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From the University to the Elementary Classroom: Students' Experiences in Learning to Integrate Technology in Instruction

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This study employed qualitative and quantitative methodologies to investigate effective approaches to technology integration in teacher-preparation curriculum, incorporating credential coursework and field placements. The study emphasized collaborative efforts among colleges of education and K-12 districts, implementation of technological innovations within the context of the school reform, and the role of technology in cultivating students' higher-order learning faculties. The findings of the study revealed a peripheral role of technology in teacher preparation experience, insufficient students' exposure to technology integration, positive shift in student attitudes toward technology use, and the pivotal role of mentor teachers in technology integration at the field placement sites.

Improved integration of technology in K-12 instruction has become a national imperative in the United States. Numerous state and federal governmental bodies have adopted legislation supporting the use of computers and the Internet as a tool to improve academic achievement (see International

Society for Technology in Education [ISTE], 2002; California Commission on Teacher Credentialing [CCTC], 2002). However, even with the latest emphasis on technology, many public school districts are faced with an unwelcome surprise. After spending millions of dollars to connect their schools and their students to the Internet, their newly installed computers often sit unused.

A key factor constraining effective use of technology in schools is teachers' limited expertise in the professional use of computers (Preparing Tomorrow's Teachers to Use Technology [PT3], 2002). Traditional teacher-preparation programs have not adequately provided preservice teachers with either effective models of technology use or sufficient experiences with technology integration in their professional education courses (Brown, 2003; Smerden et al., 2000), thus lending support to the views of many (Rowley, Dysand, & Arnold, 2005; Waddoups, Wentworth, & Earle, 2004) that preservice programs are falling short in the area of educational technology.

There is a broad range of prior research documenting technology integration in teacher education (Adamy & Boulmetis, 2006; Best, 2002; Brown, 2003). However, most existing research addressing this topic focuses primarily on documenting changes in the way faculty use technology throughout credential coursework. The current study expands these findings by delineating the connection between the university and K-12 classrooms, thus attempting to shed a new light on preservice teachers' experiences in all aspects of teacher-preparation program, including field placements.

INTEGRATING TECHNOLOGY IN PRESERVICE TEACHER EDUCATION

The concerns about integrating technology in preservice teacher education are well-documented in the literature. In a summary report that examined a number of meta-analytic studies, Brown (2003) concluded that the educational system has done an inadequate job of "empowering teachers to appropriately and effectively use computer-related technology in the classroom" (p. 3). Similarly, many researchers have voiced concerns that preservice teachers see minimal modeling of effective instructional strategies that incorporate technology into their professional education courses (see detailed discussion in Brown, 2006).

Various grant programs such as Preparing Tomorrows Teachers to Use Technology (PT3) were developed to address these concerns by assisting future teachers to use technology for optimal learning and achievement. The PT3 program goal was to affect 600,000 teachers through 441 grants during

the four years of the program, which ended in June 2003 (Market Data Retrieval, 2004). PT3 grantees developed goals, models, and tools that supported this national initiative.

Numerous instructional technology studies reported on key findings that emerged from the PT3 related research (Adamy & Boulmetis, 2006; Best, 2002; Waddoups, Wentworth, & Earle, 2004). These findings include the need for the university faculty to upgrade their technological expertise, to model technology infusion into curricula, and to provide a comfortable learning environment for technology application. These studies also pointed to the importance of placing student teachers in technologically rich and supportive environments.

Several researchers have reported on innovative learning solutions that support preservice teachers as they attempt technology infusion at their field placement sites (see detailed discussion in Brown, 2006). To illustrate, The Fermi National Accelerator Laboratory (1999) created a communal data base incorporating projects that demonstrate principles of engaged learning and effective use of technology. This data base provides preservice teachers with opportunities to model expert performance thus increasing their proficiency to infuse technology in their future classrooms.

Moreover, several research trends (Cognition and Technology Group at Vanderbilt, 1990, 1993, 1997; Grabe & Grabe, 2004; Kulik, 2003) suggest that the primary value of information technologies lies in their capability to enhance students' higher-order learning and problem-solving skills. The rapid diffusion of information and communication technology in the last decade has created an increasing variety of instructional opportunities that may facilitate aptitude development and higher-order learning among students. However, the use of technology to promote higher-order learning can only occur when classroom teachers are trained to embrace new technologies and blend them intelligently into their curricula (Kulik).

Despite the latest progress in integrating technology in teacher education, there is a continuing demand to better prepare preservice candidates for teaching in the information age. The key motivation of the current study was to help find practical and effective methods to prepare qualified teachers by examining the participants' experiences in all aspects of teacher-preparation program, including field placements.

