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ABSTRACT

This study examined how elementary teacher candidates in a program that emphasized the integration of computer-based technologies as tools for teaching and learning used technology, both personally and professionally, during the teacher preparation program. The study also examined factors that influenced their disposition to use and integrate computer-based technologies into their teaching. This paper presents baseline data from three points during the preservice component of a longitudinal study of members of a second cohort group of preservice elementary teachers involved in educational technology. It describes four factors, some internal or personal and others external or contextual, that influenced the dispositions of preservice teachers toward integrating technology across the curriculum: sense of self-efficacy about teaching and using computer tools; attitudes about using computer-based technologies; skill and knowledge base about computer technology; and actual usage of technology in classrooms during internships and student teaching. In addition, several illustrative cases convey the scope of technology integration by elementary student teachers during the first phase of the study. Results suggest that prospective teachers can and will apply what they have learned about computer-based technology to their teaching situations. Study participants had relatively positive efficacy for teaching, high efficacy and attitudes about using specific computer-based technology, and above average computer literacy upon graduation. (Contains 29 references.) (SM)

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# Is the Class of 1998 Ready for the 21st Century School? Longitudinal Study of Computer-Using Teacher Candidates

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## ABSTRACT

This paper describes four factors, some internal or personal and others external or contextual, that appear to influence the dispositions of preservice teachers toward integrating technology across the curriculum: (a) teacher candidates' sense of efficacy about teaching and about using computer tools, (b) their attitudes about using computer-based technologies, (c) their skill and knowledge base about computer technology, and (d) their actual usage of technology in classrooms during internships and student teaching experiences. In addition, several illustrative case studies are offered to convey the scope of technology integration by elementary grade student teachers during the first phase of this longitudinal study.

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## Longitudinal Study of Computer-Using Teacher Candidates

The International Society for Technology Education (ISTE) and the National Council for the Accreditation of Teacher Education (NCATE) have agreed upon standards that define the knowledge, skills, and attitudes needed by effective technology-using teachers (ISTE, 1992; NCATE, 1993). These standards call for all preservice teacher candidates to fulfill these competencies as a part of their preparation program (Taylor & Wiebe, 1994; Thomas, 1994; Todd, 1993; Wetzel, 1993). These guidelines call for teacher candidates to have either courses or experiences that will help them (a) use technology for personal and professional productivity, (b) acquire both the content and pedagogical understanding needed to teach with computer-based technologies, and (c) gain knowledge about the impact of technology on schools and society.

Wetzel (1993) suggested that the best way to meet the ISTE/NCATE standards is a combination of a core computer literacy course model and an integration model. Another way to meet the ISTE/NCATE standards is to insure the infusion of technology across the teacher education curriculum (in methods and foundation courses, field placements, and in seminars attached to the field placements) and to use portfolios as a means of assessing the success of teacher candidates in fulfilling all ISTE/NCATE guidelines (Levin, 1996).

The University of North Carolina at Greensboro (UNCG) successfully piloted the concept of using a technology portfolio with one preservice cohort group from 1994 to 1996 (Levin, 1996). Since that time the technology portfolio concept has expanded to all the teacher education programs at UNCG. Furthermore, the state of North Carolina plans to require a technology portfolio from every teacher candidate as a means of assessing advanced computer competencies required for initial licensure beginning in 1999. In addition to the

portfolio, basic computer competencies for new teachers will also be tested in multiple-choice test and with a hands-on, performance-based component, which is also required for initial teacher licensure beginning in 1999.

The overall goal of the longitudinal study described in this paper is to discover what elementary grade teacher candidates do with technology, both personally and professionally, and how they use computer-based technologies with their students and in their curriculum over time. Also of interest is how their sense of efficacy about teaching and computers, their attitudes about using computer-based technologies, and their skill and knowledge base about computer technology impact their actions with regard to integrating technology into the curriculum. The research questions for the first phase of this study are: (a) How do elementary grade teacher candidates in a teacher education program, which emphasizes the integration of computer-based technologies as tools for teaching and learning, use technology both personally and professionally during their time in the teacher preparation program? and (b) What factors influence their disposition to use and integrate computer-based technologies into their teaching?

This paper presents baseline data from three points during Phase 1 (the preservice component) of a longitudinal study of members of a second cohort group of preservice elementary education majors who fulfilled all the ISTE/NCATE competencies, and concurrently met all the competencies required of beginning teachers in North Carolina, through a technology portfolio assessment process. This paper describes four factors, some internal or personal and others external or contextual, that appear to influence preservice teachers' dispositions to integrate technology across the curriculum. These factor include: (a) teacher candidates' sense of efficacy about both teaching and using computer tools, (b) their attitudes about using computer-based technologies, and (c) their skill and knowledge base about computer

technology, and (d) their actual usage of technology during three semesters of 10-hour weekly internships and a semester of full-time student teaching.

