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ABSTRACT

A training program in computer educationtTested in 89 secondary schools focused on the use of computers as tools in all subject areas. Each school received enough computers and software from IBM to equip a full computer laboratory. The schools were organized into local networks in eight regions and received training and continuing support in these network groups. At least three teachers from each school participated in a month-long, intensive computer education program prior to the receipt of the computers. At the hub of each local network was a Teacher Training Institute (TTI) which provided training and on-going support during the project year. This report documents the TTI computer training programs and identifies critical features of the project that related to its success. The report includes a discussion of the methodology employed in the study, a description of the form and content of the computer education institutes, a narrative account of a "typical day" in one of the training programs, an evaluation of the program from participants' perspective, and an analysis of the kinds of personal and organizational characteristics that correlate with successful computer education activities. (JD)

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RESEARCH REPORT

TRAINING TEACHERS TO USE COMPUTERS: A CASE STUDY OF THE SUMMER TRAINING COMPONENT OF THE IBM/ETS SECONDARY SCHOOL COMPUTER EDUCATION PROGRAM

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Princeton, New Jersey
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TRAINING TEACHERS TO USE COMPUTERS:

A Case Study
Of The Summer Training Component
Of The
IBM/ETS Secondary School Computer Education Program

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Abstract

The IBM/ETS Secondary School Computer Education Program was initiated in the summer of 1983. Eighty-nine secondary schools in three states each received a donation of IBM personal computers and software valued at over $50,000. In addition to the hardware and software, teacher training was also provided. Each school sent representatives to an intensive, four-week, summer computer education workshop at a local teacher training institution.

ETS developed the model for the training program, focusing attention on the use of the computer as a multi-purpose tool across all subject fields. The trainers from each of the twelve computer education institutes elaborated on the ETS model in planning the summer workshop programs at each site.

A case study was undertaken to document the activities that took place during the computer institutes and to describe elements that contributed to the success of the program. The observations and analyses identified 23 variables that related to the effectiveness of the computer education program. These included contextual elements, programmatic features and personal characteristics. Specific factors are elaborated in the report.

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Introduction

In the winter of 1983, the International Business Machine Corporation (IBM) inaugurated an ambitious, $8 million computer education program for secondary schools. Eighty-nine schools in three states each received a donation of fifteen fully-equipped IBM Personal Computers and appropriate software. In addition, extensive inservice training and follow-up support services were provided for each school.

The model for this program was developed by Educational Testing Service (ETS) at the request of IBM. ETS was asked to organize the project and conduct all training and support activities. The project became known as the IBM/ETS Secondary School Computer Education Program.

The key features of the model designed by ETS were as follows:

. The program focused on the use of computers as tools in all subject areas, not just computer science or "computer literacy."

. Each school received enough computers and software to equip a full computer laboratory, a facility large enough to have a significant impact on the instructional process.

. Schools were organized into local networks in the eight regions identified by IBM, and they received training and continuing support in these network groups.

- At least three teachers from each secondary school participated in a month-long, intensive computer education program prior to the receipt of the computers.

- Regular network meetings were held throughout the school year to provide continuing inservice training and opportunities to share information and to promote the establishment of a support network that would be self-sustaining after the end of the project.

. At the hub of each local network was an institution of higher education or a training center (referred to in the project as a Teacher Training Institute or TTI) which provided training and on-going support during the project year. TTI's were selected on the basis of prior experience in the field of technology and education and a successful record of providing inservice training to teachers.

- Two experienced staff persons from each TTI coordinated the local program and delivered the

training and support activities with the assistance of the ETS staff.

- Each of the TTI trainers received two weeks of special instruction at ETS to introduce them to the IBM-PC and prepare them to conduct the local computer education activities.

Provision of extensive computer education was one of the elements that differentiated this project from other computer "give-away" programs. In fact, there were two training phases. In the first phase, two staff members from each TTI journeyed to ETS headquarters in Princeton for an intensive two-week training session. Working twelve to fourteen hours a day, the trainers were introduced to the IBM-PC's, the software that would be the focus of the program, and the computer training model they would be expected to follow when they returned to their local area.

In the second phase, the TTI's delivered instruction to 25-30 teachers from the secondary schools in their local network. Each TTI-centered network consisted of seven or eight high schools, and each high school was allowed to send between three and five teachers to the month-long summer computer education program at the TTI. This report focuses on the implementation of these four-week computer training institutes.

Purpose

This study was conceived as both a descriptive and an analytic project. The first goal was to document the TTI computer training programs and make the record available to other educators. The second goal was to identify critical features of the program that related to its effectiveness. This analysis would be used to formulate recommendations to improve the quality of computer education programs.

The case study approach seemed to be the most appropriate technique to use to accomplish these goals. An indepth study of a limited number of sites could provide a journalistic account of the events that transpired during the training. Such an investigation could depict hour-by-hour events, supplemented with direct quotations and comments from the participants, and thereby meet the expository goal of this research. In addition, such an analysis could provide insight into the elements that made the training effective. Therefore, a case study approach was adopted and resources were concentrated on a detailed view of two or three sites.

The following sections include a discussion of the methodology that was employed in the study, a description of the form and content of the computer education institutes, a

narrative account of a "typical" day in one of the training programs, an evaluation of the program from the participants' perspective, and and analysis of the kinds of personal and organizational characteristics that correlate with successful computer education activities.

Methodology

Research Model

This was an observational study that used qualitative data collection and analysis procedures. Unfortunately, there is no widely accepted taxonomy of qualitative techniques, and a number of labels are used somewhat carelessly by social science researchers. The research paradigm applied in this study falls into the class of techniques known as "participant observation," "field work," "naturalistic inquiry," or "case study research."

In such approaches the researcher attempts to understand the phenomena under study from the perspective of the participants. This is accomplished through detailed observations of naturally occurring behaviors and through open discussions with participants. The researcher compiles extensive field notes describing observed behaviors and preserving direct quotations. These data become the basis for analysis. Though it is more difficult to analyze qualitative data than quantitative data, there are valid procedures that can be used. One must undertake an impressionistic analysis. By extensively reviewing the record the researcher lets themes and commonalities emerge that reflect upon the activities from the viewpoint of the people who were directly involved.

The strength of the qualitative approach is that it does not force preconceived experimenter ideas and categorizations onto a situation where they are inappropriate. The limitation of naturalistic research is that it is easy for the novice to allow biases and preconceived ideas to affect the observations and analyses that are made. Consequently, one must apply this approach with care.

The reader who is interested in a more thorough description of the use of qualitative strategies in educational research is directed to Bogdan & Taylor (1975), Patton (1980), and Van Maanen (1983).

Sample Selection

The goals of this study were to document the training component of the computer education model developed by ETS and to gain an understanding of the relative effectiveness of various activities that were incorporated into that model. Consequently, an in-depth investigation of a small number of sites was undertaken rather than a cursory study of all twelve TTI summer institutes.

Most of the attention was focused on on a single site, a TTI whose trainers had shown a high level of enthusiasm during their own training period. This site is referred to as TTI #1. In order to be able to make some comparative analyses and determine the extent to which the events at the study TTI reflect events at all participating schools, observations were also made at two other sites. These sites were chosen solely on the basis of geographic proximity to the initial site. They are referred to in this report as TTI #2 and TTI #3.

Data Collection

Four sources of data were used in this study: observations, semi-structured interviews, written documents, and informal conversations. The major source of information was six days of participant observation at TTI #1, TTI #2, and TTI #3 conducted during the final two weeks of the four-week summer computer education institute. These data were supplemented with three and one-half hours of interviews with the trainers at the three TTI's during the weeks following the summer workshops.

The third information source used in the study was an extensive collection of documents which came primarily from TTI #1 and included: daily journals from each participant, collections of lesson plans developed by each subject-matter special interest group, participants' reviews of articles from professional journals, and participant's written evaluations of the institute. The final source of information was a number of informal conversations with participating teachers that took place before and after each daily workshop and during the weeks following the conclusion of the training program.

