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ABSTRACT

Designed to describe effective computer inservice programs and to determine the components that contributed to their effectiveness, this study identified eight school districts from across the country that appeared to be providing outstanding computer training for teachers. Case studies of these eight model districts were conducted in which computer coordinators, trainers, and teachers were interviewed and inservice classes were observed. Data analysis focused on five issues: (1) outcomes of inservice classes, including the knowledge and skills acquired by teachers concerning computers, their use of computers in instruction, and the impact of computer use on students; (2) the inservice delivery systems and effective instructional practices used; (3) teacher characteristics and relationships between teacher characteristics and outcomes; (4) organizational context and context variables related to program effectiveness; and (5) unanticipated factors that helped to explain the inservice results. The text is supplemented by 7 tables, and 38 references are provided. The appendices contain copies of the interview and observation forms used in gathering the data. (Author/EW)

RR-87-29

RESEARCH REPORT

CHARACTERISTICS OF EFFECTIVE COMPUTER IN-SERVICE PROGRAMS

Brian M. Stecher
Ronald Solorzano

Educational Testing Service
Princeton, New Jersey
July 1987

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ABSTRACT

This study sought to describe effective computer in-service programs and to identify the components that contributed to their effectiveness. An Advisory Committee identified eight school districts from across the country that appeared to be providing outstanding computer training for teachers. Case studies of these eight model districts were conducted in which computer coordinators, trainers and teachers were interviewed and in-service classes were observed.

The data analysis focused on five issues. First, the outcomes of the in-service classes were examined, including the knowledge and skills acquired by teachers concerning computers, their use of computers in instruction and the impact of computer use on students. This information helped to establish the degree to which the eight districts provided models of good computer in-service training. Second, the in-service delivery systems were described and effective instructional practices were identifed. Third, teacher characteristics were examined and relationships between teacher characteristics and outcomes were explored. Organizational context was the fourth issue to be reviewed, and a number of context variables were identified that were related to program effectiveness. Finally, a few unanticipated factors that helped to explain in-service results were identified.

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We would like to express our appreciation to the many people who assisted in this project. Foremost among this group were the staff members of the eight school districts. Interviews were conducted with dozens of administrators, trainers, and teachers, who gave willingly of their time and spoke candidly about their own experiences with educational computing.

In particular, we would like to thank the computer administrators in the districts who coordinated our site visits and offered their own knowledge and insight about computer in-service training. We are grateful for the cooperation of William Barnes, Tomas Boudrot, Susan Cowden, Lorie Gonia, Randall Johnson, Janelle Leonard, Beverly Sangston, and Rob Schamberg.

The study also benefitted from the contributions of an Advisory Committee. They helped in the identification of effective computer in-service providers and offered useful suggestions for focusing the investigations. The Advisory Committee consisted of the following individuals:

Tom Boe, Minnesota Educational Computing Consortium
Grace Mateus, Region 14 Teacher Education and Computer Center
Glenn Fisher, Alameda County Office of Education
Sandy Pratcher, Texas Education Agency
Dan Watt, Educational Alternatives
Robert Perlman, Boston Unified School District

During the initial planning phase Martin Schneiderman, of Educational Testing Service, offered suggestions about important variables related to computer in-service education. Molly Watt also contributed to the research design based on her extensive experience with educational computing.

Harold Levine, Associate Professor, Graduate School of Education, UCLA assisted in formulating a structure for data collection and procedures for data analysis.

Elaine Lindheim assisted with data gathering during the nomination process. Willis Binnard, computer resource specialist in the Palos Verdes Peninsula Unified School District, and Victor Giardina, Los Angeles Unified School District allowed us to observe or interview them as we developed and refined our case study procedures.

Finally, this study could not have been completed without the patient assistance of Elaine Clinton, Laurie McCallum, and Serena Villanueva, who struggled to make sense of almost unintelligible notes and produced the reams of narrative descriptions that formed the basis for the study.

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EXECUTIVE SUMMARY

The goal of this study was to explore effective strategies for training teachers to use computers from a sample of districts that were models of good computer in-service practices. It should be pointed out that this was not a representative sample of all districts, nor did it necessarily represent the absolute best that is being done by districts to train teachers to use computers. However, it did reflect a wide cross section of effective computer in-service programs based upon the judgments of knowledgeable computer educators.

The effectiveness of the computer in-service programs was confirmed by data gathered during the study. In the majority of cases both teachers who were enrolled in computer in-service classes and teachers who had completed such classes gave them high marks. Moreover, teachers reported that they mastered new computer-related skills, and, in many cases, used these in their classroom instruction Little direct evidence was gathered about impact on student achievement. Anecdotal evidence suggested increased motivation among students when their teachers began to incorporate computers into instruction. Similarly, the trainers confirmed that a high level of learning took place and reported positive feedback from teachers. The computer administrators, who were responsible for coordinating in-service activities, provided additional evidence about the effectiveness of the in-service classes. Finally, observations of in-service classes conducted by the researchers confirmed the impressions gained from district staff.

There was considerable variation between districts in the major emphases of the in-service programs, as well as in the variety and extent of courses offered. The major emphases of the computer training were word processing, LOGO, and curriculum applications of tutorial and applications software. Districts offered from two to fifty different computer-related in-service titles, and the individual workshops lasted from two to fifty classroom hours. The larger districts generally offered more options and longer workshops. With the exception of LOGO, which was generally targeted at the elementary or junior high school level, there were almost no workshops directed specifically towards the use of computers in mathematics and science.

Interviews and observations provided clear indications of factors that made the computer in-services more effective. As in any teaching situation, a number of distinct instructional strategies enhanced the computer workshops. Particularly, important for computer in-service were such things as the extensive use of computers, careful balance between lecture and guided practice, the provision of lesson-related materials and handouts to facilitate the learning of commands and procedures, individual attention to teachers' questions, relating lessons directly to classroom curriculum, and the use of knowledgeable trainers. Some districts had initiated training programs for computer in-service instructors to increase the quality of instruction.

Neither teachers' previous use of computer nor their length of teaching experience had a direct relationship with the outcomes of the computer in-service classes. However, trainers noted gradual changes over time in the motivation of the teachers who enrolled in computer in-service classes and their familiarity with computers.

Certain organizational factors were important determinants of in-service effectiveness. Computer in-service programs presented complex logistical problems, and successful districts developed administrative mechanisms to solve these problems. This often involved centralization of responsibilities for many computer-related services. Many districts evolved cooperative arrangements with outside agencies to supplement their own expertise and resources in computer education. Finally, respondents place a high value on institutional commitment to the use of computers in the form of organized support and encouragement at the school and district level.

Additional factors were found that helped to explain the difficulty of achieving changes in teacher's behaviors vis-a-vis computers. First, it appeared that learning to use computers as educational tools was a very complex task, perhaps more complex than is normally associated with in-service training. This is significant because program developers and policy makers may make erroneous decisions if they underestimate the complexity of the training teachers need to use computers effectively. Second, there were two elements that made it particularly difficult for teachers to translate the knowledge and skills they learned in the in-service setting into practice. These were lack of access to computers in their home schools and limited association between the content of in-service classes and the curriculum they were responsible for teaching. Great strides were being made to address the latter problem, but it had not been completely solved.

Third, there appeared to be an underlying contradiction in the nature of computer education that had to be addressed by the computer in-service coordinators. This contradiction was between the desire to establish well-defined goals to use as a basis for in-service planing and implementation and the need to maintain flexibility to adapt to changes in the nature of computers and the ways they could be used in education It was difficult to make implementation decisions under these circumstances. Fourth, little information was available about effective practices in the field of computer in-service training. Almost all coordinators in the study expressed a strong interests in knowing what had proven to be effective elsewhere because they had little knowledge about what was being done outside their districts.

INTRODUCTION

This study was prompted by concerns about the preparation of teachers to utilize technology as a tool in education. There is a tremendous need at the present time for information about effective ways to train teachers to use computers in education. This is a result of the rapid growth in the number of microcomputers available in elementary and secondary schools. Educators who were not trained to use computers in an educational setting have been asked to integrate computers into their instructional process. Teachers, administrators and policy makers have had to make educational decisions regarding the training of teachers to use computers based upon limited personal experience and limited knowledge of the experiences of others. Consequently, all three groups are anxious to learn more about effective methods.

This desire for information about technology in education has prompted a number of research efforts. One of the first questions that researchers addressed was: How much computing equipment is available for instructional purposes? Large-scale national surveys provided data to answer this question (Center for the Study of Schools, 1983; U.S. Department of Education, 1982). These studies showed that there were sufficient numbers of computers in elementary and secondary schools by the mid-1980s to have a significant impact on instruction.

As the number of computers increased, research interest broadened. For example, Shavelson, et. al., (1984) examined the strategies employed by exemplary teachers to integrate computers into their classroom. An interesting by-product of this study was the realization that it was difficult to find "successful" computer-using teachers. Few considered themselves to be models of effective computer users.

In fact, there was widespread concern about preparing teachers to use the new technology, and in-service training emerged as an issue of major proportions (Milner, 1980). Once schools acquired sufficient numbers of computers, it became apparent that most teachers were not prepared to make use of the new equipment. For example, in 1981 researchers reported that fewer than 40% of the districts in Florida provided or supported computer training for teachers (Dickerson & Pritchard, 1981). They concluded that "the lack of preparation and training of teachers is evident and acute". As Moursund (1981) noted,

> It is today a rare school that has even one teacher who uses computers as an everyday tool in coping with the problems of his or her discipline. This then is the major problem. We are asking computer-illiterate teachers to help students become computer literate at a functional level. (p.128).

The problem was so great that computer literacy for teachers and students could be called "the next great crisis in American education" (Molnar, 1978-1979). The National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983), recommended that "immediate training is required for teachers" (p.83). In-service training of the existing teacher work force remains an issue of high national priority.

While researchers and policy makers were clarifying the extent of the problem, others were taking action. A wide variety of in-service activities was initiated by private consultants, school districts, colleges of teacher education, regional education centers, private proprietary schools, and commercial vendors.

Unfortunately, very little is known about the effectiveness of these programs. Thus, teachers and school administrators have little basis for judging the merits of a particular in-service approach. Similarly, program developers have limited information to guide them in developing new programs or improving existing ones. Certainly good in-service programs exist, but little has been done to identify them, to determine what makes them effective, to foster the spread of these models, or to assist in improving them. There is a lack of empirical research to determine which approaches to in-service training are most effective in the area of computers and technology.

Only a few empirical studies have been conducted that relate to computer in-service. A few individual in-service developers have evaluated their own programs. Anderson (1981) found that students preferred smaller classes and extensive hands-on time with the computers. Elementary school teachers in a summer in-service program conducted by Carroll & Johnson (1981) also responded favorably to the laboratory segment of the course. Other evaluations have been reported, though the results did not provide information about specific program characteristics (Taffe & Weissmann, 1982; Vockell, Rivers & Kozubal, 1982).

A number of good suggestions for the format of in-service courses were offered by teachers in a study of the uses of computers in instruction (Shavelson et. al., 1984).

In addition, there were two noteworthy comparative studies of computer in-service projects. A statewide survey of computer in-service programs in Texas substantiated the belief that teachers have different in-service needs depending upon the subject and grade level they teach (Anderson & Smith, 1984). Stecher (1985) conducted case studies of three summer in-service institutes that were part of the IBM/ETS Secondary School Computer Education Program. Twenty-one variables were identified that appeared to be related to the effectiveness of the in-service. These variables related to content, to facilities and to personal characteristics.

While there were very few empirical studies of computer in-service training, the literature does contain ample evidence that researchers and practitioners were concerned about training teachers to use computers in education. First, there were numerous prescriptions from computer educators describing the appropriate content for such instruction (Bitter & Camuse, 1983; Diem, 1981; Foell, 1983; Henderson 1978; Milner, 1980; Moore, 1984; Moursund, 1981; Rogers, et. al. 1984; Taylor, Poirot & Powell, 1980; Uhlig, 1983). Second, there were many descriptions of actual in-service training programs (Anderson, 1981; Carroll & Johnson, 1981; Farris, Judd & Vedral, 1984; Fetcher, 1982; Marshall & Pfeifer, 1984; Parker, Varnell & Rinewalt, 1983; Shotwell, 1982). These writings provided a good starting point for this study, by suggesting factors that others believe are important in computer in-service education.

It is not surprising that course content and specific teacher competencies have been the most frequently discussed issues. For example, Moursund (1981) emphasized the need to learn programming skills (though this has been a widely debated issue). Taylor, Poirot & Powell (1980) proposed a list of specific computer competencies for educators that reflected the perspective of the Association for Computing Machinery. Many others have identified topics they believe belong in an in-service course for teachers (Anderson, 1981; Anderson & Smith, 1984; Foell, 1983; Shotwell, 1982; Taffe & Weissmann, 1982; to mention but a few).

Another issue that has been discussed is the relevance of the in-service to the specific needs of the teachers. Henderson (1978) suggested that different coursework was appropriate for different types of computer users. This idea has been elaborated frequently (Anderson & Smith, 1984; Computers in Precollege Education, 1983; Fetcher, 1982; Milner, 1980; Moore, 1984; Shotwell, 1982; Uhlig, 1983). Dennis (1979) differentiated three stages of computer in-service training: awareness, implementing, and maintenance; and discussed the unique information needs of each stage.

Teaching strategies and instructional methods have also been discussed in the literature. Taffe and Weissmann (1982) found that a team-teaching approach was particularly effective, as did Stecher (1984). Diem (1981) stressed the importance of follow-up activities after the conclusion of a computer workshop. Uhlig (1983) reinforced this point in another way by defining computer literacy as a continuous process, not an event. Fetcher (1982) emphasized the importance of providing hands-on time early in the training process, and many have stressed the importance of extensive interaction with the computer (Farris, Judd & Vedral, 1984; Marshall & Pfeifer, 1984; Stecher, 1985).

Participants in one program suggested that they would have benefitted by receiving outlines and background materials prior to the in-service (Schneiderman & Stecher, 1985). Vockell, Rivers & Kozubal (1982) scheduled activities in large blocks of time during a four-week summer in-service and found that extended sessions were effective. Others also preferred extended instructional periods to traditional hour-long sessions (Taffe & Weissmann 1982). Fetcher (1982) stressed that in-services should specifically address the problem of integrating computers into the curriculum if they are to be effective.

As this review indicates, there are many opinions about the best way to organize computer in-service education, but few research-based results. There are general research-based models for staff development that have some applicability in this new field. For example, Joyce and Showers (1982) emphasized the importance of "coaching" to help teachers learn to apply the abstract skills learned in the staff development setting to the classroom. Hord and Loucks (1980) based their training recommendations on the Concerns Based Adoption Model (CBAM) of innovation that focused attention on specific stages of concern and levels of use of an innovation (Hall, 1979). However, these models spoke in general terms. While they provided effective organizational and procedural structures, none of them addressed the specific concerns of technology and the problems of training teachers to use microcomputers. The literature offers a poor research foundation on which to develop methods of computer in-service training.

The goal of the present study was to bring empirical evidence to bear on this discussion. Specifically, this study sought to describe effective computer in-service programs, to identify the components that contributed to effectiveness, and to provide information to help policy makers formulate programs to help computer in-service developers avoid pitfalls, and to expedite the process of bringing meaningful training to the thousands of teachers who need it.

