teacher training, which would provide a basis for developing more rational policies and investment decisions. The overall task was to assist the Ministry of Education in developing an integrated set of programs to attract capable people to the teaching profession, to retain qualified teachers, to improve the

economic, professional, and academic standing of teachers, and, in general, to provide an adequate supply of well-trained and qualified teachers in order to improve the overall quality of basic education.

Given the severe financial constraints faced by the government of Sri Lanka, an additional task was to determine ways of making these programs as cost-effective as possible.

Section II: Methodology

Concepts and Variables

Program Characteristics

The three programs that provide teacher training in Sri Lanka are similar in their goals but varied in their structure and organization. Our premise was that differences in program effectiveness could be explained, at least in part, by these structural and organizational differences. Figure 1 provides a conceptual framework for analyzing these differences. It shows the linkages between program characteristics and program outcomes.

The program characteristics were determined both through a review of official documents and through data from program participants. The document review demonstrated the formal organizational characteristics of the programs and their evolution over time; the data collection revealed program features as they were understood and implemented by program managers and teachers. To get this information, the principals of the study's six institutions as well as 28 faculty members were interviewed. A senior Sri Lankan interviewer conducted the interviews using an interview format developed by U.S. and Sri Lankan researchers.

Program Effectiveness

"Something that is effective is seen as adequate to accomplish a purpose producing the intended or expected result."² In the commonly used definition of effectiveness is a sense of purposefulness. In other words, *something* that has been designed to be *effective is expected to have specific results*. Social, economic, and political demands heighten the need for educational policies and programs to achieve their intended effects.

In Sri Lanka, teacher training programs are created with specific goals and expectations to achieve them. Training is provided with the assumption that better educated teachers can make informed choices about curriculum, and will have a larger body of knowledge to draw upon when teaching pupils. In addition to knowledge of subject matter, teacher training programs are concerned with pedagogy, assuming that teachers need to know not

only what to teach but how to teach it. Whereas teacher training programs have an immediate goal: to increase knowledge, skills, and attitudes of current and prospective teachers, they also have long-term, social goals, such as producing teachers who are effective in the classroom, and who can favorably encourage a productive, responsible, and well-educated citizenry.

For the purposes of this study an effective program was defined as one that improved a trainee's subject matter mastery and teaching skills (on both theoretical and practical levels), and promoted the development of professional attitudes—all of which would enable the trainee to structure a classroom environ-

...teachers need to know not only what to teach but how to teach it.



ment that would encourage learning and promote pupil achievement. Pupil achievement was thus perceived as the ultimate indicator of program effectiveness.

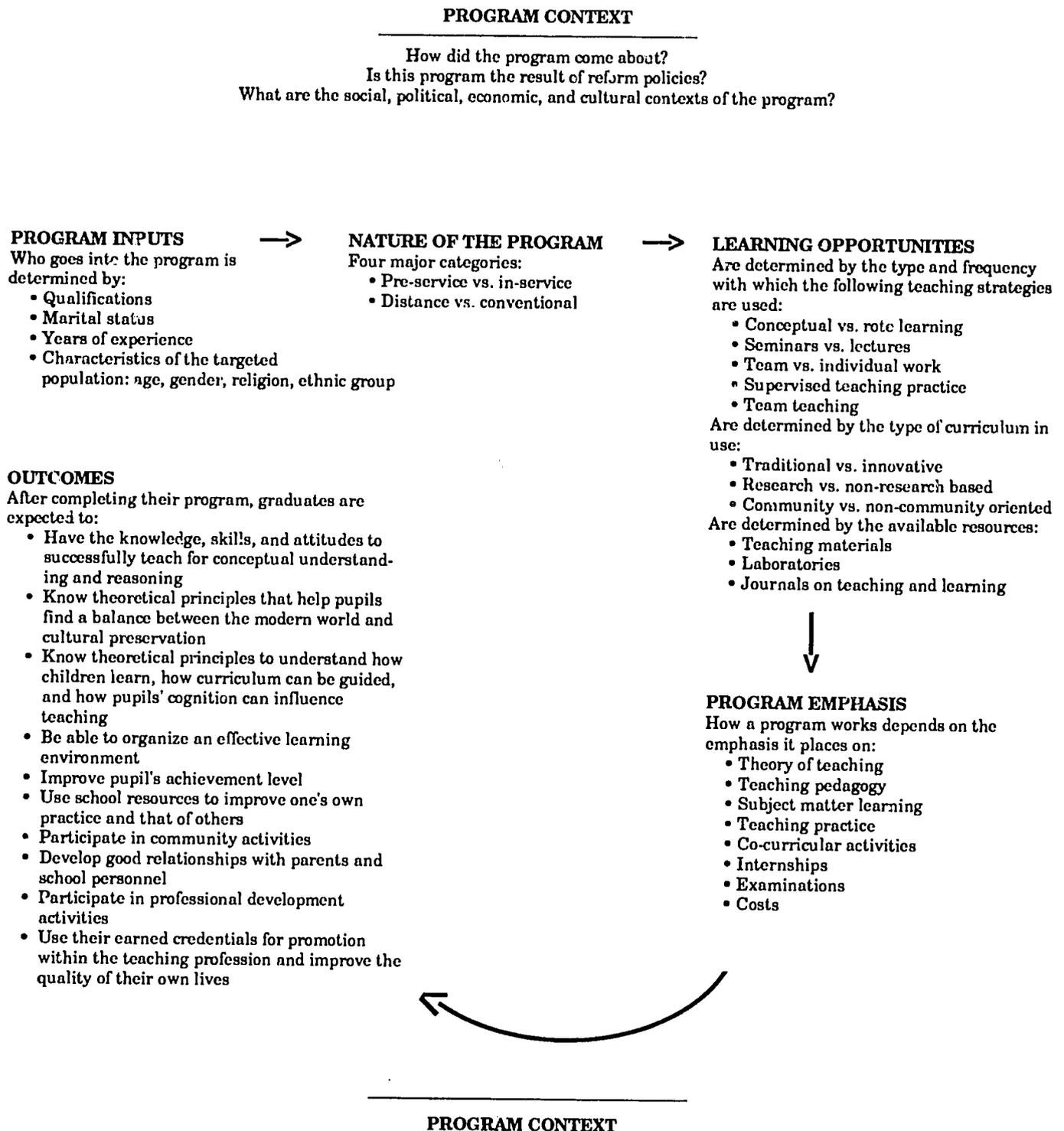
- **Mastery of subject matter** was measured through the use of two tests with both open-ended and multiple choice questions, one for mathematics and the other for mother tongue. These tests measured two levels of knowledge—one based on the newly integrated primary school curriculum, and the other based on the teacher training curriculum and the general examinations used in the three programs studied.

- **Mastery of teaching skills** had two dimensions, one theoretical and one applied.

The theoretical dimension was defined as teacher understanding of how children learn specific subjects and the related subject-specific pedagogical skills.

...official records contain no information on trainee expenditures and opportunity costs, two important cost ingredients which are often overlooked.

Figure 1: Conceptual Framework for Analyzing Teacher Training Approaches



Cost data was collected using two instruments, one for institutional costs, and the other for private or trainee costs.

Two written tests were developed, one for mathematics and one for mother tongue. The tests presented situations as they occur in the classroom in teaching specific subject matter. The respondents were expected to use their pedagogical knowledge to describe how to handle the situations. The dimensions measured included the teachers' arrangement of the classroom environment, the type of instruction used (teacher- vs. pupil-centered), attention to curriculum, use of instructional materials, and level of interaction among pupils.

The applied dimension was conceived in terms of the teachers' application, in the actual classroom, of appropriate teaching skills, use of materials, interaction with pupils, and mastery of subject matter. The length of time devoted to teacher-centered vs. pupil-centered instruction was also perceived as an indicator of teaching skill under the assumption that effective teachers devote more time to pupil-centered instruction (Good and Brophy, 1987; Fuller and Snyder, 1991). Teachers were rated on their performance along these lines using three observation instruments developed by the research team.

• Development of professional attitudes.

One of the main objectives of teacher training in Sri Lanka is to shape the professional attitudes of teachers. Attitudes about the teaching profession, about pupils, and about the community surrounding the school are all considered important by Sri Lankan educators. Likert-type³ attitude items were developed by Sri Lankan researchers to assess these domains, using some items already developed locally for other purposes.

• **Pupil achievement.** Pupil achievement in mathematics and mother tongue was measured using open-ended tests developed by Sri Lankan experts. These tests, although based on Sri Lanka's national curriculum, were different from the regular tests currently in use on the island in that they were designed to measure, not only recall, but knowledge and conceptual understanding of subject matter. The tests required pupils to perform written as well as activity oriented tasks. For this reason some of the tests were self-administered, and some were administered by researchers. The tests were carefully piloted before they were applied to the larger sample of pupils selected for the study.

Mediating Variables

• **Teacher background variables.** Factors which might affect a teacher's performance both during

training and in the classroom were measured and controlled. These included age, sex, previous training, socio-economic background, level of education prior to undertaking training, and level of experience in teaching.

• **Pupil background variables.** The study also included as control variables socio-economic factors which might affect pupil achievement, such as parents' occupational status and educational attainment.

• **School context variables** included the school's location, type ("congenial," "difficult," "very difficult"), resource allocation, and the level of professional support available to teachers and administrators. Congenial schools are those usually located in urban areas operating with appropriate resources, and easy to access. Schools classified as difficult or very difficult are usually located in rural areas, operating with scarce resources, and difficult to access by road and public transportation.

Program Costs

Program costs can be measured directly or inferred from budget statements and government documents. Following the recommendations of Tsang (1988) this study took a direct approach, using both program administrators and participants as the source of information. This was done because the Ministry of Education figures reflect intended expenditures, not actual expenditures (the former become available after a two-year time lag). They cover recurrent costs only, and are highly aggregated. Moreover, the official records contain no information on trainee expenditures and opportunity costs, two important cost ingredients which are often overlooked.

The costs in this measurement were identified using the "ingredients approach",⁴ and are as follows: *institutional costs*, both *recurrent* (salaries and benefits for instructors, administrators, and support staff; utilities and communications; building and equipment maintenance; supplies and equipment; books and publications; staff training; transportation; medical/welfare services; trainee allowances (salary maintenance); and *capital* (buildings, land, furniture, equipment), as well as *private costs* (facilities or registration fee, books and supplies, transportation, health, room and board, trainees' activities, teaching materials, personal expenses, and foregone income).

Cost data was collected using two instruments, one for institutional costs, and the other for private or

trainee costs. The institutional cost questionnaire was filled out by senior project staff during interviews with key college administrators at the Colleges and Distance Education centers involved in the study. Costs were for the 1988 academic year. In all cases administrators were asked to indicate their source of funds. In most cases the source was either the Ministry of Education or the trainees themselves. There were almost no contributions from community associations or outside organizations. This does not mean that all government funds were channeled directly through our sample institutions. In many cases they used instructors on temporary transfer from other colleges (or from the Ministry). Moreover, Teachers' College participants received salaries paid through the school where they had been teaching. In the Distance Education program, much of the budget for equipment and recurrent costs had been covered by a grant from the Swedish government. We have listed these costs as costs to the "sponsor", although strictly speaking, they represent extra-governmental resources which may or may not be assumable by the government once the Swedish aid is terminated. For purposes of our analyses of cost burden, we will consider seconded resources and grant funds as part of the sponsors' cost burden.

The trainee questionnaire was administered to those who had just completed their course. They were asked to record their personal costs and allowances for the years during which they were enrolled in their program. Opportunity costs were computed by asking trainees for an estimate of the yearly income they sacrificed to participate in the program. Colleges of Education trainees, most of whom were just out of secondary school, were asked how much they would be earning if they had taken a job instead of enrolling in the College.

Before our instruments were used with the institutions and trainees, they were reviewed by faculty members and administrators attending a professional workshop in Colombo (who reviewed the entire cost analysis design as well). Feedback from that review was used to improve item clarity and format.

