Florida Journal of Educational Research
Fall 1997, Vol. 37(1) 1 - 16

Effect of Field-Based Technology Laboratory on Preservice Teachers' Knowledge, Attitudes, and Infusion of Technology

Arlene Brett
Okhee Lee
Linda Sorhaindo
University of Miami

ABSTRACT. Teacher competence in technology is a major focus of current teacher education reform. This study examined the impact of a field-based technology laboratory on preservice teachers' knowledge and use of computers, attitudes toward computers, and understanding of infusion of technology. The study involved 105 teacher education students: 58 in the experimental group and 47 in the control group. ANCOVA results showed significant differences between groups in the use of data bases and instructional software. Qualitative analysis of students' journal entries revealed changes in understanding of infusion of technology. Results suggest field based technology laboratory can be an effective way to introduce preservice teachers to the potential of technology in classroom instruction.

Much has been written about the potential of technology to revolutionize or at least significantly improve education. Technology has the potential to change the very structure of education from emphasis on classroom lectures to individual exploration, from passive absorption to apprenticeship, from individual work to team learning, from the omniscient teacher to the teacher as guide, from stable content to fast-changing content, and from homogeneity to diversity (Reinhardt, 1995). In their synthesis of research on effectiveness of technology in schools, Sivin-Kachala and Bialo (1995) found educational technology enhanced student achievement, attitudes and self-concept, as well as the quality of student-teacher relationships. Despite the great potential of technology for classroom instruction, many teachers are not adequately prepared to use technology in their teaching.

Teacher competence in computers and related technology is a major focus of current teacher education reform. Professional organizations and individual states recommend or require teacher education programs to prepare teachers who are able to integrate technology into their teaching. The National Council for the Accreditation of Teacher Education (NCATE) has revisedits standards to include training teachers in the use of computers and related technology for the subjects they plan to teach (Wise, 1995). At least 18 states require training in computers and related technology for all teacher candidates seeking certification (U.S. Congress, Office of Technology Assessment, 1995). For example, the state of Florida's Blueprint 2000 recommends that teachers know how to use technology as an instructional tool and how to help their students use technology (Florida Commission on Educational Reform and Accountability, 1993).

In order to prepare teachers who can utilize technology for classroom instruction, teacher education programs should provide training in the use of technology, positive attitudes toward technology, and a vision of how technology can be integrated into the curriculum. Teacher preparation programs, however, often do not have room to emphasize technology in an already full curriculum (Roblyer, 1994) or do not emphasize technology as central (Charp, 1995; Fratianni, Decker, & Korver-Baum, 1990; Johnson & Harlow, 1993; Jordan, 1993; Roblyer, 1994). In addition, teacher education students report seeing very little technology use in their field experience placements (Fulton, 1993). Given these constraints, teacher education programs need to develop alternative models for including competency in technology. One such model is a field-based technology laboratory, which would provide preservice teachers with opportunities to learn to use technology, develop positive attitudes, and understand how to infuse technology into the curriculum

Knowledge and Use of Computers

Relatively few of America's teachers use computers in their teaching, and those using computers do so infrequently (Ross, 1991; U.S. Congress, 1995). For the most part, teachers are not prepared in the use of technology, and many consider themselves less computer literate than their students (Bitter & Pryor, 1994; Charp, 1995). Even many of the recent graduates of teacher preparation programs feel unprepared to incorporate technology into their teaching (Fratianni, Decker, & Korver-Baum, 1990; Jordan, 1993; Roblyer, 1994).

Systematic training in the use of computers and related technology has been shown to increase teachers' level of competency. In studies of teachers who participated in training, such as the IBM teacher preparation grant program and similar projects, teachers reported significantly enhanced computer skills as a result of the training (Bauder, Carr, Planow, & Sarner, 1992; Bitter & Pryor, 1994). They felt more adequately prepared to use computers after formal training and sufficient time to apply what they had learned.

Attitudes toward Computers

A positive attitude toward computers and related technology is a significant predictor of commitment to their use (Bracey, 1994; Kay, 1990). Without teacher commitment it is unlikely computers will be used effectively, if at all. Anxiety and fear of computers frequently affect teachers' motivation and ability to master computer skills. Teachers' anxiety must be addressed to help them feel comfortable enough to successfully integrate computers into the classroom (Brownell, 1993; Ferris & Roberts, 1994; Maurer, & Simonson, 1993).