METHODOLOGY

A case study approach was used in this research to explore the participants' experiences over time through detailed, indepth data collection

involving multiple sources of information. The study incorporated three units of analysis: (a) the program, (b) the general participants, and (c) the focus participants. According to Yin (2003), multiple units can often add significant opportunities for extensive analysis, enhancing the insights into the single case. In this particular study, examining the experiences of the general participants as they progressed through their teacher-preparation program and practiced teaching provided the insights into how they applied their knowledge within the real world context of the field placement sites. A closer examination of the six focus participants offered additional insights into the factors affecting the participants' decisions to integrate technology during field placements. Furthermore, this particular design allowed for both quantitative and qualitative approaches to case study development as recommended by Yin.

Research Sites and Participants

The general participants of the study were 110 students enrolled in the three sections of an information technology course required for the completion of the Multiple Subject Credential and the Master of Arts in Teaching Programs in an accredited public research university in the United States. The university has a reputation for excellence in educational technology research and has received two substantial grants to support enhanced technology infusion into curricula. Within the general participants' group, six students were investigated as focus participants. The focus cases were used to generate detailed observations and interviews intended to confirm themes that arose during the broader data collection. These participants were placed in various elementary schools that served a broad range of culturally, linguistically, and economically diverse student populations. Furthermore, the schools varied considerably in their academic accomplishments.

Data Collection

The primary sources of data for the study were surveys, participant observation, interviews, and student online discussion groups.

Surveys. Three different surveys were administered to the general participants throughout the course of the study. Approximately 85% of the survey questions were adopted from the Teaching, Learning, and Computing

(TLC) National Survey of Schools and Teachers conducted by Dr. Henry Jay Becker and Dr. Ronald E. Anderson in 1998. TLC survey questions on teachers' pedagogy emerged from a preliminary validation study (Becker, Ravitz, & Wong, 2000). The surveys assessed such constructs as the participants' technology beliefs, technological proficiencies, teaching philosophy, use of technology for higher-order learning, and the opportunities for technology application during field placements. Dichotomous response, Likert scale, and open-ended questions were included in all three surveys (a copy of the surveys may be obtained from the authors through e-mail request). Each participant was assigned a unique numerical identifier to preserve anonymity and to match different waves of data from the same participants across multiple survey administrations. All surveys were administered at the university campus as a regular classroom activity for the duration of approximately 20 minutes.

Participant observation. The researcher observed student behaviors during class time and student teaching through informal class observations. During the fall quarter, the researcher observed three sections of the information technology course that was designed to provide preservice teachers with a foundational understanding of technology use in the classroom. A total of 87 hours of instruction over the fall quarter was observed. The researcher focused these observations on changes in students' technological proficiencies and beliefs to corroborate findings obtained from the surveys. Observations were conducted using the "full field note" method of data collection (Olson, 1976), which involves taking extensive notes during or immediately after the events being observed. To avoid unwarranted inferences made by the researcher, care was taken to make field notes as factual and as concretely descriptive as possible, as recommended by Schofield (1995). For example, instead of or in addition to stating that a student was bored with a class, the researcher recorded behavioral manifestations of student's internal state, such as looking at material from other classes rather than at the instructor presenting the lecture.

Observations of the six focus participants during the winter quarter were conducted in local elementary schools where the participants completed their student teaching assignments. Observations were arranged with each focus participant and were carried out during times when technology was most likely to be used in teaching and learning. Classes were observed for an average of two 50-minute periods of instruction per each focus participant for a total of 12 hours of observation overall. During these observations, the researcher concentrated on noting application of knowledge

gained by the participants through their teacher-preparation courses within the real world context of their field placement sites. Additionally, the researcher spoke with the focus participants and their mentor teachers before, during, and after class observations to determine the frequency and the extent of technology use outside of the scheduled visits. The data obtained from these informal conversations were later corroborated by individual and group interviews, survey responses, and online discussion groups. Extensive field notes were taken during and immediately after the observations occurred.

Group interviews. During the winter quarter, the researcher conducted two 50-minute formal semi-structured group interviews with the six focus participants to further assess their frequency of technology use, technology beliefs, use of technology for higher-order learning, and the quality of technical and instructional support at the schools sites. Interviews were conducted in groups of three. The researcher used a semi-structured interview approach, as suggested by Glesne and Peshkin (1992). The general interview protocols were assembled in advance with some open-ended questions to allow discussion of the topics that were significant to the students.

The group interview approach provided the preservice teachers with opportunities to share their experiences concerning incorporating technology in their classrooms. As the participants engaged in conversation, they encouraged each other to expand on their responses and to recall experiences that were not mentioned during individual interviews.