The Research Design

This study employed a cross-sectional design with a control group. This required selecting groups of trainees at the beginning of their training (entry level), at the end of their training (exit level), and one year after the completion of their program (post-program level).⁵ Their scores on our various effective

measures were treated as proxies for a longitudinal design. (As indicated above, time constraints did not allow us to trace the same trainees over time.) The control group consisted of a group of teachers who had not yet received teacher training, but who were otherwise similar to the training program graduates in our sample.⁶ Sampling designs and statistical controls were used to achieve group similarity in the population of the programs studied. We refer to the three data collection points in our cross-sectional design as *levels*. The three levels are further described below:

Entry level

Measuring the knowledge, skills, and attitudes of teacher trainees as they entered their programs facilitated our understanding of what they brought with them to teacher training. The three different programs we studied presented a natural scenario for determining whether previous experience in teaching (as in Teachers' Colleges and Distance Education), no previous teaching experience but strong qualification in subject matter (as in Colleges of Education), or learning while teaching (as in Distance Education) makes a difference in the ultimate purpose of teacher training.

Exit level

Measuring knowledge, skills, and attitudes as teacher trainees finished their programs allowed us to infer how much trainees had learned. Since all programs had approximately the same learning objectives, we used the differences between the entry and exit levels as indicators of program effectiveness.

Post-program level

Measuring knowledge, skills, and attitudes one year after graduates began classroom teaching allowed us to infer whether the training was retained or whether it was "unlearned" under the pressures of the job. At this level we also observed the trainees' application of teaching skills in their own classrooms and their pupil's achievement.

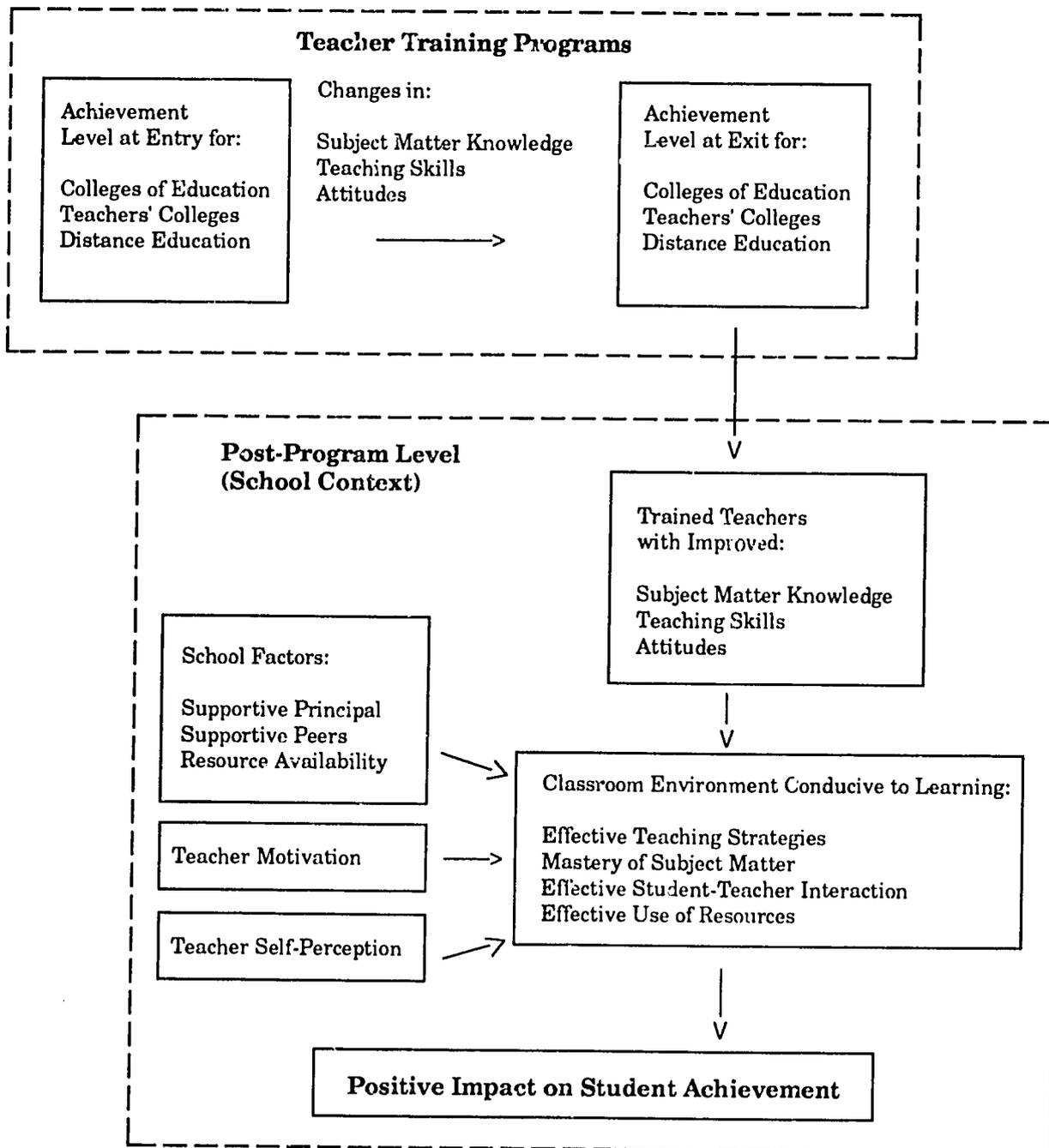
The object of this phase of the study was to contrast program effectiveness as expected by the program itself (i.e., through knowledge, skills, and attitudes) with external measures of teacher effectiveness in the classroom. The strategy at this stage was to "work backwards" in order to determine the characteristics associated with higher levels of teacher performance and pupil achievement, includ-

ing teacher training, pupil background characteristics, and school context. These dimensions (teacher performance, pupil achievement, and school context)

were then related to the measures of knowledge, skills, and attitudes collected from the teachers who had also been observed.

Figure 2 represents a visual design of the study.

Figure 2: Effectiveness of Teacher Training in Sri Lanka



Sampling

For the population of teacher trainees at the entry and exit levels, two institutions were selected from different geographical regions. Respondents were randomly selected from the entire population of trainees using a stratified sampling design according to background characteristics relevant to this study (age, gender, and educational qualifications). The sampling target was 100 respondents from each institution type for entry and exit levels. For the post-program level, cluster sampling was used (Warwick and Lininger, 1975). Selection was based on the number of trained teachers who were teaching years 2nd and 4th (grade 1 and 3) in those areas around the country where civil unrest was under control. The sampling target was 50 for the post-program level. For the control group, the target was 50 untrained teachers. Table 1 presents the sample used in the study:

Table 1. Sample for the Study

Type of Institution	Number of Institutions in Country	Number of Institutions in Study	Number of Trainees		
			Entry	Exit	Post-Pgm.
Colleges of Education	7	2	100	86	36
Teachers' Colleges	16	2	92	78	38
Distance Education (centers)	30	2	24	73	43
Untrained Teachers					31

The political disturbances in Sri Lanka during the time of the study, coupled with administrative changes in Distance Education, made it impossible to meet the desired quota at the entry level.⁷

It was the intent of the study to sample schools from as many districts on the island as the political unrest allowed. Two hundred schools from seventeen districts were included. An effort was made to have a representative number of congenial, difficult, and very difficult schools in the sample. Table 2 presents the percentage of teachers observed by type of school.

As can be seen, a disproportionate number of graduates from the Colleges of Education go to difficult and very difficult schools. This is in accordance with the government policy of providing equal and better quality education in poorer areas of the island. Such a policy requires newly trained teachers to serve for at least three years in difficult or very difficult schools.

Table 2: Percent of trained and untrained teachers observed in classrooms by type of school

Program	School Type		
	Congenial	Difficult	Very Difficult
	%	%	%
Colleges of Education	9	67	24
Teachers' Colleges	63	29	8
Distance Education	60	38	2
Untrained Teachers	22	64	14

Note: Schools classified as difficult or very difficult are usually located in rural areas, operating with scarce resources, and difficult to access by road and public transportation. Congenial schools are those operating with appropriate resources, usually located in urban areas, and easy to access.

Data Analysis

Analysis of covariance was used across the different groups of teachers studied to check for their similarity in relevant background variables. We controlled for those background variables showing a significant relationship with the outcome measures in the study. In the measures of teacher achievement for example, the analysis includes controls for age, educational level before entering the program, and previous teaching experience. There were no measures of ability at the pre-entry level that could be used to control for differences at the entry and exit levels, within or across programs. Concerning the entry and exit levels, however, the dropout rate from the programs is so small (Colleges of Education less than 1%, Teachers' Colleges less than 5%, and Distance Education between 10 and 15%), that we can assume the ability level of the graduates is not systematically different from that of new recruits. With the classroom observation data the study controlled for the same background variables mentioned above and also for school context. Finally, in the pupil achievement data analysis, pupils' background, teachers' background, and school context were controlled using multiple regression techniques.⁸ The relationships among variables reported have proven significant at the $p < .05$ level unless otherwise indicated.⁹

With respect to the cost study, capital costs were amortized over the expected lifetime of the buildings and equipment using the prevailing discount rate of 12% (the rate used by the national savings bank over the past decade). For the Distance Education pro-

gram, the costs of central office buildings and equipment were estimated in an amount proportionate to the number of trainees in the program and then added to the costs of the program. For the Teachers' Colleges which covered more than the primary school teacher training program (namely, Bolawalana Teachers' College, which has programs in English and Religion as well as Primary Education), the cost per trainee was calculated for the entire college, irrespective of the program in which trainees were enrolled. This was done under the assumption that the use of resources was basically the same for all programs.

Two cost categories, trainee allowances and facilities/registration fees, were treated as "transfer payments."¹⁰ Allowances were an expense to the college but income to the trainees; conversely, fees were an expense to the trainee but income to the college. When the cost burden is broken down by "sponsor" and "trainee", it is the net cost that is used (i.e., total costs minus income).

The basic unit cost used in our analyses was total costs per trainee per year, the base year being 1988.¹¹ Arriving at this unit cost for the Distance Education program required an additional transformation, since its trainees are part-timers, taking over three years on average to cover a course that is covered in two years at the colleges. In order to develop a valid basis for comparison, we transformed annual Distance Education costs into costs per full-time equivalent.¹²

Finally, for the cost-effectiveness analysis, a measure of total costs per trainee per cycle was developed. Since a cycle for the programs lasts two years (or two full-time equivalent years in the case of the Distance Education program), a second year's worth of costs were added. We already had unit costs for 1988; for 1987 we estimated the amount as the 1988 figure minus 7.5%, the official inflation rate for that period.¹³

These unit costs were calculated for the individual institutions and then pooled across the two institutions for each program type (Colleges of Education, Teachers' College, and Distance Education). The

unit costs are broken down by source of funds ("sponsor" and "trainee") and by cost category (recurrent and capital).

Limitations of the Study

Time pressures coupled with the unstable political conditions in Sri Lanka at the time of the study made it necessary for us to use a simulated rather than longitudinal research design and to compromise on sample breadth and size. The simulated longitudinal design, however, seems to be a promising alternative when there are time and context constraints. Being unable to use a longitudinal design meant not having the same individuals in the groups at each level. We attempted to deal with this by stratifying the sample for representativeness and by building in controls for respondent background characteristics (Cook and Campbell, 1979; Murphy, 1980; Weiss, 1972). There is, however, still the chance that some of the differences between groups are the result of historical factors, and not program effects. Having to restrict data collection to Central Sri Lanka—and to only a few colleges there—restricts the generalizability of our findings. For instance, it is not clear whether our findings would be the same in Northern Sri Lanka where the dominant ethnic group is Tamil and where language and school climate are quite different from those in Central Sri Lanka. In addition,¹⁴ the small size of the entry-level Distance Education sample, and the reduced number of respondents at the post-program level, means that the data for this group should be interpreted with caution. Finally, we are aware that the background and motivation of trainees in the pre-service and in-service programs may be different. Self-selection factors are in operation in both programs: those who have entered the Colleges of Education may be different as a group from those who entered the teaching field several years ago. Moreover, those who were selected for the various in-service training programs may be different from their peers who were not. No research design done in natural settings can completely control for self-selection biases. We have tried to understand and control for them in this study.