Relevant Research on Technology Use by Teachers

Although characteristics of computer-using educators have been identified at both the inservice and preservice levels (e.g. Becker, 1994; Dwyer, Ringstaff & Sandholtz, 1991; Ertmer, Evenbeck, Cennamo & Lehman, 1994; Loyd & Loyd, 1988; Marcinkiewicz, 1994-95; OTA, 1995; Sandholtz, Ringstaff, & Dwyer, 1996), many of these studies focused on external or contextual factors rather than internal and personal variables. Furthermore, a search of the literature uncovered no studies that begin with preservice teachers and follow them longitudinally into their induction years and beyond, with the goal of understanding the factors that impact how teachers use technology in their classrooms. However, some recent research about computer-using teachers is relevant to this study.

The Apple Classroom of Tomorrow (ACOT) project focuses on inservice teachers (Dwyer, Ringstaff & Sandholtz, 1991; Sandholtz, Ringstaff, & Dwyer, 1996) and describes mainly external factors that impact levels of computer use and innovation. This work describes the critical importance of the context for teaching and learning as well as teacher beliefs and the difficulty of altering these. It also addresses the on-going need for professional development in settings saturated with computers - one for every teacher and student, both in school and at home. The ACOT program also offers a five-stage model of the evolution of expected changes in teacher practices and beliefs based on ten years of data gathered from five classrooms around the country. Case studies of individual teachers and sites where ACOT amassed unlimited amounts of computer hardware, software, and technical expertise give us insight into what is possible. Although there are many important lessons to be learned from these ACOT data, they may

not be representative of how computer-based technology is used by the majority of teachers who have access to one computer in their classroom, or one computer lab in their school, and little to no technical support.

Becker's (1994) national survey covering computer use in grades 3-12 identified both contextual and personal variables that showed how the 5% designated as exemplary computer-using teachers differed from the other 95% who were not considered expert computer-using teachers. Becker identified four external, contextual variables that are present in the environment of exemplary computer-using teachers: (a) collegial working conditions at a school where many teachers also use computers, (b) the use of computers for a wide variety of tasks throughout the school in addition to regular use in courses, (c) support in the school for using computers in the form of a computer coordinator and good staff development opportunities, and (d) additional support in the form of resources and smaller class sizes. Several personal factors were also found that differentiated the 5% of exemplary computer-using teachers from other users, two of which Becker noted may be alterable at the school level. That is, exemplary computer-using teachers identified in this study tended to be males who spend twice as much time using computers as the others, report more formal training in more areas than others, and express a commitment to lifelong learning. However, Becker also noted that the identified exemplary computer-using teachers had liberal arts majors, rather than majors in education, which is an interesting variable related to personal background and experience that might be addressed through recruitment efforts.

In a cross-sectional comparison, Marcinkiewicz (1994-95) evaluated the level of computer use of inservice and preservice teachers using a variety of measures of motivation, including personal variables and contextual variables. In his study, Marcinkiewicz

measured levels of computer use, self-competence, perceived relevance, locus of control, innovativeness, and demographic information for 170 inservice teachers and 167 preservice teachers. Using chi-square and regression procedures to analyze the difference between preservice teachers' predicted level of use, inservice teachers' actual levels of use, and the relationships between individual teacher characteristics related to efficacy and attitude, he found that inservice teachers' level of computer use was predicted by perceived self-competence and innovativeness. However, preservice teachers' expected computer use was predicted by perceived relevance for instruction. Furthermore, he also found that self-competence, or self-efficacy, was correlated with perceived relevance for both preservice and inservice teachers. Marcinkiewicz concluded his study with a call for studying the transition of preservice teacher candidates into inservice settings and a concern that teacher candidates' high expectations regarding computer use will be lowered by external and contextual variables over which they have no control. Marcinkiewicz also expressed concern that high levels of expected computer use expressed by preservice teachers in his study is an artifact of their teacher education curriculum, where they are expected to be learners about and users of computer technology. His concern is that this will wash out if they are not required to use and integrate computer technology in their teaching.