Data Analysis

In the objective, "journalistic" component of this study information was presented without drawing conclusions or making judgements. Events were recorded as they occurred. direct quotations from the participants and word-for-word excerpts from their journals and other printed materials were used to recapitulate the activities that took place during the summer computer institute. Of course, some selectivity was exercised in the choice of events to report. However, care was taken to insure that multiple points of view were presented and that a representative cross section of activities was described.

Identifying relationships between activities and outcomes was a more complex task. One strives to achieve a participant-centered reduction and synthesis of the information rather than an observer-centered one. However, the nature of qualitative data (such as field observations, anecdotes, etc.) precludes the kinds of statistical analyses that are commonly used in educational research to reduce bias and insure objectivity. Consequently, an alternative analytic strategy must be used.

The most effective approach might best be described as "immersion;" the researcher conducts an extensive review of the record and allows the themes and categorizations to emerge from the data. Though this sounds somewhat magical, it is not. There are carefully structured and measured procedures that can be used to reduce threats to the validity of qualitative research conclusions, including multiple observers, review of supporting documentation and artifacts, etc. For example, one compares impressions gained from one source against other sources (triangulation) to insure that any tentative conclusions are an accurate reflection of the phenomena under investigation. When applied with care, such methods can yield a reliable summary of events and provide a valid reflection of the subjects' perspective.

In this case an extensive review of field observations and documents was undertaken to allow patterns and themes to emerge from the data. The field notes that were taken during the study were written up and reviewed. All the documents were reread as well, and reoccurring themes and impressions were noted. Patterns that emerge from the data were cross-checked against other sources, and correspondences and exceptions were noted.

One important advantage in this study was the extensive amount of written documentation that existed. The teachers at TTI #1 were required to keep daily journals in which they recorded their own impressions and reactions to the

training. Copies of these journal entries served as a continuing reality check during the analytic phase of the study, and they offered invaluable evidence of the attitudes and feelings of the participants.

Description

The case study yielded a vivid description of the program in action: what took place, how it was organized, how the particpants behaved, etc. However, it was difficult to capture both the organization of the program and its "spirit" in a single discussion. Therefore, these two topics will be separated. First, there will be a description of the project in more objective terms -- daily schedules, educational goals, guest speakers, etc. Then a narrative report of a "typical day" at the summer computer institute that tries to capture the feelings of the participants will be presented.

The data base also included extensive evaluative information about the project. All of the participants had multiple opportunities to share their assessment of the program. Thus another "result" of the study was an evaluation of the project from the participants' perspective. This section will conclude with a discussion of those evaluative judgements.

Program Features

The main components of any educational project include facilities, teachers, students, educational goals, and instructional activities and methods. Each of these components was important in the summer computer training segment of the IBM/ETS Computer Education Program.

Facilities. In general, each TTI made one large classroom/laboratory available for the computer-based activities and a number of alternative meeting sites for other functions. At TTI #1 a large irregularly shaped room was designated as the computer laboratory. The room was located in a new, modern building with wide hallways and high ceilings. It had large windows running the full length of two walls, which provided a pleasant view as well as a reasonable amount of indirect light. Recessed florescent ceiling lights were the other source of illumination.

The room was equipped with sufficient electrical outlets, desks and chairs to accomodate 21 computers and students. All the furnishings were new, and the chairs (in which participants would spend a great deal of time) were comfortable padded armchairs that swivelled and reclined.

The tables were organized in three double rows with computers placed back-to-back down the center. In this way, participants faced some colleagues directly across the desks and sat side by side with others.

Bookshelves for storing software and other materials ran the length of one wall. White, "liquid marker" writing surfaces covered the other two walls. These were used for lessons and notes when the class met in the laboratory.

Participants in the summer institute at TTI #1 also had access to three additional classrooms for group meetings. One was large enough to hold the whole group and one or two computers for demonstration purposes. The others were used for smaller sessions. All were equipped with new, modern furnishings and had the same clean, elegance of the computer laboratory.

Because this was a computer education program, the "facilities" included more than just classrooms and associated learning spaces. The project also required computer hardware and software. The laboratory was equipped with 28 IBM Personal Computers. Each had 128K bytes of RAM, 2 single-sided disk drives and color monitors. To conserve space, not all stations at TTI #1 were equipped with printers, but there were a sufficient number of IBM dot matrix printers for everyone to have access when necessary.

Extensive software was also available. During the four weeks of the summer institute each participant worked with the following software:

Introductory: The Instructor, Typing Tutor, Computer Discovery, and ATI tutorials.

Operating Systems and Languages: IBM PC-DOS 2.0, BASIC, LOGO, Karel the Robot, and Private Tutor.

General Applications: Easywriter, Pfs:file, Visicalc, Pfs:graph, Pfs:report, and Smartcom II.

Educational Games and Simulations: Free Enterprise, The Question, Snooper Troops I & II, Delta Drawing, and SRA software packages.

Trainers. The two trainers who directed the activities at TTI #1 were extremely well qualified. They were faculty members at an institution that stressed teaching as much as research and had a long history of providing inservice training to teachers. More importantly, the Education Department in which they worked was committed to promoting the use of microcomputers in education. Their regular teaching responsibilities focused in this area. One

specialized in administrative applications; the other was interested in the process of institutional change and the problems involved in introducing innovations into the schools.

Their teaching styles seemed equally well suited to the task at hand. Both used a great deal of humor; each was often the butt of the other's jokes. They also had a somewhat iconoclastic outlook toward educational institutions, which seemed to serve them well when working with teachers.

Participants. Each participating school selected four teachers to attend the summer computer institute. In keeping with the project's goal of promoting the use of computers in as many subjects as possible, schools were encouraged to select faculty from different disciplines. The 28 teachers who attended the summer institute at TTI #1 formed a reasonable cross-section of the staff at the seven schools. There were almost equal numbers of teachers from the sciences and the humanities. When special-interest groups (SIG's) were formed by subject area there were enough people to support groups in the following fields: Mathematics, Science, English, Computer Applications, and Business. The teachers ranged in age from 27 to 60 (the distribution appeared to be remarkably uniform across age).

Educational Goals. The program model developed by ETS stressed the use of the computer as a multipurpose tool, rather than merely a tutor (to deliver computer assisted instruction) or a tutee (to be programmed in a language such as BASIC, LOGO or PASCAL). Similarly, the project stressed the use of software that fulfilled general purposes, such as word processing, data base management, and spreadsheets, rather than software that delivered single instructional lessons. The trainers at TTI #1 incorporated these goals into their summer computer institute.

There were four major objectives: learning about the IBM-PC, mastering the various pieces of software, developing lesson plans for incorporating computers into classroom activities, and planning for implementation of a school-wide computer program. A simplified overview of the schedule at TTI #1 illustrates how the trainers incorporated these four objectives.

The instructional emphasis shifted during the four weeks as people gained facility and skill. The underlying organizational principle was that the teachers first had to be introduced to the new technology, then develop a certain facility with it, before they could begin to incorporate it into their educational planning and think about introducing it to others. In simplified form the schedule was as follows:

Week 1	Introduction to the Program Hardware: Getting to Know the IBM-PC Software: Word Processing
Week 2	Preparing Lesson Plans Hardware: DOS 2.0 Software: Data Base Management Systems
Week 3	Continued Lesson Preparation Software: Spreadsheets
Week 4	Developing School Plans Continued Lesson Preparation Software: Miscellaneous

In reality there was considerable overlap and integration of these topics. Moreover, while this capsule summary illustrates the overall plan of the computer education program, it does not do justice to the diversity of topics that were actually discussed during the four weeks. A partial list of other topics reflecting the program's secondary objectives included:

Installation of Hardware
PC-DOS
Maintenance
Security
Instructional Software, including SRA, MECC, etc.
Programming (LOGO, BASIC)
Philosophical and Ethical Issues in Educational Computing
Educational Change Theory
Equality of Access to Computers
Advanced Graphics, including CAD Systems
Telecommunications
Software Evaluation
Authoring Languages

Instructional Activities and Methods. The daily schedule below illustrates the types of activities and instructional approaches that confronted the participants each day. The schedule began at 9:30 a.m. and concluded at 4:00 p.m. A ten minute coffee break (fresh coffee was provided every day by TTI #1) and an hour lunch break were included.