Section III: Research Results

Program Characteristics

The three approaches studied can be seen as three different models to educate elementary teachers.

The rationale for the model behind Teachers' Colleges is that experienced teachers can increase their effectiveness by updating their teaching skills and obtaining a credential when they finish the program. The assumption behind this model is that experienced teachers who are already committed to teaching will take advantage of the training, thereby becoming better teachers; and, provided with avenues for promotion, will continue teaching.

The model behind the Colleges of Education is based on attracting capable individuals at the beginning of their careers and providing them with formal teacher training with an emphasis on a diversified curriculum stressing co-curricular activities, pedagogical knowledge, and supervised practice. This model represents an attempt by education officials to educate teachers within a critical thinking frame-

The Distance Education model relies heavily on instructional materials with an emphasis on subject matter and on the teacher as an individual learner. Pedagogical knowledge is something that teachers are supposed to possess as a result of their teaching experience and is a skill they will be able to perfect in the training program. The model could be described as "applying while learning". The development of close ties with other teachers is encouraged through the use of tutors and the creation of study groups at regional centers. Possibilities for promotion and advancement are similar to those of the other programs. Figure 3 compares the variations in the teacher training approaches discussed above. These variations represent the different elements of teacher training discussed in Section I: duration/location, entry conditions, content, supervised practice and follow-up, approaches to training, and costs.

The Teachers' Colleges, an in-service approach, have two years of course work. They recruit senior teachers with a good record of teaching. The curriculum focus is on pedagogy and includes supervised teaching and follow-up experiences. The internship, which used to run for one year, has been eliminated. The programs themselves follow a traditional curriculum dominated by lectures and teacher-centered instruction. This approach, as will be explained in the discussion of cost findings, is quite expensive since teachers receive leave pay while studying. They are expected (although not all of them do) to live in the government supported housing on campus. Trainees, however, move along the program as a cohort.

In contrast, the Colleges of Education pre-service approach consists of two years of course work and a one year internship. The entrance to these programs is restricted to high school graduates with excellent credentials. This approach is characterized by an innovative curriculum with emphasis on co-curricular activities and subject matter. Supervised teaching and follow-up is taken seriously by the faculty and the trainees, and great care is taken in designing the experiences and feedback provided to them. Teaching techniques are developed on the basis of current international research on teacher training, and the program's structure is biased towards a pupil-



The development of close ties with other teachers is encouraged through the use of tutors and the creation of study groups at regional centers.

work which is based on current international research on teacher training. Desired program outcomes are the formation of a critical mass of well-educated teachers who will know how to apply the curriculum and the subject matter they have been taught and who could become educational leaders. The graduates of this program will also have opportunities for advancement and promotion. The most important concept behind this model is how the program molds character and attitudes.

Figure 3: Different approaches to teacher education in Sri Lanka.

Program/Goal	Duration/ Location	Entry Conditions	Content	Supervised Practice & Follow-up	Approaches to Training	Costs
TEACHERS' COLLEGES Experienced teachers update skills and gain certification.	Full-time; 2-years course-work; optional residency; campus-based; In-service	Selection of successful senior teachers with either O/L or A/L ⁶	Emphasis on educational foundations, pedagogy; formation of cohorts	Included, but not a strong element	Teacher-centered; lecture format	High
COLLEGES OF EDUCATION Mold character and attitudes of young, well-qualified candidates. Offers diploma in education.	Full-time; campus-based; residential; 2 years course-work; 1 year internship; Pre-service	Young candidates with A/L	Innovative curriculum based on current research; co-curricular activities; subject matter emphasis; formation of cohort	Strong emphasis	Pupil-centered; experiential learning	High
DISTANCE EDUCATION To update teaching skills within existing teaching force. Offers diploma.	In-service; field-based; 3-5 years coursework	Experienced teachers with either O/L or A/L	Emphasis on pedagogy and subject matter knowledge	Important component	Carefully designed self-instructional materials; "teaching while learning"; group activities; tutorial visits; peer relationships	Low

tered approach. The cost of this approach is high since trainees are totally supported by the government, which provides a stipend and finances their living costs during the training period. Colleges of Education trainees also move along their program as a cohort.

Distance Education is an in-service approach for upgrading experienced teachers over a three to five year period. The curriculum is based on current international research on teacher training with primary emphasis on pedagogy and secondary emphasis on subject matter. The curriculum is imparted through carefully designed self-study materials. Supervised teaching and follow-up are an important component of this approach, and during the training period, a tutor visits teachers frequently. An additional feature of this approach, the face-to-face sessions in Regional Centers, reinforces on-the-job-learning. Frequent dialogue with the tutor and fellow teachers also characterizes this approach. The cost of Distance Education is low for the government, espe-

cially when economies of scale are large, (when there are large numbers of teachers that need to receive training), but high for the trainees. The specific components of these approaches are discussed in the following paragraphs. The characteristics of these approaches in relation to policy will be discussed in depth in Section V: Policy implications.

One purpose of our study was to explore the components of the three programs. A good indicator of effective teacher training is the curriculum and the emphasis placed on the different areas of such curriculum. Figure 4 shows the areas covered by the three approaches and the units (either in time or, in the case of Distance Education, as modules) assigned to them. Because Distance Education operates under a different design (using modules) than Teachers' Colleges or Colleges of Education (which use hours) it is not directly comparable with the other two. Nonetheless, we have included the distribution of time and resources to illustrate the emphasis given by each program to the different curricular areas.

...Colleges of Education trainees live for one year in the area of their designated school and regularly receive on-site feedback from program faculty.

Figure 4: Areas of Emphasis in the Three Approaches to Teacher Training in Sri Lanka

Training Approaches:	Teachers'Colleges total hrs=2620	Colleges of Education total hrs=2730	Distance Education total # of modules=105 (not in hours)
Areas of Emphasis	Percent of total time/modules allocated to the areas of emphasis in each of the approaches		
	%	%	%
Professional (Foundations)	23	17	20
Primary Education (Principles of Primary Education)	41	20	49
General Education (Subject Matter Knowledge)	16	21	31
Teaching Practice	11*	11	3 times in the academic year
Co-Curricular Activities	9	31	Two 2-day sessions 5-day session
Internship	1 year, suspended in 1988	1 year full-time	On-site
Examinations	Internal External Continuous	Formative Summative Continuous	Formative Summative Continuous
Methods of Instruction	Lectures, discussion, projects, assignments, demonstration, simulation, micro-teaching, team-teaching, community development projects, simulation, field trips.	Lectures, discussion, seminars, debates, team-teaching, role play, simulations, observations, discovery, methods, diagnostics, experimentation.	Printed materials face-to-face contact through sessions at regional centers, practice teaching, supervised practice, study circles.

Note: The Distance Education approach is regularly 3 years, but can be extended to 5. Students average 8 hours of study per week, covering 105 modules at their own pace.

* Depends on availability of resources.

A look at Figure 4 reveals that the three programs have the same areas across their curriculum: foundations, principles of primary education, subject matter, teaching practice, co-curricular activities, and internship. Of interest is the special emphasis placed by Teachers' Colleges on principles of primary education (or how to teach the elementary school cur-

riculum). In fact, 40 percent of the program is dedicated to this component alone, followed by 23 percent dedicated to foundations (or history, sociology, and philosophy of education), and the rest to subject matter, teaching practice, and co-curricular activities in that order. The traditional character of the curriculum is confirmed by the methods of instruction domi-

Distance Education's curriculum and study materials . . . present an interesting combination of traditional . . . and more current approaches to teacher training.

nated by lectures and teacher-centered instructional techniques.

In contrast, the Colleges of Education show a more balanced curriculum which dedicates 30 percent of the program to co-curricular activities (such as visiting the community, volunteering for social activities, etc.), in accordance with the objective of forming not only teachers but also community leaders. Subject matter is the next priority in the curriculum with 21 percent of the time. This can be seen as an important program emphasis considering that these trainees are already strong in subject matter knowledge. Principles of primary education (about 20 percent) and foundations (about 18 percent) receive similar emphasis. Time allocated to teaching practice is comparable to that of Teachers' Colleges. Internship is an important part of this program, and in contrast with Teachers' Colleges, where it has been suspended, Colleges of Education trainees live for one year in the area of their designated school and regularly receive on-site feedback from program faculty. Colleges of Education's curriculum is less traditional, a conclusion confirmed by the methods of instruction which emphasize debates, discussion, group work, and team teaching.

Distance Education allocates almost 50 percent of the program to principles of primary education, followed by attention to subject matter which comprises about 30 percent, and by professional foundations which comprises the remainder. Distance Education's curriculum and study materials have been designed recently (in the early 1980s) and present an interesting combination of traditional (as evidenced by the strong emphasis on principles of primary education) and more current approaches to teacher training. A special characteristic of this program is the use of instructional methods which present a combination of self-regulated learning, group discussions, continuous tutoring, and practice teaching.

Program Effectiveness

Examining the Evidence of Program Performance on Effectiveness Measures

In this section we present the results on program effectiveness as expressed by Scheffe' pairwise mean comparisons for knowledge, skills, and attitudes measures at entry, exit, and post-program levels (Scheffe', 1959). The results indicate the effectiveness of the three programs studied (see Table 3 and Figures 5.1 through 5.3).

Colleges of Education are effective in imparting a high level of mathematics knowledge and pedagogical skills in mathematics and mother tongue. They also are effective in achieving a long sustained effect even after the teachers have graduated and are teaching in the classroom. This may be the result of the strong emphasis on subject matter and practice teaching observed in the program, as well as the support graduates receive during their internship.

Teachers' Colleges are effective in raising, if modestly, the levels of achievement of their trainees in mathematics knowledge and mother tongue skills from the entry to the exit level. Changes are small in measures of mother tongue knowledge and mathematics skills at the exit and post-program levels. Changes in attitudes are minimal between entry and exit levels and drop significantly at the post-program level. These findings suggest that Teachers' Colleges seem to have difficulty in raising trainees' knowledge, skills, and attitudes beyond the level they were at when they entered the program. The apparent weakness of this program may be due to its traditional character as well as limited resources.

Distance Education is able to produce graduates showing high levels in the outcomes measured at the exit point. These levels, however, are low for those graduates now teaching in schools. The weakest areas are in the knowledge of subject matter, both mathematics and mother tongue, and in attitudes. These findings seem to be the result of the importance given to pedagogy at the cost of a stronger emphasis on subject matter.

Comparing Program Trends

The findings presented above only show how the trainees and graduates in the different approaches perform on each of the effectiveness measures at the entry, exit, and post-program levels. This information, although valuable, does not answer questions about program trends, such as: Do trainees' knowledge, skills, and attitudes improve through time as they progress in their programs? What approach is more effective through time in the different areas measured? In other words, when studying teacher training effectiveness, it is important to look at trends to have a better idea about how these programs work. In order to look at these trends we followed two procedures. First, we developed Figures 6.1 through 6.5 showing across program and within program differences based on the means of the effectiveness measures. Then, we developed a procedure

Table 3: Mean scores and standard deviations (in parenthesis) for teacher program's effectiveness measures of knowledge, skills, and attitudes, by program and level.