Self-Efficacy, Attitudes, and the Knowledge-base Related to Computer Use

Self-efficacy, teachers' beliefs that they can have a positive effect on student learning, is a characteristic consistently related to student achievement (Ashton, 1985; Hoy & Woolfolk, 1990), the goal for all teachers, no matter what media they use in their instruction. The concept of self-efficacy is derived from social learning theory, especially from the work of Bandura (1977, 1984). Teachers' sense of self-efficacy

is a motivational concept based on their judgment about whether or not they are capable of carrying out a particular course of action (called efficacy expectations) and their thinking about the likely outcomes of those actions (outcome expectancies). Although these two factors in self-efficacy are independent, they are both important to measure as they relate to teachers' work in general and with computer-based technologies. Self-efficacy in teachers has been operationalized and measured in several studies (Gibson & Dembo, 1984; Hoy & Woolfolk, 1990; Woolfolk & Hoy, 1990).

The role of teachers' general and personal self-efficacy (Hoy & Woolfolk, 1990; Woolfolk & Hoy, 1990) has to do with teachers' common beliefs in their ability to impact and overcome students' home environments and to motivate them (general teaching efficacy), as well as their personal beliefs that they can be effective with students in their own classroom settings (personal teaching efficacy). These constructs are important internal variables that are likely to influence teachers' decisions about the use of computer-based technologies. Therefore, this study uses Hoy and Woolfolk's Teacher Self-Efficacy Scale (1990) to assess teachers' sense of efficacy. This scale was selected because it includes items that measure both general teaching efficacy (GTE) and personal teaching efficacy (PTE). Alpha coefficients reported for the reliability of this instrument are 0.84 for PTE and 0.72 for GTE. For both scales, a higher score represents a greater sense of efficacy.

Delcourt and Kinzie (1993) indicate that "teachers who use computer technologies are likely to be important models for their students" (1993, p. 36), but that to be successful models they must have positive attitudes and feel efficacious about using computer-based technologies. Furthermore, they agree with others (Ashton & Webb, 1986; Marcinkiewicz, 1994-95; Sandholtz, Ringstaff, & Dwyer, 1996) that teachers' attitudes and efficacy about computer use are most likely influenced by their level of prior training. In order to measure

affective variables related to teachers' use of technology, in particular attitude and efficacy, Delcourt & Kinzie (1993) developed two instruments. The Attitudes Toward Computer Technologies scale (ACT) measures comfort, anxiety, and the perceived usefulness of computer technology in general. The Self-Efficacy for Computer Technologies (SCT) measures perceived self-efficacy for specific computer technologies, because the construct of efficacy is considered to be situation and task specific (Pintrich & Schunk, 1996). Delcourt and Kinzie's (1993) ACT scale is used in this study as a general measure of attitudes toward technology because it provides information related to why teachers might prefer to use computer-based technologies for teaching and learning. The SCT instrument was also selected because it measures efficacy related to specific computer technologies used during the teacher preparation program studied in this paper (e.g., word processing, e-mail, data bases, and multimedia authoring). Furthermore, the internal consistency reliability, or alpha coefficients, reported for the ACT instrument are 0.90 for the comfort/anxiety factor and 0.83 for the usefulness factor. For the SCT, the alpha coefficients are 0.97 for word processing, 0.98 for e-mail, and 0.98 for CD-ROM databases. For the ACT scale, a higher score represents better attitudes, more comfort, less anxiety, and higher perceived usefulness of computer-based technologies. For the SCT scale, higher scores represent greater self-efficacy for each of the specific technologies rated in the questionnaire. However, it should be noted that for the purposes of this study, the SCT instrument was modified by the addition of questions about developing databases and using a multimedia/hypermedia authoring tool (HyperStudio by Roger Wagner Publishing). Stems from the original instrument were retained in these revisions.

Another instrument designed by Jones and Pearson (1996) to measure skill and knowledge levels (i.e. a measure of computer

literacy) was also selected for this study. This instrument was normed on an undergraduate population similar to the one in this study. Using their original instrument consisting of 12 multiple choice items, including "Don't Know", Jones and Pearson attained reliability coefficients of 0.95. Furthermore, although this instrument is brief, the overall average score over several administrations spanning five years is only 33%, which the authors claim measures what respondents know, not what they can guess (Jones & Pearson, 1996). This objective measure of computer literacy, along with other measures of attitude and efficacy, assessment of the participants' Technology Portfolios, and description of technology-related teaching practices during student teaching are employed to assess the personal or internal factors that may interact with external or contextual factors as preservice teachers actually use computer technologies in their classrooms.