Reducing anxiety and developing a positive attitude can be accomplished by early exposure to technology (Cates & McNaull, 1993; Ferris & Roberts 1994; Hunt & Bohlin, 1993). Programs designed to increase computer skills have also been shown to reduce anxiety (Maurer & Simonson, 1993; Reed, 1990; Woodrow, 1992). For most teachers, training in the use of hardware and software not only increases their sense of competence, but also reduces their anxiety and fear of technology.

Infusion of Technology in Curriculum

Major factors influencing infusion of technology into schools include: (a) the availability of hardware and software and (b) the ability and commitment of teachers to integrate the hardware and software in their teaching. Even though the number of computers in schools is increasing, their presence alone does not automatically benefit students. The way in which teachers use the technology determines whether it changes the nature of teaching and learning (Woronov, 1994).

Teachers have to learn not only how to use technology, but also how to integrate it into the classroom to change the nature of teaching and learning (Siegel, 1995). Although students currently entering teacher education programs have more technology skills than students of five years ago, they do not know how to use technology to support teaching and learning (Glenn, 1993). Knowing how to use technology does not mean that teachers know how to infuse technology into the curriculum. Unfortunately, the process of integrating technology is difficult because there is no systematic body of research as to what is effective (Bitter & Pryor, 1994).

Research indicates that teachers need to use computers for a considerable period of time before they are comfortable enough to incorporate them into their teaching (Fazio & Polsgrove, 1989). Teachers report it takes at least five years to master computer-based practices. With that experience, teachers change their expectations about what students can produce, tend to individualize instruction to a greater degree, and are more likely to act as coaches or facilitators of learning (Bracey, 1994). For instance, the results of the Apple Classrooms of Tomorrow project, which followed teachers in technology-infused classrooms over several years, indicated that teachers underwent stages from struggling with management of hardware and software in support of traditional instruction to implementing activities in which students dynamically used technology to gather, produce, and share knowledge (Tally & Grimaldi, 1995).

This study examined the process and impact of a field-based technology laboratory on preservice teachers with regard to: (a) knowledge and use of technology, (b) attitudes toward technology, and (c) understanding of infusion of technology of undergraduate teacher education students. The field-based technology laboratory was the first course of a teacher education program predicated on a knowledge base which emphasized three domains of knowledge, skills, and attitudes expected of effective teachers; within each domain, a particular theme was selected (see Figure 1). The domains and their respective themes included: (a) subject matter specialization with liberal arts theme (b) knowledge of pedagogy with a technological applications theme, and (c) knowledge of students and society with a diversity and congruence theme (Author, 1995). Specifically, the field-based technology laboratory was designed to expose preservice teachers from the beginning of the program to technological applications with diverse student populations in field experience settings. The study was conducted during the first implementation of this restructured teacher education program.