Individual interviews. The researcher conducted two 50-minute interviews with each of the six focus participants at different times of the winter quarter. Additional interviews were scheduled with the participants who provided information that furthered the goals of the study. The individual interviews provided a personalized opportunity to explore the story of each focus participant in greater detail and to examine the factors influencing their decisions to integrate technology in their teaching. These semi-structured interviews included questions concerning the participants' personal experiences with technology, their mentor teachers' attitudes toward technology use, and computer configuration in their classrooms and the school sites. Most interviews were conducted at the university campus or at local elementary schools where the participants completed their student teaching assignments. All interviews were conducted using procedures similar to those described in Schofield (1995). For example, questions were posed in a balanced manner so that leading questions were avoided. Interviews were carried out

without being video-or audio-taped to encourage more spontaneous interaction. However, detailed field notes were recorded during and immediately after the interviews to insure accuracy of collected data.

Online discussion groups. The researcher used online discussion groups to gather additional information concerning students' attitudes and experiences throughout the course of the study. The participants were encouraged to contribute a minimum of one message per week and to discuss issues concerning their experiences in the program, their attitudes and beliefs regarding technology use in the classroom, and any additional topics they considered pertinent to the goals of the study.

Data Analysis

Qualitative data analysis was conducted in an ongoing fashion during the course of the study. Participant observations and personal interviews were coded and analyzed according to the recurring key themes, which in turn refined subsequent observations and tailored the topics for personal interviews. All field notes were coded using procedures similar to those described in Schofield (1995). The coding consisted of an iterative process that began long before data collection was completed. This process involved reading the notes numerous times, coding them by topic and theme, studying, comparing, and contrasting the notes classified under any given code, and finally looking for patterns and themes that integrated separate codes.

During the course of the study, the data were triangulated among various sources such as student responses to survey questions, researcher's observations, and personal interviews. For example, during the winter quarter, the researcher's observations focused primarily on technology integration practiced by the participants within the real world context of their field placement sites. In addition to participant observation, questions about technology integration were included in personal interviews and a winter survey. Furthermore, the researcher checked all hypotheses and conclusions by explicitly looking for contrary evidence, carefully considering rival explanations and conducting member checks.

Qualitative data analysis techniques included pattern matching, domain analysis, and content analysis. Pattern matching was used as a first pass through the data to identify and confirm broad patterns emerging during the data collection process.

The researcher used domain analysis to identify the ways in which preservice teachers conceptualized technology infusion based on their experiences

during student teaching assignments. Content analysis was employed to make justified inferences from various documents such as course catalogues, schedule of classes, and school web sites.

As a part of quantitative data analysis, the researcher reviewed each survey to assure accuracy, legibility, and completeness. A verbatim listing of all the responses to the open-ended questions was generated and numerical categories were assigned to the groups of logically related responses. Quantitative analytical procedures consisted of descriptive statistics (e.g., frequency distributions), two-tailed paired samples *t*-test procedures, correlation analysis, and regression analysis. For instance, frequency distributions were calculated to convert open-ended survey responses into percentages presented in the tables. Two paired samples *t*-test procedures were used to respectively compare changes in the participants' attitudes and their technology skills at the beginning and at the end of the information technology course. A correlation analysis was performed to establish the relationship between the participants' attitudes toward computers and their technology use during field placements. A regression analysis was performed to determine the variables contributing to technology integration during field placements.

SUMMARY OF FINDINGS

The data analysis revealed four major patterns, which we labeled *peripheral role of technology in teacher preparation experience*, *insufficient exposure to technology integration*, *positive shift in student attitudes toward technology use*, and *pivotal role of field placements*.

Peripheral Role of Technology in Teacher Preparation Experience

Data collected during credential coursework indicated escalating levels of anxiety concerning the participants' workload in the program and their inability to focus on the information technology course. These data were triangulated among various sources such as the participants' survey responses, the researcher's observations, and online discussion groups to insure internal validity. The participants' concerns about the workload were particularly evidenced by their comments posted to the online discussion group. In general, such comments indicated that the participants were overwhelmed with the amount of homework required by their methods courses and that they appreciated the fact that most of their assignments for the information technology

course could be completed during class sessions. As one participant stated, "I appreciate the fact that the professor allows us to do our work during class time. This is very helpful since we are overwhelmed with work." Another participant concurred, "Today we have the class period to work on our research papers, iMovies, and other class projects. I really appreciate having this time to work on our projects because of the large workload that we have from our other classes. Thank you."

The same pattern persisted throughout field placements. During field placements, the use of technology was considerably constrained by overwhelming demands placed on student teachers, thus perpetuating the peripheral role of technology in a teacher preparation experience. Data triangulated from student interviews, winter surveys, and the researcher's observations revealed that the participants' attempts to use technology consistently lost out to stronger pressures to focus instruction on covering standard curriculum material and to prepare students for testing. As one participant acknowledged, "there is a major focus on testing right now and computers are not a part of this focus." Another participant concurred, "There is so much content needs to be covered in so little time. It's hard to allow enough time for all students to use computers."