Context for this Study: Undergraduate Teacher Education at UNCG

In recent years the field of teacher education has moved away from apprenticeship models with single student teaching experiences toward Professional Development School (PDS) models (e.g. Darling-Hammond, 1994; Lieberman & Miller, 1992). In most PDS programs prospective teachers spend significant amounts of time in a variety of practica or internships and other field experiences prior to student teaching. They take their foundations and methods courses at the university concurrently with their field experiences, and they progress through their program in cohort groups for mutual support. The PDS program in the Department of Curriculum and Instruction at UNCG has been in place since 1991. Four cohort groups of prospective elementary and middle grades teachers, approximately 100 new teachers, graduate each year.

At UNCG elementary and middle grades education majors begin their undergraduate teacher education program as college juniors. They stay together in cohort groups of 15-25 for two years under the

guidance of a faculty member who serves as their field supervisor, their academic advisor, and their weekly seminar leader. They take all of their methods courses together and serve as interns in classrooms for ten hours every week for three semesters prior to full-time student teaching during their fourth semester. Internships are typically served in two different PDS sites designated for each team. Additional coursework is also completed concurrently at the university to fulfill requirements for a second major or concentration (24-27 semester hours for elementary education majors and 36 hours for middle grades majors who must complete two second majors) and all credential requirements (48 semester hours). Interns change schools and/or grade levels each semester before selecting a classroom in which to do their student teaching at one of the designated PDS sites. One of the many benefits of this PDS program and cohort-group model is that activities and experiences can be planned to span two-years, building on each other, and achieving a well-ordered, developmentally-appropriate, and coherent preservice teacher education program (Ammon & Levin, 1993; Levin & Ammon, 1992, 1996).

Technology Education at UNCG. Another goal of UNCG's PDS program is to infuse technology throughout the preservice program. We want to prepare teacher candidates who can use technology appropriately in the classroom to meet their content and pedagogical objectives. In order to meet this need and to address accreditation goals, our elementary and middle grades preservice teacher education program has adopted a technology portfolio assessment process as our way of both infusing and assessing these standards. Implementing the ISTE/NCATE guidelines and the North Carolina initial and advanced computer competencies at the preservice level helps us (a) prepare new teachers who are knowledgeable and competent with computer-based technologies when they graduate, (b) guide faculty in designing appropriate activities in their courses that meet their objectives and

support students in learning more about how to use technology in each area of the curriculum, and (c) insure that our teacher candidates will have the knowledge and skills to pass the required state computer competency test and the portfolio for advanced competencies tied to the initial teaching license, and (d) provide documentation of their experiences with using computer-based technologies for learning and teaching, which may serve both as a resource for the future and a marketing tool for the prospective teacher looking for a job.

Unlike other models for fulfilling computer competencies for preservice teachers, the responsibility (and also the success) of the portfolio process at UNCG rests mainly with the teacher candidates rather than with any single faculty member. The role of each faculty member becomes that of a facilitator and an assessor who provides opportunities for connecting technology use with teaching and learning in the context of their own discipline, especially within methods courses. Consistent with our constructivist philosophy, we provide the guidelines and the incentives, but students must do the real work as they develop their technology portfolios. Our requirement is that the teacher candidates present evidence that they have fulfilled all of the required computer-based technology competencies, at least at a knowledge and awareness level, and that they write reflections to accompany each entry in their portfolio before they begin student teaching.

## METHODS

One cohort group, the author's PDS cohort group for 1996-1998, was selected for this longitudinal study. This team of 22 preservice teachers received extra instruction about integrating technology into the elementary school curriculum beyond what other cohort groups received in their methods courses. Instruction in ways to integrate computers into the curriculum was offered regularly across the two-year teacher preparation program to support the attainment of skills for

using the computer and software as tools for learning and teaching. After learning basic computer skills themselves, the preservice teachers in this group were required to plan and teach at least three technology-related lessons every semester in their internship classrooms. They were also required to fulfill all the ISTE/NCATE and local state requirements for computer-competent teachers. They provided evidence of this through the development of a Technology Portfolio. Expectations were established that all members of this group would integrate computers and other forms of technology into the curriculum wherever and whenever appropriate. The assumption was made that if this cohort group, which received additional instruction and focused on technology integration during their teacher preparation program, did not show evidence of integrating computers into their teaching, then we would need to revise our approach to technology education for preservice elementary grade teacher candidates.

In order to follow prospective teachers longitudinally, volunteers were solicited from the PDS cohort group described above. These volunteers agreed to complete several questionnaires and to be observed and interviewed semi-annually during the first five years of teaching following their graduation in May, 1998. About half the PDS team volunteered for the longitudinal phase of this research (Phase 2). The other members of the team served as a comparison group during Phase 1 of the study. That is, their scores on the four instruments used in this study provided baseline data to see if volunteers for the longitudinal study were any different from the non-volunteers on measures of attitudes, efficacy, or computer literacy. The assumption was made that if the volunteers and non-volunteers scored similarly on the instruments used, then the volunteers would not be considered more or less predisposed or knowledgeable about computers and the use of computers for teaching than the rest of the cohort.