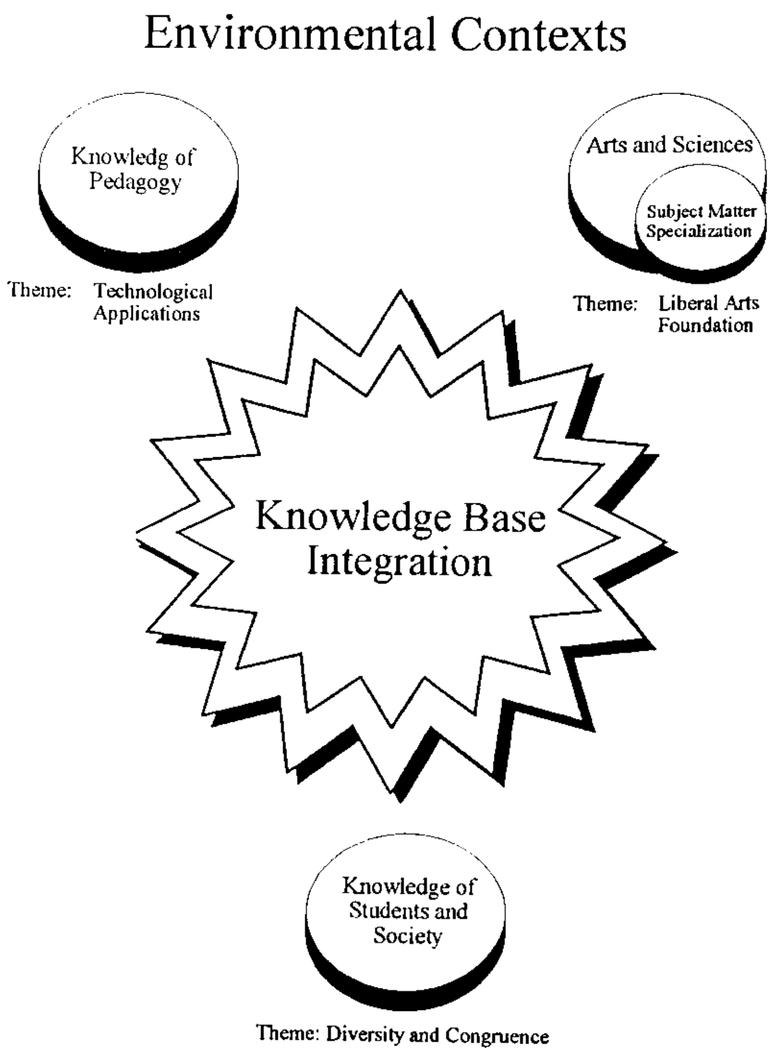

Figure 1

Method

Subjects

The sample in the study consisted of 105 undergraduate students in teacher education programs at a large private university in the Southeast. All teacher education students at the university had their primary majors in the College of Arts and Sciences and second majors in the School of Education leading to teacher certification. The teacher education programs included elementary education and selected areas of secondary education (English, social studies, and science).

Two groups of students were selected for participation. The experimental group consisted of 58 students enrolled in the introductory course in the restructured teacher education program. Of the 82 students enrolled in the course, 58 participated in the study, 21 were music education students who were not required to attend the technology laboratory, and 3 did not have complete data (missing pre or post test). The control group consisted of 47 students enrolled in the second and third courses in the existing teacher education program. The students in the existing program had not been formally introduced to computers or technology for classroom instruction.

The Field-Based Technology Laboratory

As a requirement of all students enrolled in the introductory education course, the technology laboratory involved six hours of instruction on the use of computers and technology and 12 hours of experience in the classroom and the newly built media center. To link technology with a classroom setting, instruction and field experience took place at a public elementary school adjacent to the university campus.

Four cohorts of students were formed over the period of one semester. Each cohort completed the technology laboratory within a three-week period. With each cohort, a university professor gave six hours of instruction on how to use computers and related technology, software evaluation, and applications of technology to teaching and learning. During the 12 hours of field experience each student worked with an assigned teacher, assisting with computers and other technology in classrooms and the media center. The media center had 10 Apple Macintosh LCIII computers, two external Apple CD-ROM drives, four MS-DOS computers running the Impact data base system, and an MS-DOS multimedia computer for the electronic encyclopedia. In addition, a VCR, television, and videodisc player were available. All of the classrooms had at least one computer; a few rooms had three computers, which included Apple II, various models of Apple Macintosh, and MS-DOS. Most classrooms also had a printer. The software was limited to what teachers and the media specialist had purchased in previous years, and varied in its applicability to the objectives of the curriculum.

Students were required to keep journals of their field experience, demonstrate the ability to operate the computers, and evaluate at least two pieces of software with children. They were also required to complete four of the following assignments: help children locate books using *Impact*, check out books using *Circulation Plus*, work with one or more children in word processing or desktop publishing activities, help children use a multimedia encyclopedia, or produce instructional materials for use in the classroom. At the conclusion of the technology laboratory, the students completed a written test on computer use in classroom instruction. All of the students scored 80% or better on the written test.

Research Design

A nonequivalent control group design was used in the study (Campbell & Stanley, 1963). The independent variable, the treatment, was the field-based technology laboratory experience. Although the inclusion of a university-based technology course would have been desired as a comparison group to the field-based laboratory, the constraints of the program (i.e., the field-based technology laboratory was required of all students) did not allow this research design. Two of the dependent variables were computer knowledge and use, and attitudes towards computers. The third dependent variable, infusion of technology into the curriculum, was analyzed qualitatively through content analysis of journal entries.