The first half hour was devoted to a group meeting to review the previous day's activities, answer questions and go over the schedule for that day. The balance of the time was divided into four or five instructional periods, and a different activity was planned for each period.

As an example, this was the published schedule for Thursday of the third week.

9:30 - 10:40	Using the PC in the Secondary Classroom (Small group discussions in Special Interest Groups in lecture hall.)
10:40 - 10:50	Coffee
10:50 - 12:00	PC DOS (Guest lecturer from ETS, demonstration in the Computer Laboratory.)
12:00 - 1:00	Lunch
1:00 - 2:30	Software Evaluation Criteria (Guest speaker in the lecture hall.)
2:30 - 3:30	Karel the Robot (Demonstration, hands-on activity in Computer Laboratory.)
3:30 -4:30	Daily Diary & Journal Reviews (Individual work in the Computer Laboratory.)

Despite frequent changes in schedule, the basic structure of the day remained much as outlined here. The general length of the sessions and amount of variety was maintained. Wednesdays were an exception. Beginning in the second week, Wednesdays were set aside for individual learning and no group activities were scheduled. This allowed the teachers to catch up on their work and spend more time learning the software programs of greatest interest.

Despite the fullness of the "official" institute day, the teachers regularly spent extra time with the machines. The facilities were made available before and after the workshop in response to demands from the teachers. Some were waiting for the door to be opened at 8:00 a.m.; some stayed until the room was locked at 6:00 p.m.

The pedagogy utilized by the two trainers was as diverse as the subject matter. A number of different instructional methods were used to communicate the information outlined above. These included lectures, group demonstrations, hands-on work at the computer, discussions, small group meetings, and guest presentations.

The composition of the instructional groups was also varied during the four weeks. Sometimes the whole workshop met together; other times they worked as individuals. In addition, the teachers were given some assignments that forced them to work in school groups and others that called

for them to meet in special interest groups (SIGs) across schools. These changes encouraged the formation of communication networks within schools and between schools.

Equally important to the success of the project were the types of assignments that were given. Creative exercises were designed to reinforce the new skills teachers were learning. The first major assignments consisted of a daily diary (which was to be recorded using the word processing program). Next, each teacher had to prepare a collection of journal abstracts (using a data-base management program). Finally, each SIG was required to compile a set of 10 computer-based lesson plans, using the software of their choice for storing the information. These activities gave the participants practice using the software and provided practical models of ways to use computers in instruction and planning.

A Typical Day

The four-week training program at TTI #1 appeared to be a very engaging experience for the participants; they arrived early and stayed late. They showed high levels of enthusiasm for the activities in which they were engaged, and there was a great deal of animation in the classroom throughout the day. In an attempt to caputure the spirit of the training program, we will describe a "typical" day at TTI #1. The activities and conversations described in the following section actually occurred, and all quotes are authentic. However, the "day" is a composite of observations that were made on more than one occasion.

Tuesday, July 27, 1983
(The fourth week of the Summer Computer Institute)

People start arriving at 8:00 a.m., though the day's activities do not get underway officially until 9:30 a.m. One might expect to observe a lot of fatigue at this point in the training, yet none is apparent. People are busy, cheerful, and intent on their work.

Dimitri unlocks the door to the computer laboratory at 8:05 a.m., and five people who are already waiting file inside and begin to work on a number of different projects.

> Jack is developing a lesson on the periodic chart of the elements using the software package called "Question."
>
> Martin is distributing copies of an application to join the "Computer Using Educators" group. He is describing the group to those who are present and

leaving copies of the form on the desks of those who have not yet arrived.

Karen is writing a program in BASIC to demonstrate a Monte Carlo technique for estimating the irrational number pi. At the moment she is having some trouble getting the random number generating function on the IBM-PC to behave in the way she wants it to.

Mary Ann and David are discussing a newspaper article one of them has brought in concerning the problem of increasing the number of math and science teachers in high school. "Adding one course in science or mathematics at each American high school would require 40,000 new teachers," David explains, "Where are all of those people going to come from?"

As new people enter the room they are greeted by their colleagues who are already there. The greetings are usually warm and light-hearted. Robert comes in at about 8:30 a.m. and is surprised to find Howard already there. "Good grief, Howard," he says, "did you stay all night?" "Look under the benches," Howard replies without looking up from his keyboard, "and you'll see where I rolled over."

By 9:15 a.m. most of the group have arrived. The two activities that are receiving the greatest attention are daily diaries and lesson plans. Each participant is required to write a daily diary using Easywriter. The diaries are free-form, and most entries are chatty.

"Well, things are looking good - the administration is very positive about our plans - it looks like they would like to move quickly.....If I can keep up with this and all my class preparation, I should make it through the year."

"Beginning with a demonstration of a CAD system, continuing with a backup of "Question," and concluding with a demonstration of DELTA GRAPHICS, today was interesting, fast-paced and informative. In addition I practiced my typing with typing tutor."

"I spent much of yesterday working on my "question" presentation. I believe I worked out all the bugs. This morning I presented it. All went fairly smoothly... This could be a great one for students to make. By actually inputing their own questions and answers they will be learning..... I went to Pedro's Tacos for lunch but my tip for the day is to get a pastrami sandwich at Betsy's right next door."

Other people are working on lesson plans incorporating the computer in their particular subject area. Five special

interest groups (SIG's) have been formed in the fields of English, Mathematics, Science, Business and Computer Literacy. Each group was assigned the task of preparing 10 computer-based lesson plans in their subject area. Copies of each set of lesson plans will be made available to all seven schools. Since this is the last week of the training institute, a lot of attention is being given to completing the lesson plans. One SIG group is meeting in the small classroom to review their plans and decide if revisions are necessary. In the computer laboratory Anne Marie is using Pfs:file to store a lesson plan on biorhythms.

By 9:30 a.m. there is activity in the computer room, the workroom, and the coffee room. Edith and Alan are talking about the difficult task of transferring their knowledge to the rest of the teachers back at their school.

"So far we've been overlooking staff development. Teachers are hard to change, and the change agency element has been underdone."

Though they have the support of their principal, they both agree this is not enough to ensure that the innovative ideas will catch on.

"What we need is support from the other teachers," Edith says.

"Teachers are fragile," she continues, "and they are not used to having their authority challenged. They'll need time away from the students until they become comfortable with the PC's, and they'll need time and assistance."

Just then the lights in the room flash and someone in the doorway shouts, "Shut it down." People seem to recognize the signal and begin to gather in the classroom next door to start the day's activities. Gradually over the next few minutes, all 28 people migrate to the classroomm.

The printed schedule for today is as follows:

9:30-10:00	Morning Meeting (Room 202)
10:00-11:00	SIG Lesson Plans (Rooms 202, 212, and Computer Lab)
11:00-12:00	Preparing School Implementation Plans (Rooms 202, 212, and Computer Lab)
12:00-1:00	Lunch
1:00-2:30	Private Tutor Demonstration (Room 202)

2:30-3:30 Presentation of School Plans
(Room 202)

3:30-4:00 Daily Journals/Diaries

Art Kneper and Rudy Wallace, the two trainers at TTI #1 are involved in three or four animated conversations. For the first couple of minutes there is a lot of general talk and kidding around. Then Art calls the meeting to order.

The first order of business is to revise the schedule for the day. The afternoon demonstration of Private Tutor (an authoring system) will be postponed until Thursday because the guest speaker had a last minute change of plans. Instead, Irving Brownlee from Computer People is here to demonstrate a new word processor called PFS:write. Brownlee's presentation will have to take place in the morning because he has to catch a plane immediately after lunch. A few other switches are made to make more time for schools to work on their implementation plans. The revised schedule is a follows:

10:00-11:00 SIG's groups

11:00-12:00 Pfs:write

1:00-2:30 Prepare School Implemenation Plans

2:30-3:30 Present School Plans

3:30-4:00 Daily Journals/Diaries

The next few minutes are devoted to announcements from the floor. This includes some joking and some useful sharing of information.

Then Karen announces that it is time for her "Tip of the Day." This is one of the rituals that seems to have evolved over the past three weeks. Standing and approaching the front of the room with mock solemnity, she announces that today's tip is of special interest to religious institutions (two of the seven schools in this network are religious schools).