PROCEDURES

Research Design

The purpose of this study was to provide information for planning more effective in-service training programs relating to the educational use of computers. It was also hoped that the study would provide data regarding in-service practices to help policy makers address resource allocation decisions. With these purposes in mind, this study examined exemplary district-based computer in-service programs and tried to identify the conditions and practices that were the most effective. The study was designed to explore five questions:

1. Are there any models of effective in-service computer education programs?
2. What are the components of these programs, including access to microcomputers?
3. Who are the staff of these programs and what training have they had?
4. Which elements contribute to program effectiveness from the perspective of the staff and the participants?
5. What guidelines for effective computer in-service can be derived from these model projects?

Given the exploratory nature of this analysis and the complexity of the variables under investigation a qualitative research approach was adopted. A small number of highly-regarded, district-based computer in-service programs was identified and they were examined in depth. Open-ended interviews were used to obtain the participants' perspectives on issues relevant to the preparation of teachers for the use of technology in the classroom, and observations were conducted to provide direct evidence of in-service practices. Previous research and evaluation suggested a number of factors that might be relevant to the questions under investigation. However, the study was not limited to these variables. A naturalistic approach was adopted to make the study more sensitive to unanticipated factors.

Advisory Committee

An Advisory Committee was formed to provide additional knowledge and experience concerning computer-related staff development activities. The Advisory Committee had two primary responsibilities. The first duty was to assist in the identification and selection of eight exemplary districts to serve as the sample for the study. The second responsibility was to help focus the research questions and offer suggestions about issues to be addressed, probes to be used, and ways to elicit relevant data from informants in the districts.

Two criteria were used in forming the committee. First, members had to be educators who were active in the area of educational computing. Second, the overall committee had to represent diverse geographic areas to ensure that the sample of districts did not have a narrow regional focus. The final six member Advisory Committee met both of these criteria.

Sample Selection

A sample of eight school districts was selected through a two-phase process. First, nominations were solicited from educators around the country. Over 30 individuals familiar with educational computing were asked to suggest school districts or agencies that were doing an outstanding job of training teachers to use computers. They were also asked to suggest other individuals who might have this kind of knowledge. Nominations were taken primarily from university-based researchers and school district-based computer coordinators. However, representatives of national computing organizations, staff from regional educational centers, grant recipients from previous NSF computer-related research, and educational representatives from computer manufacturing companies were also contacted.

A list of approximately 50 organizations was compiled during the nomination process. This list included over 30 school districts, 12 institutes of higher education and six regional educational centers. Each of these agencies was contacted and asked to supply information about their program. Based on written material or telephone conversations, a one-page summary of the in-service program in each location was prepared for review by the Advisory Committee.

The second phase of sample selection was carried out by the Advisory Committee. The one-page descriptions were circulated to all the members of the Advisory Committee for their review prior to the meeting. When the committee met, individual members offered further descriptions of districts and in-service programs of which they had personal knowledge, and the group discussed all the organizations that had been nominated.

One of the first things that the Advisory Committee decided was that it would be best to narrow the scope of the study to district-based programs. Given the limited number of site visits to be made, they felt it would be better to concentrate on a single class of service providers, and they believed that district-based training was the most important model to consider. This approach would make the study relevant to the largest number of teachers and in-service providers.

Though the committee members had limited knowledge of programs outside their own region of the country, all were able to identify one or two sites from the list in their own regions that were doing exemplary staff development work in the field of computers. These nominations formed the basis for the final sample.

While there was never any intention to select a nationally representative sample, the Committee did strive to balance the sample as much as possible. Thus, they selected districts that varied in size and represented a wide geographic diversity. The final sample contained four large urban districts, two middle-sized suburban districts, and two small

suburban districts. In addition, the eight districts came from seven different states representing the west, southwest, east coast, New England and the Midwest. The districts and their enrollments are listed in Table 1.

Insert Table 1 here

The committee was comfortable that it had achieved a broad based purposeful sample of districts that were doing outstanding work in in-service training. To that extent it was as broadly representative of exemplary districts as possible, though it would be improper to generalize these findings beyond that particular classification.

All eight of the districts agreed to participate in the study, so it was not necessary to contact any alternate sites.

Even at this early point in the project, it was apparent that few people had any broad information about computer in-service practices. The respondents in the initial telephone survey mentioned school districts or colleges in their immediate local area and had little knowledge of practices in other parts of the region or country. Moreover, there was very little overlap in the nominations received from different individuals. It appeared at the time (and nothing has occurred since to contradict this impression) that no one possessed comprehensive information about in-service practices in the field of educational computing on a nationwide basis.

Data Collection

Specifying variables. Some of the research questions involved variables that could be measured fairly directly. These included such things as program activities and procedures for staff training. However, questions concerning program effectiveness and the relationship between program components and outcomes were more complex and required further elaboration. A simple conceptual model was formulated as the first step in identifying the variables to be measured. The model described the relationship between in-service outcomes and three broad clusters of influential factors. The results of the in-service were presumed to be related to 1) personal characteristics of the teachers, 2) in-service practices, and 3) organizational context in the district. A fourth factor representing unanticipated variables was included to cover elements that might turn up during the investigation. This model is presented in Figure 1.

Insert Figure 1 here

The model captured relationships at a high level of abstraction. To be useful as a guide to data collection, each of these factors was defined in more specific terms based on elements discussed in the literature. For example, research suggested that important personal characteristics of the teachers included prior knowledge and experience with computers, expectations regarding the use of technology and education, specific classroom objectives for the use of computers, teaching experience and background, and prior

experience with staff development. Similarly, each of the broad factors was defined in more specific terms. The specific areas of investigation are summarized in Table 2.

Insert Table 2 here

Further specification was necessary to guide data collection, so the variables were operationalized in greater detail. For example, three specific issues were addressed in the category "staff development organization." These were the presence of a explicit pedagogical model or in-service approach, the extent to which teachers were involved in planning and organizing the computer in-service, and the presence or absence of external agencies in program planning and development. These specific areas of inquiry were listed in a topic guide that formed the basis for instrument development. The topic guide is shown in Appendix A.

The topic guide was not considered to be an exhaustive list limiting data gathering, but a starting place for inquiries. It was important to leave opportunities for other relevant factors to emerge during the investigation. In particular, the inclusion of unanticipated factors in the model reflected a conscious effort to maintain an open and context-sensitive investigation.

Selecting respondents. In order to gather information about all of these variables, it was necessary to observe different activities and talk to a variety of people in each district. These included participants in computer in-service classes (classroom teachers) and trainers who were providing the instruction. In addition, it was important to talk to selected district administrators, particularly those who were coordinating computer activities and those who were involved in staff development. Teachers who had completed computer in-service classes were interviewed and asked to reflect back on their experience in class in light of their current use of computers with students. Finally, the Advisory Committee felt that school-level computer coordinators (teachers who had been freed from some or all classroom duties and given responsibility for some coordination of computer activities at a
school) also would have useful information about many of these topics. As a result, an attempt was made to interview the following categories of individuals in each district: computer administrator, staff development coordinator, trainer, graduated teacher, participating teacher, and school computer coordinator. The researchers also tried to observe as many in-service workshops as possible, and observe at least one lesson taught by a teacher who had completed a computer in-service class.

Developing interview protocols. To gather relevant information in a limited amount of time while still maintaining flexibility, a topic-centered interview strategy was adopted (Patton, 1985). Initial probing questions were developed for all of the topics. It was not necessary to gather information from each informant about all issues, so subsets of issues were selected for each class of respondents. For example, a classroom teacher might know little about the organization of the Computer Education Department, while the staff development director might have more knowledge about this topic.

Six different interview guides were developed. Each contained probing questions in selected topic areas to begin the investigation and to ensure that the key topics were addressed. Beyond that, the interchange was allowed to flow naturally. The interview guides were formatted to facilitate easy use. Both a simple prompting question and a brief topic heading were provided. This allowed the interviewer to refer to a prepared question to initiate the conversation, or rely on a topic heading as a simple mental key for questioning. During the initial interviews the interviewers often relied upon the prepared questions; after gaining more familiarity with the topic guides the single word cues were enough of a reminder to prompt an appropriate inquiry. The interview guides for each respondent are contained in Appendix B.

A similar process was followed to organize data collection during the in-service and classroom observations. Simple observational guidelines were constructed to aid in recording impressions from these two types of observations.

The research design called for the researcher to observe one in-service class each day during the site visit. The purpose of the in-service observation was to investigate the way the class was organized, the kinds of interactions that took place, and the reactions of the teachers. It was decided that the best format for recording such data was an open-ended one utilizing whichever system the researcher found most efficient. However, four specific questions were asked to force the observer to address key elements in each in-service observation. A one-page form was developed to aid in recording relevant data from the in-service workshops.

If time permitted, the researcher also tried to observe a computer trained teacher working with a class of students on a computer-related lesson. (As it turned out this was possible in fewer than half of the districts because of scheduling conflicts.) The purpose of this observation was to see the impact of previous computer in-service training on instructional practices. Since the goals for the classroom observations were different than the in-service observations, a different recording guide was developed. Final versions of the observational guides for in-service and classroom observation will be found in Appendix C.

The Advisory Committee was asked to review the initial interview protocols and observation guides. The Committee suggested alternative ways of formulating questions and new areas in which it might be useful to collect information. The data collection forms were revised on the basis of this input.

Pilot testing. Once the instruments had been developed, they were pilot tested in two local school districts. The pilot test included observation of an in-service session and interviews with an in-service trainer and a computer administrator. The two researchers who would be doing all of the field work both participated in the pilot test, but they worked independently and did not compare notes until they had completed their work. In this way, the pilot tests served as an opportunity to check on the usefulness of the instrumentation as well as an opportunity for the two researchers to calibrate their own observations.

After the pilot test interviews and observations were written up, the researchers compared notes and discussed areas in which their observations or field notes differed. Both researchers felt it would be better to simplify the wording of questions and probes, so this was done. Similarly, the single page interview guides were reorganized to make them less complicated visually.

Scheduling. Once the instrumentation was revised and the researchers had been trained, the site visits were scheduled. Each district was contacted by telephone and in writing. The initial telephone contacts were made with the computer coordinator. If this individual expressed an interest in the project, a formal written request for cooperation was submitted to the superintendent. When approval was received a contact was made with the person designated to coordinate the visit to review the purposes of the study and describe the activities to be conducted. A brief one-page outline was sent to each liaison person describing the interview and observation goals of the project. A copy of this outline is contained in Appendix D.

In each case, the district liaison person was allowed to arrange the schedule of activities and interviews. This individual was given guidelines for the specific types of individuals to be interviewed and the kinds of sessions to be observed and was asked to make arrangements. Scheduling difficulties made it impossible to comply with every one of the guidelines, but the participating districts were able to arrange for interviews with each type of staff member that had been requested and for observations of at least one in-service session during each visit.

Free time was used to pursue whichever avenues seemed most promising. In addition to the activities envisioned, almost every site visit afforded the researcher the opportunity to meet with staff informally before and after school or during lunch, and to meet with principals, superintendents, and other specialist teachers.

Only two deviations from the original scheduling plan were necessary. Originally all site visits were to be conducted in the winter and early spring of the year. However, the research approval process in some districts was quite lengthy, and it was not possible to conduct some of the site visits until somewhat later in the school year. In addition, in two districts there were only limited opportunities to observe in-service workshops. These districts did not conduct formal in-services frequently enough for the observer to visit more than one session during the site visit.

Each of the site visits lasted three full days. Since in-service activities were scheduled after school, data collection often lasted from morning until evening. As a result, each site visit involved 25 to 30 contact hours.

Recording. Brief field notes were taken during each interview or observation, and these notes were expanded as much as possible after each conversation. The districts had been asked to schedule intervals between interviews to give the researcher an opportunity to make additional notes. Late evenings were spent reviewing the day's activities and compiling more extensive field notes. Portable tape recorders were used as a secondary recording device during the evenings and between conversations as a way to

expand the researchers' note-taking abilities. Tape recorders were not used during the interviews or the in-service observations.

Field notes and recordings were transcribed into more detailed narratives at the conclusion of the site visits. In most cases, the researchers also brought back relevant documentation concerning such things as the mission of the computer in-service division, the schedule of in-service classes, and the organization of the computer staff.

Data Analysis

After completion of the site visits field notes were expanded into narratives which were catalogued and filed by district. Subsequently, impressionistic summaries and cross-referencing techniques, such as those described by Miles and Huberman (1985), were used to aggregate and compare the information. The first step in data reduction was to prepare a three or four page summary of the major observations that were made during each site visit. These district level summaries contained the researchers' views of the important observations that were made in each district and the major issues that had been raised during the site visit. They served as the first level of aggregation for summarizing results and testing whether relationships held across districts.

The second step was to carry out a detailed indexing of the field narratives themselves, using an expanded topic index as a coding system. Comments that were related to variables of interest were given code numbers, and these codes were added as marginal references on the field notes. This allowed for more flexible review and comparison of data, and served as a second filing guide. It facilitated the process of compiling and analyzing data relating to any theme or question.

The indexing and summarizing enhanced the researchers' ability to explore relationships and confirm or deny hypotheses. The site visits generated a number of preliminary hypotheses about computer in-service training; these were reviewed first. Thereafter, whenever themes or patterns emerged from the data they could be tested against the entire field data base.

Limitations

These results reflect the perceptions of key individuals in the districts that were visited. Two factors should be considered before they are generalized to other situations. First, the districts that were visited represented a purposeful sample of school districts with good reputations for computer inservice training. Though they varied in size, geographic location, computer focus and length of experience with computers, they may not be reflective of all districts in the country. Second, the attributions of in-service effectiveness were based on teacher perceptions and other subjective judgments. Though attempts were made to validate these impressions, they must be interpreted with some caution.

RESULTS

The results will be presented in five sections, corresponding to the five factors in the initial conceptual model for the study shown in Figure 1: outcomes, in-service delivery system, teacher characteristics, organizational context and unanticipated factors. Analyses of outcomes will be presented first. Since the purpose of the study was to learn from the practices of effective districts, it is important to establish the degree to which these districts provided models of good computer in-service activities.

The second section will examine the in-service delivery system. This discussion will begin with descriptive information regarding the computer in-service activities taking place in the sampled districts. These results provide a basis for understanding subsequent discussions. Specific in-service practices that were linked to positive outcomes will be described next. The section will conclude with a look at follow-up mechanisms and their relationship to in-service success.

Teacher characteristics will be examined in the third section. This will be a brief presentation because little relationship was found between these variables and outcomes. Changes over time in the characteristics of teachers in computer in-service classes will be discussed.

The fourth section will address organizational context variables. It will include discussions of logistics and the centralization of administrative services, coordination with outside agencies, administrative support, district goals, and the relationship of these factors to successful in-service programs.

The section on unanticipated factors will focus on the complexity of the learning task that must be addressed by computer in-service training. It will also explore the difficulty of applying new knowledge and skills in the classroom.

Measures of Outcomes

The sample was selected to represent a cross section of effective district-based computer in-service programs. This selection was based on professional judgment, rather than any objective measures of effectiveness. As a result, it was important to determine the extent to which the districts did, in fact, exemplify effective computer in-service practices.