Program	Level	n	Math know. mean (sd)	Lang. know. mean (sd)	Math skills mean (sd)	Lang. skills mean (sd)	Attitudes mean (sd)
Colleges of Education	Entry	100	39.95 ^{ab} (12.8)	47.72 (13.7)	33.82 ^{ab} (13.7)	44.60 ^{ab} (14.1)	183.7 ^a (12.2)
	Exit	86	48.25 ^a (15.2)	47.69 (17.5)	51.45 ^a (14.5)	61.47 ^{ac} (11.8)	181.3 ^b (13.3)
	Post- Prog.	36	48.15 ^b (14.9)	53.83 (11.6)	58.27 ^b (18.9)	63.33 ^{bc} (11.5)	160.1 ^{ab} (8.3)
Teachers' College	Entry	92	35.7 (15.9)	51.55 (15.5)	50.45 (17.0)	53.47 ^{ab} (14.3)	180.8 ^a (16.7)
	Exit	78	40.25 (19.6)	51.45 (16.8)	50.45 (18.8)	68.27 ^a (17.8)	181.8 ^b (16.8)
	Post- Prog.	38	41.3 (18.8)	52.52 (19.0)	52.81 (15.7)	64.2 ^b (17.0)	60.38 ^{ab} (11.8)
Distance Education	Entry	24	35.2 (14.1)	44.83 ^a (11.6)	50.73 (13.0)	56.40 ^{ab} (13.0)	166.4 ^a (10.3)
	Exit	73	40.75 (15.7)	54.31 ^{ab} (16.6)	56.45 (18.7)	70.20 ^a (14.6)	185.1 ^{ab} (11.5)
	Post- Prog.	43	35.65 (13.1)	45.27 ^b (15.7)	53.27 (18.3)	66.20 ^b (17.1)	160.38 ^b (13.4)

Notes: (1) Level means which share superscripted letters differ significantly at the $p < .01$ level according to Scheffe pairwise mean comparisons; the blue italic letters are significant at the $p < .05$ level.
 (2) The comparisons of significant differences among the means are within programs and across levels (entry, exit, post-program) for each effectiveness measure.
 (3) The knowledge and skill scales have been transformed into percent correct. The attitude scale is the sum of ratings for all items. Its range is 61-305 where a higher score represents a more positive attitude.

Figure 5.1: Measures of achievement at the entry, exit, and post-program levels for Colleges of Education trainees.

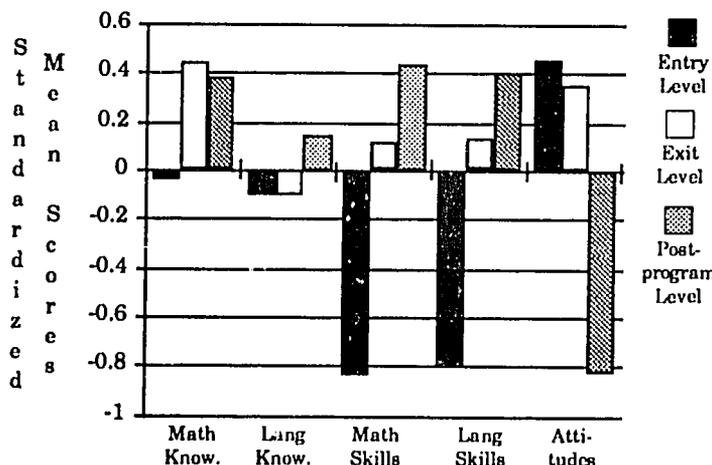


Figure 5.2: Measures of achievement at the entry, exit, and post-program levels for Teachers' Colleges trainees.

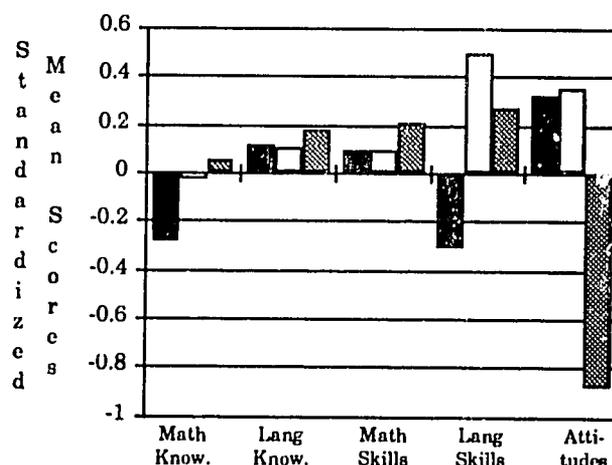
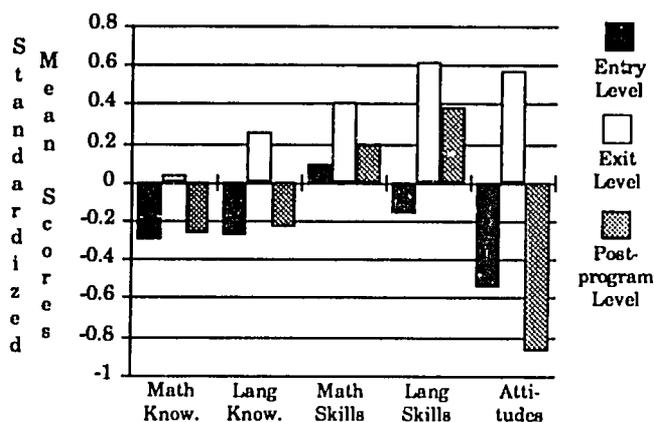


Figure 5.3: Measures of achievement at the entry, exit, and post-program levels for Distance Education trainees.



to statistically prove whether the trends observed in Figures 6.1 through 6.5 were significant. (The outcomes of the statistical analysis are included in the Appendix in Tables 13 and 14, showing the contrasts requested for our analysis and for the multi-analysis of variance coefficients and t-ratios. In this section we will only present a description of our findings using Figures 6.1 through 6.5 and will support our assertions using the statistical results from our analysis.) In our analysis we assumed group similarity on important background variables. We attempted to test two main hypotheses of program effectiveness:

- Trainees in an effective program improve as they progress in the program. In other words, an effective program is one in which learning occurs.
- One of the programs is more effective than the others in providing the trainees with the knowledge, skills, and attitudes required for good teaching.

When contrasting the effectiveness of pre-service versus in-service approaches in imparting mathematics knowledge, the research shows that on average, across the three levels (entry, exit, and post-program), pre-service trainees score higher than in-service trainees. This finding is significant with a t-ratio of 3.75. When looking at the changes in trainees' mathematics knowledge, it is evident that across the three programs, most of the learning occurs between the entry and the exit levels. Mathematics knowledge diminishes between exit and post-program levels, or as the trainee starts working in schools. These trends are significant as well. Pre-service trainees score higher across the three levels; an advantage partly explained by the fact that the pre-service

program selects highly qualified candidates who are already good in mathematics. Their performance is maintained but not changed by the program. The insignificant interaction between the programs in teaching mathematics knowledge over time shows that although there is growth in mathematics knowledge, none of the programs are significantly effective in this area (see Table 14 in the Appendix). Figure 6.1 shows these relationships.

Figure 6.1: Measures of mathematics knowledge at the entry, exit, and post-program levels for the three approaches studied.

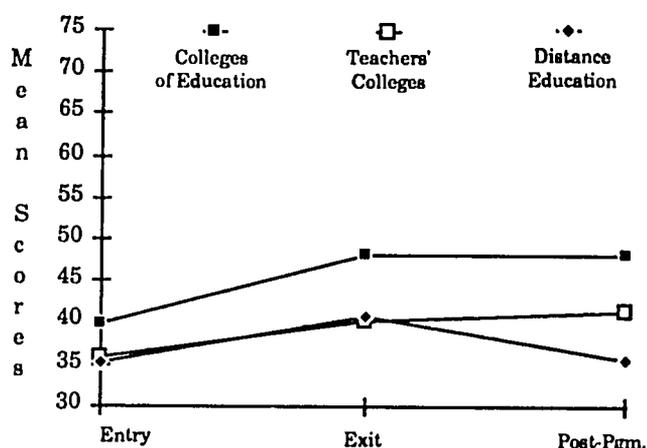
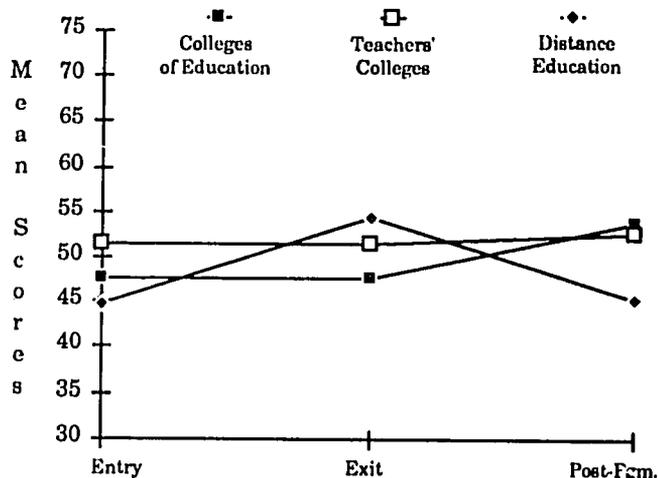


Figure 6.2: Measures of mother tongue knowledge at the entry, exit, and post-program levels for the three approaches studied.

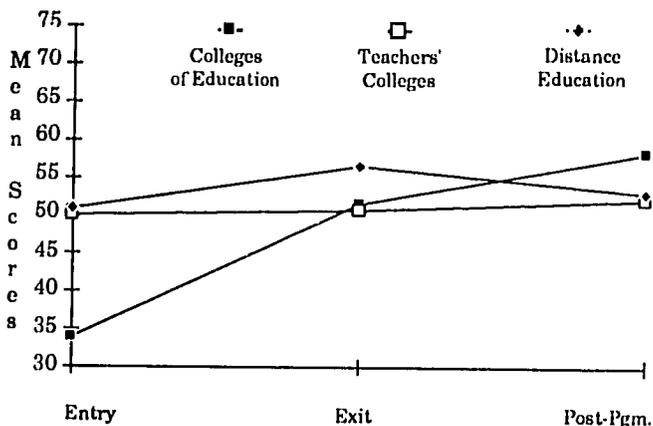


By the end of this first year C. E. trainees' attitudes are at almost the same level as those of the trainees from the other programs, implying that the workplace itself has powerful socialization effects.

When contrasting programs on their effectiveness in mother tongue knowledge, we found in-service program trainees—particularly those in Distance Education—do better than their pre-service counterparts. Most of these gains, however, occur between the entry and the exit levels. Their transition to the classroom is marked by a decrease in their knowledge of mother tongue. This trend proved to be significant (see Figure 6.2 below and Table 14 in the Appendix).

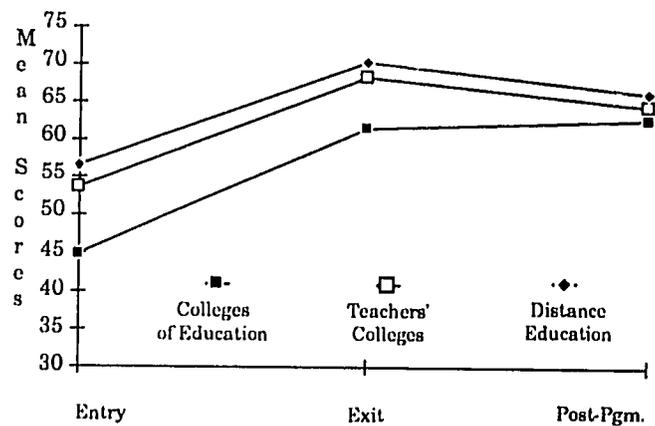
In the area of mathematics skills, the contrast between pre-service and in-service approaches shows that, on average, in-service program trainees—particularly those in Distance Education—score higher across entry, exit, and post-program levels. This finding is significant with a t-ratio of 3.17. As with the measure of mathematics knowledge above, the level of mathematics skills in the trainees increases over time, but, this rate of increase diminishes as the trainees start teaching. When examining the trends between the different approaches and levels, it is evident that trainees in the pre-service programs are gaining at a faster rate than their in-service counterparts. The negative coefficient in this comparison of pre-service versus in-service approaches (-.46392) indicates that, initially, pre-service trainees are at a disadvantage with respect to their more experienced counterparts in Teachers' Colleges and Distance Education. They rapidly increase their teaching skills in mathematics, however, thus achieving parity and even surpassing the trainees in the other approaches at the exit and post-program levels. This trend is also significant (see Figure 6.2 below and Table 14 in the Appendix).

Figure 6.3: Measures of mathematics teaching skills at the entry, exit, and post-program levels for the three approaches studied.