"This is less hedonistic than my usual tips," Karen announces.

"Amen," from someone in the crowd.

"In the beginning, as we all know, there was the word." (Grumbling can be heard in parts of the room.) "Then there was the word processor."

A few "boos," are heard.

"Now, there is the 'THE WORD' word processor," Karen continues undaunted.

She holds up a newspaper clipping that advertises a piece of software, called "THE WORD". It is an automated concordance that allows the user to identify a particular biblical passage. By now people are laughing and passing the clipping around.

Karen tries to explain how the software works. "You move the cursor to make a selection..."

But Stephan from St. Dominic High School shouts out, "No cursing."

Everybody laughs uproariously, and Karen returns to her seat.

This is the last announcement from the group, so Rudy makes some final remarks about lesson plans and adjourns the meeting. The group disintegrates into a jumble of activities. Over the noise and movement snatches of conversations can be heard:

"I have the MECC Teacher Utility #1. Who wants it next?"

"Shall we meet in the coffee room or in 135?"

"You know the English group is using PFS:file instead of Easywriter."

The mathematics SIG moves to Room 212 to discuss their lesson plans. Eloise is using the Question program to build a review of geometric concepts. Arthur describes a lesson based on an article from an old issue of the Arithmetic Teacher. After Arthur finishes describing his lesson, John asks, "What do you think of using Easywriter to prepare a sheet for writing geometric proofs?" "I don't understand what you mean," Estelle counters, and an interesting discussion ensues. Some people seem to be having a difficult time trying to find elements in their mathematics curriculum that utilize the general application software the teachers have been learning. It is a challenge to think of ways to use the word processing or filing capabilities of the computer in mathematics. "If someone were interested in the history of mathematics or in biographies of mathematicians, they could use Easywriter to compose and edit the reports." While everyone agrees that this is true, no one is teaching the history of mathematics or mathematicians in any of their classes, so the idea is dropped.

At 10:45 Art and Rudy call the whole group back together to get progress reports from each of SIG's and discuss an important item that was inadvertently left off the morning agenda - tomorrow's meeting with the school principals. Wednesday will be the second official visit by the principals from the seven schools, and Art and Rudy want to get ideas from the teachers about topics that should be addressed. They want the principals to see what the teachers have accomplished and to understand the implementation plans they have developed. Tomorrow's visit will provide an opportunity to bring the collective weight of the group to bear on the principals, to persuade them to implement the program according to the teacher's design. "We are going to lobby your principals actively," Rudy says. "I am going to tell them, 'your people are going to be trying to convince you, and I want you to listen to what they have to say.'"

Art solicits ideas for the next day's activities. "We'd like to take suggestions for tomorrow's schedule." There are a lot of responses, both well-intentioned and humorous. There seems to be a comfortable tension between the instructors and their administrators. The teachers know what they want and and they also appear to be aware of the elements in their plan that will be the most difficult to implement. They ask for Art and Rudy to use their persuasive powers to convince principals of a number of things:

"Release time. We need to be able to come back to the monthly group meetings."

"Tell them that they have to provide funds for more software. They are going to think that we've got everything we need."

"Yes, I need a PC at home," Melinda interjects. "I need one too," Art shouts back. "What else?"

They continue in this vein for about five minutes until at least six points have been put up on the board for the next day's discussions with the principals.

(Later Rudy and Art will explain that they plan to focus more attention on the principals once the school year starts. There has not been time to involve them very deeply in the educational or the social aspects of the institute this summer. "During the fall we want to get the principals in for some hard hitting, intensive discussions, and then go out to dinner and have a good time," Rudy will say, "I'm convinced that the social aspect is as critical here as it is with the teachers.")

Next, Art introduces Irving Brownlee, who is here to demonstrate PFS:write. A computer with a large monitor has been set up in the classroom for the demonstration. Mr. Brownlee is very enthusiastic about the features of PFS:write, and the software appears to be very well received by the teachers. It seems to be easy to edit a document, move text around, etc. "How do you underline?" someone asks. "It's easy," Irving demonstrates the procedure. One of the diaries for Tuesday contains this entry:

> The BIG item of the day was Irving Brownlee ... his demonstration of PFS:write was quite the best news of the month. Our two biggest difficulties with Easywriter, underlining and moving blocks of copy are a cinch to execute with PFS:write. Now the big question: Since we will have Easywriter at school in the fall, do we start teaching it or hold off and start with PFS:write?

The demonstration lasts about an hour, until 11:45 a.m. At this point the group meeting breaks up and people return to the laboratory to work on different projects until lunch time. Carol plays with a reasoning game called Snooper Trooper, and Milton boots up an economic simulation called Free Enterprise. Some people continue to work on their their lesson plans.

There is no official signal, but at approximately noon people begin to band together for lunch. They go off in groups, but not just with staff from the same school. At first, Rudy reports, they stayed with their school colleagues, but these barriers broke down fairly quickly. "The SIG's got people working with each other. Now they seem to identify as schools and as SIG's and as a whole group."

After lunch we reconvene in the classroom and Art puts up the tentative agenda for Wednesday.

9:30	- 10:30	Software demonstration.
10:30	- 12:30	Implementation Plans.
12:00	- 1:00	Take your principal to lunch.
1:00	- 2:00	Principal's meeting.

"Remember," Art says as he writes, "principals must experience the software themselves. This is not just a demonstation of you using a computer. Go over your implementation plans. Show them how much you've thought this through and what it will take. Then have lunch with them."

"Then when you get back," Rudy adds, "Art and I will tell them the truth."

As Art is writing on the board, Rudy realizes they will need extra places for the schools to meet with their principals. He whispers to Art "We'll need space for all the groups to talk." Art picks up on this and announces, "We'll open extra rooms on this floor for all of you to meet with your principals." Then he makes a note to be sure to check that the facilities are made available. (Art and Rudy seem to be good at thinking on their feet and handling the logistical problems of working with groups of people.)

Next, there is a big commotion as Mary Ann and Helen return from lunch ten minutes late. Apparently this has occurred before, because it is cause for humorous rebukes from Art, Rudy and the teachers. In a familiar gesture of punishment, Rudy writes the names on the board. Helen protests, and Rudy calmly puts a check mark by her name signifying extra punishment. A second check mark for some additional minor offense causes a great deal of laughter in the group.

This light-heartedness is followed by some serious discussion, as the group quickly gets back "on task." Rudy reminds them, "Everyone who isn't going with the IBM maintenance agreement must write a letter to Kramer (the college V.P.) saying what maintenance agreement they have."

Next, Art and Rudy turn the meeting over to Henry, a teacher who spent 20 years in marketing. They asked Henry to talk to the group about the implementation plan his school has developed. He discusses a number of schemes to introduce other staff members to the IBM-PC and help them learn to use computers. For example, he and his colleagues have collected articles and prepared information sheets describing computer use in various subject areas. These will be sent to teachers in each department to peak their curiosity about the PC's. Then the school will schedule brown-bag lunches for small groups of teachers who respond to these initial handouts and fliers.

Henry offers a number of other ideas for generating excitement and interest among the staff. He reminds people that they should try to get reporters from the local newspapers out to the school. "In fact," he says, "your local paper should be here for the summer computer institute. Everyone of your communities has some small newspaper that's dying for news. If they knew that the students at X high school were having an opportunity to work with IBM personal computers they would be out at your school taking pictures and publicising it. You have to take advantage of these opportunities."

His approach to staff development sounds a lot like a well organized marketing plan. "You've got to expect some resistance, and think of ways to counter the negatives that will come up. Remember, this is going to be a gradual process and you need to take a long-term view. But never let them forget you are there!"

Henry's high energy presentation is a good inspiration for the other school groups. When he finishes speaking, Art reemphasizes three points that he wants all the schools to think about in their implementation plans.

> "Remember your goal is to evolve broad-based support for using computers in instruction. In order to do this, teachers need plenty of direct hands-on experience with the machine. Look how much time you've put in."
>
> He reminds the group that teachers have a "hierarchy of concerns" that need to be addressed:
>
> "First, they need information to increase their awareness."
>
> "Second, they need a personal interaction with the machines and familiarity with the mechanics of using a computer."
>
> "Third, they need to think about the impact of computers on the students."