Participants

Of the ten volunteers, eight are female and two male. One female is African-American and all the rest of the volunteers are Caucasian. One male and two of the females are non-traditional students, approaching the age of 30, who are coming into teacing as a seciond career. The remaining volunteers are traditional college-age students, ages 20-22. Seven of the volunteers had their own computers at the start of their teacher education program, and the remaining participants in the longitudinal study had access to computers in any of the labs on the campus. The demographics of this group of volunteers and the level of access to computers at home or on campus are similar to non-volunteers in the cohort group.

Data Sources

The sources of baseline data available at three points during Phase 1 of this study include: (a) the first administration of each of the instruments described above to all members of the cohort present on the day they were distributed in December, 1996, when volunteers were first recruited, (b) a second administration of all instruments to all members of the cohort in December, 1997, just prior to student teaching, and (c) a third administration of all instruments following the completion of student teaching in May, 1998. All teacher candidates at each administration were asked to complete all questionnaires but only those volunteering for the longitudinal part of this study were asked to put their social security numbers on each instrument. This practice was repeated at each of the three data points during Phase 1 of the study to see if the volunteers were more efficacious about computers or about teaching in general, more knowledgeable about computer technology, or had better attitudes about technology than the non-volunteers. Only those who volunteered consistently for the longitudinal study (N=10) will be

followed during Phase 2 (1998-2003) as they move into their initial teaching years.

## FINDINGS

Tables 1, 2, and 3 display the means and standard deviations of the volunteer and non-volunteer groups at three points during Phase 1 of this study: December, 1996, August, 1997, and May, 1998. These scores are offered here to show the similarities between the volunteers and non-volunteers on measures of efficacy, attitudes, and knowledge about computer-based technology. Because of the small number of participants, no statistical tests were applied to these data and they are presented here for descriptive purposes only.

Table 1 includes means and standard deviations for both the volunteers and non-volunteers for this study with regard to their general teaching efficacy (GTE) and personal teaching efficacy (PTE). The means for GTE for the volunteers was 32.50 in December, 1996, 32.67 in August, 1997, and 32.30 in May, 1998. For the non-volunteers the mean GTE scores were 30.92 in December, 1996, 30.92 in August, 1997, and 34.00 in May, 1998. The means for PTE for the volunteer group were 35.80 in December, 1997, 22.83 in August, 1997, and 41.20 in May, 1998. The non-volunteers' mean PTE scores were 37.58 in December, 1996, 19.69 and in August, 1997, and 44.00 in May, 1998. The range for both of these measures is 10-50.

Insert Table 1 here

### Self-Efficacy for Computer Technology (SCT)

As can be seen in Table 2, participants' sense of self-efficacy for using four specific computer technologies, as measured by a modified version of the Delcourt & Kinzie (1993) scale, was relatively high in all four skill areas (word processing, e-mail, databases, and a multimedia authoring program (HyperStudio by Roger Wagner Publishing) for

both the volunteers (V) and non-volunteers (NV) at each of the data collection point in Phase 1 of this study. One trend in these data appears to be an increasing sense of efficacy in using word processing, e-mail, data bases, and HyperStudio across the two-year span of this study. In fact, with the exception of databases, all the participants' scores approached the ceiling on the SCT instrument, indicating a high degree of self-efficacy for using computer tools in both the volunteers and the non-volunteers.

Insert Table 2 about here

Computer Literacy

As can be seen in Table 3, the mean scores for the computer literacy test based on the Jones & Pearson instrument show no obvious differences between the two groups with regard to their computer literacy scores on this measure. Furthermore, while the volunteers as a group were perhaps slightly more computer literate at the outset of this study, any difference in knowledge about computer technology apparently disappeared over the next eighteen months. Furthermore, both the volunteers and the non-volunteers scored relatively high on this measure of computer literacy compared to the norming group, which averaged 3.33 correct out of the twelve items.

Attitudes Toward Computer Technology (ACT)

As can also be seen in Table 3, participants' attitudes toward computer technology as measured by the Delcourt & Kinzie (1993) scale were above the median score of 47.50 for both groups throughout Phase 1 of this study.

Insert Table 3 about here

Unsolicited Anecdotal Data

Several teacher candidates wrote unsolicited comments on the ACT instrument, which are of interest and reported here as they provide additional insight into what is behind attitudes expressed on this scale.