In mother tongue skills, the in-service program trainees—specifically Distance Education—are, on average, more capable than their counterparts in the other approaches. Their skills increase between the entry and exit levels and start to decrease as they move into the classroom. When examining the interactions of the programs across the entry, exit, and post-program levels, it is evident that the trainees in the pre-service programs gain at a faster rate than their in-service counterparts. As was the case with mathematics skills measures, pre-service trainees start the program at a disadvantage as evidenced by a negative coefficient (-.51904), but rapidly increase their abilities achieving a higher performance in this measure than trainees in the other two approaches. These trends are significant (see Figure 6.5 below and Table 14 in Appendix).

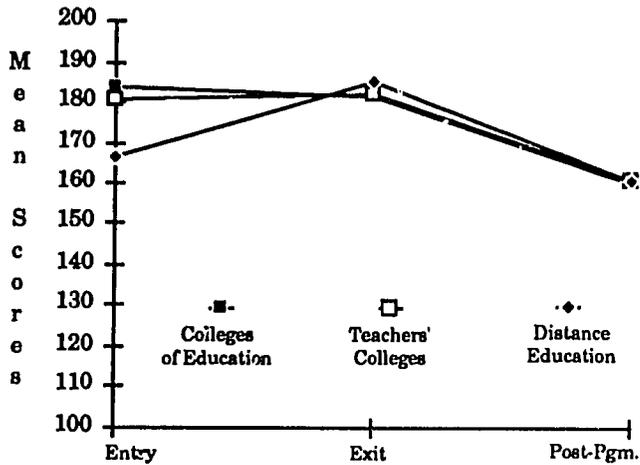
Figure 6.4: Measures of mother tongue teaching skills at the entry, exit, and post-program levels for the three approaches studied.



Finally, the attitude measures make it clear that the Colleges of Education and Teachers' Colleges trainees have more positive attitudes than the Distance Education trainees when they begin their program. Trainees in all programs, however, show a decrease in their positive attitude when they graduate and go into the classroom. Distance Education trainees had the most rapid attitude level increase between entry and exit levels but, just as with the other trainees, their attitudes became less positive during the post-program level. All of these trends are significant (see Figure 6.5 below and Table 14 in Appendix).

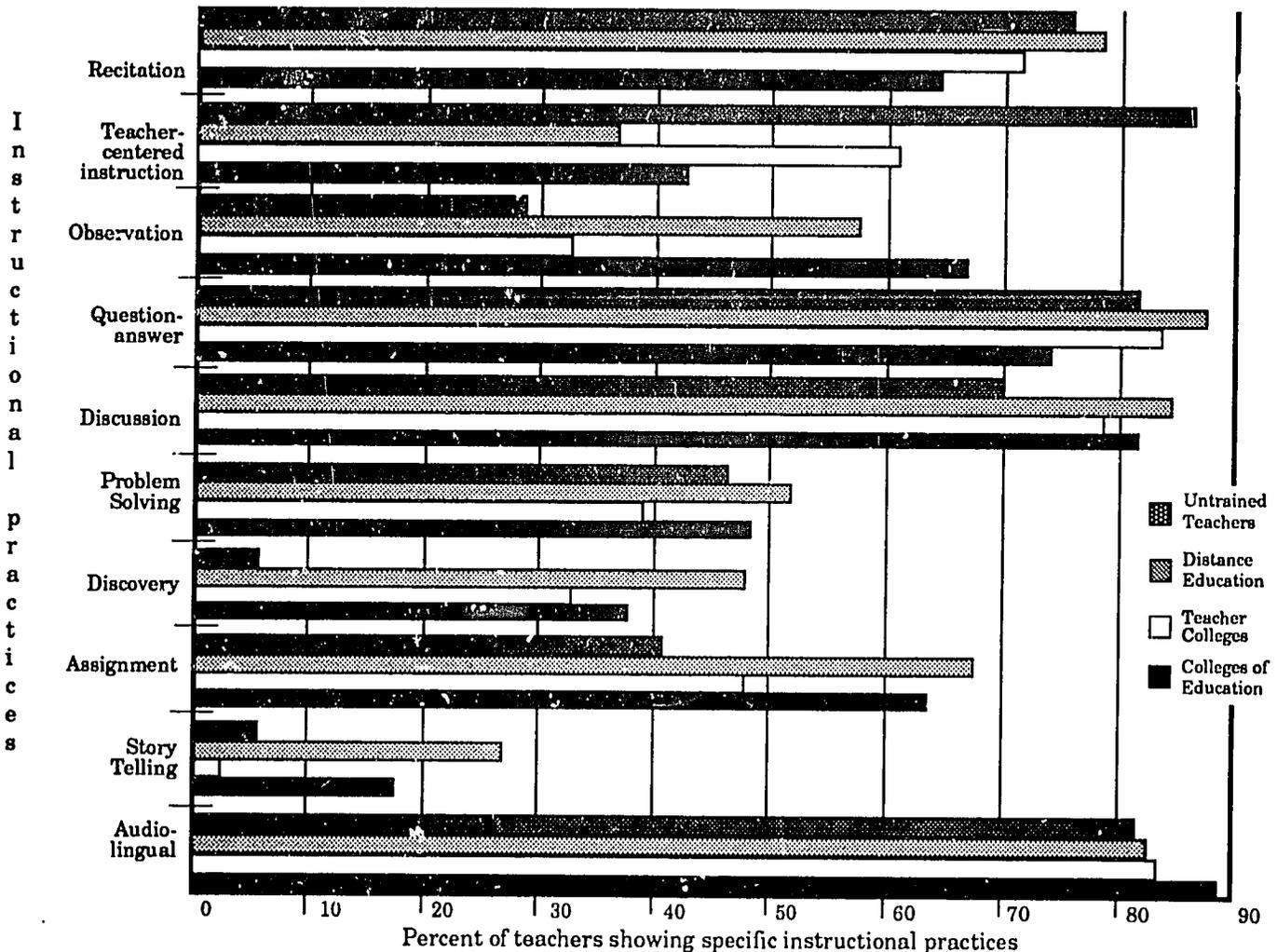
The stability of (Teachers' Colleges graduates') scores from entry to exit and post-program levels may be explained by the fact that their program was designed to reinforce what the teachers already know and do in their classrooms.

Figure 6.5: Measures of attitudes at the entry, exit, and post-program levels for the three approaches studied.



These trends indicate the possible effects of program design. For example, the decrease in the Distance Education trainees' performance between exit and post-program levels can be seen as the result of losing the tutor and peer support they had during the program. In contrast, Colleges of Education graduates seem to maintain or improve their performance on all effectiveness measures, except those concerning professional attitudes. Since the first year of teaching after course completion is an internship year, their improvement could be the result of further professional support and on-the-job training. The plunge in their attitudes may reflect a tapering off of the idealism which they, as elite recruits, initially brought to their training, a decline perhaps brought on by the stress and frustrations of the real world of teaching (especially given the fact that they are assigned to the most difficult schools). By the end of this first year their attitudes are at almost the same

Figure 7: Instructional practices for the population observed.



level as those of the trainees from the other programs, implying that the workplace itself has powerful socialization effects.

Teachers' Colleges' graduates are almost the same in effectiveness measures one year after graduation as they were upon exit from the program, except in another tongue teaching skills, where they are somewhat lower, and in attitudes where they experience a significant drop. The stability of their scores from entry to exit and post-program levels may be explained by the fact that their program was designed to reinforce what the teachers already know and do in their classrooms. The decline in attitudes may be a reflection of the same kinds of workplace conditions that seem to have affected the other groups.

The only positive attitude change is that experienced by those in the Distance Education program during the course of their on-the-job training. This program is characterized by strong professional support systems (study circle meetings and tutors' visits) and a significant improvement in teacher competence. In contrast, the campus-based programs, which have explicit socialization aims, appeared to have virtually no impact on attitudes. This suggests that professional support and satisfaction with one's professional growth may have more to do with attitude formation than more direct socialization experiences, even those found in the intense social atmosphere of the Colleges of Education. The fact that the attitudes of the Distance Education graduates decrease, and their knowledge and skills decline once their support systems are withdrawn, seems to support this argument.

Teacher Performance and Pupil Achievement

The quality of actual classroom teaching was considered an important indicator of program effectiveness. Effective teaching strategies include assigning and reviewing homework, actively involving pupils in the teaching and learning process, careful monitoring of pupils' progress during class, effective teacher-pupil interaction, and effective use of instructional resources.

Observations of teacher's classroom performance (Table 4) show that graduates from Colleges of Education and Distance Education have a higher level of performance in the use of effective teaching strategies than their counterparts in Teachers' Colleges. This result would be expected from Distance Education graduates (according to their performance in the written measures of pedagogy while in the

program and after finishing it); but is an unexpected result for Colleges of Education graduates, especially when considering that they have less experience in classroom teaching than the graduates from in-service programs. Since Teachers' Colleges seem to follow a more traditional curriculum and lack resources to acquire current information on teaching strategies advocated by research, it is not surprising to find them at a disadvantage.

Table 4: Mean scores, standard deviations, and significance level for trained and untrained teachers' classroom performance as ranked by observers.

Program	n	mean	sd
Colleges of Education	61	64.2*	8.8
Teachers' Colleges	62	56.9	10.5
Distance Education	73	63.8*	10.1
Untrained Teachers	17	52.7	11.7

F 11.18*

* Significant at the $p < .0000$ level

Note: Teachers were ranked by observers on a Likert scale (1-5) where the maximum score was 65.

The observations of instructional practices (Figure 7) indicate that, overall, Colleges of Education and Distance Education graduates make more use of innovative instructional techniques than Teachers' Colleges graduates or untrained teachers. Colleges of Education and Distance Education graduates made more use of observations, discussions, problem solving, discovery, assignments, and story telling than Teachers' Colleges graduates or untrained teachers who seemed to concentrate more on teacher-centered instruction, question-and-answer periods, and audiolingual methods. Distance Education trainees resorted to recitation and to question-and-answer periods more frequently than did any of the other teachers observed.

These findings are not surprising given that Colleges of Education graduates have not been socialized into the culture of the schools and have not taught previously. In a sense, these trainees are "blank slates" so it may be easier for them to use innovative techniques than it is for the other teachers. Distance Education graduates are an interesting case in point. They combine traditional methods learned in schools with new methods from their

training program. It may be difficult for them to abandon the old ways, resulting in what seems to be a compromise between the old and the new (Cohen, 1990). Teachers' Colleges graduates follow a more traditional curriculum and are probably rarely challenged in the instructional techniques they use. Untrained teachers also use traditional techniques; they may simply be reproducing the way they were taught (Lortie, 1975).

The time spent on instruction (Figure 8) is on average, the same for the four groups of teachers observed (from 45 minutes to an hour per subject area). The way that time is used, however, varies among the groups. Colleges of Education graduates spend most of their class period presenting materials in innovative ways and working on pupil-centered activities, such as group work. Teachers' Colleges graduates spend more time working with pupils, giving in-class assignments, and lecturing. Distance Education graduates allocate more time presenting materials and allowing pupils to work on their own, and less time working with them. Finally, untrained teachers spend more time lecturing and working with pupils through teacher-centered activities.

Figure 8: Time of classroom activities for the population observed.

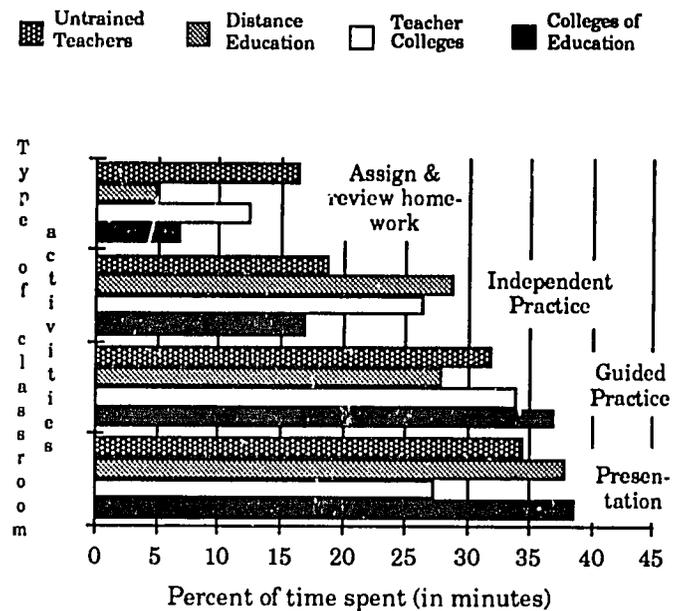


Table 5: Mathematics achievement for 4th year pupils by trained and untrained teachers.