At this point, Rudy produces large pieces of chart paper, masking tape, and marking pens. He assigns each school group to a classroom to prepare a presentation about their staff development plan. For the next hour school groups work on this task.

At 2:30 the whole group reconvenes to make formal presentations. Each school group has outlined their plans on a piece of chart paper. These are taped up on the walls all around the room, and groups cluster near their displays when they give their presentation.

Some of the discussions are quite general. For example, the Penbrook High School team outlines three or four steps they are going to take to inform staff about the Hardware that is available, but they don't really elaborate on any details. On the other hand, the staff from Los Marcos High School describe a department-by-department approach that includes specific plans to gradually involve the staff in each department. Many of the other presentations are equally specific, including detailed calendars of events for introductory meetings and follow-up activities with the rest of the school staff.

The whole group is in high spirits during these presentations. There is spontaneous applause at the end of each presentation, and constructive suggestions are offered. For example, Robert suggests the phrase, "Here's how the computer can lighten your load" as a slogan for the brochure Domingues High School plans to develop for all teachers.

It is a very supportive group. No one seems to mind when ideas suggested by one school are echoed by another. For example, two of the latter presentations make specific references to ideas presented by other schools. The Boatright High School team says, "We're thinking of following the same plan as Muir," and the group nods approval.

The team from the St. Dominic's school explains that they have daily faculty meetings during which time information about the new computers might be disseminated. People can't believe that the staff really meets this often. In fact, two or three teachers interrupt to verify this fact.

"Wait a minute, wait a minute. Do you mean you have a faculty meeting everyday?"

Eloise explains that every morning the entire staff from St. Dominic's meets to share 20 minutes together with the Lord. This silences the skeptics in the audience. Eloise adds that the new computers are so important to the school that "we might be able to take a few minutes each day and devote them to IBM."

The last presentation concludes at 4:00 p.m., which is the end of the official day. As a result a few people leave immediately thereafter. However, most return to the computer lab to work on various projects. Some begin to record their thoughts in their daily diaries. Others return to the activities they were working on earlier in the day.

People begin to leave in larger numbers after 4:30 p.m. Yet, at 5:00 p.m. there are still five people hard at work in the computer laboratory. The last three teachers do not leave until 6:00 p.m. when the lab is locked for the night.

Participant's Evaluation

The summer computer institute was a success by almost any measure. Responses on an evaluation form collected on the final day of the program were extremely lauditory. Similarly, the teacher's diaries are laced with positive comments about the program. Moreover, our first-hand observations during the four weeks yielded similar impressions.

We tabulated the responses to four of the questions on the evaluation form administered at TTi #1. Twenty -hree completed evaluations were received, and yielded the following information.

1. Teachers were overwhelmingly positive when asked about their overall "general impression of the training" they received.

   56% gave the program extreme praise, saying that it was "excellent," "super!," "extraordinary", etc.

   39% praised the program, saying it was "well planned," "valuable," "well structured," etc.

   4% (one person) suggested changing the emphasis of the training.

One cannot help but be impressed by judgments such as the following:

"Absolutely fantastic!"

"Art and Rudy did a super job coordinating this whole month."

"The positive approach of the instructors and their continual focus on 'computer as tool' made the training."

"I think this has been an extraordinary class. I've never learned as much, had such great fun, and been paid simultaneously."

"Fine instructors made it the best! They are professionals in the true sense of the word."

"The training was super! I enjoyed the rapport between the instructors and students. I will miss the close associations we have shared."

"It was very professional in content and impressively interesting. The instructors demonstrated by their words and actions that use of computers does <u>not</u> dehumanize (one of my former fears)."

"My training has been outstanding. Those who trained us were outstanding. Their concern and care, sense of humor when you were struggling to learn, all blended into a successful training period."

2. Similarly, the participants had positive "feelings about the IBM PC."

> "I am in love." "I'm impressed with its capabilities." "Seems excellent to me." "Nice and smooth." were typical of their comments.

3. When asked to comment on the "most beneficial experiences" they had during the training, participants mentioned ten different activities. Those receiving more than one positive comment were:

> Sharing with other teachers; working in SIG groups; exchanging ideas with peers (11).
>
> Hands-on time with the computers (6).
>
> Developing self-reliance with computers; learning from their own errors, etc. (4).
>
> The variety of topics and presentations (3).
>
> Structure; organization without rigidity (2).
>
> Positive interactions with instructors (2).

4. Finally, when asked to indicate ways in which the program might be improved, participants made only a few direct suggestions:

> More time; particularly more time for hands-on work with computers (6).
>
> Better screening of outside speakers; two or three presentations were not effective (5).
>
> More variety in the software (2).
>
> More examples of CAI (2).
>
> Faster pace (1).

Some mentioned other things that did not relate to the training itself:

> More equipment for schools (3).
>
> Make sure equipment and materials are sent on time (2).

Four people offered no suggestions for improvement.

As these results demonstrate, the participants were extremely satisfied with the computer education program implemented at TTI #1.

Comments in the teachers' daily diaries substantiate these findings.

> "Discussion on use of pfs and vc in sig groups was good, getting down to details! Would like copies of other sigs reports since now ideas are really beginning to flow."
>
> "At the moment the paradox is that I feel tired and excited at the same time. I'm so glad the week is almost over but I'm so looking forward to the rest of TTI."
>
> "For the first time I am beginning to feel the computer could become a part of me --just as my skiis, flute, hiking boots are. This must be what they mean by "friendly." Although I still have to ask many questions, today for the first time I have been able to do many things without asking or looking up instructions."
>
> "I've never had an experience such as this. I remember back to my college days how innovative the teaching tools and methods were at that time. Now those methods seem so archaic compared to computer use in the classroom."
>
> "Good day, lots of ideas to think about, since after all the computer is just the tool to 'do what needs to be done...' The whole focus on change and problem areas are, for me, the crux of the sessions. Both (of the trainers) were of much help in focusing the plan for the rest of the year."
>
> "Today was our day with principals. I felt it was a very productive and reassuring day. (The principal) was very cooperative and receptive, and I have a good feeling that he will work with us to make the program succeed."
>
> "I found the discussion on change in the school culture very valuable in forming a strategy to get teachers interested in trying the computer in their classrooms. I feel like I'm about to embark on a great adventure."
>
> "This is an exciting opportunity for our schools and for us as individuals. I am very enthusiastic and optimistic about the implementation of these computers

into our curriculum. Our teacher training has been a valuable experience."

"Tears were shed in joy and sadness as this great program came to an end."

"The class has been extremely enjoyable, mostly I would say due to the joint efforts of our instructors. I have learned a lot, but not enough. I have a long way to go, but eventually I will get proficient in the application of the pc."

"Packing up... Feeling sad to break away from a wonderous group. (The trainers and support staff) all are the grandest!!!!!!! No more blinking of lights on and off, now I can stay glued to this screen...will be sending my lawyer to (the trainers) to collect my divorce fees."

"This has been an extraordinary experience. (The trainers) interest and dedication to this program is unique. Congratulations on a job well done!!"

"I've learned and been exposed to many things over the course of the past four weeks. I anticipate a great many things of a positive nature to happen in many classrooms as a result of this experience."

"In my opinion the IBM Models School Program is the most significant innovation of the 20th Century that promises hope for the futuristic school of tomorrow."

Conversations with the trainers yielded similar assessments of program impact. When asked to comment on the project a week after its conclusion, the trainers gave it high marks. "The computer-as-a-tool approach worked!," said one trainer at TTI #1. And he was equally optimistic about the amount of learning that had taken place. "They really internalized the software. We gave them instructions on how to back up the disks and how to get started, and then we gave them time for free play and some assignments, and it really worked."

The other trainer brushed off attempts to analyze why the program was successful. In his characteristically light-hearted and self-effacing style he replied, "If it was right, we probably stumbled into it; if it was wrong, we screwed up."