Insufficient Exposure to Technology Integration

In addition to the fact that technology played a peripheral role in a teacher preparation experience, the findings of this study suggested insufficient student exposure to technology integration throughout the information technology course in this program. Most of the emphasis during the course was placed on mastery of hardware and software functions rather than on training the participants to integrate technology into classroom teaching. At the end of the course, most participants did not feel prepared to enter a classroom ready to teach in technologically rich environments. The participant' opinions concerning the lack of emphasis on technology integration during the course were succinctly captured by the following comment on the second fall survey: "I feel as though the course did not emphasize integration very well. We learned technology skills, not tasks that can be used for integrating technology into our classrooms." Although the findings of the current study concerning this topic may be attributed to the expertise or personal preferences of the individual instructor, they converged with the general trend depicted in the prior literature (Adamy & Boulmetis, 2006; Smith, 2002).

Furthermore, the students' project work during the information technology course did not reflect the use of technology to promote higher-order learning. Many researchers agree (Cognition and Technology Group at Vanderbilt, 1990, 1993, 1997; Grabe & Grabe, 2004) that the primary value of information technologies lies in their capability to enhance students' higher-order learning and problem-solving skills by using collaborative project-based instruction. Yet, in the information technology course in this program, all project work was completed individually and focused primarily on the mastery of hardware and software functions rather than on critical collaborative uses of technology. The following excerpt from the researcher's field notes captures an example of the project-based work during the information technology course:

> Today, students work on completing their web page projects. They seem to enjoy this activity, although they still appear confused by the abundance of software features available with Netscape Composer. The majority of their questions tend to focus on basic software functionality thus overlooking overall design considerations. Some students are still unclear about saving their work on the departmental servers. It seems like these technical concerns prevent the students from focusing on the content.

Insufficient exposure to technology integration and the lack of emphasis on using technology to enhance higher-order learning were also evident during field placements. Few participants consistently used technology at their placement sites for higher-order learning or problem-solving activities involving acquisition of information, analysis of ideas, and demonstration of content understanding. Only 10.8% of the participants reported using technology in collaborative projects, 12.2% used technology to acquire content expertise, 12.2% used technology for data collection, and 13.5% used computers for writing and multimedia presentation tasks. Furthermore, the findings of this study indicated that word processing applications and web search tools used for information acquisition were the most common computer activities during field placements. Conversely, more sophisticated analytic software such as simulation modeling programs, were used regularly in only a small minority of academic classes.

Positive Shift in Student Attitudes toward Technology Use

Despite insufficient exposure to technology integration and the lack of emphasis on technology use for higher-order learning, the findings of this

study suggested a positive shift in the participants' attitudes toward technology throughout the program. These findings were obtained by using both quantitative and qualitative methodological approaches.

The participants' technology beliefs concerning advantages and disadvantages of computer use in eight specific areas were measured by two 8-item Likert-type questions on the survey administered at the beginning and at the end of the information technology course. The questions addressed such issues as integration of computer activities into the lesson plans, using computers for high-order learning and collaborative work. The two indexes of the participants' technology beliefs (advantages and disadvantages) were measured by the same set of Likert-type questions in both surveys in order to detect changes over time that could be attributed to the program's effect. The differences in means between two survey administrations were computed using a two-tailed paired samples t-test procedure.

Table 1

Paired Sample *t*-Test Comparing Preservice Teachers' Attitudes at the Beginning and the End of the Fall Quarter

		N	Mean	Std. Deviation	*t*	Effect Size	Sig. (2-tailed)
Advantages of computer use	Survey 1	110	2.6387	.48691	2.361	**.3325**	.021
	Survey 2	110	2.8216	.61199			
Disadvantages of computer use	Survey 1	110	2.0602	.49685	.154	.0187	.878
	Survey 2	110	2.0701	.56052			

As conveyed in Table 1, the difference in the participants' beliefs concerning the advantages of computer use was significant as measured by the *t*-test (2.361) and the effect size (*d*) of .3325. In this particular study, the effect size of $d = .3325$ ($d > .25$ was used as a benchmark) represents a substantial increase in the participants' beliefs in the advantages of computer use, which may be attributed to the program's effect. Conversely, change in the participants' beliefs about the disadvantages of computer use was not significant as measured by the *t*-test (-.154), and the effect size of $d = .0187$ was trivial.

To corroborate findings obtained from the Likert-type responses, the participants' technology beliefs concerning advantages and disadvantages of

computer use were also measured by the open-ended questions included on the same surveys. The participants were asked to comment about changes in their attitudes toward technology use during the informational technology course. The results of the survey indicated that despite the fact that the participants entered the program with a wide variety of technology related skills and abilities, there was a positive shift in the participants' attitudes toward technology use during the course (Table 2). Moreover, the analysis of the open-ended responses reveled that no students reported a decline in their attitudes toward technology use during the fall quarter course.