Instrument

The questionnaire used in the study had two sections. Section I was the *Computer Anxiety Scale*, which consisted of thirty items on a 4-point Likert scale (strongly disagree, disagree, agree, and strongly agree) (Loyd & Gressard, 1984). These items measure three constructs concerning computer attitudes: (a) anxiety about computers, (b) enthusiasm in working with computers, and (c) confidence in the ability to use and learn about computers. Alpha reliability indices were .86, .91, .91, and .95 for the computer anxiety, computer enthusiasm, and computer confidence subscales, and the total scale, respectively. Factor analysis showed substantial loading of items measuring each of the constructs (Dukes, Discenza, & Couger, 1989; Woodrow, 1991).

Section II of the instrument, designed to measure prior knowledge of computers, included three items concerning frequency of the use of computers: (a) computer as a word processor, (b) computerized data base, and (c) instructional software. These items were measured on a 4-point Likert scale (never, seldom, somewhat frequently, and very frequently).

Data Collection and Analysis

Two sources of data were collected: (a) questionnaire, and (b) journals. The questionnaire was group administered in class at the beginning and end of the course and took approximately 10 minutes to complete. In addition, students kept journals of their field experience working with children over the three-week period as part of the course requirements. They were instructed to describe their experiences with technology, as well as their overall reactions to the field experience.

Student responses on the questionnaire and their journal entries were analyzed with regard to: (a) knowledge and use of computers (word processing, data base, and instructional software), and (b) attitudes toward computers (anxiety, enthusiasm, and confidence). Infusion of technology was examined only through journals; it was not included in the questionnaire. The questionnaire data were analyzed using the SAS general linear model (GLM) procedure for an unbalanced analysis of covariance (ANCOVA), with the pre-test as covariate (Alpha = .05). Students' journal entries were analyzed using qualitative methods (Erickson, 1986; Strauss & Corbin, 1990). Frequency accounts as well as vignettes of examples and quotations illustrating major themes and patterns of student responses were obtained.

Results

The means and standard deviations of ratings for computer use and attitudes on pre- and post-tests are presented in Table 1. Although students in both groups reported high frequency of computer use as word processor, they were less familiar with data bases and instructional software. Students in both groups reported moderately positive attitudes toward computers in general.

Table 1

Computer Use and Attitudes

	Experimental (n = 58)				Control (n = 47)					
	Pretest		Posttest		Pretest		Posttest			
	M	SD	M	SD	M	SD	M	SD	*F*	p
Computer Use										
Word processing	3.59	0.64	3.67	0.63	3.60	0.57	3.63	0.61	0.20	.65
Data base	2.28	0.99	2.39	0.79	2.21	1.08	2.08	1.03	4.48	.03
Software	1.96	0.89	2.53	0.86	2.23	1.02	2.26	1.10	6.51	.01
Computer Attitudes										
Anxiety	3.06	0.57	3.14	0.59	3.13	0.57	3.11	0.57	1.68	.20
Enthusiasm	2.81	0.58	2.79	0.65	2.90	0.85	2.82	0.64	1.33	.25
Confidence	3.04	0.53	3.04	0.53	3.15	0.56	3.07	0.56	0.71	.40

The ANCOVA results showed that while there were no significant differences in the use of the computer as word processor, there were differences in the use of the computer as data base, $F(1, 103) = 4.48, p < .03$, and the use of instructional software, $F(1, 103) = 6.51, p < .01$. There were no significant differences between the experimental and the control groups in any of the three constructs of computer attitudes.

Consistent with the statistical results, students' journal entries indicated noticeable changes in their experiences with data bases and instructional software. In contrast to the statistical findings of no significant change in computer attitudes, journal entries revealed more positive attitudes towards computers. Journal entries also revealed students' growing understanding of infusing computers into the curriculum. Major patterns and themes in student responses from journal entries are described next.

Knowledge and Use of Computers

Students reported a variety of experiences with word processing, data base, and instructional software.

Word processing. The students used various types of word processing programs which were available in the classrooms and the media center. Many students attempted to become familiar with all of them, as one student wrote, "I booted up every kind of computer that was in the media center to make sure that I knew how to do it."

Word processing programs were used for a variety of activities, including class reports, letters, posters, and stories. The most frequently used program was *The Writing Center* (a desktop publishing program by The Learning Company). Almost all students reported using *The Writing Center*, with the frequency of 58 accounts throughout the journal entries. This program was highly rated by the students and the children for its visual stimulation and illustrations along with writing. The students noted that even children who did not seem to be motivated to write were attracted to this program and expressed enjoyment.