Reasonable indicators of success would include such things as increased knowledge and skill on the part of teachers, changes in teacher's instructional behaviors in the direction of greater computer use in the classroom, and enhanced learning on the part of students. Unfortunately, it was not possible to measure these variables directly. This would have required extensive testing and longitudinal data collection that was not possible within the limits at the present study. Instead, it was necessary to rely on the judgments of district staff concerning the impact of the in-service activities. Additional data was provided through direct observations of in-service classes carried out by the field researchers.

The three principal sources of evaluative judgments were teachers who participated in the in-services, trainers who were responsible for delivering instruction and had opportunities to receive feedback from teachers, and district computer administrators who coordinated in-service activities and had responsibility for their success or failure. During the interviews each group of respondents was asked to judge the success of the in-service activities he or she was familiar with. Their judgments were supplemented with the impressions gained from direct observation of selected in-service classes. General conclusions about the success of district computer in-service efforts were based on the following impressions.

Teachers' Judgments

Teachers were asked to provide an overall evaluation of the in-services and to comment specifically on the degree to which the courses had met their needs, the impact of the training on their own teaching behaviors, the skill of the trainers, and the carry-over impact on students.

At the most general level, the vast majority of the teachers in the eight districts made favorable comments about the computer in-services they participated in. While they were not asked to rate the classes on a specific scale, they described their experiences as "good," "excellent," "exciting," and used other positive terms. Frequently, teachers who were new to computers mentioned that the in-service had reduced their anxiety about computers and changed their attitudes about the usefulness of technology. As one teacher put it, "We opened up the computer and looked inside and I saw that it didn't have any teeth." Another indicated that the in-service had shown "all that did not exist five years ago that could have a big impact on students..."

While the vast majority of judgments were positive, there were smaller numbers of teachers in about half of the districts who were less enthusiastic about their computer in-service experience. For example, teachers who already had some experience with computers sometimes found the introductory courses to be boring. Occasionally knowledgeable teachers were frustrated by what they saw as a lack of direction to the workshops. One science teacher complained that the in-service was bad because "nobody knows how and when to use it [the computer];" instead there was "all kinds of fumbling around and a lot of trial and error."

On the other hand, teachers without any background could be "overwhelmed" if they had to learn too much in too short a time. One teacher recalled an intensive one-day workshop during which teachers were very quiet, but "as soon as they got out the door they cried for help." The coordinator in this district soon learned that "those with no knowledge felt confused" by the workshop and she therefore took steps to provide additional explanation.

Other teachers gave negative evaluations because of external conditions that were actually outside the control of the in-service trainer. These teachers indicated that their overall computer experience had been frustrating because of other problems, such as access to computers at their school, availability of software, or cooperation from other school staff. These issues, which colored their judgments about the in-service class itself, will be discussed in later sections.

While most teachers confirmed that the computer in-service class had met their personal needs and expectations, a significant minority of the teachers had difficulty answering this question. Many novice computer users reported that they had no idea what to expect from the computer in-service course, and were unable to make a judgment about whether the activity met their needs. As one teacher commented, "I was not sure what I was supposed to be learning, so I didn't know what to expect." In fact, as many as 20% of the teachers said they could not evaluate the in-service in general because they knew so little about the subject. As one might imagine, such teachers felt they had little to add to the in-service planning process either. Another teacher summed up this point concisely, "I didn't know enough about computers to make an intelligent decision on planning courses." This was one of the first indications that there was something special about technology as a subject that might present special obstacles to effective training and use.

Almost all teachers indicated that they had learned a great deal from their computer in-service course(s). For example, one teacher who knew nothing about computers prior to the in-service was "hooked on them" after participating in the class. This was a common reaction. Another teacher was delighted with the fact that now "someone like me who knew nothing about computers" was actually able to use them. Moreover, the vast majority of the respondents suggested that this knowledge had improved their attitudes towards computers and increased their enthusiasm for the use of computers.

Many teachers could cite specific instances in which they used skills learned in the computer in-services. This occurred most frequently among teachers who were being trained to conduct specific instructional units that used computers, such as word processing for composition. Teachers in more than half of the districts recalled specific skills they learned that were useful in their classrooms.

Teachers were also asked to comment on the skill of the individuals who taught the in-service classes. These comments were even more positive than the overall in-service evaluations. The vast majority of teachers were satisfied or extremely satisfied with the capabilities of the people who provided the training, and many teachers spoke enthusiastically about specific trainers. One teacher talked about everything that had been learned about computers and explained " I owe it all to the trainer." Another said "the trainers were structured, but not too structured... I felt they were excellent." A third explained that the trainer had done the sort of thing that was typical of good teachers anywhere, "[The trainer] let me take home the computer in the evenings and weekends though it was against the rules to allow me to do it...[The trainer] encouraged me to run on my own."

Frequently, the teachers described a particular talent or ability of the trainer that made the course a success. Teachers commented favorably on the trainers' ability to communicate computer concepts, their understanding of teachers' concerns, their patience with people who were unfamiliar with the computers, their sense of humor, and their organizational skills. They also commented that, as teachers themselves, the trainers were able to relate the material to the specific concerns of the current audience. Specific characteristics that seemed to enhance the effectiveness of the computer in-services will be described in a later section. At the present, it is sufficient to note that teachers gave the trainers high marks.

Finally, teachers were asked whether they observed changes in their students as a result of the training the teacher had received. About half of the teachers described changes they had seen when their students worked with computers. They cited both greater motivation and enhanced performance among their students. "The students' attention span was much higher (using the computer) than if I had been using traditional methods," one teacher commented. A special education teacher was extremely enthusiastic about the impact the computers had on the writing skills of students with visual motor problems. "It's incredible, the quality and content [of their writing]. They edit their own work; they see their errors better. It takes two days to complete a story vs. two weeks by hand. It's 100 times better; they can think and type at the same time." At the other extreme an English teacher with a gifted class reported similar results, "I have seen such progress [using the computers]. I run them through hoops, revising and revising, and the computer is a real advantage." Similarly, many English teachers indicated that students were writing more using word processors than they had with pencil and paper.

A few teachers also reported that the students learned to use the computers faster than the teachers. In fact, one or two teachers commented that the presence of the computers was changing the traditional teacher/student relationships in the classroom. Both groups were learning together, because the teachers did not possess all of the expertise.

Though these measures were imprecise, it would seem clear that teachers judged most of the in-service activities to be successful. There was some variation from district to district, but in six of the eight districts the judgments were overwhelmingly positive.

Trainers' and Administrators' Judgments

Trainers and computer administrators were also queried regarding the success of the computer in-service efforts. In general, they had more to say about the overall value of the in-service than the participating teachers had. Because trainers and administrators had contact with greater numbers of teachers they could cite more examples of the positive or negative impact of the computer in-service program.

Overall, trainers reported that the in-service workshops were well-received by teachers. It was common for teachers to communicate their feelings about the course to the trainers, and in general, trainers recalled very positive feedback from teachers. For example, one teacher told a trainer that the course had provided "a new lease on life." A trainer in another district recalled a teacher who described the computer in-service course as "a burnout prevention program" for teachers. A third trainer reported that teachers commented "this is one in-service that wasn't a waste of time." Almost every trainer related similar anecdotes from individual teachers who had been favorably affected by the program.

The trainers were pleased about the level of knowledge and skills acquired by the teachers who participated in their classes. "If you walk around [the high school] you will see that computers are being used by the teachers. Many do all their assignments on the word processor," a trainer indicated. Similarly, another trainer said, "All of the teachers who

practiced now use the word processor. That included six of the ten people from the last [in-service] class." Finally, some noted that many of the teachers had learned enough to share information with colleagues at their home schools.

Computer administrators had a clearer sense of the overall impact of the computer in-service program. In about half of the cases they received written course evaluations or questionnaire results on which to base their impressions. Computer administrators reported that written teacher evaluations were quite favorable. Only the administrators in the one district which required computer training for all teachers reported mixed reactions from participants. Other administrators indicated that feedback from teacher participants was very positive. They too were able to cite instances of teachers who had benefitted from the computer in-service program. For example, one coordinator said, "I've seen many teachers who have not only gotten involved in teaching these [computer] elective courses in areas they did not know before, but are using computers to support instruction in lots of other ways as well."

Computer administrators also cited growth of the in-service programs as evidence of its effectiveness. Excluding the district in which participation was mandatory, almost all other coordinators reported that demand for computer in-service courses had increased since the courses first were initiated. In some cases, this increase was dramatic. In all cases, the coordinators said the increase was accompanied by positive reactions to the courses. Consequently, the growth could be taken as an indication of the effectiveness of their efforts.

There was one instance in which negative feedback from teachers caused a district to refocus its in-service activities. After a number of successful sessions one district coordinator began to receive negative feedback from teachers in an introductory computer in-service course that included a unit on programming in BASIC. Feedback from the initial classes had been positive, but subsequent groups reacted less favorably to the component on programming. As a result, the course was being redesigned to focus more on applications software. This indicated that the administrator was receiving sufficient information to recognize that a problem existed, and it adds credence to the overall impressions that the coordinators had fairly accurate impressions about the success of the computer in-service program.

One or two administrators cited comments from outside agencies as indications of the quality of the computer in-service programs. For example, one district received a special state grant to continue an effective teacher in-service program involving a bus set up as a computer laboratory that traveled from school to school. The computer coordinator in another district indicated that publishers used their district to field test new software because of the abilities of their teachers.

Finally, coordinators in two or three districts suggested that the continuing commitment of district funds was evidence of the success of the program. The size of these programs had increased over the years, allowing the computer administrator to hire additional trainers, buy more hardware or software, and increase the services provide. This support was cited as an indication that the training program was operating in an effective manner.

Observers' Judgments

The researchers observed in-service sessions in each district and drew their own conclusions. By and large, the observers' judgments about the effectiveness of the in-service programs were positive. At the conclusion of the site visits the researchers made an overall judgment of the quality of the in-service program in each of the districts. Each district was rated on a scale from 1 to 10, where 10 represented "the finest computer in-service." On this scale, 7 out of 10 districts were given ratings of 7 or 8. One received a nine, while two receives sixes. Specifically, the observers noted that almost all the in-service sessions observed were well-planned and well-executed. While they varied in content and duration, all seemed to have clear goals and appropriate plans for achieving these goals. There was evidence of a variety of good instructional techniques and strategies. In particular, the observers noted positive rapport between trainers and participants in most of the in-services and were impressed by attempts to personalize the interactions in the class, in contrast to the impersonal nature of the subject matter.

Summary of Effectiveness

There was a high degree of correspondence between the judgments of teachers, trainers, administrators and the researchers about the effectiveness of the computer in-service programs in these eight districts. Though the term "exemplary" may be too strong a word to describe the computer in-service programs in all the districts, evidence from participants, trainers, administrators and researchers suggests that the in-service activities in each district were generally successful in instilling new knowledge and skills in teachers and increasing their use of computers and therefore worthy of attention.

Computer In-service Delivery System

Computer In-Service Activities

The presentation of results begins with a description of the in-service activities that were taking place in the sampled district's. This section summarizes information about the major emphases of each districts computer education program, the length and duration of computer in-service classes, requirements for computer training, the variety of topics covered by in-service workshops, and the scheduling of computer workshops.

To provide an initial basis for investigation, an attempt was made to establish the focus of instructional computing activities in each of the eight districts. These were the uses and applications of computers that were receiving the greatest official encouragement and support.

Table 3 summarizes the main emphases of the instructional computing programs in the eight study districts. The four principal applications of computers at the time of the study were LOGO (generally among junior high and elementary school students) word processing, computer literacy and the use of curriculum-related software from the Minnesota Educational Computing Consortium (MECC). In this case, computer literacy referred to a general introduction to computer operations, the history of computers and their

social impact, elementary BASIC programming, and a discussion of software selection. While these four applications were predominant, Table 4 shows that there was wide variation in the computer applications that were being emphasized. In one district no centralized focus had been adopted and each school was pursuing its own options. This district encouraged schools to use their own local initiative to identify meaningful educational applications of computers.

Insert Table 3 here

Table 3 lists only the applications that were receiving the greatest encouragement. It is not meant to suggest that individual teachers were not using computers in other subject areas. Nevertheless, it is interesting to note that neither science nor traditional mathematics were areas of significant emphasis in computer in-service training in most districts.

One way in which these emphases were determined was to ask what were the districts' goals and objectives for computer use. It was surprising how little similarity there was in form or content between the goals or objectives that had been prepared in the various districts. For example, one district's philosophy was contained in a "mission statement" for the computer education department. Another district's planning was guided by a "definition" of computer literacy. A third had a detailed curriculum guide covering grades K through 12 that indicated which computer-related topic was to be taught at which grade level. Overall, there was no consensus whether computers were subjects in themselves, strategies for reinforcing the the existing curriculum, instructional materials, or enrichment programs.

Statements of goals or purposes are not important, per se, but they provide direction for developing computer education activities and in-services. In general, there was a lack of precision in describing the way computers were to be used. It was interesting to compare the districts' objectives for computers with their curriculum outlines for other subjects. In traditional subjects such as mathematics, English, or language arts, there was a thorough curriculum guide containing a statement of broad goals and specific objectives for learning at each grade level. The objectives for computer use were less clearly specified. As one staff development coordinator explained, "Computers are different than math, where we know exactly what we want to be teaching. We don't think we know enough yet." In fact, the computer literacy curriculum in this district was 20-30 pages long while the curriculum guides in other subjects were many times that length. "This reflects what we don't know," the coordinator indicated. A coordinator in another district reported, "We view the computer as a tool or medium and not the object of study. We do not have objectives for the overhead projector or the pencil, either."

A lack of clear objectives regarding computer use also may reflect the fact that the goals of computer use have changed over the last few years and continue to be in a state of flux. One district considered itself to be in an "exploratory" phase and was encouraging individual schools to try different approaches to computer education. Two of the districts indicated that they were in the process of rethinking their goals and changing their

emphases. In fact, there was evidence of disagreement about implementation and goals within districts. In one instance, the coordinator boasted about the flexibility of the computer education program and was pleased with the fact that individual schools were following their own directions. "We are still exploring how computers will fit in the schools...[and we are] comfortable with not having everything totally defined." A elementary school member of the computer-education coordinating committee in this same district was pushing hard for standardization and felt that some of the schools were misguided and were wasting time and resources. "At the high school they have had [staff development grant] for three years and they are still just getting started. They are moving so slowly! We're already working on curriculum integration."

Extent of computer in-service courses. Table 3 illustrated the types of applications that were receiving official encouragement, but it did not indicate the extent of the computer in-service efforts that were being provided. Table 4 shows the number and duration of regularly-scheduled, formal in-service workshops; many of the districts also provided informal assistance to teachers that are not reflected in the table. It also should be noted that some of the smaller districts relied upon regional training centers for some of their basic computer in-service training courses. Introductory workshops provided for teachers by other agencies were not included in the table.