Table 2

Change in the Participants' Attitudes During the Fall Quarter

Preservice Teachers' Attitudes	*Percent*	*N*
Improved, technology is attainable and beneficial	67.7	
No change	21.5	
Improved, but need more guidance	10.8	
Total	100.0	110

Students' comments posted to the online discussion group resonated with the responses obtained from the survey, as illustrated by the following excerpts:

> Linda: I think this course is helpful because I generally try to avoid using computers whenever possible. I am now a bit more comfortable and see the benefits of technology for students in a classroom but am still having difficulty with Macs.

> Karl: I just want to say thank you so much for being patient with me. It was frustrating at first to work with the computer but I feel lot more confident now in using the computer.

The positive shift in their attitudes may be explained by the increased proficiency in computer skills resulting from the participation in the information technology course. As one student stated, "I now know that computers are not as threatening as they appeared to be. In this class, the instructor has walked us through each project making computers, for me, more tangible."

A continued positive shift in the participants' attitudes toward technology was observed during field placements. At the end of their students teaching assignments, preservice teachers' technology beliefs were re-measured by an open-ended question included on a third survey. The participants were asked to comment about changes in their attitudes toward technology integration during field placements. The results of the survey indicated that despite the variability in the participants' experiences with technology integration during their field placements, there was a continued positive shift in their attitudes toward technology infusion into classroom teaching (Table 3).

Table 3

Change in the Participants' Attitudes During Student Teaching

Preservice Teachers' Attitudes	Percent	*N*
Enthusiastic, would like to see more integration	59.5	
No change	19.0	
Computer integration is not feasible	21.5	
Total	100.0	74

In general, the participants' comments indicated that computers are particularly beneficial when used for such learning activities as differentiated instruction, assessment, and Internet research. The participants' attitudes toward technology integration in instruction were succinctly captured by the following student comment on the winter survey: "I see tremendous benefits to using technology in the classroom. It allows students to work at different levels; it allows me to assess all students' learning and progress; it provides access to infinite research."

The positive shift in the participants' attitudes during the winter quarter may be attributed to their increased experience with using technology within the real world context of the field placement sites. To corroborate this assertion, a correlation analysis was performed to establish the relationship between the participants' attitudes toward computers and their technology use during field placements.

Table 4
Correlations Between the Participants' Computer Use and Their Beliefs About Technology

	Change in the Participants' Beliefs in the Advantages of Computer Use	*N*	Sig. (2-tailed)	Change in the Participants' Beliefs in the Disadvantages of Computer Use	*N*	Sig. (2-tailed)
Frequency of Technology Use During the Winter Quarter	**.309(*)**	74	.031	.042	74	.774

Table 4 indicates the correlation between changes in the participants' beliefs and their technology use during the winter quarter. According to Becker (2000), in the survey measurement context correlations above .30 are considered substantial. In this particular study, the correlation coefficient of .309 indicated that the increased computer experience within the real world context reinforced the participants' beliefs in the advantages of technology in teaching. At the same time, using computers in their teaching was not associated with either an increase or a decrease in the disadvantages believed to be associated with computer use. Overall, then, there was a positive shift in the participants attitudes during field placements.

Some of this shift may be attributed to the children's enthusiasm about using computers. Many participants indicated that using technology in their classrooms was highly motivating for students of various levels and abilities. The following excerpt from a student's winter interview illustrates this point:

> In my class, using a computer was considered a privilege or reward for the students. For example, we used Accelerated Reader program to assess students' reading comprehension. Some of my students wanted to take a test even before they finished reading a book because they were so excited about using a computer. Often, I saw them fight over their turn to use the machines.

While prior studies have found that individuals' attitudes toward computers might improve as the result of proper instruction (Kluever, Hoffman, Green, & Swearingen, 1994), the results of the current study extended these findings by suggesting that the increased proficiency in computer skills resulting from a mere familiarity with hardware and software functionality improves the participants' beliefs in the utility of technology in their teaching.

Pivotal Role of Field Placements

The pivotal role of field placements in increasing the participants' technological proficiency and improving their attitudes toward computers became apparent during the current study. The participants in this study encountered a myriad of factors influencing their decisions to integrate technology at their field placement sites. However, based on both qualitative and quantitative methodological investigations, the effective use of educational technology by the preservice teachers most strongly depended on observing proficient mentor teachers who modeled technology-enriched instruction.