Pupils taught by teachers trained in:	n	M	sd	Adjusted Mean ^a	Programs' Mean differences ^b			
					TC	CE	DE	UT
Teachers' Colleges	224	35.4	14.1	36.6				
Colleges of Education	509	35.2	14.0	34.4				
Distance Education	325	34.6	14.1	33.3	*			
Untrained Teachers	118	29.6	15.0	30.6	*	*		

F= 16.80, p <.000 (for the regression equation controlling for school type, pupil, and teacher backgrounds)
F=5.16, p <.005 (for program effect)

* p<.05

^a After adjusting for school type, pupil and teacher backgrounds ^b According to orthogonal contrasts

Table 6: Mother tongue achievement for 4th year pupils by trained and untrained teachers.

Pupils taught by teachers trained in:	n	M	sd	Adjusted Mean ^a	Programs' Mean differences ^b			
					TC	CE	DE	UT
Teachers' Colleges	226	44.5	20.4	47.0				
Colleges of Education	502	43.4	22.4	41.5	*			
Distance Education	329	41.5	21.1	38.6	*	*		
Untrained teachers	118	34.8	21.9	37.1	*	*		

F=17.84, p <.000 (for the regression equation controlling for school type, pupil, and teacher backgrounds)
F=8.26, p <.000 (for program effect)

* p<.05

^a After adjusting for school type, pupil and teacher backgrounds ^b According to orthogonal contrasts

. . . teachers with strong subject matter knowledge, teacher skills, and professional support from supervisors, can positively influence pupil achievement in spite of working in disadvantaged schools.

Pupil Achievement

Achievement of the pupils taught by the different groups of teachers was considered relevant when discussing teacher training effectiveness (see Tables 5 and 6 which show the means and adjusted means for pupil achievement in mathematics and mother tongue).

Fourth year pupil achievement measures in the areas of mathematics and mother tongue 4th year are consistently higher for pupils taught by teacher trained in the three approaches, than they are for pupils taught by their untrained counterparts. Pupils taught by graduates from the Teachers' Colleges and Colleges of Education do better on the tests for the two subjects than do pupils taught by the other teachers. This finding may reflect that what Teachers' Colleges graduates know and do in the classroom is effective in encouraging higher achievement in their mostly urban pupils. For Colleges of Education graduates, this finding indicates that teachers with strong subject matter knowledge, teaching skills, and professional support from supervisors can positively influence pupil achievement in spite of working in disadvantaged schools. This finding is also associated with the instructional techniques graduates learn and use in the classroom. Research on teaching and learning supports this assertion since pupil-centered teaching and conceptual learning has proven to have a positive effect on subject matter understanding (Good and Brophy, 1987).

The lower achievement of pupils taught by Distance Education graduates may reflect the lower performance observed in these graduates once they are teaching in the classroom. It is also possible that the same circumstances that affected teacher performance also had an impact on pupils. Such factors can range from poor school conditions to local political disturbances at the time of the study.

Pupil Achievement, Teacher Training and Performance, and School Context Variables

Table 7 shows the correlations among the variables measured in the study and pupil achievement in mathematics. Correlations for the study variables and mother tongue achievement are low. Although it is difficult to attribute higher pupil achievement to teacher training directly, research on teaching and learning has shown a strong correlation between what the teacher does in the classroom and how much pupils learn (Fuller and Snyder, 1991; Tillema and Veenman, 1987; Fuller, 1986b). The results of this study confirm the same trend. Teachers' use of innovative instructional techniques and practices, and subject matter knowledge, in this case mathematics, is positively correlated with measures of pupil achievement. *Teacher proficiency* is a composite variable representing measures of subject matter knowledge, teaching skills, and classroom performance. Teacher proficiency is positively correlated with measures of pupil achievement in mathematics. *The time used* on traditional instructional techniques such as *teacher-centered activities* (i.e., recitation, lecturing) is negatively correlated with measures of pupil achievement in mathematics. In other words, extended periods of lecturing are not correlated with higher pupil achievement in math.

Pupil-centered activities may give the pupil more opportunity to explore and achieve a better understanding of the subject, especially mathematics, than lectures or other teacher-centered activities. The school context variable (congenial or difficult) shows a negative correlation with the mathematics achievement variable. This is because Colleges of Education graduates who perform highest at mathematics in the measures of teaching knowledge and skills are mostly teaching in difficult or poor schools. The regression equation for this table is in Table 14 in the Appendix.

Table 7: Correlations among study variables and pupil achievement in mathematics.

Measure	n	M	sd	Correlations		
				(1)	(2)	(3)
(1) Pupil score in mathematics	165	34.5	13.7			
(2) Teacher proficiency index	165	-2.7	4.6	.19*		
(3) Time spent on teacher-centered instruction	165	-1.3	8.5	-.48**	-.02	
(4) School type	165	.1	.4	-.30**	-.62**	.33**

*p < .01 **p < .001

Note: The means have been standardized for this analysis

Colleges of Education trainees pay the most per year.

Pupils' scores in mother tongue seem to be primarily influenced by the richness of the environment as expressed by the positive correlation between school type and pupil score in the achievement test. Teacher skills and teacher professional attitude also have an influence on this variable.

In summary, there are three important findings from this analysis. First, teacher training seems to make a difference in what the teacher does in the classroom, and what the teacher does in the classroom is positively correlated with pupil achievement. Second, trained teachers do perform differently from untrained ones. While the first seem more informed about their subject matter and pedagogy, the latter seem to turn to traditional instruction, probably derived from their own personal experience as students, to direct their teaching. Third, trainees in the Colleges of Education and in Distance Education seem to be stronger both in subject matter and pedagogy than trainees in Teachers' Colleges. We discuss these findings in detail when we talk about program characteristics and their relationship to program effectiveness.

Program Costs

The results of the cost analyses are presented in Tables 8-10. Table 8 shows the net costs per trainee per year (that is, the total costs incurred accounting for transfer payments).

The unit costs for the Colleges of Education (CE) in our study are higher than those for the Teachers' Colleges (TC) and the Distance Education (DE) program. The CEs are 1.6 times more expensive per trainee per year, than the TCs and 5.6 times more than the DEs program. Comparing the two in-service training programs only, the TCs have unit costs that are 3.5 times higher than the DE programs.

Looking at the source of funds in both the CEs and the TCs, the sponsor (the government) bears a relatively heavy cost burden (in the \$700 to \$1,000 range), whereas in the DE program the sponsor bears less than \$100 per trainee per full-time equivalent year. The breakdown for the trainee cost burden, which takes into consideration both transfer payments (allowances minus fees) and opportunity costs, shows some stark contrasts. Colleges of Education trainees pay the most per year. Given their good high school qualifications they have relatively high opportunity costs, and, although they receive a substantial allowance, most of it is spent on fees and expenses. Finally, trainees in the DE program have a relatively heavy cost burden. They receive little in

Table 8. Total costs per trainee per year by type of institution and source of funds in 1988, in US Dollars.

Source of Funds	Colleges of Education	Teachers' Colleges	Distance Education
Overall	1,401	878	251
Sponsor	982	702	88
Trainees	226	<285>	167

Note: The numbers in brackets under Teachers' Colleges indicate that trainees bear a negative cost burden; that is, they receive allowances which average \$285 more than they have to spend or forego.

the way of allowances even though they continue to work full-time while they study, and they tend to forego some supplementary income. Their burden is not as high as that for the CE trainees unless it is seen in relation to the overall costs. From this perspective, DE trainees pay or forego 67% of their overall program costs per year, whereas trainees from the CEs pay or forego about 16%.

Table 9 examines the different patterns of cost allocations in the different types of institutions. (The total costs in this table are lower than those in Table 8 because they do not include transfer payments and trainee costs). Once again the difference between the overall level of expenditures between the Colleges of Education and the other two programs is apparent. In addition, there are clear differences in the allocation patterns. The CEs allocate 40% of the total towards capital costs (buildings and furniture/equipment), whereas the TCs put up only 29% and the DE program, a mere 9%. Buildings alone account for about 28% of the CEs' capital costs, whereas for the other programs they account for 17% and 6% respectively.

In the recurrent cost category, salaries and benefits for lecturers and instructors take the largest share in all programs; those for administrative and support personnel are not much less, except in the DE program. In those programs, very little is spent on administrative and support personnel; however, a relatively high proportion is spent on self-instructional modules and test materials, items which appear in the "other" category. When contrasting the most expensive (CE) and the least expensive (DE) programs, the former invests relatively heavily in campus facilities and personnel required to teach and manage a full and varied program; the latter invests

almost all of its funds (91%) in tutors and self-instructional materials.

Table 9. Capital and recurrent expenditures per trainee in U.S. dollars and percents.

	Colleges of Ed.		Teachers' Colleges		Distance Education	
	\$	%	\$	%	\$	%
CAPITAL	446	40	69	29	8	9
Buildings	317	28	42	17	5	6
Furniture/ Equip	129	12	27	11	3	3
RECURRENT	675	60	172	71	85	91
Salaries/ Benefits	285	25	71	29	42	45
Admin/ Supt Staff	251	22	55	23	10	10
Other	139	13	46	19	33	36
TOTAL COST/ TRAINEE	1,121	100	241	100	93	100

Program Cost-Effectiveness

Table 10 presents the results of the cost-effectiveness analysis. Before discussing the results, a brief review of our approach might be helpful. The effectiveness measures include those for teacher mastery of subject matter (mathematics or mother tongue), and knowledge of the appropriate skills for teaching subject matter.¹⁴ Standard or "Z" scores were computed for both the entry level groups (T1) and the exit level groups (T2). For this analysis the standard scores for the five outcome measures were combined into a composite index. Finally, the difference between the T2 and T1 on the composite index was determined, yielding a score which simulates a "change score."

It should be emphasized that this analysis covers the period of active training, from entry to exit, and not the post-program period. What we present, therefore, is the cost-effectiveness of the programs in fulfilling their goals of teacher preparation. This study does not analyze the cost of teacher training against the effectiveness of their classroom teaching.

Table 10. Cost-effectiveness of the various teacher training programs.

Program	Difference in Composite Index (T2-T1)	Total cost per cycle	Cost per unit difference
	(a)	(b)	(b/a)
College of Education	2.355	\$2,697	\$1,145
Teachers' College	1.078	1,690	1,473
Distance Education	1.954	483	247

Column "b" in the table lists the total costs per trainee per cycle, namely those costs, both direct and indirect, which are borne by both the sponsor and the trainee during the length of a two year program (or its full-time equivalent, as in the case of DE). The last column is simply the cycle costs divided by the difference in the composite index. This yields a cost-effectiveness index, which is essentially the expenditure required per unit difference or "change" in the effectiveness measures. The lower the expenditure per unit, the more cost-effective the program.

The analysis reveals that the Distance Education program is by far the most cost-effective program in preparing teachers for their roles, its cost per unit being \$247. This is about 4.5 to 6 times more cost-effective than the others. When the two kinds of residential colleges are compared, the Colleges of Education are more cost-effective. While their costs are considerably higher, their effectiveness is even more so, thus making their cost per unit of effectiveness lower than that for the TCs. Policymakers should note that the most expensive programs are not necessarily the least effective. But the Distance Education program demands attention because the costs are very low and given support they could maintain effectiveness at the post-program level.