Insert Table 4 here

Table 4 shows that there was significant variation in the number and duration of computer in-service courses offered in the sample districts. Some districts offered a wide variety of thorough and comprehensive workshops, while others offered only introductory opportunities. Formal courses ranged in length from fewer than three hours to as many as fifty classroom hours. The lengths of the workshops seemed to cluster into three groups. There were a number of short courses generally held in a single session lasting two to three hours. These served as introductions or refreshers. There were many courses of intermediate length that involved two to five meetings lasting from two to three hours each. Finally, some of the districts provided workshops that were the equivalent of a graduate level course. These ranged in length from 20 to 50 classroom hours and carried the equivalent of one, two or three units of credit. In fact, in one district, computer in-service courses earned graduate credit from a local university. Such courses offered more in-depth coverage of a topic with extensive opportunities for directed practice in the use of computers.

The breadth and depth of the computer in-service offerings were directly related to the size of the school districts. The large districts had much more extensive computer in-service programs than did the smaller districts. Furthermore, the districts that offered the greatest variety of in-services were also the ones that had the largest number of "in-depth" classes. The smaller districts tended to have more short, exploratory offerings.

It should be noted that in two of the districts a significant number of computer workshops were not scheduled in advance, but were planned and conducted at the request of teachers. Teachers who wanted information and

did not care about credits often opted for these customized classes. In fact, in one large district there were probably more not-for-credit workshops taken than regular in-service courses. These are not reflected in Table 4. In most cases such custom workshops ranged in length from two to fifteen hours.

Computer in-service requirements. Table 5 summarizes computer in-service requirements in the eight districts. Most of the districts did not require any computer in-service training for teachers, but made participation voluntary. Only one district had an absolute requirement that all teachers obtain some training in the operation and use of computers. However, coordinators in many districts indicated that teachers were "strongly encouraged" to learn new skills in this area. In fact, in two of the districts, schools had an opportunity to participate in intensive computer projects and such participation usually carried with it pressure for teachers to increase their awareness of computer use.

Insert Table 5 here

Course offerings. One of the districts provided a model of the variety of specific topics that can be addressed under the broad label of computer in-service training. Table 6 shows the catalogue of regularly-scheduled in-service courses provided in this district. There were more than a dozen fifteen-hour to thirty-hour in-service courses focusing on distinct applications of computers in various parts of the curriculum and ranging from basic introductions to computer operations to advanced applications in specific subject areas. The district in question also provided short-term workshops at individual school sites to meet specific school needs.

Insert Table 6 here

It is also interesting to note that none of the workshops in this district focused on science or mathematics. In fact, with the exception of LOGO, there were almost no computer in-service courses for math or science teachers in any of the districts.

Scheduling. The vast majority of the courses described in the previous paragraphs were offered after school. Occasionally, computer in-service activities were offered during special staff development or planning days at the beginning of the year. Only one district provided significant amounts of released time during the school day for teachers to take computer-related in-service classes. Two districts offered teachers special summer programs that occurred during normal school hours. Four districts participated in the IBM Model School program that provided summer training during 1985. However, the vast majority of formal computer in-services took place after school. Typically, courses lasted from 4:30 PM to 6:30 PM or 7:30 PM and met for one or two nights a week over a period of weeks.

Instructional Practices

As one might imagine, specific instructional practices had a great deal to do with the success of the computer in-services. A dozen strategies were identified in the effective in-service presentations that seemed to contribute to their effectiveness. These will be described in the following paragraphs.

It was interesting to note that a number of teachers were critical of themselves as students. A high school teacher recalled a computer in-service class, "After six hours of working, it's like dealing with a room full of junior high school students. They all have short attention spans." An elementary school teacher, in comparison, said, "There is no difference between a bunch of teachers and a bunch of second graders...in fact teachers may be worse because they have a certain fear about computers." Many expressed sentiments similar to those of a third teacher, "Teachers need to be nudged and coddled along more than kids do concerning computers."

Despite these cautious appraisals of teachers as computer students, there were some techniques that seemed to make the in-service classes more effective. These are summarized in Table 7 and described in the following paragraphs.

Insert Table 7 here

Extensive practice with computers. The first practice that increased in-service effectiveness was the extensive use of the computers during in-service instruction. The single thing that teachers recalled most frequently about their classes was the opportunity or lack of opportunity to operate the computer. Satisfied teachers said the in-service "allowed enough time" to use the computers. Dissatisfied teachers often complained that "there was not enough time...to play with what we were learning," or "we needed more time to practice."

The observations of in-service classes confirmed that direct experience with the hardware and software was an effective way for teachers to acquire new knowledge and skills. Most in-services that were observed lasted from two to four hours and at least half of this time was dedicated to direct interaction with computers.

Respondents also reported that it was best for each teacher to have a computer system of his or her own to use during class rather than sharing computers among two or three teachers. As one teacher said, "Sometimes helping one another on the same machine works well, but other times it is frustrating." One or two classes were observed in which machines were shared by two teachers and there did not appear to be any significant decrease in learning, but in others an insufficient number of computers did clearly reduce the level of direct participation of teachers.

It should be noted that adequate software must be provided to accompany the hardware that is present in the in-service classroom. Hardware and software often are purchased separately, so one cannot assume that the

presence of one ensures the presence of the other. In two districts, the trainer was supplied with a classroom set of software to bring to the in-service class in the event that adequate software was not available at the training location.

Comfortable and relaxed atmosphere. The classes that seemed to be the most effective also had a warm and comfortable ambiance. As noted earlier, many teachers approached computers with a heightened level of anxiety. An English teacher described other teachers in this field, "English teachers are, generally speaking, anti-machine people. They are afraid to touch the machines. They are afraid they will break." Another said that anxiety about new things was a general trait of teachers: "There is a tremendous difference between teachers and kids in terms of their fear of failure....This is probably true of most adults, but it is true for teachers more than any other segment of the population." Whether this general observation is true or not, technology did seem to cause anxiety in many teachers. To combat this, the successful trainers managed to create a warm and friendly atmosphere during the lessons. "The more technical the course, the more relaxed the atmosphere should be," one trainer explained. A teacher described the benefit of this approach, "[The trainer] was so easy-going that I wasn't afraid anymore." Many other teachers praised trainers and explained that they were effective because their openness and ability to make the teachers feel comfortable. Humor was used frequently to reduce tension in the classes. As one teacher described, "the trainer must be compassionate and have a good bedside manner."

In-service workshops usually met after school for 2-3 hours. In many cases the trainers or the participants provided refreshments to be eaten during a break in the class. For example, one trainer brought cheese and crackers, punch, soft drinks, and dessert to the first lesson, and arranged for two teacher participants to provide similar refreshments during each subsequent lesson. In another class everyone shared responsibility, and an informal potluck meal was constructed each week. As one teacher quipped, "In-service runs on food." The opportunity for food and social interaction not only satisfied people's hunger, but it seemed to create a congeniality that carried over into the lesson and encouraged helpful contacts between classmates. "The key element is camaraderie," one trainer said. It appeared that attention to creature comforts and attempts to create a warm and friendly atmosphere were particularly useful when the topic was computers.

Appropriate balance between lecture and guided practice. The balance between lecture and guided practice also affected the success of the in-service classes. In the classes that had the greatest impact, the didactic portions of the lessons (in which the trainer presented new material in a lecture format) were short and they were interspersed with longer practice sessions (in which teachers had an opportunity to try out new skills at the computer). A teacher described the proper balance: "The lessons should be made up of small pieces .. 15 minutes of lecture, then 45 minutes on the computers, then 15 minutes back together again to talk." Another teacher echoed this model: "Present a little bit of new material, then hands-on time, then a little bit more material, then hands-on..." Lengthier lectures that lasted 30 or 40 minutes were not as well received by teachers during the workshops that were observed. (Only limited use was made of large screen monitors that would allow the instructor to demonstrate

computer interaction while talking to a group.) When teachers recalled the elements that made computer in-services effective, they often mentioned the opportunities to practice what they had learned. They used terms like "activity oriented" and "guided practice" to describe the preferred format.

Individualized attention. Providing individualized attention to teachers' questions was seen as promoting greater learning of computer skills. In interviews, teachers often praised the trainer's willingness to answer their individual questions. This individualization occurred most often during the periods of time when teachers were practicing skills at the computers. The effective trainers circulated around the room checking on teachers' progress and offering assistance if necessary.

Another effective technique was to have a second trainer or a computer aide available to work individually with teachers who had specific questions. A teacher made the case well: "Without a TA it would be terribly difficult to handle the class. Fifteen to one or 30 to one is hard. Everyone has questions, and one teacher cannot get to them all." One district made it a policy to have two instructors in any in-service class with more than 15 teachers. Another district required each prospective trainer to act as an aide before being allowed to teach a class. Regardless of the method, there was ample evidence that individualized attention was beneficial in the computer in-service classes.

Knowledgeable trainers. The person who is providing the training should be knowledgeable about computers and the use of computers in education. Moreover, he or she needs to be able to communicate technical topics to nontechnical audiences. This may seem obvious, but not all the trainers who were observed were adequately prepared. Some of the teachers recalled that effective trainers had both an in-depth understanding of the machinery and the ability to communicate that understanding to teachers.

Coordinators in two districts explained that the initial group of trainers had come from the ranks of local "gurus" -- the first teachers to become interested in computers -- and had thorough knowledge of the machine and its educational applications. However, this did not always make them effective trainers. As one trainer explained: "When I teach kids I can just about assume they all know something about computers and many of them know something about LOGO. Teachers often know nothing; so you have to switch gears." Trainers needed the ability to communicate with the teacher audience.

Coordinators also reported that as the computer in-service program grew, it became difficult to monitor the performance of all trainers. As a result, three of the larger districts instituted formal training programs for their computer in-service trainers. They also developed standardized curriculum objectives and lesson plans to ensure common curriculum. Nevertheless, as the number of trainers expanded and additional generations were added, it became more difficult to monitor the quality of trainers.

Detailed curriculum guides and lesson plans. The more effective in-services were based upon detailed curriculum guides or lesson plans. In many of the districts, lesson plans and/or curriculum guides for the computer in-service classes had been developed by the computer education department.

In one instance, a complete set of student and teacher materials including a class guide with outlines of individual lessons, detailed lesson plans, worksheets, and a software disk containing guided practice lessons had been developed by the district. This was one of the most effective classes observed. Furthermore, the in-class exercises emphasized the new material learned during that session, and the homework focused on these topics. A teacher in another district praised an in-service instructor for providing a similarly well-organized class: "[The trainer] was clear, organized, and well-structured...and gave specific assignments geared to the features we just learned." There appeared to be a positive relationship between the effectiveness of the computer in-service and the presence of a well-planned curriculum.

Clear and relevant objectives. A number of respondents indicated that it was important for teachers to know "why they were there, what they were going to learn, and what it was going to be used for." In other words, the teachers should understand the objectives of the course and see the course's relevance to their job. A teacher said that teachers should be told "why they are taking the in-service and what they will need to know." Moreover, the purposes need to be relevant to their classroom needs. As one trainer explained: "You need to show them that it is a tool they can use tomorrow. You need to show them some application that is immediately relevant and makes their job easier tomorrow." A teacher explained the other side of this picture: "It sounds like a selfish motive, but it basically comes down to, can the computer help me in my job? What is it going to do for me?"

Of course, there were many different objectives. Some in-services began by showing teachers how the computer could help them personally. One coordinator explained this approach: "The way to hook the teachers on the value of computers is for them to see how helpful they can be as a personal tool." Others began with instructional applications. Whatever the goal, it seemed important for the teachers to have a clear understanding of the objectives of the in-service and for these to be relevant to teacher's duties and responsibilities.

Lesson-related materials and handouts. A key component of effective curriculum planning was the preparation of lesson-related materials and handouts. These served to summarize and reinforce the information that was presented during the lessons. It was very helpful for teachers to be freed from the burden of extensive note taking or from reliance upon thick computer manuals as the only reference for the proper sequence of steps to accomplish a procedure. A teacher suggested that the trainer should prepare handouts ahead of time so the class would not require "a lot of copying from the board so it is easier to concentrate and follow along." Many trainers (or in-service developers) did this. Handouts for one class included a brief recapitulation of the sequence of keystrokes needed for each task in the lesson. In another district, two teachers who were interviewed retrieved handouts from previous classes that were still useful to them when they worked on certain computer-related tasks.

It may be the technical nature of the subject that makes these printed backups so important. Whatever the case, teachers in the in-services seemed to appreciate presence of written materials that highlighted the key commands that they needed to learn and written assignments that were carefully

targeted to the topics they had just addressed. Such materials were found more frequently in the larger districts. This may be because they had greater resources to devote to planning or because implementing in-services on a large scale required greater centralization of lesson planning and material's development. Although not always present, in-service workshops in the smaller districts also benefitted from attention to appropriate handouts, materials and assignments.

In-service lessons linked to instruction. Another aspect that was extremely important to a number of teachers was the extent of which in-service lessons related directly to classroom instruction and to the computer activities they were going to be introducing to their students. Those teachers who enrolled in in-service classes in preparation for specific computer-related instructional units had very specific needs. For these people the success of the in-service was strongly related to the match between what was taught in class and what they were going to be asked to do with computers when they got back to their own classroom.

For example, in one district all eighth grade teachers were required to teach a unit on word processing. For these teachers it was critically important that the in-service class provided them with the specific skills they needed to teach these lessons. They wanted to learn more than just how to use the word processing software; they wanted to learn how to integrate it into their lessons. This particular in-service was very effective because it accomplished both of these goals. "The actual teaching method had been thought out by someone, and we practiced just like the kids would have to," one participant explained. Another participant agreed that the in-service was beneficial because it was organized as a "nice step by step course for teachers that went though all the lessons one step at a time. [Trainer] even prepared lesson plans and overheads for us to use." The teachers learned to operate the computer and the software, and they received a well-designed sequence of lessons they could use as a basis for the new unit.

Many people commented on the value of modeling as an in-service technique. "The trainer should make the presentation to the teachers just like they're going to teach it to the kids," one teacher recommended. A trainer echoed these sentiments: "I try to relate my in-service lessons directly to the classroom. This is exactly the same way that I would do this with students. At least it has worked for me with my classes." One coordinator summed up many of the advantage of modeling computer instructional behaviors: "Teachers have never seen a computer teacher, so you must create an environment in the in-service class that is the sort of environment you want them to create with their students. My course has to be designed to show teachers how to be computer teachers... Furthermore, you should tell teachers what it is you're doing in modeling these behaviors for them." In one district the teachers took the same examinations in the computer in-service class that their students would be required to pass later on.

Two trainers spoke about the differences between conducting computer in-service classes for elementary school teachers and conducting such classes for secondary school teachers These comments are included here because one of the major differences they spoke about had to do with modeling. The trainers felt that the two groups should be treated differently. As one put

it: "Split the elementary from the high school teachers. You don't mix apples with oranges." When working with elementary school teachers, "you train them as if they are students. They loved to be role modeled. You do to them exactly what you want them to turn around and do with their students." In contrast, high school teachers, "hate to be modeled; they hate to be guinea pigs... Show them steps one, two and three, and let them extrapolate four, five and six." Looking at it another way, one commented, "With elementary school teachers it's more a matter of trust; every secondary school teacher is from Missouri [the 'Show Me' state]." While others may disagree with this conclusion, it is worth noting that most districts were using computer differently at the elementary and secondary levels. Because of these differences alone there may be some differences between the manner in which in-services classes are presented for the two groups of teachers.