Data base. A rather limited number of data base programs was noted in the journal entries, including *Impact* (a program to locate books by Auto-Graphics), *Circulation Plus* (a system for tracking books by Follett Software), *Compton's Interactive Encyclopedia* (Compton's NewMedia), and *Interactive Nova: Save the Planet* (a hypermedia data base by Scholastic).

The *Impact* program in the media center was used often, with 56 accounts of use throughout journal entries. Children in third grade and above did not experience difficulty using the system, as one student noted, "The simplicity of the program made it easy for the children to master." First and second grade children, however, had some difficulty, as one student working with first grade children remarked, "With my assistance, the children could find the books that they wanted. But it will a long time before they can do this on their own."

Use of the multimedia encyclopedia was reported frequently, with 37 accounts. The students raved about the program, "The program has many features that appeal to the kids," and "was engaging, informative, and attractive." In fact, the students themselves were "awed by the encyclopedia" and wished to have had "these wonderful materials" when they were in school. Commonly mentioned features included colorful pictures, animation, graphics, sound, information readily available, time saving, multiple avenues of locating information, and relevance to personal interest. For instance, one child was interested in learning about dogs because he was about to get his first dog. Another child "looked at World War II on the multimedia encyclopedia. He then started to tell me about his grandfather fighting in that war. He was very excited to see something his grandpa was involved in on the computer."

Instructional software. Throughout the journal entries, students reported using approximately 40 software programs with children across subject areas. Of these programs, one was by far the most popular: 70 accounts of the use of *Math Blaster* (math skills by Davidson). Other programs with frequent use included 30 accounts of *Kid Pix* (paint and graphics by Broderbund), 28 accounts of *Reader Rabbit* (early reading skills by The Learning Company), 14 accounts of *A Field Trip to the Rainforest* (exploration and discovery by Sunburst), 12 accounts of *Math Rabbit* (basic math skills by The Learning Company), 12 accounts of *Just Grandma and Me* (interactive story by Broderbund), and 11 accounts of *Word Munchers* (vowel sounds by MECC). All the other programs were used six times or less.

Software was limited to those programs which were currently available in the classrooms and the media center. Students discovered the importance of good software as they interacted with children using software of varying levels of quality. For instance, a number of students explained why the children enjoyed the *Math Blaster* program:

> S: The children practice adding, subtracting, multiplying, and dividing numbers in a fun and exciting way. This program had great graphics, color, and sound as well as an action packed arcade-game style, so it held the children's attention for a long time. Because it had 4 games within one program, the kids did not get bored. If they didn't like one game, they could switch to the next one. This program made math relevant, interesting, and stimulating. The children enjoyed it greatly. In fact, the children complained when I told them it was time to stop.

Additional observations. In addition to student responses to word processing, data base, and instructional software described above, two major issues commonly expressed by a number of students are described here. One issue concerned the varying degrees of experiences with computers by the students, children, and teachers. Based on demographic information on the experimental group, 16 students perceived themselves as expert computer users, 29 reported using computers mainly as word processor, and 13 reported little or no previous experiences with computers prior to the technology laboratory.

Some of the elementary school children, even those in first grade, had previous experience using computers. The students were often surprised at "how little help the kids needed from me" in using computers and related technology. Even the children who had not had experience were inquisitive, interested, and willing to learn. While the students were impressed by the children, they also noted that many of the teachers had only limited knowledge or experience with computers. On a number of occasions, the students demonstrated to the teachers the basic operations, introduced software programs, and helped them overcome fears of technology.

The other issue concerned the difficulty of keeping up with technological advancement in the classroom. This issue became more serious when some children had more advanced computers at home compared to those in the classroom. One student noted, "Sometimes they lacked willingness to learn the old computers." Another student noted the difficulty as follows:

> S: Both students had more advanced computers at home than the Apple IIs in the classroom. The Apple is an antique to them. This is sad because it forced them to be less advanced. However, the class is lucky to have its own computers. Keeping up with technology these days is difficult and quite costly. Despite working with this antique, the children listened to everything I had to say and were quite inquisitive.

Attitudes toward Computers

The students frequently expressed their attitudes toward computers in their journal entries. These responses were categorized in terms of anxiety, enthusiasm, and confidence.