For example, a non-volunteer with a score of 54.5 out of a possible 76 on her ACT questionnaire wrote: *At first I was very apprehensive about using computers. Although I still am not very good with them, I feel I have become more and more comfortable with them now..* However, another non-volunteer with a score of 51 out of a possible 76 on her ACT questionnaire wrote about wanting more practice with computer technology: *I am not too familiar using computers. Certain things I can do, but I don't feel comfortable doing things on my own. I need a lot of practice so I can feel confident and comfortable using computers.*

Sounding like others with relatively low scores on the ACT, a volunteer who had a 46 on her ACT survey, the lowest score in the volunteer group in December, 1996, wrote about her anxieties and need for more experience with computer technology: *I enjoy working with computer technologies, but I am not extremely comfortable with any of it. I have not had enough experience with computers to be computer literate, therefore computers do scare me. I think that if I had more practice working with them, I might develop confidence working with computers. Actually, I enjoy creating things by hand more, because, I am very creative and artistic.* A volunteer who had a 49.5 on her ACT survey also wrote about her lack of knowledge: *I think the anxiety I have about technology comes from my lack of knowledge. If I were more knowledgeable I would not be as scared.*

However, by May, 1998, unsolicited comments written on the survey instruments included the following from a volunteer: *Having knowledge about a MAC and IBM computer has helped me greatly during student teaching. Due to my knowledge I was able to help my*

*supervising teacher enter the computer world..* Another volunteer wrote: *It's been a while since I took this survey [SCT] but I don't believe I strongly agreed with it then. Now I am sure that I can do everything on this sheet and much more.* And finally, another volunteer wrote the following unsolicited comment on the ACT survey in May, 1998: *Computers and technology are a fundamental part of the classroom today. In years to come they will play an even greater part. As a teacher I must accept my responsibilities to bring them into my classroom..*

These unsolicited comments speak to the importance of teachers' attitudes about and sense of efficacy regarding the use of computers in the classroom. However, what prospective teachers actually do with regard to using computers and other technologies for teaching and learning is also important. Therefore, three scenarios are presented next to represent typical uses of technology by three of the volunteers for this study during their student teaching in Spring, 1998.

Elizabeth in Kindergarten

During her student teaching semester Elizabeth took her Kindergarten students to the school's computer lab every week where they regularly used programs such as Bailey's Bookhouse, Easy Color Paint, and Snap Dragon. Prior to her arrival in the class, these programs had only been used for free exploration. In contrast, Elizabeth used these programs as tools to connect what the children were learning in the classroom in a purposeful and guided way. For example, the children used Easy Color Paint to draw a body and place a heart on it following a health lesson. They also drew teeth with cavities during Dental Health Week and stages of the life cycle of butterflies after learning about those topics in class. Elizabeth indicated in her journals that the computer served as a great assessment tool for her because she could see what the children had learned and where their misconceptions were. In addition, Elizabeth designated the one

computer in the back of the Kindergarten classroom during center time for drawing and writing, although it was not a required station. Elizabeth also used the computer to record and display data from their winning science fair project. For her own productivity, Elizabeth used the computer to create letters home to families, make spelling lists, and to create schedules and lists for centers and lab times. She also used the Internet to locate background information and to locate to pictures to use for some of her lessons.

Jenny and Vicky in a 2nd grade classroom

Vicky and Jenny shared a student teaching placement in a second grade classroom in a highly impacted school. This arrangement gave each student teacher six weeks of "solo" student teaching and also six weeks of serving as an assistant. With this schedule decided, the regular teacher worked mainly with small groups and individuals in the back of the classroom and in other classrooms throughout the school. Although this school serves a low income neighborhood, it has a computer lab of new Power Macintosh computers and there were also two Power Macs and a printer set up on a table in the back of Jenny and Vicky's classroom. From the outset, Vicky and Jenny organized their reading program into centers and included the two in-class computers as learning stations. Students rotated to use the classroom computers at least every other day for word processing, reading electronic storybooks, and practicing their reading and writing skills using programs such as Reader Rabbit, Wiggle Works, and Living Books. They also taught students to use the Student Writing Center, Kid Works Deluxe, and Ultra Key (for keyboarding practice). Accelerated Reader was also encouraged in this school, so the computer was used to test the children's comprehension about books they read. Math software was also used but with less consistency than the variety of reading, writing, and language arts software available. For whole class presentations Vicky and Jenny used Windows on Science

laserdiscs several times to present visuals related to science topics they taught. They also arranged a virtual fieldtrip via the Internet to the White House during President's Day. These instructional uses of the computer were supplemented by a weekly newsletter that went home to parents, which included pictures from a digital camera and word processed stories from the students. In addition, Jenny and Vicky arranged for class keypals via electronic mail with another school. And finally, all lesson plans, student worksheets, other assessments, and needed forms or letters were word processed and stored for easy reference or duplication by either Jenny, Vicky, or their supervising teacher.