For instance, the qualitative investigation conducted during field placements revealed essentially identical patterns in both the frequency and the nature of technology use between the participants and their mentor teachers. The information depicted in Table 5 was obtained from recording events during participant observation in local elementary schools where the candidates completed their student teaching assignments and the interviews with the six case study participants and their mentor teachers. During these interviews, the researcher attempted to determine the effect of additional factors such as computer availability on the participants' technology use. In general, the participants' indicated that while the availability of computer equipment affected the frequency of students' computer lab visits, it did not have direct influence on their teaching practices involving the uses of technology. The following excerpt from Nancy's interview illustrates the role of modeling and apprenticeship in preservice teachers' deployment of technology during field placements:

> For the most part, students do not use computers in my classroom... I only saw my [mentor teacher] using computers once during the quarter. She used a CD that came with a textbook for our health unit. Our district requires that students take some computerized tests, but students in my class do very poorly on those tests since they are not used to this mode of testing. I don't feel comfortable using computers in my instruction because my [mentor teacher] has an established routine and I don't want to disrupt her routine.

In addition to the qualitative investigation, a regression analysis was carried out to determine the variables contributing to technology integration during field placements. The regression equation examined the predictive power of ten independent variables to account for variability in the preservice teachers' amount of computer use. The independent variables included the participants' technology beliefs concerning advantages and disadvantages of computer use assessed at the beginning of the information technology

course, change in the participants' technology beliefs concerning advantages and disadvantages of computer use during the information technology course, the participants' teaching philosophy, frequency of technology use by the participants' mentor teachers, computer availability at the placement sites (classrooms and other locations), grade taught during the winter placement, and technology support at the placement sites.

Table 5

Technology Use by Preservice Teachers and Their Mentor Teachers

Preservice Teacher	Mentor Teacher's Technology Use		Preservice Teacher's Technology Use	
	Frequency of Technology Use	Technology Use for Higher-Order Learning	Frequency of Technology Use	Technology Use for Higher-Order Learning
Becky	High	Some	High	Some
Nancy	Very Low	None	Very Low	None
Sima	High	High	High	High
Crystal	High	Some	High	Some
Emily	Low	Low	Low	Low
Suzanne	High	Some	High	Some

The results of the regression analysis conveyed in Table 6 support the qualitative findings presented in this study. The standardized regression coefficient of .570 indicates that the use of educational technology by the preservice teachers is strongly associated with observing proficient mentor teachers who model technology-enriched instruction.

DISCUSSION AND IMPLICATIONS

This study was carried out within the preservice teacher-education program of a single university, and thus cannot be generalized to other contexts. However, there is much in other related research (Adamy & Boulmetis, 2006; Brown, 2003; Hernandez-Ramos & Giancarlo, 2004) to suggest that many of the issues noted in this program are indicative of broader trends.

Table 6

Regression Analysis Representing Regression Coefficients

	Standardized Coefficients	Correlation Coefficients	Signif. or Beta
	Beta		
Advantages of computer use assessed in the beginning of the fall quarter	.239	.064	n.s.
Disadvantages of computer use assessed in the beginning of the fall quarter	-.174	-.079	n.s.
Difference in technology advantages between the beginning and the end of the fall quarter	.031	-.048	n.s.
Difference in technology disadvantages between the beginning and the end of the fall quarter	-.128	.060	n.s.
Participants' teaching philosophy	.029	.025	n.s.
Frequency of technology use by mentor teachers	**.570**	.541	$p < .01$
Number of classroom computers	-.103	-.143	n.s.
Maximum number of computers in other locations	.246	.137	n.s.
Grade taught	-.134	-.329	n.s.
Support at the school sites	-.051	-.065	$p < .10$

The current study thus supports the view that many new teachers entering the profession are inadequately prepared to effectively use educational technologies. In less than a decade, over two million teachers must be recruited to replace retiring teachers (PT3, 2002). There is no guarantee that these future teachers will be well-prepared, technology-proficient educators without considerable improvements to the teacher-preparation system (see discussion in Brown, 2006). Based on the findings of the current study, such improvements may include (a) technology infusion into the methods courses, (b) systemic revision of the information technology course, (c) placements of teacher candidates with technologically proficient mentors, and (d) increased collaboration between colleges of education and K-12 districts.

Infuse Technology into the Methods Courses

Several trends of prior research (Adamy & Boulmetis, 2006; Best, 2002) found that traditional teacher-preparation programs have not adequately provided preservice teachers with modeling of technology integration in their professional education courses. The results of the current study extended these findings suggesting that even in a program that presumably promoted the development of technology-enriched instruction, the participants observed little technology integration into their methods courses. In general, the participants in the study indicated that faculty in their professional preparation courses did not model technology infusion into curriculum, but rather that the program relegated technology training to a single information technology course.

Effective technology integration into the methods courses may provide contextualized, collaborative learning environments that support curricular content. Kulik (2003), who summarized the results of evaluative studies addressing the effectiveness of computer-mediated learning, concluded that it has been "producing positive results in mathematics programs for decades" (p. 60). Students using the Knowledge Integration Environment (KIE) framework, which was designed to incorporate the growing wealth of Internet resources to promote an understanding of science, were more likely to creatively expand their understanding of scientific phenomena and to successfully evaluate new scientific information (see discussion in Brown, 2006).