Anxiety. Seven students expressed their anxiety and apprehension about their lack of knowledge and experiences with computers. Owing to the atmosphere of support and assistance available through their technology laboratory, even the students with anxiety soon became comfortable using the computers and working with children. The following examples represent common responses:

> S: I was rather shocked that these children knew more about turning on the computers and clicking into programs than I did, and I did not feel that I was much help to them at all. Actually they were able to teach me a few things!

> S: On this first day of going to school, I was a little nervous because I did not know what to expect from the children and I did not feel very confident using the computers. As I sat with the kids and got them using the computers, I felt much more comfortable.

Enthusiasm. The students were enthusiastic about the use of computers in classroom instruction. Of the 58 students in the study, 33 expressed such enthusiasm. Many students were impressed by the fact that children were excited about computers, knowledgeable with computers, and willing to learn to use computers:

S: The most gratifying aspect of today was watching the children socially and mentally interact with one another while trying to manipulate and figure out the outcome of software programs.

S: As I was walking out to my car, I heard a child calling my name. It was Alexander. He asked me if next time he could finish what he was typing and learn some more. I was so excited to know he was anxious to learn.

A number of students also emphasized the importance of technology in education:

S: Overall, my field experience was very enjoyable and I had an opportunity to witness how important technology and the use of computers has become as an educational tool. The programs I used with the children allowed them to see their mistakes as they wrote them and also served as a tool to fine tune their skills.

S: It [technology laboratory] allows both the teachers at the school and the future teachers from the University to see how much technology can enhance learning at all levels of education.

Confidence. Of the 58 students, 20 expressed increased confidence with the use of computers. Students with little prior knowledge or experience became more comfortable:

S: I definitely learned so much about computers. One month ago, I didn't even know how to turn on a computer!

Students with some knowledge and experience were eager to share their skills with the children and their teachers:

S: I was able to teach my students and the teacher many of the things I had learned or already knew, which made me feel much more confident about computers.

Some students with advanced knowledge and experience provided technical assistance with various types of equipment, as one student said, "Toward the end of the day, I got the hang of how to work with the new system. I love when things work!" Several students found ways to expand the use of existing programs or even created new programs (e.g., graphics programs).

Infusion of Technology into the Curriculum

The students often commented on the importance of incorporating technology into the curriculum. Fourteen students specifically wrote about their efforts to use technology to support the curriculum. In choosing the computer programs or different levels within the programs, the students considered subject areas, instructional objectives, grade levels, and abilities of individual children. One student wrote, "I asked the teacher what they were learning and doing in class, so I could correlate the computer programs with what they were learning." In the following example, one student with no experience with computers attempted infusion on her first day of working with sixth grade children:

> S: I took two students to the media center to help them with their class projects on rain forest. First, we used the Macintosh to observe the *Field Trip to the Rainforest* program. Then we used the CD-ROM - *Compton's Encyclopedia* and searched under the subject of rain forest. We printed out the material and then used the *Impact* program to find books about the rainforest. I then brought the kids back to class. (The kids I worked with on the rain forest received A's on their report.)

While emphasizing the importance of infusion, a number of students expressed concerns and difficulties with their efforts. One concern was the use of computers as reward or punishment for good or bad behavior, rather than a component of classroom instruction. One student noted, "Time on the computers seemed more a reward for completing their work or good behavior, than a tool for actual teaching."

Another concern expressed by several students involved a great range of variations in the academic abilities and computer knowledge and experiences among children. The students found it difficult to make adaptations to meet the needs of individual children. Several students described incidents in which more experienced and capable children dominated small group interactions without allowing their peers to participate or contribute. One student described a boy who was generally well mannered and good natured in class, but he got bored with the program which was too easy for him while other group members were struggling. The boy complained, called others "stupid," and did not try other programs until the student intervened and helped the boy to work more cooperatively. Several students emphasized the importance of cooperation, patience, and understanding among children in the use of computers.

Still another major concern expressed by 11 students involved the teachers' lack of knowledge or experience with computers and related technology. The students often did not receive guidance or observe the teachers model the infusion of technology into the curriculum. Instead, the students had to devise plans of infusion:

> S: The programs available in the classroom seemed primitive compared to those in the media center. I found myself wondering how much, or how little, the teacher used the computer in her teaching, if at all.