Even teachers who did not have specific instructional units to teach commented on the value of lessons that addressed the actual use of computers with students. There was praise for in-service class that went beyond the mere introduction of hardware and software to discuss how these tools could be used in instruction. For example, one trainer in an introductory in-service discussed some of the ways a skill like word processing could be used in English and language arts curriculum. No actual lesson plans were developed, but such attention to the application of computer skills to the teachers' instructional duties seemed to be important to the teachers in the class.

Such attention to specific applications of computers was important even if the in-service focus was not on instruction. In one district the teachers at the high school were introduced to the computer as a personal tool. The emphasis of the in-service class was on how teachers could use the computer for their <u>own</u> activities. The teachers were allowed to decide how relevant it would be for their students. One teacher at this school explained that the in-service had been quite useful because of the new things the teacher was able to do, like keeping the class gradebook on the computer and using the computer for establishing a test question file. This case suggests broadening the conclusions made in the previous three paragraphs: In-service courses were effective if the knowledge and skills were related to useful teacher or student applications.

<u>Peer interaction</u>. Peer interaction enhanced the effectiveness of the observed in-service classes. Particularly during hands-on practice sessions communication between teachers was beneficial. There were many instances in which teachers would ask a colleague sitting on one side or another for help with a problem, or turn around to look at the screen next to theirs to see how another teacher was accomplishing a particular task. One teacher recalled, "I liked it when we were encouraged to work with each other. The desks were close enough that you could lean over and look and talk to the other person." In fact, it appeared that many teachers asked questions of one another much more freely than they asked questions of the trainer. (There were other teachers who preferred to have the trainer answer their inquiries and did not solicit help from their neighbors). Though no single style was best for everyone, the overall level of teacher-to-teacher interaction that took place in the better classes was quite high.

Occasionally, teachers commented directly on the value of such interactions. One or two teachers indicated that it was extremely helpful to interact with teachers from other schools during the in-service workshops. It provided an opportunity they would not otherwise have had for sharing ideas and learning how things were done elsewhere. Other teachers indicated that it had been useful to have other teachers they could talk to during the week with questions about the lesson. It was especially convenient if there were teachers from their own school in the in-service class. Many agreed that it was beneficial to create support groups that could be called upon to solve problems in the future.

Voluntary participation. Finally, many of the teachers indicated that the in-services were better received because they were voluntary. Teachers were not required to attend, so those who enrolled had demonstrated a desire to learn. While computer in-services were voluntary in seven of the eight districts, participation was "strongly encouraged" for selected teachers in at least two of these. For example, school principals "made it clear" that participation was expected. However, the teachers and the trainers were almost universal in their belief that voluntary participation leed to more effective classes. One trainer was quite direct about the importance of voluntary participation: "When every teacher is required to take computer in-service, then I don't want to teach it. I want to teach people who are there because they want to be there."

People in the district that required all teachers to take a computer in-service class had mixed feelings about this requirement. Most teachers and administrators said that a voluntary program would be better. However, a few of the teachers and administrators said that it was proving to be better in the long run to require everyone to participate. They felt that teachers who participated learned that computers were not as bad as anticipated. A trainer noted that because it was a required activity, "the teachers are less enthusiastic." However, the trainer added, "I cannot think of any case in which they did not come in resentful, and I cannot think of any case in which they were not happy they learned what they did." One teacher explained that, in the future, no teacher would be able to function properly without some knowledge of computers; as a result the in-service classes should be mandatory. However, the one mandatory workshop that was observed contained people who seemed more interested in socializing than in attending to the topic of discussion.

Strategies for teaching heterogeneous classes. One of the more difficult problems encountered by computer in-service trainers was coping with students who had different amounts of knowledge about computers and were learning at different speeds. Comments from a trainer in a small district were typical of those heard in almost all districts: "It was hard to work with the group when they came in at so many different levels." Another trainer continued the thought, "(not only did they begin at different levels, but) there was a huge span between the slowest and the fastest learners... teachers go at such different speeds." Clear evidence of these differences was observed in one in-service class in which teachers were learning LOGO commands by directing their turtles through a maze that was displayed on each monitor. The trainer had programmed a clock into the exercise, and teachers were monitoring the time it took them to complete the maze. The first teacher finished the maze in 120 seconds; the second in 200, and most in

fewer than 300 seconds. The final teacher was having a difficult time with the exercise, but kept at it doggedly until completing the maze. Then the teacher announced proudly, "I did it in 627 seconds." (The observer was pleased to note, that in spite of the potentially threatening nature of the exercise, the class and the trainer were very encouraging, and the teacher seemed to feel a great sense of accomplishment.) This example illustrates a case in which the speeds of the slowest and fastest teachers differed by more than 400%.

Such differences are not likely to disappear. In fact, one trainer felt that "each year it seems to get worse." Whether this is true or not, there were some examples of strategies that could be used to cope with this heterogeneity. The approach that was seen and discussed most often was the use of Teaching Assistants to provide more individualized instruction. Maintaining the right pace was another suggestion. As one trainer noted, "you cannot go too fast and you cannot go too slow... You must have a feel for your audience." Another tactic was to provide flexible time periods for certain tasks. One trainer described the way certain portions of the class are carefully timed to allow for differences: "When you know that you're reaching a topic in which people are going to go at different speeds, then you do this right before a break. Say you have a ten minute activity for most people. You know some will get it done in five and some will get done in twenty. So, you start just before the break and then you let people go to break when they're finished."

Better diagnosis and grouping of students were also mentioned. One trainer thought that in the future they would have "less variability" if they could "do a better job of diagnosing what [teachers'] needs are, so they could group people at the same level together in one in-service." Another trainer echoed this sentiment, hoping that in the future in-services could take a "more narrow and specific focus for smaller groups of teachers who are at about the same level and have the same kinds of concerns." Better matching of classes to teachers' knowledge and needs would help overcome many of the problems of training heterogeneous groups.

Follow-up Support

There is considerable research to suggest that lack of follow-up support is a significant barrier to the application of new techniques and strategies learned in in-service training (Joyce & Showers, 1982). Continuing contact with trainers or other "mentors" can help teachers translate information gained in in-service courses into practice. This is particularly true for information about computers, because they represent such a marked potential for change from teacher's traditional instructional patterns.

Most of the computer coordinators had a general awareness of the importance of this issue. As one explained, "I don't go for a quick and dirty in-service. Information giving is not staff development... [There needs to be] further contact, follow-up, coaching..." A high school coordinator concurred, describing the preferred model as "training, then time for experimentation, then follow-up."

Despite this sensitivity, most districts lacked systematic procedures for providing follow-up contact. There was no common approach in these eight

districts for providing supplement assistance to teachers who had completed in-service courses, and it appeared that the overall level of such support was low.

However, many different strategies for follow-up were being tried. The options included: 1) having a school level person designated as computer coordinator and giving this person a small amount of free time to work in this capacity, 2) encouraging people to remain in contact with the trainer from their in-service course and to utilize that person as a resource, 3) providing supplemental assistance and teaching ideas at a monthly meeting of all teachers who are teaching a particular computer-related class, 4) making the trainer available for in-class team teaching and coaching to help the teacher implement the strategies discussed in the in-service, 5) establishing a centralized consulting staff with responsibilities for visiting schools and solving teachers' problems, 6) expecting teachers to take additional courses to satisfy their additional questions, and 7) utilizing site-level instructional support teams to provide implementation and curriculum assistance to classroom teachers.

As this list suggests, there was wide variation in approaches for providing follow-up support. Unfortunately, it was not possible to determine whether one approach was more effective than another. This was true both because of the wide variety in support systems that existed and the limited amount of follow-up support that was observed.

Not all the options described above were operating on a wide scale, nor were all fully implemented. For example, the school-level computer coordinators mentioned above assumed administrative responsibilities almost exclusively, and spent more time scheduling the computer laboratory than solving teachers' problems. In fact, teachers in one of the schools indicated that the individual chosen as school site coordinator was not the person most knowledgeable about computers.

In another district the school computer coordinators served as the official line of communication between the computer department and the individual schools. Their duties included disseminating information about computers and supporting the needs of staff. However, no provisions had been made to provide released time for these people to carry out their role. Only when individual principals valued this service highly did they find ways to provide released time.

The most effective support networks occurred in schools with a larger number of computer-using teachers. In such cases there was enough expertise nearby to solve teachers' problems on an informal basis. Good support also occurred when trainers continued to work as teachers and could provide additional help to other teachers in their own schools. A teacher who worked in school with one of the computer in-service trainers agreed: "It is good to have someone on site who knows quite a bit about the software."

A prime example of the kind of follow-up that can be provided by trainers occurred in one district in which an in-service trainer had a regular teaching assignment with flexible hours. The trainer was available to the teachers to assist with any of the computer-related lessons they were supposed to present to their students. In fact, the trainer spent as much as

two weeks conducting lessons for students while the newly trained teacher gradually merged into the instruction, though most teachers asked the trainer to assist with lessons for only a day or two and resumed responsibility for their classes after that. This was the most thorough example of "coaching" that was encountered. It was praised quite highly by the teachers who were able to benefit from it.

Other less elaborate approaches to follow-up were also appreciated by teachers. Teachers in one district applauded their trainer for providing a home telephone number and encouraging them to call if they had problems. When the trainer is "in house," a teacher explained, "you can call during the week with questions." This ability to "go to the source" seemed to be very well received. Another district made regional coordinators available to answer questions by phone. A coordinator told the teachers at the first sessions of an in-service workshop, "you're not expected to memorize all of this. That's why I'm here. If you need to, call me on the phone." The telephone was a substitute, but still provided some of the advantages of face-to-face contact.

It is an unproven, but appealing, principle that the likelihood that a person will seek out assistance decreases as the amount of effort needed to obtain the assistance or the distance to be covered to acquire it increases. This "principle of proximity" would seem to apply in the case of in-service follow-up support.

Two districts had formal staff development support systems, involving specially-trained coaches or supervising teams. It was interesting to note how these mechanisms were integrated with the computer in-services. In the first district, each school had an instructional support team responsible for follow-up; the team was trained to act in a coaching capacity to help implement the district's staff development program. Unfortunately, the team was not able to assume this role vis-a-vis computers because the team members were not knowledgeable enough about computers or about the content of the computer in-service to act in a coaching capacity. As a result, the normal follow-up mechanism in the district was effectively "on hold" as far as computer in-services were concerned. The staff development coordinator admitted that "computers are different. Computers take their own place because the principals aren't comfortable with them."

A second district had an existing in-service network with a centralized core of clinical consultants. Two of these individuals were actively involved with computer education as well, so they were already "integrated" into the existing system. In this way they brought computer expertise into the in-service network. To the extent they could respond to teacher needs, effective follow-up existed. However, it was limited by the small number of consultants familiar with computers.

It appeared that the development of mechanisms for providing follow-up occurred after the development of the in-service training program. One trainer summarized the situation in the following words: "The first assumption was that you just buy a whole lot of hardware and it will be enough. The second assumption was when people realized that training was needed for all the teachers. The third assumption may be that we need someone to hold hands in the building itself." Most districts in this sample

were still focusing their attention on increasing the availability of hardware and software and on providing adequate initial training to a large number of teachers. They had not yet shifted their attention to follow-up services to a significant extent. Computer coordinators in almost all the districts were beginning to realize the need for continuing support for teachers, but few districts had the staff expertise and resources necessary to provide such support on a large scale. Most were still struggling to provide hardware and software and initial instruction so that teachers could begin to think about ways of utilizing technology in their classrooms.

Teacher Characteristics

Respondents represented a diverse cross section of teachers in length of teaching experience and in past experience with computers. Teaching experience ranged from one or two years to more than 20 years, with most respondents having between 10 and 15 years experience. The distribution of experience varied somewhat from district to district, as would be anticipated with small samples, but there were no dramatic differences.

Respondents reported limited prior experience with computers. More than half had no experience with computers prior to their in-service classes. Most of those who were familiar with computers had only a year or two of experience.

No clear relationships were found between teacher background characteristics and the impact of the computer in-service. For example, the number of years a person had worked as a teacher had little relation to the person's responses to the in-service. There were eteran teachers who became enthusiastic computer users as a result of in-service activities and veteran teachers who were unimpressed with the in-service and had no interest in using computers. The opportunities that existed for computer use, and the way in which the training was provided appeared to be more strongly related to outcomes than years of teaching experience.

Similarly, teachers' past experience with computers was related to outcomes only to the extent that the in-service courses were presented at an appropriate level of difficulty. Teachers with previous computer experience did not benefit from an in-service that was too simple and repetitive, while those who lacked experience did not gain from instruction that required knowledge or skills they did not possess.

Changes In Teacher Characteristics

Coordinators in three districts described gradual changes over time in the characteristics of the teachers who were signing up for in-service courses, changes that may have an impact on training effectiveness. These administrators described three types of teachers who approached the in-service experience very differently. The "first wave" of participants in computer in-service had been teachers with some previous computer experience and a strong interest in the topic. They were people who "ate up anything you gave them". The bulk of teachers constituted the "second wave", and have become involved in computer in-service classes more recently. These individuals tended to have less experience with computers, and to be less self-motivated. A coordinator described the difference this way: "The main

motivation for teachers who are taking the in-services now, in contrast to the teachers who were getting involved voluntarily in the past, is one of anxiety and fear of being left behind." While this may not characterize everyone in the second wave, the group does differ from the first in terms of motivation and experience. This change is important because the differences between the teachers affect the success of the in-service efforts. More attention must be paid to the design of in-services and the techniques used for presenting the material.

There remains a "third wave" of reluctant teachers who will be the last to become involved and who may be more difficult to train. As one coordinator quipped, "The day that the Board of Education mandates that the computer will be a part of the curriculum, that's the day you'll get the rest of the people involved in staff development." New approaches may be needed for these individuals.

Organizational Context

Information concerning organizational context will be presented in four sections. The first will deal with the logistical problems associated with computer in-service classes and the organizational approaches adopted in the sampled districts to handle these problems. Centralization of computer-related services appeared to be an effective way to deal with some of these problems, and this topic will be addressed at the conclusion of the first discussion. Coordination with outside agencies and the need for additional expertise will be described next. The third section will address the need for administrative support and the respondents comments about the value of institutional and personal commitment to the in-service program. District goals for computer use and their relationship to outcomes will be addressed in the fourth section.

A computer coordinator in one of the districts described the role of the coordinator as "trying to overcome the barriers" that existed to computer use in the schools. This proved to be a useful metaphor for thinking about some of the ways that organizational factors interacted with computer in-service activities. In the following discussions the notion of barriers or obstacles will be used to illuminate some of these relationships. Other factors are more naturally discussed in positive terms.

Logistics

Logistics were a major concern of the computer administrators in the sample districts. They had to be concerned about the acquisition of hardware, software and facilities, the maintenance of equipment and facilities, the transportation of material, and the training and monitoring of personnel as they related to the in-service program.

For example, one could not simply send a trained individual out to a school computer laboratory to teach a particular workshop on the use of computers in education. In most cases the site has to be prepared in advance to ensure that a sufficient number of computers are available for the participants, that adequate and appropriate software is available in the proper quantities for the particular lesson that is being given, that the trainer's materials reflect the hardware and software combination to be found

at this site, that equipment failures have been repaired so an adequate number of computers are operational for the in-service workshop, that access to the building and to secured computer laboratories are available after school, and that adequate directions have been provided to the teachers who are unfamiliar with the site.