Analysis

There were twenty-three factors that appeared to be directly related to the success of the summer computer training phase of the IBM/ETS Computer Education Program. Some have been

referred to in earlier discussions. For example, comments on the TTI #1 evaluation form indicated a few of the organizational characteristics of the institute that contributed to its success: flexibility, SIG groups, variety, etc. In addition, many of the teachers offered quite explicit descriptions of the important elements of the computer institute. For example, the field notes document the following conversation:

> Caroline explained how much she has enjoyed the program. In fact, she listed five reasons why it had been so great. "The first thing is that Art and Rudy didn't look down on us teachers. They respected us for what we knew. It was also great that they admitted their own lack of knowledge. They weren't embarrassed to say that they didn't know something." (Other teachers also mentioned how refreshing it was that Art and Rudy admitted when they didn't know things. This issue is important for teachers.) The third thing that Caroline mentioned was time; they had enough time to really explore the software. She also liked the fact that "the easier material was presented first and then things got harder as we went along." Finally, "another thing that was good was the variety that we got to do every day. It was refreshing to have the day broken up into segments of an hour or two. It kept us interested and alert."

This was one participant's viewpoint. This analysis incorporated all the comments and observations that were available to produced a more complete list of variables that were correlated with successful computer education activities. (Of course, Caroline's judgements were incorporated into the overall assessment.) To provide some structure the variables have been grouped into three broad categories: contextual, programmatic, and personal. Contextual elements include facilities, materials, institutional support, etc. The title programatic components refers to the scheduling and organization of project activities. Finally, the personal variables are those that relate to the styles and personalities of trainers and participants.

The 23 contextual, programmatic and personal variables that related to project success are listed in Table 1. Within each category the elements are listed approximately in decreasing order of importance (though no exact scale is implied).

Contextual Elements

We were not surprised to observe that contextual elements affected program success. It would have been remarkable if the "surroundings" did not influence the instruction. Particularly noteworthy were five contextual elements that related specifically to computer education: hardware availability, software selection, institutional support, classroom facilities, and the features of the computer systems.

Hardware Availability. Each of the teachers in this project had access to his or her own computer at all times. No one was required to share equipment, learn jointly, wait in line for access, or feel rushed to accommodate others. Because sufficient hardware was readily available, each participant used 100% of the designated "computer time". Consequently, each teacher in the IBM/ETS Computer Education Program actually spent 75-100 hours using the computers during the training. Moreover, many participants took their machines home during the month of August, so their actual practice time was greatly increased.

Providing extensive access to computers was one of the most important and most effective elements in this computer training program. The value of adequate "computer time" cannot be overemphasized in planning for computer education.

Software Selection. The software was carefully selected to match the goals of the program and be appropriate for use in schools. This program was designed to promote the use of the computer as a multi-purpose tool in all subject areas, and the software that was used related directly to this goal. Thus, the participants had access to general application software such as word processors, spreadsheets and filing systems, which integrated well into the planned curriculum.

Moreover, the software was not too complex for use in schools. There are many word processing programs for the IBM-PC. Easywriter was chosen for use in the summer computer institutes because it had the features necessary for most school applications, yet it was relatively easy to use. When Pfs:Write became available midway through the summer it was demonstrated at all the TTI's because it was even easier to use while still providing the most frequently needed features. Computer education will be improved if program developers pay close attention to software selection.

and try to match the software to the program' goals and the level of sophistication of the intended user.

Of course a similar statement could be made about educational support materials in general. Any instructional program will benefit from well chosen supplemental materials. However, concern about the quality and appropriateness of materials appears to be more important in computer education than it is in other fields. At the present time there is greater variety in the content and quality of computer-related materials than in the content and quality of instructional support materials in other fields. Greater care may be necessary when selecting software and support materials relating to computers than is necessary when selecting a textbook or workbook in another subject. Thus until some level of standardization is achieved in this new field, careful software selection will remain a critical element in any computer education program.

Institutional Support. This study revealed the extent of the instutional and logistical support required to conduct a successful computer education program. In addition to the facilities discussed above, the program at TTI #1 received invaluable assistance from the school administration in the form of human resources, financial support and access to supplemental hardware and software. For example, the Assistant Dean of the college was actively involved in planning the program. She also met with the school principals and used her position and authority to "insist" that the schools provide the appropriate guarantees regarding the use and maintenance of the machines.

In addition, the school administration offered the assistance of support staff who were working in their own computer education program, including the software librarian and the technicians. The school also granted participants access to the software library and the microcomputer laboratory whenever necessary to supplement the materials provided by the IBM/ETS program. The technical support was particularly useful. In fact, each of the three TTI's provided some additional technical expertise beyond the two assigned trainers.

The school also contributed financial resources to the project, providing release time for the trainers to work with the network schools during the year.

Educational planners will find that computer education programs are far more complex than they might at first imagine. This study indicated that the level of resources necessary to conduct an effective computer education program may be twice as great as would be necessary for a comparable inservice program in some other field. An inadequate level

of support will certainly have a negative impact on a computer education project.

Classroom Facilities. The classrooms at TTI #1 were attractive, spacious, well lit and comfortable. While the attractiveness helped brighten the atmosphere, it was not critical to the success of the program. On the other hand, spaciousness, lighting and comfort all seemed to enhance the program's impact.

A computer-based program requires more space than a standard educational program. In addition to regular classroom space for people to meet and listen to lectures, a computer program needs enough table space for the hardware and enough storage space for software, manuals, etc. A demonstration classroom with large screen monitors for group computer presentations is also important. TTI #1 provided adequate space for all these functions. In fact, the total amount of space was almost double the amount that would be required for a non-computer program.

A computer laboratory also requires good lighting, since headaches and eyestrain are a real concern when video terminals are used in improperly lit surroundings. Such problems are exacerbated in a computer education program where participants may also be experiencing anxiety about learning to operate a computer for the first time. Under these conditions proper lighting is an even more important consideration.

The key "comfort," from the perspective of a computer education program, were the chairs. The computer laboratory at TTI #1 was equipped with modern, padded, reclining swivel chairs with arm rests. Anyone who has to sit in front of a computer for four or five hours a day will soon appreciate the value of a good chair. It appeared that the "mean time between getting up and walking around" was greater at TTI #1 than at TTI #3, where hard, less contoured chairs were used in the computer room (though we did not test this observation with a stopwatch).

Other "creature comforts" were also well attended to at TTI #1. Freshly brewed coffee was provided free of charge each morning, and vending machines were located next door to the computer laboratory for anyone who desired a snack. Many of the teachers commented favorably on the presence of the coffee; it made them feel they were respected. Providing coffee was a small gesture (though it was indicative of the care and planning that went into the program at TTI #1) that would be recommended to planners of any type of extended educational program.

Computer System Features. Each machine that was used in this project was equipped with a color monitor, dual disk drives and a printer. Thus every participant was able to learn on a full-feature computer, not a "stripped-down" model. One important result of this was that all the software ran in full-feature, multi-color mode.

In addition, the machines were of extremely high quality. In fact, the IBM-PC was seen by the participants as the "Cadillac of Microcomputers." While other machines might be functionally equivalent, there was a certain heightened excitement and pride in using the PC's. Of course, one does not necessarily need the power and sophistication of an IBM-PC to conduct a computer education program for teachers. However, the computers that are used must have all the features that will be required and availalble in the school setting.

Programmatic Components

It is difficult to dissect a complex educational program and determine which individual components contributed most to its effectiveness. Yet, there were a number of programatic features that clearly seemed to be related to the success of this project.

Adequate Learning Time. Simply stated, it takes a long time to learn to operate a computer, become familiar with software, and develop a plan to integrate such technology into instruction. Each participant in this project spent at least 120 hours becoming a "computer educator," and most still considered themselves advanced novices at the end of the training. Probably the single most important element in this project was the amount of time that was provided for the teachers to learn about computers and use the equipment.

For most of the teachers the IBM-PC was a strange and exciting new challenge. They had to overcome their fears and false starts, learn from their mistakes, and just log enough "time in the saddle" to become comfortable with the machinery. Some people had already used computers and learned the intricacies of the PC more quickly. For them the key element was time to become facile with new software and think about ways to integrate it into instruction. The daily diaries provided a good picture of the learning process as it was as taking place. As one participant wrote, "every time I made a mistake, large or small, I learned more than when I was successful." Learning from one's mistakes is time consuming.