Additionally, teacher-education faculty needs to model appropriate, pedagogically sound uses of technology (Adamy & Boulmetis, 2006) in their methods courses. For example, constructivist pedagogy, which focuses on developing students' cognitive faculties, presents possibilities for classroom practices that may lend themselves to using technology. Consequently, when teacher educators cultivate personal philosophies that support a student-centered, constructivist pedagogy, computers become a valuable instructional tool (Becker, 2000).

Revise the Content of the Information Technology Course

This study suggests that in addition to improved technology infusion into the methods courses, effective strategies for technology integration must be presented to preservice teachers throughout the information technology course. Until an adequate technology infusion is modeled across the teacher

preparation curriculum eliminating the need for a single information technology course, the instructional content of such a course needs to be revised to incorporate effective approaches to technology integration in classroom teaching.

In addition to incorporating strategies for technology integration, the content of the information technology course needs to emphasize collaborative student projects that use technology to investigate questions within curriculum units. The essence of this approach lies in the development of an instructional framework within which the technological tools can be applicable.

Place Preservice Teachers with Technologically Proficient Mentors

Modifications to teacher preparation curriculum need to extend to all aspects of teacher education programs including field placements. Several prior studies documented the benefits of placing preservice teachers with mentor teachers who effectively model technology integration and encourage its use during practice teaching (Brown, 2003). The findings of the current study, by using both qualitative and quantitative methodological approaches, added explanatory power to previous, but related, studies. For instance, the qualitative investigation of the focus participants revealed that they mirrored both the frequency and the nature of technology use exhibited by their mentors. The results of the regression analysis conveyed in Table 6 supported the qualitative findings presented in this study. The standardized regression coefficient of .570 indicates that the use of educational technology by the preservice teachers is strongly associated with observing proficient mentor teachers who model technology-enriched instruction.

In the event that preservice teachers are not placed with technologically-proficient school-based mentors, teacher-preparation programs may profit from electronic collaborations that support preservice teachers as they attempt technology infusion at their field placement sites. To illustrate, Bonk, Hansen, Grabner-Hagen, Lazar, & Mirabelli (1998) reported on a study that examined both synchronous and asynchronous electronic collaborations among preservice teachers who worked in subject-matter specific teams. Their results presented a broad range of opportunities for "apprenticing preservice teachers in mentoring techniques, project-based learning, and global collaboration" (p. 289).

Increase Collaboration Between Colleges of Education and K-12 Districts

Prior studies (Adamy & Boulmetis, 2006) recommended that teacher education institutions and school districts cooperate in designing technology-training curricula to meet teachers' specific technology needs. Similarly, many mentor teachers interviewed in the current study expressed a strong interest in learning about effective approaches to technology integration from university faculty. Furthermore, these teachers emphasized the importance of collaborative professional development efforts in designing technology-training curricula that enhance their technical and pedagogical skills.

Hernandez-Ramos and Giancarlo (2004) offered an example of such collaborative efforts that resulted in conducting an instructional technology course in an elementary classroom. The course was co-taught by two university faculty and a school-based coordinator. In addition to lab time focusing on the acquisition of computer skills, the course design included classroom visits, observations, and conversations with technologically-proficient mentors. The authors remarked that:

> The gap between the university classroom, where most preservice preparation takes place...and the classrooms where teachers practice must be narrowed to the ideal point where the transfer rate is consistently high. One potential way to close this gap is to move teacher preparation courses into authentic venues (p. 121).

CONCLUSION

Improved use of information and communication technologies in schools is critical to preparing our students for the social and educational challenges of 21st century life (Partnership for 21st Century Skills, 2004). In the long term, a restructuring of preservice teacher education will likely be required to better prepare future teachers to use technology for optimal learning and achievement. Efforts at such broad restructuring face serious constraints, however, including a societal emphasis on high-stakes testing of basic skills that renders much of what can be best achieved with technology on the margins of current educational priorities.

At the same time, this study suggests some concrete steps that can begin immediately, including better infusion of technology into teachers' professional preparation courses and the field placement of preservice teaching

candidates with mentors who themselves are proficient and sophisticated users of technology in instruction. The best teacher preparation occurs through collaborative apprenticeship, and the modeling of effective classroom technology practices by both methods teachers and school-based mentors is thus critical to preservice teachers' own professional development in the educational use of information and communication technologies.

References

Adamy, P., & Boulmetis, J. (2006). The impact of modeling technology integration on pre-service teachers' technology confidence. *Journal of Computing in Higher Education, 17*(2), 100-120.