Jackie in a 4th grade classroom

At another school in a more affluent area of town, Jackie was anxious to teach her fourth graders to use HyperStudio during her student teaching semester. After showing them some HyperStudio stacks that she had previously created, Jackie took half the class at a time into the computer lab to learn this multimedia authoring program. She asked them to create stacks about themselves and their families and then later asked them to create other stacks for science and social studies topics they studied. She also had them use Kid Pix to draw lighthouses after studying their role in North Carolina. Jackie also used the Internet to take her fourth graders on a virtual fieldtrip to the state capital prior to going there on a fieldtrip. Jackie's fourth graders also practiced their keyboarding skills regularly using UltraKey and used a variety of programs available on CD-ROM, including multimedia encyclopedias. They developed a class cookbook and did all their own typing and desktop publishing using Microsoft Works. The fourth graders also learned about data bases when they made entries in a class data base about their favorite things. Jackie's students also used several math programs both in the classroom and in the computer lab on a regular basis. Almost all of Jackie's students took tests on the

computer for the Accelerated Reader program and used a complementary program from the same company to assess their reading comprehension level.

## DISCUSSION

Unlike most classrooms where the computer sits idle in the back of the room, or is used only by children who finish their work early, these teacher candidates explicitly planned ways to use computers and other technology in their curriculum -- especially in the areas of reading and writing -- and believed that this would help their students be successful. They used the computers available to them in both the classroom and in the school computer lab. Of course, it is likely that having high self-efficacy about specific computer technologies, such as for word processing, electronic mail, databases, and hypermedia authoring tools, that made using these tools with children possible. Although knowing how to use the computer oneself may not always transfer to knowing how to use it in teaching others. A sense of confidence in one's personal knowledge and skill helps relieve anxiety about how something works or what to do if something fails to work, but it does not insure that technology will be integrated into the curriculum or become a regular teaching tool. Nevertheless, one's sense of efficacy for teaching and for teaching with computers are important internal or personal variables related to actual practice.

During Phase 1 of this study, the volunteers and the non-volunteers appeared to be very similar with regard to their sense of general and personal efficacy, their attitudes about computers in general, their efficacy for specific computer technologies, and their computer literacy scores. However, while both the volunteers and non-volunteers evidenced an overall increase in confidence in their ability to make a difference in the classroom following their student teaching (May, 1998), these data mirror the research literature on teacher efficacy. That is, PTE, the belief that an individual teacher can

make a difference in a child's life, tends to be higher than GTE, which is a measure of beliefs about the overall power of teachers and teaching to help children overcome difficult backgrounds. In addition variability in PTE scores is expected because the construct of efficacy tends to be state-like rather than trait-like. Therefore, during Phase 2 of this study, which will follow the volunteers into the first five years of teaching, it will be very important to identify and describe both personal and contextual factors that influence these beginning teachers' use of computer technology as a tool for teaching and learning.

## IMPLICATIONS FOR TEACHER EDUCATION

Although this study only tracks a small group of elementary grade teachers over time, the hope is that their experiences with technology can provide us insight into how teacher educators can help prospective teachers use computer-based technologies effectively both personally and professionally when they leave the academy. This study also has utility as a means for evaluating the viability and efficacy of the technology portfolio process and the goal of infusing technology across the teacher preparation curriculum at UNCG. These data may also inform other colleges and universities in other states that require prospective teachers to be competent to teach with technology but who may not have room for separate computer courses in their curriculum.

## FUTURE RESEARCH

As discussed earlier, Marcinkiewicz (1994-95) found that self-competence, or self-efficacy, was correlated with perceived relevance for both preservice and inservice teachers and concluded his study with a call for studying the transition of preservice teacher candidates into inservice settings. Marcinkiewicz also posited that high levels of computer use by the preservice teachers in his study was an artifact of their teacher education program, where they are expected to be learners about and users of computer technology. His concern was that this will wash out if they are not required to use and integrate computer

technology in their teaching. This longitudinal study is designed to explore these assumptions over time as these beginning teachers move into their first years in the classroom. In this way the impact of external, contextual variables, as well as the influence of internal or personal factors, can be assessed as they interact with the baseline measures of efficacy, attitude, and knowledge shared in this paper. Identifying critical aspects in the context of teaching and learning for these volunteers (external or contextual factors), the role of teachers' sense of efficacy, attitudes, and knowledge regarding computers (personal or internal factors), and the on-going need for professional development will be among the factors studied in Phase 2.