As one of the trainers at TTI #1 put it, "the software must become second-nature to them. Only then will they really be able to use the computers in their classrooms," and the

trainers believed that the program had succeeded in this respect. "They internalized the software," one reported with pride after the project was over. This level of familiarity requires time. This study suggested that adequate time to use the computers is the sine qua non of computer education.

Clarity of Goals. The trainers at TTI #1 had clear goals and objectives for their program. Consequently, they were able to design specific activities to achieve these goals and were successful conveying useful skills to teachers. There are so many topics that are relevant to the use of computers in education, that one might be tempted to try to address everything. This could cause the program to lose its impact, covering everything superficially while failing to treat any topic in sufficient depth. The successful trainers in our study benefitted from a clear and limited set of goals.

Group Interaction. Another effective tactic used in this project was to encourage collaboration among teachers by providing opportunities for them to work together. At TTI #1 teachers worked both in school groups and in special interest groups (SIG's), and were given special project to work on in each cluster.

All of the teachers from a given school were brought together to work on a major project -- the development of an implementation plan for computer education activities at their site. This gave them an opportunity to establish close working relationships with their colleagues in other departments.

Alternatively, the teachers were clustered into subject-based SIG's that cut across school lines. The SIG's were also given a major project, to develop a set of computer-based lesson plans in each subject field. (At the end of the summer these were disseminated to all of the schools in the network.) Working in SIG's provided teachers with an opportunity to meet colleagues at other schools and establish relationships with people who shared their specific interests and concerns.

Teachers responded favorably to both of these projects. They appreciated the chance to work together, share ideas with their peers, and establish communication channels with teachers at other schools. In fact, interaction with other teachers was the most frequently praised element of the program at TTI #1 (based on the written evaluations). Other educators are strongly encouraged to incorporate such activities into their inservice plans.

Planning for Implementation. Computer education is a vast subject, and it would have been possible to devote

the entire four weeks to discussing only the hardware and software. Many computer education programs limit their objectives to these topics and nothing more. The ETS model went beyond hardware and software to stress the development of lesson plans to use the technology in the classroom. TTI #1 expand the approach even further by encouraging teachers to plan for the implementation of computer education activities in each school.

Planning for implementation included a number of activities. First, teachers were required to develop school plans that addressed the need for inservice training for the rest of the staff, scheduling of access to the computers, sharing lesson plans, etc. Second, school administrators were involved in the program and were given an opportunity to work directly with the equipment on at least one occasion. Third, the trainers and the TTI #1 administrators brought their own pressure to bear on principals to insure that the implementation plans received appropriate attention.

Site visits to schools after the completion of the project showed that these implementation plans had been effective in hastening the integration of the computers into the school's overall eductional program. Attention to implementation was an important element in the success of the summer computer institute at TTI #1, and this issue should be addressed by other computer education programs.

Software-Based Assignments. Mastering a general application program, such as a word processor or a spreadsheet, requires a considerable amount of time. First, one must learn the fundamental commands that control the basic operation of the software. Then one needs time to internalize these procedures and become an effective user.

There are many ways that a computer education project can provide this learning and practice time. One method would be to set aside unstructured time for teachers to practice whatever skills they wished. While this approach appears to be attractive, it has a potential flaw. To be effective, the participants must be able to use free time well. They must be able to act as self-directed learners, set appropriate goals, and create their own activities. When the subject matter is new (and somewhat fearful) as it is in the case of computer technology, these can be a very difficult tasks.

An alternative approach that was effective at TTI #1 was to impose specific assignments that required the use of particular pieces of software. For example, each participant at TTI #1 was required to keep a daily diary. The diary assignment was introduced immediately after the teachers had learned to use the Easywriter word processor. There were no rules about what had to be included in the

diary (though the trainers indicated an interest in peoples' thoughts about the training and their growing knowledge of the PC's), but the assignment had to be completed using Easywriter.

Similarly, after the teachers had been introduced to the PFS:file data base management system, they were given an assignment that required them to use PFS:file on a regular basis. Each teacher was responbsible for reading and reviewing a computer-related article from a magazine or journal each day. The instructors suggested categories to use when summarizing the articles, but the teachers were allowed to set up their own filing form. They were responsible for finding educational articles, reading them, writing an abstract, and storing the information in the file they created.

Teachers were also encouraged to use the computer for storing other kinds of information. For example people used the computers for composing, correcting and storing their lesson plans.

These software-referenced assignments provided structured opportunities for practice with the software and also reinforced the idea of the computer as a tool. They proved to be an effective device for encouraging the teachers to master the new technology.

Structured Lessons. The presence of a thorough schedule and a well-defined daily plan of activities at TTI #1 seemed to have a positive impact on the participants. The clear framework was beneficial for at least three reasons. First, participants had "advanced organizers" so they knew what topics would be addressed and when certain questions were going to be answered. Second, they also knew when free time would be available, so they could budget their own time. Third, the clear schedule reinforced the feeling that the trainers were experts and the program was likely to be successful. It mimicked the type of scheduling and planning teachers are asked to do for their own classes. "Teachers are fairly structured people and there exists a certain authenticity to publishing a schedule," one of the trainers said, and added with caution, "in fact, changes can be disruptive."

The emphasis on structure could also be seen in the lessons themselves, when it appeared to be equally effective. The most successful lessons began with clear directions, continued with a shared example of the product or process, provided opportunities for individual exploration, and concluded with a related assignment. In contrast, lessons with a minimum of introduction and a greater amount of open discovery left many people confused and frustrated. Remarks

from teachers who received less structured lessons included:

"More structured planning with written instructions like formatting copying, etc."

"Lecture first."

"A little more directed instruction."

When learning about computers teachers seemed to respond well to lessons that provided clear direction and practice with fundamental skills before "turning them lose" on their own. On a larger scale, this study suggests that a computer education program will benefit from a clear framework and a well designed instructional plan.

Voluntary Participation. Not all of the teachers at the three sites were pleased about the opportunity to participate in the program. The most serious objection came from teachers who were told to attend though they had no indication that they were going to be involved in the school's computer activities in the future. This occurred because some schools were notified of their participation in the program at the last minute, and they pressed available teachers into service to attend the institute. The two or three teachers who fell into this category did not benefit from the institute as much as teachers who were eager to participate and involved in the school's plans for use of the computers. It would seem best to include the most willing and eager participants first in computer education programs. Those who volunteered for this project appeared to be the most dedicated learners.

Attention to Social Needs. The social needs of the participants were an important concern at TTI #1, and the program was successful, in part, because of the attention that was paid to the social aspects of the group. Freshly brewed coffee was provided every morning at no charge; two catered buffet luncheons were held. An open house and dinner for participants and their families was arranged. Participants reported that these extra personal touches made a great difference in the effectiveness of the project. They helped establish an esprit de corps among the teachers, gave them pride in their participation and provided a tangible demonstration that they were respected professionals.

Reduced Distractions. One significant advantage of a summer program is that participants can devote more time to the subject because there are no pressing classroom responsibilities requiring their attention. Teachers could really "throw themselves into it," as one participant

described it, without the daily pressures and demands of their jobs.

Such attentiveness is particularly important for computer eduation programs because the subject is so technical. It was possible to arrive early and stay late (as so many teachers did) because they did not have pressing classroom responsibilities. This freedom seemed to increase their patience with the difficult skills they were trying to master. They had the fortitude to persevere when learning was difficult because no "next morning" teaching duties demanded their attention. While it is not possible to have all training take place during the summer, one should strive to maximize attention by minimizing external demands and distractions.

Supplemental Experts. Few individuals possess such broad knowledge of educational computing that they can adequately address all teacher concerns in this area. One would be wise to utilize outside experts to supplement the knowledge of the instructor. For example, seven or eight guest speakers made presentations during the summer computer institute at TTI #1. While two or three of these presentations were not well received, participants agreed on the overall value of the guest lecturers. They provided specialized expertise and information that was valued by the teachers. They also provided different perspectives on some issues and gave the participants a broader experience.