Cost-effectiveness in preparing teachers for their roles is not necessarily a predictor that teachers will perform well in their classrooms after training. One year after training, teachers from the highly cost-effective Distance Education program use innovative instructional practices, but they do not retain their knowledge and skills as well as the Colleges of Education graduates. It should be noted, however, that the Colleges of Education graduates continue to re-

ceive guidance and support during their internship year, which requires an additional investment of funds. It is possible that the Distance Education program would be able to maintain or increase the knowledge and skills level of its graduates if it were

given the funds to continue group and tutorial support. This suggests that the government would do well to maintain programs of regular and continuous professional support.¹⁵

Section IV: Relationship Between Program Characteristics and their Effectiveness and Costs

Program Characteristics and Effectiveness

In this study we were interested not only in exploring program effectiveness and costs but also in finding out how program characteristics relate to effectiveness of the different programs and their costs.

Major program features observed to have a positive effect on program success:

Clearly established standards/strategies for recruiting and selecting excellent qualified candidates to be trained. The higher achievement of the Colleges of Education trainees, especially in subject matter knowledge, shows the effectiveness of the selection policy in the Colleges of Education, in which only A/L graduates are admitted. Colleges of Education programs may help to reinforce and increase the knowledge that trainees bring to the program, especially in mathematics.

Use of updated knowledge and teaching techniques proven effective in previous attempts to educate teachers and to teach children. Colleges of Education and Distance Education graduates do better in classroom performance due to the quality of the training and constant feedback on



... previous knowledge and understanding of the community facilitates teacher success once in the classroom.

performance. The Colleges of Education and Distance Education graduates, seem to be more effective teachers than their counterparts in Teachers' Colleges or than untrained teachers. Both Colleges of Education and Distance Education programs, the results of innovations, promote a newer curriculum

emphasizing the application of teaching techniques and methods informed by recent research on effective schools.

Inclusion of a strong subject matter component in a balanced program that combines subject matter mastery with new teaching techniques. The two most successful programs had a strong subject matter component in their curriculum or recruited candidates who had good knowledge of the subject matter.

Frequent interaction between what is being learned and what is applied in the classroom, either through supervised practice or through classroom teaching with timely feedback. The Distance Education program offers teachers not only the possibility of practicing while they learn but also the possibility of interacting with tutors and other teachers. Colleges of Education graduates show a relatively low level of pedagogical skills at the beginning and end of their program; the graduates that were observed in the classroom, however, show an impressive change in performance level, parallel to that of the Distance Education graduates. This may indicate the effect of supervised practice with feedback during their year's internship in the classroom.

Both practices, learning while teaching and supervised practice for a year, are effective in improving and increasing performance in pedagogy. The weaker performance of Teachers' Colleges graduates in this area may be due to the erratic character of supervised practice which was finally suspended in 1988.

Face to face interaction. Many Distance Education programs are run through correspondence courses and leave the learner isolated. An important feature of the Distance Education approach in Sri Lanka is the strong emphasis on incorporating the teacher into a community of learners. Face-to-face interaction with the tutor and fellow teachers, who are themselves undergoing training, is facilitated through weekly and bi-weekly visits to regional centers. This, together with a newly designed program which stresses teaching while learning, is a successful intervention.

Integration of the program's curriculum with the community where the teachers will work. This area is emphasized especially for those trainees enrolled in the pre-service program. The purpose is to help trainees understand the social context of schools. The high performance level of graduates from Colleges of Education, in spite of their assignment to difficult schools, indicates that previous knowledge and understanding of the community facilitates teacher success once in the classroom.

Exploring the relationship between the characteristics of the programs and their associated effects allows educational policymakers and program directors to know not only whether their programs are successful, but why.

Program Characteristics and Costs

The relatively high costs of the Colleges of Education program are a reflection of the government's efforts to create an elite core of teachers through pre-service training. This effort has involved the creation of incentives (financial and social status) in order to attract candidates of high ability. The Colleges of Education program offers intensive social and academic experiences. The campuses—many newly built or renovated—include well-equipped lecture halls, laboratories, hostels or residences for all trainees, and a wide variety of social-recreational programs and facilities. The relatively high expenditure on capital equipment reflects an attempt to create an attractive "total environment" for the trainees. Relatively high personnel costs reflect the staffing needs of such an environment, not only in terms of highly qualified instructors, but in terms of program administrators, counselors, organizers of social, service, and athletic events, and service personnel (cooks, gardeners, etc.).

Teachers' Colleges are far less expensive than the Colleges of Education in terms of their capital expenses and staff costs, a situation which reflects their status as conventional in-service training institutions. Generally, Teachers' Colleges campuses are relatively old and cater mostly to lecture-style teaching. They have hostels, but not for all trainees, and allocate limited time for social or extra-curricular programs under the assumption that trainees have already been socialized into the profession. Teachers'

Colleges are relatively expensive because allowances are provided to the trainees in the form of teachers' full salaries. The extra cost to the government comes in covering the salary and benefits of replacement teachers, if any are provided, or in absorbing the loss of school effectiveness, if not.

The relatively low costs of the Distance Education program reflect the capacity of that program to replace lecture halls and instructors with self-instructional processes undertaken by trainees in their own homes or at simple, local (often borrowed) study centers. The low capital costs of this program reflect these facts, as well as the fact that the program has practically eliminated the use of radio and TV. It is directed from a national center which itself is housed in low-cost, borrowed buildings. Also, unlike the colleges, the program provides no trainee allowances—trainees study while "on-the-job." In fact, requiring the trainees to study while holding a full-time job has made the program relatively expensive from the trainees' point of view, since besides receiving no allowance, they have little time for earning extra income. Ironically, this program feature (on-the-job training) seems to be one of the keys to its success.

Dealing with trainee opportunity costs deserves special attention. Opportunity costs are heavily influenced by program characteristics. The participants in the Colleges of Education do experience some opportunity costs since the total nature of their learning experience keeps them from holding outside jobs. In addition, since they are relatively able A-level graduates, they are foregoing relatively good job possibilities to go to school.¹⁶ For the Teachers' College trainees opportunity costs are quite low, since they keep their regular salary, and the low demands on their time and their ability to travel home allow them to continue work on outside jobs. For the Distance Education trainees the situation is quite different. They work full time and study almost full time (covering a two year full-time program in three) leaving them little or no time to pursue extra income. Non-monetary incentives for Distance Education recruits include: earning a teaching certificate, being able to stay at home, and having Fridays off from teaching in order to study. Interestingly, enrollment in the Distance Education program has not been a problem.

Section V: Policy Implications

The purpose of this section is to highlight the conclusions of the study and present policy implications.

The pre-service approach fulfills the purposes of the reform on teacher training—to educate a whole teacher, and to prepare teachers for work in difficult schools. An important accomplishment of the reform is the requirement that graduates of Colleges of Education serve three years in difficult areas (including teachers who have received training and have not served previously in those schools). The strategy of training young, energetic, and well-prepared teach-



...affordable and sustainable systems that fill future needs for trained teachers could use the best features of existing programs...

ers to serve in difficult schools is a serious step towards raising the quality of primary education in poor areas of the country.

These findings are important because of their potential impact on future policies for teacher training. It is conceivable that, as the backlog of untrained teachers diminishes, pre-service training may become the main source of trained teachers. The current program, while serving as a model of an effective pre-service approach, is probably not sustainable on a large scale. First, it is expensive, and second, it would cease to be exclusive if it became the main vehicle for training new teachers. Thus it would lose its ability to attract an elite corps of trainees (i.e., highly qualified high school graduates). Nevertheless, the present attempt to train teachers sets a precedent for future pre-service training. Although this program has been quite effective, it was not particularly successful at improving teacher attitudes.

Distance Education is both an effective and an

inexpensive way to produce certified teachers. Although some of its effects seem to diminish in the school setting, this in-service approach does better than the other programs at reinforcing and imparting pedagogy. This program could be improved by placing more emphasis on knowledge of subject matter, and on finding ways to reinforce training once graduates are in schools.¹⁷ Distance Education shows that providing training while trainees are teaching in their classrooms, providing strong support from tutors, and face to face dialogue with fellow teachers, are effective ways to train teachers. Although it is the most cost-effective program, at present it is seen as a temporary means of reducing the backlog of untrained teachers. As the number of untrained teachers is reduced (assuming that no more untrained teachers enter the system), this program will begin to lose the cost-effectiveness that economies of scale produced. Confronted with this situation, the Sri Lankan government should decide whether this is a temporary program, or whether it could be used for different purposes, such as lifelong learning. For lifelong learning directed at experienced teachers, the Distance Education approach seems like an ideal option if it is modified to provide trained teachers with more sophisticated knowledge. Some possibilities would include: a) more training in teaching skills related to current research and a growing awareness of what constitutes effective teaching in Sri Lanka; b) a deeper focus on subject matter mastery; c) emphasis on new curricula which may be developed in the future; d) the continuation of a support network to allow teachers to assist one another in solving problems and to develop a sense of identity, connectedness, and solidarity with fellow professionals; e) a forum for the development of teacher-led action research in the classroom; f) a focal point for in-service training under the emerging administrative mechanism of school clusters, assuming that Distance Education study groups can be organized at the school cluster level; g) the development of an avenue for certification at higher levels (or a transition to university-level courses in education and subject specialties which the Sri Lanka Open University provides through distance education).

Teachers' Colleges are neither as effective nor economical as other programs. The traditional curriculum, the methods of teaching, the residential character, and the provision of teachers' salaries while in the program makes it quite costly. Since this study was carried out, the program was reduced to only two years of course work. Without an internship it is unlikely that these experienced teachers can perform at the level of their counterparts in the other two programs. The function of the Distance Education approach and the Teachers' Colleges may be equivalent, although their purpose is quite different. Whereas Teachers' Colleges seem to be directed towards an elite group of untrained but senior teachers, Distance Education is directed toward the large population of untrained teachers. Because their purposes cover different agendas, from political and social viewpoints, it may be difficult to eliminate the Teachers' Colleges approach.

The Colleges of Education approach seems to work better on a small scale to train high quality teachers. This approach makes sense in contexts where training large number of teachers is not an urgent need, or where there are highly qualified recruits and available resources, or where the purpose is to train a few excellent teachers. The third year internship for Colleges of Education, because of its excellent record, may be applicable in those situations where the purpose is to strengthen the effects of teacher training once graduates are teaching in schools. The Teachers' Colleges approach seems to be appropriate when the purpose is to update teacher's knowledge and skills and to motivate teachers for long years of service. This approach makes sense in contexts where training large numbers of teachers is not an issue, where teacher preparation is seen as developing pedagogical knowledge and skills, and where there are resources available for selected groups of teachers. Finally, the Distance Education approach, as it has been implemented in Sri Lanka, seems appropriate when the agenda is to train large numbers of untrained teachers at a low cost. Except for its weak emphasis on subject matter knowledge, this approach seems to be the most appropriate among the ones studied for contexts with limited

resources and with a large backlog of untrained teachers.

Alternative Approaches

The development of affordable and sustainable systems that fill future needs for trained teachers could use the best features of existing pre-service and in-service approaches. For those recruits who are new to the profession, a year of institutional training such as the one provided by the Colleges of Education could be a good induction strategy. A continuing two year course modelled on the Distance Education program would provide trainees with the classroom experience, supervised practice, and continuous feedback (in tutor-led study groups and interaction with teachers) that make Distance Education so successful. The Distance Education program may be improved by combining the successful field experience with a year of campus-based training. Examples of these approaches can be seen in Africa in Zimbabwe (ZINTEC), and in Asia in Papua New Guinea, Indonesia, and Malaysia (Biniakunu, et al., 1982; UNESCO, 1986b). Since the Colleges of Education graduates sustain high levels of teaching performance in their classroom internship, training programs need to think about ways to support teachers who have completed their training and are back in the classroom. Peer teaching, tutoring, and regular feedback by other teachers or school personnel other than the school supervisor may be a good way to start this process.

As Sri Lanka moves along the path of modernization, teacher training plays an important role in educating a new generation to function according to the country's growing needs. Educational leaders are aware of the problems inherent in past attempts to train teachers and have learned to be sensitive to Sri Lanka's needs. The interest of policymakers in this study is one more example of their commitment to providing access to a high quality education for the Sri Lankan people. A combination of the best features from each of the approaches to teacher training may contribute to the development of an education system that fulfills the societal, economic, and developmental needs of Sri Lanka.