The point of this discussion is that a high degree of strategic planning is necessary to make a computer in-service workshop effective. Moreover, the number of logistical problems associated with computer workshops may be significantly greater than the number of problems associated a workshops in more traditional subjects.

Such logistical considerations were relevant in small districts as well as in large ones. The main difference was that the problems grew in scale as the size of the district increased. For example, an equipment failure occurred in one of the smaller districts during the site visit. The teacher called the district computer coordinator directly, and this individual left the central office, drove to the school, and solved the equipment problem within an hour. The coordinator was personally responsible for keeping the computer lab operational. In the larger districts, whole departments were created to handle these problems, and elaborate systems had been developed to coordinate purchasing, maintenance, scheduling, training and the other critical elements of the program. In every case a significant amount of attention was given to fundamental logistical questions because they directly affected the in-service program.

Procedures for handling some of the problems will be described in the following paragraphs. Most districts in the sample centralized the purchasing of computers to a large degree. Either a single office was given responsibility for all hardware purchases, or funds were supplied to individual schools, but their requests were channelled through a central unit. In fact, in one district the responsibility for deciding which schools would receive equipment was given to the computer coordinating office. Guidelines existed to ensure that all schools received some equipment, but supplemental allocations were made by the computer coordinating office.

On the other hand, most districts did not handle software acquisition in the same manner as they did hardware. In some cases there was an initial limited provision of software on a coordinated basis, but subsequently most districts left software purchase decisions in the hands of the individual schools. Consequently, part of the in-service planning process involved arrangements to be sure that appropriate software was available at each site. In at least two of the districts the trainers routinely brought required software with them to ensure that the needed programs would be available.

Facilities presented another problem. Since both hardware and software must be present, computer in-services cannot necessarily be held at the most "convenient" location for every teacher group. Sites with the proper equipment must be identified, and arrangements must be made to provide access and ensure security. Two districts circumvented these problems by creating centralized or regionalized computer training centers. These centers were well equipped with computers and software and were under the direct control of the computer coordinating office. Coordinators in these districts felt that this enhanced the implementation of the computer in-service. In-service

instruction could be conducted more efficiently in these well-equipped centers because all facets could be controlled easily by the in-service staff.

Maintenance was a continuing problem with all computer education programs and affected computer in-service training as well. In about a third of the in-service workshops that were observed, one or two of the machines in the room were in need of repair. Each of the districts had provisions for equipment repair, but the responsibility for initiating repair procedures lay with the regular school staff, not the in-service staff. One district had a particularly effective repair procedure. They maintained a small supply of replacement computers at a central facility. If a machine broke at a school, one person phoned the repair division to see if the problem could be solved over the telephone. If this failed, the broken computer could be transported by car to the central facility and exchanged immediately for an operating unit. As a result, the school never lacked a functioning computer for more than a few hours. The broken unit was repaired centrally and put back into the general pool. Other districts handled maintenance on a more ad-hoc basis, providing some repairs themselves and relying upon vendors in the local area for others. Some districts had set aside a central fund to pay for maintenance, other required the individual schools to budget for this function.

Scheduling was another logistical problem to be overcome. As noted above, many classes lasted 20 or more hours, which represented a significant amount of teacher and trainer time. It was not easy to find this amount of available hours. Two options were reducing the amount of instructional time provided to students, or extending the length of the day for teachers. Neither was satisfactory to all involved. However, since there were legal requirements regarding student contact hours, most computer in-services were held after school. To provide teachers with adequate opportunities to practice on the computers most computer in-service sessions lasted two or three hours. As a result in-service classes ran until 6:30 or 7:30 at night.

This created some pressure to find other times to hold the classes. The two most common alternatives were to release teachers for a limited number of hours during the school day by providing substitutes, and to schedule computer in-services during "pupil-free" staff development and preparation days that usually occurred at the beginning of the school year. These alternatives were utilized to a small degree in almost all districts in the sample.

One district was fortunate enough to be able to provide summer salaries for selected teachers to work in the area of computer education. This district also offered summer workshops during one week in August and paid teachers a small daily stipend to attend. Three other districts participated in the IBM model schools program which also provided stipends for extensive summer training during 1984. Teachers who had the opportunity to participate in these summer programs thought that they were excellent. A major advantage was that teachers could devote more time and attention to mastering the computer-related skills. Such experiences suggested that the summer was a very good time to provide computer in-services.

These examples illustrate some of the ways in which districts handled the fundamental logistical problems affecting the computer in-service program. These issues may seem quite simple, but in reality they were constant concerns for most of the districts. The solutions were not complex, but they required continuing attention and resources.

Centralization. As described above, the introduction of computers in education is a complex process, and the staff development component cannot be isolated from many larger problems. Those responsible for staff development must be concerned about logistical issues like hardware, software, maintenance, scheduling and transportation. Similarly, they must be involved in curriculum development, communication, and follow-up. The very complexity of this task argues for centralization of authority. While not all of the districts in this study adopted a wholly centralized approach to computer in-service, the degree of central coordination increased as the level of computer use and the amount of training increased. For example, one coordinator described the responsibilities that had been given to the computer department: 1) To develop curriculum and develop teacher training programs relating to instructional computing; 2) To train trainers who would then give in-service training to teachers; 3) To evaluate and select hardware for the district and handle purchasing; and 4) To evaluate and select software that relates to the curriculum. In this sample the district with the greatest variety of computer in-service activities had the greatest centralization of responsibility for acquisition, coordination, and application of computers. The most decentralized district had the lowest level of training activity.

An unanticipated positive consequence of increases in computer in-service training, computer education, and centralized computer related services was the appearance of new opportunities for involved individuals to enhance their professional capabilities and responsibility. Shavelson et al. (1984) noted that many teachers who became knowledgeable about computers left education to pursue careers in other areas. In the districts in the study almost all the individuals who assumed positions of responsibility in the area of computer education were classroom teachers who used technology as an avenue for professional growth within the field of education. Almost all of the trainers interviewed were classroom teachers, as well. Familiarity with computers does not necessarily act as an incentive to leave education: it can provide people with new opportunities to renew their excitement about education and to make meaningful contributions. In fact, curriculum-oriented in-service training offers few incentives to leave teaching. Early on, one coordinator was asked by the superintendent whether all the computer training was just preparing teachers for new careers. "Now, because the training is so clearly linked with the curriculum, this is not a problem," she explained.

Coordination With Outside Agencies

Many of the districts utilized services provided by outside agencies to enhance their computer inservice programs. All districts realized that there were limits to the resources they could devote to computer in-service training and limits to the computer expertise available within the district. This was particularly true in smaller districts. Most of the districts made use of resources and expertise from external agencies to provide some of their computer in-service training.

Most of the districts had long-term relationships with regional training centers or local colleges and universities. For example, teachers in both of the California districts made use of instruction provided by the Teacher Education and Computer Centers (TECC) funded by the legislature. In many cases, districts chose not to duplicate these service, but referred teachers to basic in-service courses offered by the nearby TECC In fact, many TECCs offered classes at district locations if there was sufficient enrollment. In some cases, the TECCs acted as a convenient organizational and fiscal mechanism for districts to use to develop customized workshops taught by the district's own staff. Districts in Minnesota received similar support through the Minnesota Educational Computing Consortium (MECC).

Two other districts made use of services provided by regional centers established in other states. This included in-service courses for teachers as well as local consulting regarding educational computing. Furthermore, other external agencies played important roles in computer education in at least two of the districts. For example, one district had a cooperative arrangement with a local college to provide computer in-service training courses. Many of the teachers completed an extended training program and received an advanced certificate in educational computing from this institution.

Overall, more than half of the districts made important use of education resources and expertise drawn from outside.

Administrative Support

The most important types of administrative support discussed by the coordinators and trainers in this study were fiscal resources and a broader idea they referred to as "commitment." Educational computing is a costly endeavor and almost all respondents hoped that more resources would be available for computers and computer in-service training. They looked to the district administration as a source for this support.

In addition to financial support, the respondents talked about the importance of individual and institutional commitment as an element in an effective computer in-service program. The term "individual commitment" was used to describe the attitudes of teachers and principals, who showed special interest and dedication to the use of computers in education. For example, the cocrdinator in one district described the difference between the participants in the initial in-service course and those who were involved at the present time in the following way: "The initial people really had a commitment to computers, but the current group are less committed."

The term was also used as a laudatory adjective to describe school principals who placed greater emphasis on the use of computers and encouraged their teachers to implement computer-related instruction. A coordinator described a principal as "one of the people who is committed to the use of computers; so you will see much more interest at that school." In both of these examples commitment referred to an individual's active interest in educational computing and willingness to devote time and energy to the implementation of computer-related activities in the classroom. There was no

direct evidence to suggest how such personal commitment could be increased. Most often it was discussed as if it were a trait that some people possessed and others did not.

Respondents also talked about "institutional commitment" as a factor that made a significant difference in the effectiveness of computer in-service activities and the use of computers in education. Institutional commitment referred to the presence of organized institutional support and encouragement which was often accompanied by individuals with personal interest and excitement about computers. A computer coordinator who had discretion over the location of two or three specialized computer education activities made the choice of sites on the basis of institutional commitment. The schools that eventually received the equipment were those where there appeared to be both interested individuals and the organizational support needed to make the program more effective. This was one example of respondents' belief that institutional commitment at the school level was related to the effectiveness of the computer in-service program.

The school principal was often cited as the key individual in encouraging the interest and creating the support network that was described. The coordinator in one district placed major responsibility for the success of the whole computer education effort on the shoulders of the principals. "Principals who are interested have gone out and worked to get extra funds... and have tried to get teachers interested. Other principals are not as interested and haven't gone out of their way." A teacher who does a lot of training described another important function of the principal, "The really important thing that the principal does is to reward me." This sentiment was echoed by a trainer in another district: "It's the personal support, the coordination and communication that makes the difference. You cannot expect the teachers to do it; they need administrative support at the school." A principal in another district encouraged teachers to learn more about computers by allowing them to list computer-related projects among their personal objectives that formed the basis for their performance evaluations for the year.

Some respondents felt that things could be done to encourage institutional commitment at the school level. Two examples may clarify this notion. One district was in a unique position to provide computer hardware and software to schools because it had received a substantial grant of money from a private organization to encourage the use of computers with students. This district decided it was important for individuals in the school and the extended school environment to be actively involved in and supportive of whatever instructional activities took place. They wanted to create a sense of wider institutional commitment to the program. Each school was promised a large number of computers and a substantial amount of training. However, in order to qualify for this large grant, the school and surrounding community had to raise a smaller amount of money on their own. The school was required to involve teachers, students, parents and the neighborhood in a campaign to raise funds for the computer activities. By structuring the implementation in this way, the district insured that there would be a significant amount of organizational commitment to the program. As a result of the planning and organization undertaken, there was greater enthusiasm for training and it had a positive impact on teachers' behaviors.

Another district required each of its schools to develop a computer use plan before receiving promised support. Again, hardware and training and consultation were to be provided, but each school first had to determine how it was going to make use of the computers. This forced the staff to work together to think about computer issues. They did not have to work in a vacuum: the district provided help in developing the computer use plans. However, the planning process itself created a degree of institutional commitment.

District commitment was also important because of the complexity of the tasks involved in educational computing. An organized, reliable mechanism for training was one way in which district commitment was evident. A trainer in one district explained that the staff development program in the district was so good that "you could plug in anything and it would work. They have shown total commitment..." The staff development program itself had created an atmosphere of trust and support that carried over into new content areas. In another district, the computer coordinator met personally with the leadership team in every junior high and senior high school to discuss the computer education program and training opportunities. This helped them understand the ways in which the district was supporting the computer in-service efforts. As noted above, computer in-service involves provision of hardware, software, curriculum, trained staff, scheduling, maintenance and other elements. Without clear guidance and the continuing pledge of resources from the district no effective program was possible.

Goals for Computer Use

While there were significant differences in the overall goals for computer education in the sampled districts (See Table 2) these differences did not relate directly to the success of in-service activities. There was no evidence that computer in-services were more or less effective because they were geared towards computer literacy, curriculum applications, or programming. In the long run, the degree of change in teachers' knowledge about and attitude toward computers and their computer-related instructional behaviors may be related to the specific computer goals that were adopted, but this was not apparent in the time frame examined in this study.

Unanticipated Factors

Two issues emerged during data analysis that did not fit within the three broad categories that have already been discussed. The first of these concerned the difficulty of using computers in education and the complexity of the tasks teachers had to undertake to become computer users. The second dealt with the difficulty of making the transition from knowledge gained in an in-service setting to application in the classroom.

Complexity of the Learning Task

Teachers indicated that learning to use computers in their classrooms was a complex task that was not easily accomplished. This complexity represented a barrier to effective in-service instruction. The task of computer in-service training was seen as being more difficult than traditional in-service and staff development activities. Most traditional staff development programs involve the acquisition of advanced knowledge in a

familiar subject or the refinement of existing pedagogical skills. In the computer in-service programs studied here teachers were being asked to master more complex combinations of knowledge and skills. As one trainer said: "Learning computers is different from handing teachers a book or any other teaching arena. Working with computers has to be done differently." Another added, "Even though teachers are adults, you have to realize you are teaching individuals who are learning a skill that is new."

Specifically, teachers had to learn at least four things. First, they had to learn to operate new, unfamiliar equipment. As one teacher explained, even this was a strong deterrent to many: "Teachers would rather have a TV and a VCR than a computer, because they know how to use television and video. The computer has two strikes against it. One, the technology is frightening; and two, you have to learn a whole new routine and a new mode of teaching." Clearly, another thing to be learned was new classroom management strategies for dealing with a computer laboratory, a classroom computer environment, or a computer-assisted instructional situation. "It is difficult to manage the use of computers with kids," one coordinator admitted. A science teacher explained that even the math teachers were not used to working in a laboratory setting so "you have to include some training on how to run a laboratory class." Third, teachers had to become familiar with new software, including lesson-specific software and generalized applications software that required adaptation for use in the classroom. Fourth, they had to determine how these tools might be relevant to the curriculum. This was a far larger task than one normally confronts in the staff development situations, and it was more difficult. One might draw an analogy between the growth involved in going from walking to running and the growth needed to go from walking to driving a car.

Recognition of the complexity of the learning task leads to the realization that effective computer in-service cannot be accomplished overnight. It will require extended periods of time and long-term commitment of resources. Teachers will not be able to implement technological innovation in the classroom after one fifteen-hour in-service. They can begin to move in this direction, but there will be much more to learn, practice and apply. One coordinator was quite clear on this point: "I estimate that 150 to 200 hours of training are needed for a teacher." In fact, this same person explained that working with computers requires relearning and rethinking so it "creates more work for teachers in the beginning." Clearly, a second, third or fourth in-service class may be needed to accomplish this, and continuing support will be required at the district and school-level.

The myth of computer in-service training. As the previous discussion suggests, the use of the term "computer in-service training" in this report may be perpetuating an unfortunate myth -- that teachers need only a small amount of additional knowledge to become instructional computer users. Most people underestimate the complexity of the learning task involved in becoming a technologically literate teacher. Rather than a quick refresher course to acquaint someone with a few recent developments, this task involves substantial "reeducation" to a new way of operating with new tools and new materials. It would be a mistake to think that this can be accomplished in the short-term without a long-term commitment of time and resources from both teachers and school districts.