Personal Elements

Just as in any other educational endeavor, the success of a computer education program depends upon the skills and abilities of the trainers. Recognizing this, ETS devoted as much time as possible to the selection of the trainers and the TTI's. Selection was difficult for many reasons. Certainly the lack of any set of criteria that characterize a "good teacher" or a "good computer teacher" was a major stumbling block. As a result, the main criterion used in the selection process was experience.

Now that the training component is completed, it is possible to say more about the talents possessed by the more effective computer educators in this project. Observations made during the project suggested a number of skills and abilities that served the trainers well. Of course, fundamental teaching skills were critical - the ability to express oneself clearly, to plan a presentation in a logical order, to understand and respond to feedback from students, to model courteous and cooperative behavior, etc., were required. Beyond there, however, there seemed to be some specif'c abilities that were important to be an effective computer educator.

Respect for Students. Trainers at TTI #1 were highly praised for demonstrating respect for their students. Apparently such respect is not always evident in inservice education programs, because this was one of the most frequently praised aspects of the project.

Respect is particularly important in the field of computer education because it is so easy for technologically sophisticated individuals to "talk down" to people who are unfamiliar with computers. Intended or not their tone can be condescending. The two trainers at TTI #1 avoided this problem; they acknowledged the skills and abilities of the teachers and treated them as professionals. A comment from one of the trainers captures the attitude that was evident at TTI #1. "Let's face it, the teacher knows more than anyone else about the situation that exists in their classroom. They are the experts on this score." Anyone who hopes to conduct successful computer education activities for teachers should strive to achieve such an attitude.

Knowledge of Computers and Their Use in Education. It should be clear that knowledge of the subject is necessary for effective instruction. This is particularly true in technological subjects because so much new information has emerged in the past decade. As an example, the number of hardware and software questions that arose during summer computer institute was staggering. Though ETS provided an intensive introduction to the hardware and software, trainers who already had an an extensive working knowledge of computers learned much more and were more effective during the project.

It was also extremely important that the trainers were familiar with the educational uses of computers. Neither assembly language programming ability, nor familiarity with advanced computer data analysis were particularly relevant to the educational applications addressed in this project. A computer educator must be familiar with the expanding role that technology is playing in education; knowledge of business or scientific applications is not an effective substitute for familiarity with computer literacy, computer assisted instruction, computer management of education, etc. Knowledge of computers should be a key selection criteria for computer educators working in this field.

Flexibility. Something unexpected happened almost every day during the summer computer institutes. These "surprises" ranged from a guest speaker who did not arrive on time to a piece of software that crashed; from a wonderful lesson idea that emerged unexpectedly to a power failure. The technical nature of the machinery and the intensive format of the workshop seemed to guarantee that unpredictable things would occur.

An effective computer educator needs to be able to deal with the unexpected and make adjustments to accommodate small diversions and minor catastrophes. Some trainers we observed reacted to these circumstances by not planning carefully. This seemed to be a mistake. As was pointed out above, good planning and structure were important. However, the ability to be flexible and adapt to changing circumstances was a necessary complementary skill.

Familiarity with Schools. Familiarity with school operations was one of the criteria used to select trainers for this project, and this study confirmed the importance of this factor. As a key example, the module on planning for implementation developed at TTI #1 grew out of the trainer's own concern about the characteristics of change in schools. It proved to be one of the most important parts of the training project. The study supported the notion that an effective computer educator needs to be familiar with the way schools operate and the complexities of educational organizations.

Creativity. Though the trainers were provided with a model to follow during their two week ETS introduction, they had to develop many of the training activities on their own. As a result, there were variations in the program from one site to the next, and much individual initiative was apparent. Many of the most effective presentations were the result of creative ideas generated by the local trainers. Generalizing from this experience, it appears that creativity is an extremely important criterion for an effective computer educator. Computers are a relatively new element in education and there is a lot to be learned about introducing teachers to this new tool. Over time the successful ideas generated by this project and others will be shared and will improve the quality of computer education in general. However, at present a generous helping of creativity is a must for an effective computer educator.

Sense of Humor. Concentrated technical education can be a stressful experience for students as well as trainers. The trainers at TTI #1 used humor as an effective tool for easing tension and keeping the program operating smoothly. This is not to suggest that computer educators must aspire to be stand-up comics; however a light-hearted manner and a pleasant sense of humor may be a valuable asset.

Strength of Personality. One does not have to be a bold, intense personality to be a good teacher. However, the huge amount of technical knowledge that must be conveyed in computer education makes it important for educators in this field to be very directive at times. The effective trainers in this project had enough forcefulness to be able

to pull a group of people together and impose some order when information needed to be conveyed.

A certain amount of assertiveness was also an asset. Some trainers acted as advocates for the teachers in their program. They cajoled third party software vendors and outside experts to assist with the project. They demanded and received answers to questions from ETS and IBM. Their projects were more effective because of their assertiveness and advocacy. A truly meek leader would not have been as effective.

Evaluativeness. Those trainers who had an active curiosity about how well the program was doing, seemed to be more effective in making improvements. An interest in formative evaluation seemed to come naturally to some trainers, but not to others. Some planned for evaluation from the outset and were extremely interested in the kinds of feedback they might get from the participants. To others evaluation was an afterthought. In general, the former group was more effective than the latter.

Discussion

There is little doubt about the need for research to identify effective strategies for computer education. The Congressional Office of Technology Assessment (1982) reported that "widespread use of technology in the classroom will require that teachers be trained both in its use and in the production of good curriculum materials" (p. 9). Unfortunately, the report concluded "... there is little evidence that most of the teacher training colleges in the United States are providing adequate instruction to new teachers in the use of information technology" (p. 10).

The IBM/ETS Computer Education Program was designed as a model for computer education, and the goal of this case study was to document the program and learn as much as possible about the elements that were effective. As it turned out, the main study site was extremely successful. Consequently, the descriptive sections of this report provide useful examples and illustrations for other program planners. More importantly, the analyses reported here identified 23 features that contributed to the project's success. (See Table 1.) Herein lies the value for those who are concerned about computer education. The results can assist in formulating computer education programs and can serve as a guide to further research on this topic.

To facilitate the use of these results, the variables were ranked in priority order based on impact. While this ranking was somewhat subjective and was a function of the

context in which the observations were made, those elements at the top of the list should certainly receive attention in any computer education project. Without a doubt the provision of Adequate Learning Time, and appropriate Hardware and Software are indispensible. Similarly, it is hard to overemphasize the importance of Clear Goals, Planning for Implementation and the provision of opportunities for Group Interaction. Instructors should certainly possess a thorough Knowledge of Computers and Computer Use in Education.

Other studies have confirmed the importance of many of these key factors. Adequate time on the computer and opportunities to plan for integrating the computer into the curriculum are the elements reported most often in the literature that exists on this topic. Shavelson, et al. (1983) reported that teachers wanted on-site computer inservice training that provides "as much hands-on practice as possible" (p. 87). Kane et al. (1983) found that what teachers "want most was more time to use the machines, to develop their expertise, to review available software and plan for its use in the classroom" (p. 19). Similarly, OTA (1982) concluded that information technologies can be most effectively applied to tasks when they are well integrated into their institutional environment.

Even with this confirmation the results of this study must be used with care. It is not true that each of the features that was identified must be present to have a successful computer education program. Neither is the presence of all variables sufficient to guarantee an effective program. This was a study of a single project, and educational planners will have to interpret these results in light of individual circumstances. To the extent that conditions are similar (and there are many similar elements in most computer inservice activities) program developers would be wise to attend to the variables identified in this research and try to incorporate them into other computer education programs.

Table 1

Key Features for Computer Education Programs

Contextual Elements

- Hardware Availability
- Software Selection
- Institutional Support
- Classroom Facilities
- Computer System Features

Programatic Features

- Adequate Learning Time
- Clarity of Goals
- Group Interaction
- Planning for Implementation
- Structured Lessons
- Software-Based Assignments
- Voluntary Participation
- Attention to Social Needs
- Reduced Distractions
- Use of Supplemental Expertise

Personal Characteristics

- Respect for Students
- Knowledge of Computers and Their Use in Education
- Flexibility
- Familiarity with Schools
- Creativity
- Sense of Humor
- Strength of Personality
- Evaluativeness

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