Becker, J.B. (2000). Findings from the teaching, learning, and computing survey: Is Larry Cuban right? *Educational Policy Analysis Archives*. Retrieved February 5, 2006, from http://epaa.asu.edu/epaa/v8n51

Becker, J.B., Ravitz, J.L., & Wong, Y. (2000). *Constructivist compatible beliefs and practices among U.S. teachers*. Retrieved February 5, 2006, from http://www.crito.uci.edu/TLC/FINDINGS/REPORT4/

Best, L.M. (2002). Comparison of the perceptions of university faculty and preservice students' technology skills and integration of technology in selected elementary education courses. (Doctoral dissertation, Indiana University of Pennsylvania, 2002). *UMI Dissertation Services*, 3045741.

Bonk, C.J., Hansen, E.J., Grabner-Hagen, M.M., Lazar, S.A., & Mirabelli, C. (1998). Time to connect: Synchronous and asynchronous case-based dialog among preservice teachers. In C.J. Bonk & K.S. King (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse*. Mahwah, NJ: Lawrence Erlbaum.

Brown, D. (2006). Can instructional technology enhance the way we teach students and teachers? *Journal of Computing in Higher Education, 17*(2), 121-142.

Brown, S. (2003). *The effects of technology on effective teaching and student learning: A design paradigm for teacher professional development*. Retrieved February 5, 2006, from http://www.waukeganschools.org/TechPlan/ResearchFindings.pdf

California Commission on Teacher Credentialing. (2002). *Standards of quality and effectiveness for professional teacher induction programs*.

Cognition and Technology Group at Vanderbilt. (1990). Technology and the design of generative learning environments. *Educational Technology, 31*(5), 34-40.

Cognition and Technology Group at Vanderbilt. (1993). Anchored instruction and situated cognition revisited. *Educational Technology, 33*(3), 52-70.

Cognition and Technology Group at Vanderbilt. (1997). *The Jasper project: Lessons in curriculum, instruction, assessment, and professional development.* Mahwah, NJ: Lawrence Erlbaum.

Fermi National Accelerator Laboratory. (1999). *K-12 classroom projects.* Retrieved February 6, 2006, from http://www-ed.fnal.gov/trc/projects/index_all.html

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers.* New York:Longman.

Grabe M., & Grabe, C. (2004). *Integrating technology for meaningful learning.* New York: Houghton Mifflin.

Hernandez-Ramos, P., & Giancarlo, C. (2004). Situating teacher education: From the university classroom to the "real" classroom. *Journal of Computing in Teacher Education, 20*(3), 121-128.

International Society for Technology in Education. (2002). *National educational technology standards for teachers: Preparing teachers to use technology.* Eugene, OR: International Society for Technology in Education.

Kluever, R.C., Lam, T.C.M., Hoffman, E.R., Green, K.E., & Swearingen, D.L. (1994). The computer attitude scale: Assessing changes in teachers' attitudes toward computers. *Journal of Educational Computing Research, 11*(3), 251-261.

Kulik, J. (2003). *Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say.* Retrieved February 5, 2006, from http://caret.iste.org/index.cfm?fuseaction=studySummary&studyid=1044

Market Data Retrieval. (2004). *Technology in education highlights.* Retrieved February 5, 2006, from http://www.schooldata.com/mdrtechhilites.asp

Olson, S. (1976). *Ideas and data: Process and practice of social research.* Homewood, IL: Dorsey.

Partnership for 21st Century Skills. (2004). *Learning for the 21st century: A report and mile guide for 21st century skills.* Washington, DC: Author.

Preparing Tomorrow's Teachers to Use Technology. (2002). *Technology infusion in higher education.* Retrieved February 5, 2006, from http://pt3.org/search?SearchableText=Technology+infusion+in+higher+education

Rowley, J., Dysard, G., & Arnold, J. (2005). Developing a new technology infusion program for preparing tomorrow's teachers. *Journal of Technology and Teacher Education, 13*(1), 105-123.

Schofield, J. W. (1995). *Computers and classroom culture.* New York: Cambridge University Press.

Smerden, B., Cronen, S., Lanahan, L., Andersen, J., Iannotti, N., & Angeles, J. (2000). *Teachers' tools for the 21st Century: A report on teachers' use of technology.* Retrieved February 5, 2006, from http://nces.ed.gov/pubs2000/2000102A.pdf

Smith, T.C. (2002). An analysis of teacher educators and technology integration projects at four universities (Doctoral dissertation, Arizona State University, 2002). *UMI Dissertation Services,* 3043832.

Waddoups, G. L., Wentworth, N., & Earle, R. (2004). Teaming with technology: A case study of a faculty design team developing electronic portfolios. *Journal of Computing in Teacher Education, 20*(3), 113-120.

Yin, R.K. (2003). *Case study research: Design and methods.* Thousand Oaks, CA: Sage.