Notes

1. The background information on teacher training is based on a synthesis of the literature written by K.H. Dharma-dasa in 1988 for the Sri Lanka BRIDGES Project.
2. The Random House Dictionary of the English Language. New York, NY: Random House, 1987.
3. "A Likert-type scale is an instrument designed to measure attitudes. It is usually a questionnaire which includes a series of attitudinal affirmations focused towards extremes of agreement-disagreement according to which the respondent expresses value judgements, emotions, and dispositions towards the object of study (in this case the teaching profession). A number of statements are developed about the specific object of study and the respondent is asked to answer such statements by selecting a point in a continuum of five or seven points fluctuating from 'extremely agree' to 'extremely disagree'. This task requires from the respondents a fine level of discrimination to answer the scale correctly." (Henerson, Morris & Fitz-Gibbon, 1978).
4. Levin, pp. 51-52, states that, "... every intervention uses ingredients that have a value or cost ... If the ingredients can be identified and their costs ascertained, we can estimate the total costs of the intervention as well as the cost per unit of effectiveness."
5. Trainees attending the Colleges of Education have an internship year following two years of campus residency. This internship year constituted their post-program level.
6. Seventy-nine percent of the population, including untrained teachers, were female. The highest concentration of males was in the Colleges of Education. The next highest concentration of males were among Untrained Teachers, Distance Education, and Teachers' Colleges in that order.
In Sri Lanka, students take the GCE/OL (General Certification of Education/Ordinary Level) at the end of year 9 of elementary education. Students take the GCE/AL (General Certification of Education/Advanced Level) at the end of year 12, which is the end of the senior level of elementary education.
Most of the students in Colleges of Education (96%), have a GCE/AL, the rest have either a high school certificate, or the equivalent studies. Fifty-eight percent of the Teachers' Colleges students have a GCE/OL or a secondary school certificate, the rest have either a GCE/AL or a high school certificate. Fifty-four percent of Distance Education students have a GCE/OL or a secondary school certificate, and the rest have a GCE/AL or a high school certificate. Finally, among untrained teachers, 21 percent have a GCE/OL or secondary school certificate, 18 percent have a GCE/AL or high school certificate, and the rest, 61 percent, have a bachelors degree or other higher degree. This last group was excluded from the comparisons since members of the group have a significantly different educational background. At the beginning of their respective programs, the teaching experience of Teachers' Colleges students ranged from 1 to 10 years, 0 for Colleges of Education students, and from 1 to 9 years for Distance Education students. Untrained teachers had from 1 to 11 years of teaching experience.
7. The low number of trainees at the entry level for Distance Education (24) is due, in part, to the time when these trainees were measured (April 1989). This was the last measurement for the study and the most difficult to accomplish due to political disturbances in the country. The 24 trainees who attended the measurement session arranged by Sri Lankan researchers, did so at great risk to their personal safety. In addition, the program was moved from its location in the National Institute of Education to the Ministry of Education, with a consequent delay in that year's recruitment of new trainees. In 1989, there were fewer Distance Education trainees than in 1987 or 1988 when the program was newer and the backlog of untrained teachers was larger.
8. After analysis, the data for second year students was eliminated due to its low reliability. In Sri Lanka, second year students are the equivalent of first grade students in the U.S. The low reliability of the data was attributed to the young age of the students. The final number of pupils studied was 1,175. The number of schools included in the final analysis totalled 117 when accounting for missing data.
9. A $p < .05$ means that we can be confident that in 95 percent of the cases the relationship reported is true, and that we have a 5 percent chance that it is false.
10. Students at the colleges (Teachers' Colleges and Colleges of Education) receive allowances during their training program and pay fees. Colleges of Education students receive a modest monthly stipend, most of which is recovered by the College in the form of facilities fees. Teachers' Colleges students, all of whom are experienced teachers, receive their regular salary during their leave of absence, some of which they pay back as facilities fees. Participants in the Distance Education program continue to receive their salaries, but they also maintain full teaching loads. Thus, we did not consider them as having received an allowance.
11. Since the cost figures for the final year for Teachers' Colleges participants was for 1987, those figures were converted to 1988 values using the prevailing inflation factor of 7.5%.

12. The multiplier which we used for this was 1.55, namely, the average Distance Education time (3.1 years) divided by the completion time in full-time programs (2 years).

13. Interviews confirmed that there were no extraordinary events which changed the cost structure from one year to the next.

14. We excluded the attitude measures from this analysis because their results were inconsistent with the results of other measures.

15. Professional support is, in fact, one of the purposes behind the school re-organization that has been developing in Sri Lanka over the past few years. (Forthcoming paper

by Cummings, et al., "Management Reforms and the Impact of Education." BRIDGES Research Report Series, expected January 1992.)

16. This is not as large an opportunity cost factor as it might seem since many stated that they would not be in the labor force if they were not in the program.

17. The weakness of the Distance Education Program in imparting subject matter knowledge should be seen as a feature of program design in Sri Lanka. Distance Education in other countries has shown a capability for providing teachers with improved subject matter mastery (Biniakunu, 1982; Gana, 1984; Mahlck and Temu, 1989; Taylor, 1983).

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Appendix

Table 11. Effect sizes of different effectiveness measures based on standardized z scores.

Programs /level	Attitudes	Mother Tongue Know.	Mother Tongue Skills	Math Know.	Math Skills
Colleges of Ed.					
Entry	.392	-.159	-.878	.043	-.832
Exit	.242	-.160	.085	.464	.116
Post-Program	-1.000	.163	.377	.367	.427
Teachers' Colleges					
Entry	.225	.107	-.373	-.302	.069
Exit	.273	.099	.480	-.024	.069
Post-Program	-1.048	.175	.246	.040	.200
Distance Ed.					
Entry	-.678	-.360	-.202	-.332	.085
Exit	.478	.298	.592	.005	.391
Post-Program	-1.050	-.327	.351	-.303	.197

Note: Effects sizes were computed by subtracting the grand mean from the standardized mean values, and dividing the result by the overall standard deviation.

Table 12. Contrasts designed for the multi-analysis of variance to test the hypothesis of program effectiveness through time.

Levels Predictors:	Colleges of Education Program			Teachers' Colleges Program			Distance Education Program		
	Entry	Exit	Post	Entry	Exit	Post	Entry	Exit	Post
Program (d.f. 2)									
In-service vs. pre-service	1	1	1	-1/2	-1/2	-1/2	-1/2	-1/2	-1/2
Teachers' Coll. vs. Distance Ed.	0	0	0	1	1	1	-1	-1	-1
Level (d.f. 2)									
Linear	-1	0	1	-1	0	1	-1	0	1
Quadratic	-1	2	-1	-1	2	-1	-1	2	-1
Program x Level (d.f. 4)									
(In-service vs. pre-service) x linear	-1	0	1	1/2	0	-1/2	1/2	0	-1/2
(In-service vs. pre-service) x quad.	-1	2	-1	1/2	-1	1/2	1/2	-1	1/2
(Teacher Coll. vs. Distance Ed.) x linear	0	0	0	-1	0	1	1	0	-1
(Teacher Coll. vs. Distance Ed.) x quad.	0	0	0	-1	2	-1	1	-2	1

Note: Contrasts shown in Table 12 are repeated by effectiveness measures in Table 13.

Table 13. Multi-analysis of covariance coefficients and tests of significance for testing program effectiveness over time (using z scores).

Outcome Variable	Predictor	Degrees of Freedom	Coefficient	Standard Error	t-ratio
Mathematics Knowledge:					
	<u>Program:</u>	2			
	In-S vs. Pre-S		.33460	.089	3.75***
	TC vs. DE		.13755	.110	1.24
	<u>Level</u> (entry, exit, post):	2			
	Linear trend over time		.30666	.115	2.65**
	Quadratic trend over time		.53098	.166	3.18***
	<u>Program by level</u>	4			
	(In-S vs. Pre-S) x linear		.24445	.232	1.05
	(In-S vs. Pre-S) x quad.		.11408	.340	.334
	(TC vs. DE) x linear		.23857	.294	.808
	(TC vs. DE) x quad.		-.40564	.420	-.96
	<u>Covariates:</u>				
	Gender		.18280	.10	4.4***
Mother Tongue Knowledge:					
	<u>Program:</u>	2			
	In-S vs. Pre-S		-.04355	.089	-.48
	TC vs. DE		.21997	.113	1.94
	<u>Level</u> (entry, exit, post):	2			
	Linear trend over time		.12072	.117	1.02
	Quadratic trend over time		.25012	.170	1.46
	<u>Program by level</u>	4			
	(In-S vs. Pre-S) x linear		.23323	.236	.98
	(In-S vs. Pre-S) x quad.		-.79121	.348	-2.27*
	(TC vs. DE) x linear		.02882	.302	.09
	(TC vs. DE) x quad.		-1.1698	.431	-2.70**
Math Skills:					
	<u>Program</u>	2			
	In-S vs. Pre-S		-.46392	.146	-3.17***
	TC vs. DE		-.11848	.108	-1.08
	<u>Level</u>	2			
	Linear trend over time		.58834	.123	4.77***
	Quadratic trend over time		.34797	.167	2.08*
	<u>Program by level</u>	4			
	(In-S vs. Pre-S) x linear		1.1750	.228	5.13***
	(In-S vs. Pre-S) x quad.		.43854	.335	1.30
	(TC vs. DE) x linear		-.03305	.293	-.11
	(TC vs. DE) x quad.		-.69365	.415	-1.66
	<u>Covariates:</u>				
	Age		-.08889	.010	-2.1*
	Gender		-.11410	.076	-2.7**

*p < .05; ** p < .01; *** p < .001

Table 13 continued on next page

<p>Key In-S=In-service Pre-S=Pre-service TC=Teachers' Colleges CE=Colleges of Education DE=Distance Education</p>

Tabel 13 (continued)

Outcome Variable	Predictor	Degrees of Freedom	Coefficient	Standard Error	t-ratio
Mother Tongue Skills:					
	<u>Program</u>	2			
	In-S vs. Pre-S		-.51904	.132	-3.93***
	TC vs. DE		-.11903	.099	-1.20
	<u>Level</u>	2			
	Linear trend over time		.86233	.112	7.69***
	Quadratic trend over time		.94263	.151	6.23***
	<u>Program by level</u>	4			
	(In-S vs. Pre-S) x linear		.64954	.208	3.12***
	(In-S vs. Pre-S) x quad.		-.36113	.305	-1.18
	(TC vs. DE) x linear		-.00515	.267	-.01
	(TC vs. DE) x quad.		-.00010	.378	-.00
	<u>Covariates:</u>				
	Age		-.08449	.008	-1.99*
Attitudes:					
	<u>Program</u>	2			
	In-S vs. Pre-S		-.02964	.126	-.23
	TC vs. DE		.21035	.094	2.28*
	<u>Level</u>	2			
	Linear trend over time		-.89145	.106	-8.34***
	Quadratic trend overtime		1.6569	.145	11.36***
	<u>Program by level</u>	4			
	(In-S vs. Pre-S) x linear		-.54062	.197	-2.73**
	(In-S vs. Pre-S) x quad.		-.85044	.292	-2.90**
	(TC vs. DE) x linear		-.89927	.254	-3.53***
	(TC vs. DE) x quad.		-1.3137	.364	-3.60***
	<u>Covariates:</u>				
	Age		-.09254	.008	-2.15*ns.
	Gender		-.07329	.085	-1.71

*p < .05; ** p < .01; *** p < .001

Table 14. Regression equations for pupil achievement in mathematics and the relationship to several predictor variables.

Dependent Variable	Predictors	B	SE	T-ratio
Pupil score in mathematics achievement test	School type	-.071941	2.88	-.76 ns.
	Time in teacher-centered instruct.	-.457721	.11	-6.22*
	Teacher proficiency index	.134384	.26	1.51 ns.
	Intercept	35.05	1.09	32.0*

r²=.27; F=19.74; * p>.0001

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