S: The teachers we are assigned need to be more aware and knowledgeable of the computers and technology that we are required to do. That will allow us to spend more time on these things.

Student Responses to Field Experience

In addition to student responses to technology, many students expressed their reactions to field experience in general. On the first day of their field experience, 23 students expressed their excitement and anticipation as well as nervousness and uncertainty. On the last day, 30 students reflected on their field experience. The responses were overwhelmingly positive, in terms of appreciation of teaching as rewarding but hard work, enjoyment of working with the children, and confirmation of their desire to be teachers. While some students expressed sadness to leave the classrooms, others continued to make regular visits. Of all the responses, only two students expressed overall negative responses to their field experience. In both cases, the students were frustrated working with teachers who did not provide them with enough opportunities to work with the children using technology.

Conclusions and Implications

The study was part of the on-going evaluation of a restructured teacher preparation program that emphasized technological applications as a major theme of its knowledge base. The findings of the study are valuable for revising and improving the technology laboratory and the program, as well as contributing to the growing body of literature on technology in education.

Considering that most of the students in both the experimental and control groups were already frequent users of word processors (i.e., a ceiling effect), it is not surprising that there was no significant change in the use of computers as word processor. Although students in both groups had not used data bases or instructional software before the study, the students in the experimental group reported more familiarity with these applications after completion of the laboratory. The qualitative results indicated that students gained experience with various types of data bases and instructional software. The most noticeable findings were in the area of infusion of technology into the curriculum. These results are noteworthy, especially considering the short duration of the field-based technology laboratory and despite the lack of modeling and guidance by some of the teachers. The students were surprised to discover that some elementary children seemed to know more about computers than the teachers (Jordan, 1993) and they were disappointed at little technology use in their field experience (Fulton, 1993). The students helped some of the teachers to become familiar with computers, overcome fears of technology, and recognize the importance of infusing technology into classroom instruction.

The technology laboratory experience did not result in any significant change in students' attitudes towards computers in general as measured by the questionnaire. Their journal entries, however, revealed that the students became more enthusiastic and confident in using computers with children in instructional settings. Even those students with little or no prior experience, after receiving the instruction on the use of computers and related technology, became more comfortable. For these students, exposure to technology and changes in attitudes seemed to occur simultaneously (Maurer & Simonson, 1993; Reed, 1990; Woodrow, 1992).

The findings provide important implications for computers and related technology in teacher education. As these implications are put into practice, the implementation process and impact need to be investigated using a variety of research methods. Major implications are discussed next.

The results highlight the role of field experience as the context for technology training. Most of the preservice teachers in the study reported frequent use of computers as word processor, but to a much less extent of data base or instructional software. The significance of the technology laboratory for these preservice teachers was not improved attitudes towards computers in general, but greater familiarity with data bases and software and infusion into the curriculum. The field-based technology laboratory with children in classroom settings helped them recognize the potential of technology for curriculum and instruction, as well as its limitations (e.g., poor quality of some software). The laboratory also made them aware of management issues associated with computer use, such as the importance of sharing and cooperation among children, choice of appropriate software, and responsible handling of equipment (Butzin, 1992).

The technology laboratory is also significant in terms of its role in the overall teacher preparation program. The technology laboratory was part of the first course in the program, exposing the preservice teachers to technology early on. In addition, unlike many teacher preparation programs which do not emphasize technology as central (Charp, 1995; Johnson & Harlow, 1993), the program in the study emphasized technological applications in education as a major theme in its knowledge base. Building on students' early exposure to technology, the program will provide modeling and guidance in the infusion of technology as an integral component of classroom instruction.

Collaboration between the school and the university was another important feature of the technology laboratory. Many university programs have inadequate resources for integrating technology (Roblyer, 1994), while schools face discomfort of teachers with technology (Ferris & Roberts, 1994). The collaboration in the study involved a public elementary school providing its new media center and a university contributing a technology educator and graduate assistants to help teachers and children. The collaboration is currently moving from logistical issues in the first trial into on-site staff development by university technology educators. Staff development started with helping teachers identify appropriate software for meeting instructional objectives. As the teachers receive continued support for the use of technology in classroom instruction, they will provide modeling and guidance for preservice teachers as well as improve their own teaching. These preservice teachers, in turn, will provide modeling and guidance for other teachers in the future.

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