Application of Skills

A long-standing concern of staff developers in all fields is the problem of helping teachers make the transition from learning to application. (Joyce & Showers 1982). This is particularly true in the field of computers, because so much of what must be learned at the beginning are facts about computers and routine procedures for computer operations that are not directly relevant to instruction. While there are many barriers that make the transition from learning to application difficult, two seemed particularly relevant to computer in-service training. These were limited access to computers in the teachers' home schools, and the lack of attention to instructional relevance in in-service workshops.

Access to computers. In the earlier discussion of the quality of the sampled in-service programs almost all teachers reported that they learned new knowledge and skills from the workshops they attended. Some described ways they had changed their own instruction as a result of this training. However, others reported that their ability to apply these new skills in their own teaching was limited by their access to computers at their home school. These teachers indicated that they had insufficient opportunities to use computers and practice what they had learned. As one teacher observed, "It's just like a foreign language, if you don't use it you lose familiarity with it." Another commented on the lack of computers for teachers to use, "If they are going to learn about computers, they should be there using one instead of having to wait in line to use one." Coordinators were aware of this problem, too. As one quipped, "If you want to kill enthusiasm, that's the way to do it."

Even though many schools had computer labs and teachers could arrange to bring their classes to the lab, both scheduling and equipment problems made this difficult. One science teacher explained why the computer lab was not used more often: "I cannot wait a week to get into the lab because the curriculum moves on... If we [the science department] had a center with 60 computers and 60 copies of each piece of software, then we could use it." Other teachers felt that they would be able to make better use of the skills they had learned if they had computers in their classrooms.

Curriculum relevance. Another barrier to implementation of instructional changes was the lack of curriculum relevance, i.e., there was no direct relationship between the knowledge and skills conveyed in some computer in-service classes and the content of the teachers regular instructional program. Teacher in-service courses that involved direct application of computer skills to the classroom curriculum or instructional uses were more likely to lead to changes in teachers' instructional behaviors. Such lesson-related in-services were observed in at least three of the districts. For example, one trainer made the connection explicitly, "I am going to be switching back and forth between being a teacher teaching you [like a regular class of students] and being in an in-service session." A teacher in another district complained that the computer in-services did not have enough direct applicability to teaching in the school setting. What this teacher wanted was "a teacher who has done a good job explaining how to use the computer within the limitations of the situation here."

It was more common to observe a second type of in-service in which references were made to elements of the regular instructional program, but there were no examples of direct application of computers to specific lessons. In such classes teachers were introduced to computer applications, such as word processing or data base management, or to various tutorial software programs, and were encouraged to discuss the way this software might be relevant to their instructional program. However, they did not develop any specific lesson plans that utilized computers. They were left to apply computers in their classroom at their own discretion.

A third type of course focused on the computers themselves with little or no reference to curriculum. For example, one district offered a computer literacy course that was designed to give teachers a familiarity with the operation of the machine, teach them something about its history and social impact, and introduce them to programming. Another district provided an introductory in-service that included one lesson each on four or five different applications at a very general level. These courses were designed to familiarize teachers with the machinery and show them some of the things computers can do. While this was an important initial objective, it might be more effective to combine these lessons with introductions to classroom applications. There was no evidence that such introductory courses had a direct impact on teachers' classroom behaviors. The coordinator in the first district mentioned above recognized the limitations of the computer literacy class and had instituted changes to make the training more effective. As the coordinator explained: "In the early days we started with computer literacy and then moved on to more advanced things, but now the computer literacy is the last thing we do. We start with more relevant instructional areas... [the training] can't be isolated from what they're doing, it must be relevant to what they're doing."

It could be argued that an in-service program that adequately served the needs of all teachers would have courses of all three types. While there is no doubt that introductory courses are needed, there is no reason why these cannot have a "practical" orientation as well. Almost all of the coordinators described efforts to increase the impact of computers on the curriculum by increasing courses of the first and second type. Courses that showed teachers what to do in a specific school situation, be it a classroom instructional unit or a teacher productivity application, were uniformly well received by teachers.

DISCUSSION

Physicists and mathematicians appreciate parsimonious solutions, and researchers have a similar tendency to try to fit results into simple categories. Case studies often produce data that defy neat categorization. In this case, a few important observations that did not fit neatly anywhere else and will be presented here. They concern a fundamental contradiction that underlies current efforts in the area of computer education, the lack of information that exists regarding computer in-service training, and the specific training needs of teachers of science and mathematics. Finally, suggestions will be offered for future research and development relating to computer education for teachers.

The Conflict Between Structure and Flexibility

The field of educational computing is undergoing rapid change. There has been tremendous growth in the availability of computers for school use and there have been significant changes in the focus of computer education activities. Seven to ten years ago the main thrust of elementary and secondary educational computing was the teaching of programming and the use of computer-assisted instruction. Most district-level computer-related curricula focused on the operation of the computer and the teaching of BASIC programming skills. Then a broader approach, dubbed computer literacy, gained favor. This emphasis included the social and historical elements of computer use in addition to operation and programming. In the first half of the 1980s most districts that were actively implementing programs to bring technology into classrooms adopted a computer literacy focus. A more recent change places greater emphasis on the use of computers as support tools for achieving better mastery of the existing curriculum. It might be fair to characterize the second half of the 1980s as the era of "curriculum integration" in computer education.

These changes were apparent in the interviews conducted with computer coordinators in the eight districts. Some commented explicitly that they were changing directions to place greater emphases on a different approach to the application of technology in the schools. Others were not making specific changes at present, but were quite aware of the trends that were taking place in computer education nationally.

All of this argues that a computer administrator should adopt a stance that is open, flexible, and responsive. Those interested in computer use in the schools need to be alert to new applications and continuously monitor the local use of computers to identify those applications that are the most meaningful.

In contrast, research on educational innovation suggests that it is important to have a clear set of goals and objectives to implement new techniques effectively. Gersten et. al. (1986) expressed this idea concisely, "what is clear, tends to be well implemented". Clear goals and objectives are important for good staff development, too (Joyce and Showers, 1982). This study confirmed that detailed lesson planning and materials development enhanced the effectiveness of computer in-services. Such well-designed lessons and materials derive from clear objectives. In the case of computer in-service, distinct goals and objectives for the application of computers form a better basis for a training program than imprecise or changing notions about the purposes served by computers.

This points up a fundamental contradiction between the volatile nature of computer education in the 1980s and the type of well-defined objectives that characterize good implementation. Program developers work best with relatively well-defined content areas, while computer education continues to change. The level of change is greater in the field of computer education than in traditional subjects, and the conflict between the desire for structure and the need to remain flexible is more apparent. In a sense, the computer educator is aiming at a moving target when developing training programs.

It was difficult to judge exactly how well the districts in this study dealt with this contradiction. Those who were having the greatest success adopted an incremental approach. They implemented in-service courses in a particular subject area with as much structure as possible. At the same time, they remained alert to changes in the field and new applications of computers, so that additional courses could be developed in the future. In almost all cases the type and variety of in-service courses had grown slowly over the past few years, and changes were incorporated in this manner.

As a result of this basic conflict, computer educators would be wise to educate their audiences regarding the likelihood of changes. It would be a mistake to tell educational policy makers that actions taken now will be sufficient to meet the demands of educational computing in the future. It might be wiser to speak of "exploring" the applications of technology to education rather than portraying decisions as final directions for action. One trainer described the situation at his school after three years of training teachers: "We are still at the pilot stage. We try it out, see what works and what does not. Two years from now we will think about bringing it all together." Certainly, no one should develop computer-related plans -- be they implementation plans, acquisition plans, or use plans -- without building in explicit mechanisms for periodic review and revision.

Lack of Information

From the outset the researchers were surprised at the limited amount of information that existed concerning computer in-service training. Even the expert Advisory Committee lacked a broad view of the status of educational computing and teacher training nationwide. In fact, coordinators in the model districts indicated their own interest in finding out what others were doing because they had no clear impressions of what was being done elsewhere. There does not appear to be any accurate information about the preparation of the nation's teachers to use technology in education.

The nationwide surveys conducted at John Hopkins University (Center for the Study of Schools, 1983) funded by the National Science Foundation provided basic information about the number of computers that were available and how they were being used. However, they did not examine the preparation of teachers. It is important that policy-makers have better information about the way new teachers are being prepared and existing teachers are being trained. As a result, it is strongly recommended that indicators of the state of teachers' preparation to use technology be developed.

Beyond that, it is important to learn more about the impact of technology on the learning process. These districts were identified on the basis of secondary criteria, such as judgments of participating teachers. Ultimately, computer education will be judged by the degree to which it enhances the educational experience of students. More needs to be done to investigate the classroom impact of technology, and how computer in-services change student learning. Teacher training is a critical component in this process, and it too, has to be judged in light of changes in student accomplishments.

Computer In-service Training in Mathematics and Science

The National Science Foundation is particularly interested in the preparation of teachers in the fields of mathematics and science. This includes activities that are being undertaken to train current teachers to use computers. Unfortunately, there was little evidence of specific in-service courses directed toward this particular group of teachers. Beyond the introductory courses, applicable to all teachers, and LOGO workshops designed primarily for elementary and middle school teachers, there were almost no formal district workshops that focused on the use of computers in the mathematics or science curriculum.

This is not to suggest that no training was available for this audience. There were short-term, informal sessions conducted within mathematics and science departments. However, these were not institutionalized and replicated in the way that the regularly-scheduled courses were.

A number of points should be made by way of explanation. First, there are fewer secondary mathematics and science teachers than there are elementary teachers and teachers in language arts and the humanities. As a result, there is relatively less demand for computer in-service courses that focus on secondary mathematics and science. In fact, in smaller districts there may be so few chemistry, physics, or trigonometry teachers that it is difficult to justify a regular in-service course. Second, a greater proportion of science and mathematics teachers already have basic computer skills. Third, it is more difficult to find teachers who can act as instructors, because only staff from these disciplines have enough knowledge of the subject matter to prepare appropriate lessons. Fourth, until recently there was only limited software that was relevant to mathematics and science instruction. For all of these reasons, the number of regular computer in-service classes geared toward the needs of mathematics and science teachers was quite small.

Nevertheless, there is every reason to believe that technology holds promise as an instructional tool in mathematics and science as well as in other fields. Mathematics and science teachers could benefit from focused training that addressed their curriculum needs and helped them become familiar with new computer applications. One district indicated that they were going to focus their attention during the following year on the use of spreadsheets and data base software as tools in mathematics and science. This may prove to be one effective way to utilize computers in these disciplines.

The crux of the problem is that there may not be sufficient demand or expertise within individual school districts to address the technology in math and science. Instead, an organization with regional or national scope may be needed to develop and present computer in-service workshops directed toward these specialized audiences. If this speculation can be confirmed through a more comprehensive study, then the National Science Foundation should consider the efficacy of sponsoring the development of such training materials and the provision of regional training workshops. The mathematics and science professional societies are an obvious source of expertise for the development of such workshops.

In summary, this study identified a number of factors that were related to the effectiveness of computer in-service training programs in the schools. Districts should be encouraged to use this information to improve their own efforts in this area. Because of the relatively small number of mathematics and science teachers and the specialized content of these disciplines, districts may not be in the best position to address the in-service needs of teachers of mathematics and science. The National Science Foundation should consider promoting activities to address this problem. Finally, this study pointed out a serious lack of information regarding computer in-service training. Indicators of the state of preparation of the nation's teacher to use technology should be developed.

Table 1

Selected School Districts

District	Enrollment
Alief ISD, Texas	24,000
Anoka-Hennepin ISD, Minnesota	31,000
Boston PS, Massachusetts	60,000
District of Columbia PS	88,000
Jefferson County PS, Kentucky	93.000
Los Alamitos USD, California	6,00
Montgomery County PS, Maryland	93,000
New Haven USD, California	10,000

Figure 1

Conceptual Model

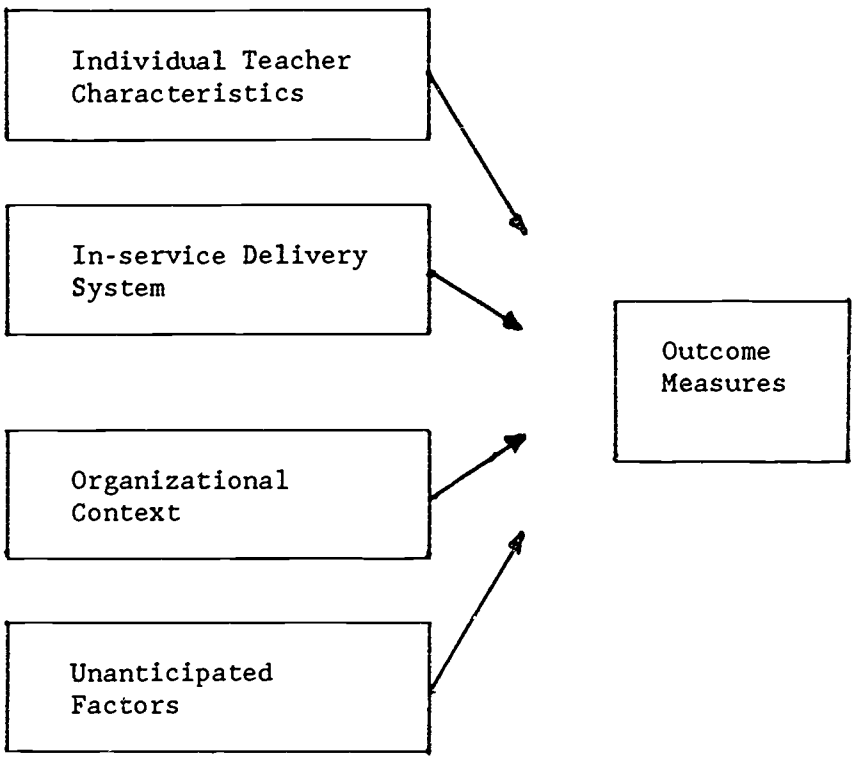


Table 2

Potentially Significant Variables

Individual Teacher Characteristics:
- Prior Knowledge and Experience with Computers
- Expectations Regarding Computer In-service
- Objectives for Computer Use
- Teaching Experience
- Staff Development Experience

In-service Delivery System:
- Planning and Development
- In-service Content
- Delivery Methods
- Training Personnel
- Follow-Up Activities

Organizational Context:
- Previous In-service Activities
- Staff Development Organization
- District Goals for Computer Use
- District Commitment to Technology
- Administrative Structure

Unanticipated Factors

Outcome Measures:
- Teacher Knowledge and Skills
- Teacher Attitudes Toward Computers
- Instructional Changes
- Student Knowledge and Skills
- Curricular Changes

Table 3

"Major Emphasis" of Computer-Related Educational Activities in Eight Districts 1985-86

	Elementary	Junior	Senior
District 1:	Word Processing, LOGO, CAI		CS
District 2:	LOGO, CAI	LOGO, Word Processing	Exploration, CS
District 3:	Local Exploration	Curriculum Applications, (CAI, Word Processing, Data Bases), CS	Curriculum App. (CAI, Word Processing, Data Bases), CS
District 4:	LOGO	Computer Literacy	Teacher Productivity Tools, CS
District 5:	Word Processing, Problem Solving, CAI	Word Processing, Problem Solving, CAI	Word Processing, Problem Solving, CAI, CS
District 6:	Local Exploration	Local Exploration	Local Exploration CS
District 7:	Word Processing, LOGO, CAI	Word Processing, LOGO, CAI	Curriculum App. (Word Processing, Data Bases, CAI, Graphics), CS
District 8:	CMI, Exploration, Computer Literacy For Staff	CMI, Exploration, Computer Literacy For Staff	Exploration, Computer Literacy For Staff, CS

"Exploration" denotes a variety of computer-related activities including word processing and CAI, based upon individual school and teacher interest and initiative.