## SUMMARY AND CONCLUSIONS

Various types of data were collected during Phase 1 of this longitudinal study: measures of general and personal teaching efficacy, attitudes toward computers, efficacy for specific computer activities, a measure computer literacy, solicited and unsolicited writing, and classroom observations. Both quantitative and qualitative data presented here indicate that prospective teachers can and will apply what they have learned about computer-based technology to their teaching situations. This study also shows that the prospective teachers described in this paper have relatively positive efficacy for teaching, high efficacy and attitudes about using specific computer-based technology, and above average computer literacy when leaving their teacher preparation program. In other words, the prospective teachers who volunteered for this longitudinal study are ready to incorporate computer technology into their teaching. In fact, they have already used computers and other technologies for themselves personally, for helping their children in their student teaching classrooms learn, and for assessing what children are learning.

The hope of the faculty of our teacher education program is that the integration of computer education opportunities throughout the

program, along with high expectations for using computers for personal and professional productivity throughout all aspects of our teacher preparation curriculum -- in methods courses, in field experiences, and in weekly seminar activities -- will not be washed out by external and contextual variables over time as Marcinkiewicz predicts (1994-95). However, only time will tell.

Table 1.

Means and Standard Deviations for

General Teaching Efficacy (GTE) and Personal Teaching

Efficacy (PTE) in December, 1996, August, 1997, and May, 1998.

| | GTE (Range 10-50) | PTE (Range 10-50) |
|---|---|---|
| Volunteers (N=10) Dec., 1996 | 32.50 (4.92) | 35.80 (3.96) |
| Non-Volunteers (N=12) Dec., 1996 | 30.92 (4.38) | 37.58 (3.61) |
| Volunteers (N=12) August, 1997 | 32.67 (5.07) | 22.83 (4.24) |
| Non-Volunteers (N=13) August, 1997 | 30.92 (5.48) | 19.69 (4.39) |
| Volunteers (N=10) May, 1998 | 32.30 (6.88) | 41.20 (4.64) |
| Non-Volunteers (N=10) May, 1998 | 34.00 (6.09) | 44.00 (4.81) |

Table 2.

Means and Standard Deviations for

Self-Efficacy for Specific Computer Technologies in

December, 1996, August, 1997, and May, 1998.

| Specific Computer Technologies | Word Processing (Range 10-40 | Electronic Mail (Range 9-36) | Databases (Range 5-20) | Hyper-Studio (Range 6-24) |
|---|---|---|---|---|
| Volunteers (N=10) Dec., 1996 | 36.91 (4.66) | 33.73 (4.27) | 15.55 (3.48) | 18.18 (3.74) |
| Non-Volunteers (N=12) Dec., 1996 | 35.40 (4.27) | 29.20 (6.71) | 15.70 (4.97) | 17.60 (5.74) |
| Volunteers (N=12) August, 1997 | 38.25 (4.95) | 33.67 (5.92) | 16.63 (3.78) | 20.33 (4.18) |
| Non-Volunteers (N=13) August, 1997 | 37.50 (3.63) | 33.56 (3.24) | 16.38 (3.11) | 19.25 (3.65) |
| Volunteers (N=10) May, 1998 | 39.90 (0.18) | 35.60 (0.64) | 18.10 (1.90) | 22.90 (1.56) |
| Non-Volunteers (N=10) May, 1998 | 39.70 (0.48) | 34.30 (2.04) | 17.40 (2.20) | 23.70 (0.48) |

Table 3.

Means and Standard Deviations for

Attitudes Toward Computer Technology and Computer Literacy in December, 1996, August, 1997, and May, 1998.

| Phase I of Longitudinal Study | Computer Literacy Test (Range 1-12) | Attitudes Toward Computer Technologies (Range 19-76) |
|---|---|---|
| Volunteers (N=10) Dec., 1996 | 7.82 (1.89) | 62.77 (9.11) |
| Non-Volunteers (N=12) Dec., 1996 | 5.20 (1.16) | 58.25 (1.16) |
| Volunteers (N=12) August, 1997 | 6.50 (1.92) | 68.50 (9.64) |
| Non-Volunteers (N=13) August, 1997 | 7.00 (1.83) | 69.00 (7.54) |
| Volunteers (N=10) May, 1998 | 8.30 (1.90) | 67.90 (4.90) |
| Non-Volunteers (N=10) May, 1998 | 7.50 (1.80) | 69.30 (5.70) |

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