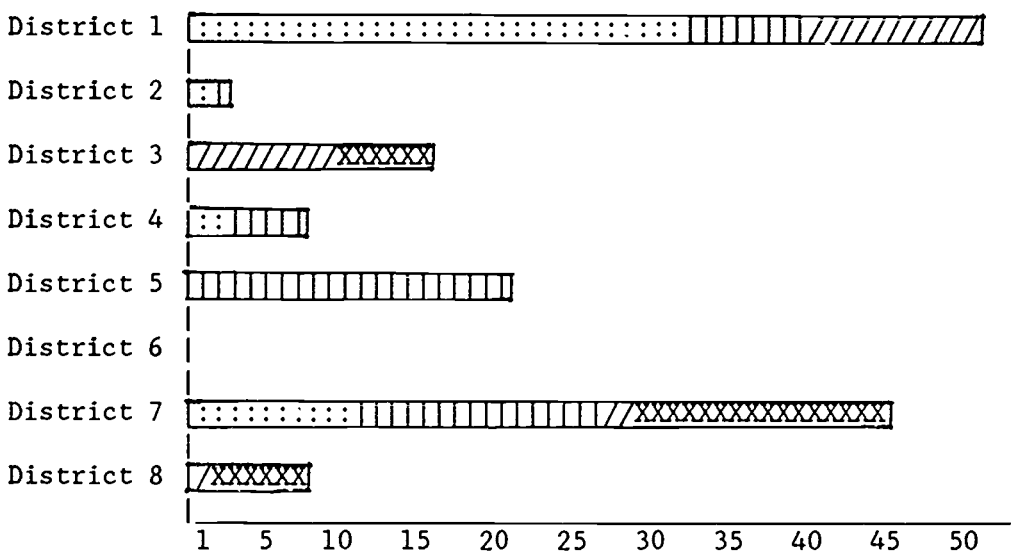
CAI -- Computer-Assisted Instruction (Tutorial Software)

CMI -- Computer-Managed Instruction (Systematic Assessment & Prescription)

CS -- Computer Science (Programming)

Table 4

Number and Duration of
Regularly-Scheduled Computer In-service
Courses in Eight Districts
1985-86



Key:

0-3 hrs 4-10 hrs 12-15 hrs 30-50 hrs

This table does not include informally-scheduled workshops or workshops scheduled at schools request. This approach was used in District 6

Table 5

Computer In-service Requirement
in Eight Districts, 1986

	Required Training	Duration
District 1:	All staff at "project" schools.	60 hours (core of 5 teachers)
	LOGO, Word Processing, Tutorials	24 hours (others)
District 2:	Staff assigned to teach LOGO (3-8)	9 hours
District 3:	None	
District 4:	None	
District 5:	None (Encouraged in "project" schools.)	18 hours
District 6:	None	
District 7:	None	
District 8:	All teachers and administrators Computer Literacy	50 hours

Table 6

Computer In-service Courses
Offered by One Exemplary
District
Spring, 1986

Title (Target Grade Levels)	Classroom Hours	Number of Sections
Introduction to the Apple for Secondary Teachers	30	4
Computer Literacy for Teachers,7-12	45	1
BASIC Programming for Teachers,7-12	45	1
Introduction for the Apple for K6 Teachers, Part 1	15	3
Introduction for the Apple for K-6 Teachers, Part 2	15	1
Using Logo in the Classroom (3-6)	15	1
Using Word Processing in the Classroom (K-6)	15	2
Using Data Base in the Classroom (4 6)	15	1
Word Processing - Applewriter	15	1
Graphics (7-12)	15	1
Data Files (9-12)	15	1
Using Word Processing to Support the Writing Curriculum (7-12)	30	3
Appleworks: An Introduction to Integrated Software (9-12)	30	4
Implementing Data Base and Filing Systems in the Classroom (9-12)	30	1
Using Data Bases to Support the Social Studies Curriculum	15	1

Table 7

Effective Computer In-Service Practices

Extensive Practice with Computers
Comfortable and Relaxed Atmosphere
Appropriate Balance Between Lecture and Guided Practice
Individualized Attention
Knowledgeable Trainers
Detailed Curriculum Guides and Lesson Plans
Clear and Relevant Objectives
Lesson-Related Materials and Handouts
In-service Lessons Linked to Instruction
Peer Interaction
Voluntary Participation
Strategies for Teaching Heterogeneous Classes

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Staff Development Administrator Focused Interview (SDI)

Site:_____ _____ Date: _____

Administrator: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results... (Note Age, Sex.)
Experience	Tell me about your own background and education:
Teaching	How long have you been involved in education?
Computers	What have you done with computers?

Organizational Context

District's staff development model	What is the district's approach to staff development?
Computer inservice model	What is the approach to computer inservice? If different, how?, why?
Communication/ Coordination	How do you coordinate staff development activities within the district?
Computer coordination	How are computer inservices coordinated?

Development

History	Can you tell me a bit about the history of the computer program? Who? What issues? Funding?
Administrator's role	What is your role vis-a-vis computers?

Inservice Features

Positive features (examples?)	What are the elements that make the staff development program work best for the teachers? Are these present in computer inservices?
Limitations	Are there things that make staff development difficult for teachers? Are these problems for computer inservices too?

Outcomes

Success	Do you feel the computer inservice program has been a sucess? Why or why not?
Changes	What would you like to make?

Computer Administrator Focused Interview (CAI)

Site: _____ Date: _____

Administrator: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results...
	(Note Age, Sex.)
Experience	Tell me about your own background and education:
Teaching	How long have you been involved in education?
Computers	What have you done with computers?

Attitudes, Expectations

Administrators feelings re: computers in education	Why do you think teachers should learn to use computers?
Districts' reasons	Does the district share your feelings?

Inservice Features

Positive features (examples?)	What are the elements that make the inservice work best for the teachers?
Limitations	Are there things that make it difficult for teachers?
Follow Up	Do you do follow up activities? What?

Development

History	Tell me a bit about the history of the computer inservice program. Who? What issues? Funding?
Administrator's role	What was your role in all ' is?

Organizational Context

Communication/ Coordination	How do you coordinate these activities within the district?
District support	How much support do you receive from the district? In what ways?
Principal's role	Are school principal's involved? In what ways?

Outcomes

Success	Do you feel the program has been a success? Why or why not?
Teachers	What changes have your seen in teachers? The way they teach? Their feelings? ...
Changes	What changes have you made? What would you like to make? Will you make them?
Surprises	What have you seen that you would not have predicted?

School Coordinator Focussed Interview (SC1)

Site: _____ Date: _____

Trainer: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results...
	(Note Age, Sex.)
Experience	Tell me about your own background and education:
Teaching	How long have you been teaching?
Computers	What have you done with computers?
Duties	Explain what your duties are?
Training	Have you done much inservice training?

Attitudes, Expectations

Coordinators feelings about computers in education	Why do you think teachers should learn to use computers?
Districts' reasons	Does the district share your feelings?

Inservice Features

Positive features (examples?)	What are the elements that make the the inservice work best for the teachers?
Limits.	Are there things that make it difficult for teachers?
Follow Up	Do you do follow up activities? What?
District Support	Is the district supportive? In what ways?
Curriculum	How does the training relate to the curriculum?

Organizational Context

Communication/ Coordination	How do you coordinate your activities with trainers, etc.?
Principal's role	Is the principal involved? In what ways?

Outcomes

Teachers	What changes have your seen in teachers? The way they teach? Their feelings? ...
Students	What changes have you seen in students? Examples?
Duties as planned	Have you been able to do things the way they were planned? Why or why not?
Changes	What changes have you made? What would you like to make? Will you make them?
Surprises	What have you seen that you would not have predicted?

Trainer Focussed Interview (TFI)

Site: _____ Date: _____

Trainer: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results...
	(Note Age, Sex.)
Experience	Tell me about your own background and education:
Teaching	How long have you been teaching?
Computers	What have you done with computers?
Training	How long have you been doing training?

Attitudes, Expectations

Teachers needs re: computers	What do you think teachers should learn to do with computers? Why?
District's purposes	Does the district share your beliefs?
Course goals	What are the goals of this course?

Inservice Features

Content	What are the subjects of the inservices you teach?
Positive features (examples?)	What are the elements that make the inservice work best for the teachers?
Negative features	What are the elements, if any, that limit the effectiveness of the inservice?
Follow-Up	Do you do follow-up activities? What?
District support	Is the district supportive? In what ways?

Organizational Context

Communication/ Coordination	How do you coordinate these activities within the district?
Principal's role	Are school principals involved? In what ways?

Outcomes

Program plans	Have you been able to do things the way they were planned? Why or why not?
Teachers	What changes have your seen in teachers? The way they teach? Their feelings? ...
Changes	What changes have you made? What would you like to make? Will you make them?
Surprises	What have you seen that you would not have predicted?

Participating Teacher Focused Interview (PTI)

Site: _____ Date: _____

Trainer: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results...
Experience	Tell me about your own background and education:
Teaching	How long have you been teaching?
Computers	What is your experience with computers? Your feelings about them?

Attitudes and Expectations

Stage of Concern	How would you describe yourself as a computer-educator: novice, average, expert?
Reason for inservice	Why did you sign up for the inservice? What help do you need? Was it voluntary?
Anticipated outcomes	What do you hope to learn? What do you hope to be able to do? Be specific.
Effect on students	What do you think this will do for students? How will they respond? What will they learn?
Computers in education	How do you think computers should be used in education?

Inservice Features

Positive features	What are the elements that make the inservice work best for you? Examples?
Limitations	Are there things that limit its success?

(As a backup, show list of features and ask: Others say these features are most important, what would you add or delete? Does your inservice have these?)

Planning	Did you have any input into planning the inservice or into future inservices?

Outcomes

Meeting needs	Is the class satisfying your needs? How so?
Impact on teaching	Have your changed what you do in class? In what ways?
Students	Have you seen changes in your students? (slow kids learning faster, shy kids coming out of their shells, more attention in class, more written work, etc.?)

Graduated Teacher Focused Interview (GTI)

Site: _____ Date: _____

Trainer: _____ Researcher: _____

Introduction	Introduce yourself and the topics: experience, feelings, features, results...
	(Note Age, Sex.)
Experience	Tell me about your own background and education:
Teaching	How long have you been teaching?
Computers	What is your experience with computers?

Attitudes and Expectations

Computers in education	What do you think we should be doing with computers in education?
Teaching	What would you like to be doing with computers in your own classroom?
Effect on students	What effect will this have on students? How will they respond? What will they learn?
Reason for inservice	Why did you sign up for the inservice? Was it voluntary?
Anticipated outcomes	What did you hope to learn? What did you hope to be able to do?

Inservice Features

Content	What was the subject of the inservice you completed?
Positive features	What were the elements that made the inservice work best for you? Examples?
Limitations	Were there things that limited its success?

(As a backup, show list of features and ask: Others say these features are most important, what would you add or delete? Did your inservice have these?)

Changes over time	Would your answers have been different just after you finished the inservice?
Planning	Did you have any input into planning the inservice or into future inservices?

Outcomes

Expectations	Did you learn what you hoped to learn? Why? Why not?
Knowledge and Skills	What did you learn? What facts and skills?
Teaching	Did it affect the way you teach? Either how you teach or what you teach?
Students	Have you seen changes in your students? (slow kids learning faster, shy kids coming out of their shell, more written work, more attention in class, etc?)
Plans	What do you plan to be doing with computers in the future?
Problems	What problems have you had that the inservice did not prepare you to solve?
Changes in inservice	How would you change the inservice?

Inservice Observational Guide

Site: _____ Date: _____

Trainer: _____ Researcher: _____

Content

1. If this was one lesson in a multi-lesson inservice, describe the goals of the full inservice, its content, the total number of hours involved, and the place of this lesson in the overall course.

2. Write an open-ended, narrative, descriptive account of what happened in class today. In particular, note the subject of the lesson, where held, the materials used, the frequency and type of trainer interactions with teachers, the degree to which hands-on experience was present, the "personableness" of the trainer (or other personality features), the level of creature comforts and amenities present, the type of interaction among teachers, etc.

3. How typical was today's lesson (Please ask several students and trainers about this. Ask, "on a scale of one to ten, with ten most typical, how typical was this lesson? Why wasn't it a ten?"

4. Was instruction geared more toward "low-level" computer competencies or more toward an integrated use of the computer within the curriculum? [4.8] (Also ask trainers about this.)

5. Did anything noteworthy (to you) stand out about the class today? If so, what was it, and would you guess that it is a significant factor in the success or failure fo the lesson? (If appropriate, you may wish to discuss this with trainers or teachers.)

Classroom Observational Guide
(Graduated Teachers)

Site: _____ Researcher: _____

Teacher: _____ Date: _____

Field researcher to observe and comment about the following topics only:

1. What was the topic of the lesson for the day?

2. What style of instruction did the teacher use?

3. Was the teacher making procedural, or conceptual mistakes regarding computers? (i.e. cannot recall how to boot up machines, using wrong commmands, etc. Has the teacher mastered the computer-related skills required for the lesson?)

4. Was the computer being used in a "meaningful" way? (i.e. was it integrated into curriculum, was the use "non-trivial")

5. Was the teacher mimicking the teaching models provided in the inservice training?

Field researcher also to ask (during the lesson or during an interview, as appropriate):

Where would you like to go from here?

How did the inservice change your thinking about teaching?

What kind of support do you need to make the inservice training more effective?

Schedule for Computer Inservice Visit

The primary purpose of our three-day visit is to observe inservice workshops and talk to coordinators, trainers and teachers who are involved in these activities.

Specifically, we would like to:

- Talk with the administrator/coordinator who is responsible for computer inservice activities [approximately one hour].

- Talk with the administrator/coordinator with overall responsibility for staff development, if this is a different person [approximately 30 minutes].

- Talk with 2 trainers who deliver inservice workshops [approximately one hour each].

- Observe inservice workshops [one session each day, if that is possible].

- Talk with a school computer coordinator, if this position exists [approximately 45 minutes].

- Talk with 2-3 teachers who are participating in one of the workshops that was observed [approximately 45 minutes each].

- Talk with 2-3 teachers who completed computer inservices in the past [approximately 45 minutes each].

- Observe 1-2 computer lessons in classrooms or computer laboratories [approximately 45 minutes each].

As time permits, we would also like to talk informally with one or two teachers who are active computers users or with other people who are knowledgeable about district computer inservice activities.

We would appreciate it if you could help us arrange these contacts. The staff member who will visit your district has no pre-set schedule for the three days, so these activities can be planned for any convenient time.

Thank you for your cooperation.

Brian Stecher
Ron Solorzano
Educational Testing Service