Appropriation, Mastery and Resistance to Technology in Early Childhood Preservice Teacher Education

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Abstract

This report describes how early childhood preservice teachers appropriate, master, and/or resist learning to use technology in teaching. The data collected were part of a three-year study supported by the National Science Foundation of an entire teacher education program to investigate how preservice teachers (PSTs) become socialized to the role of teaching and how they develop as technology using teachers in a technology-rich teacher education program. The article presents survey data from all the students in the program, focus group and interview data with a cohort of early childhood PSTs, and intensive case studies with two early childhood PSTs with data from their freshman to their senior years. The findings suggest that the pathway to appropriation of technology as a teacher is not uni-dimensional and has a varying set of contributors and constraints. (Keywords: technology, teacher education, early childhood, appropriation, resistance.)

Understanding the appropriation, mastery, and resistance to technology of students in teacher education can contribute both to developing technology-using teachers and to advancing a theoretical framework for how teachers appropriate technology into their teaching practices. Practically speaking, technology is becoming increasingly available in schools in the United States (NCES, 2000), yet studies of technology usage suggest advanced technology is not widely nor substantially improving schools (PITAC, 1997; Web-based Education Commission, 2000). One of the most prominent explanations for the low level of impact is that teachers do not feel well prepared to use technology effectively (Becker, 1999; Becker & Anderson, 1998). Current inservice teachers are not well prepared to use technology, nor does it appear that the next generation is being adequately prepared to enter the profession as technology-using teachers. Upon completion of a survey of teacher education programs, David Moursund, past Executive Director of ISTE, summarized the findings as such: "In the past few years, teacher education programs have made substantial progress in preparing future teachers in information technology, but they still have a long way to go" (Moursund, 1999). Teacher educators and their institutions need new knowledge about the implications of their practices and the potential of reform efforts to better prepare teachers to use technology in their teaching. Similarly, educational researchers need to advance models and frameworks for understanding how teachers come to appropriate and use technology in their teaching.

THEORETICAL PERSPECTIVE

From a theoretical perspective, the process of learning to use technology so as to teach with technology offers a rich environment to not only see the appropriation

of a tool into action, but to also see the appropriation of a tool for the design of action. In this sense, teachers must not only come to be users of a tool, but also to design usage of the tool by learners. Following in the traditions of Burke (1969) and Bakhtin (1981), Wertsch (1998) advances a sociocultural theory of human action that focuses on the relationship between mental processes and the sociocultual setting to help explain human action. Wertsch defines appropriation as "the process of taking something that belongs to others and making it one's own" (Wertsch, 1998, p. 53). From a sociocultural framework, the path to appropriation is not likely to be linear nor easy, but inherently involves tension between the tool and the use we make of it within a particular context, tension that often results in resistance.

In a review of telecommunications and teacher education, Blanton, Moorman, and Trathen (1998) argued for research that helps us understand the learning of both individuals and communities by including the use of cultural tools in the analysis of individual and collective action. They use the work of Clift, Thomas, Levin, and Larson (1996) to illustrate the power and need for a sociocultural framework. Clift et al. found that preservice teachers' use of telecommunications technology was more strongly influenced by the type and frequency of its use in their field placement settings than by its type and frequency of use in the university context.

The goal of our study is to explain the use of technology and stances toward future use of technology in teaching of preservice teachers (PSTs) by examining their access to and professional development with interactive computer tools. Our approach is to examine the use and stances toward technology within the context in which the PSTs find themselves preparing to teach and use these tools. The context includes influences from society at large, the university, the college of education, and field placements during the teacher development program. Appropriation, mastery, and resistance are key constructs for understanding what is salient in the tools and contexts. These constructs can be used to characterize the relationships between the actions and stances of preservice teachers and the tools and contexts of their teacher education program and expected positions in schools. For example, we can define "mastery" as the "know how" that PSTs demonstrate in the context of their professional development program. They show they can use technology within the structure of course assignments and with the support services of the university environment. Appropriation refers to their "making the use of technology their own" so that we would see their use of technology in other courses, as well as in their planning for future teaching. Resistance indicates their concerns, inability, or unwillingness to transfer the capability to their own teaching practices. The explanation for resistance may come from the context, the tools, or the personal history of the individual.

Some of the resistance to the use of technology in early childhood education (ECE) for PSTs may be rooted in the controversy about how exposure to technology may be harming young children. For example, a collection of early childhood professionals called the Alliance for Childhood has raised concerns as seen in their report, *Fool's Gold: A Critical Look at Computers in Childhood* (2001). Given that this controversy exists, we may find differences in appropriation and resistance between ECE PSTs and PSTs for older students.

Teachers' adoption of technology has been most frequently treated as a linear movement from an entry level of developing awareness through appropriation and innovation, in which teaching roles and practices are transformed (CEO Forum, 1999; Dwyer, Ringstaff, & Sandholtz, 1991). The sociocultural framework suggests that the path is not simply linear and that tools may be mastered but not appropriated, appropriated for some roles in some contexts while not in others, and that it may be more useful to see appropriation as not simply a psychological or individual stance but rather a stance within a context.

Given a programmatic goal of the teacher education program of having PSTs master and appropriate technology into their future role of teacher, we ask the following questions: Is there evidence that PSTs are mastering and appropriating technology? Does a sociocultural framework for understanding action help explain the processes, mastery, and appropriation of technology? And what are the constraints and advantages of the technology infrastructure and the curriculum for the emergence of mastery and appropriation?

METHODOLOGY

Context of the Study

In 1993, the College of Education at the University of Missouri–Columbia began a major revision of its curriculum that resulted in a new Teacher Development Program first implemented in the fall of 1996. One of the goals of the program revision was to move toward an apprenticeship model of learning, with an increasing emphasis on learning to teach from situated experience. This goal was accomplished through placing preservice teachers (PSTs) in field experiences from the very first of their course of study in education, and concluding their program with a capstone semester-long internship experience in student teaching. Two key values of the new program—inquiry and reflection—were integrated into the curriculum through action research projects each semester, based on observations, reflections, and inquiry into questions that emerged from field experiences.

At the same time, the college implemented a substantial technology infrastructure. The general goals of the new technology infrastructure were to support the implementation of the new curriculum approach and to immerse students in a technology-using environment in which there was ready access to, and high levels of support for, using advanced technology for multimedia and networking applications. For example, the technology infrastructure included providing laptop computers for all incoming students and implementing a new type of computer lab, the Reflector, that emphasized collaborative work and high levels of support (Wedman et al, 1998; Laffey et al, 1998). Instead of providing a course, as had been the previous approach, or courses on technology in teaching, the new program sought to infuse technology into the curriculum of every course. The faculty was expected to model technology use in their teaching and require PSTs to use it in their work. At the same time, PSTs' performance with technology was to be assessed according to standards set by the program, both at the level of individual courses and in the review of PSTs' portfolios as they passed through the four phases of the program.

Data Collection and Sample

Surveys of all PSTs

A set of surveys was given to all (approximately 300 students in the class of 2001) PSTs in the program each year to gather general descriptive and comparative statistics about demographic variables, the level and subject area they were preparing to teach, their current technology use, and their attitudes about teaching with technology. Among other survey instruments each year of the study, we measured PSTs values and beliefs about teaching with technology through a 10-item questionnaire that asked them to choose one of three scenarios (low to high technology use) for each of the questions posed (see Appendix, p. 381, for instrument).

Observation and interviews with primary sample

Over the course of our first year of observations of the second cohort of PSTs (approximately 300 students in the class of 2001) in this newly revised program, we identified 30 PSTs as participants in a primary case study sample. Through our selections, we attempted to build a sample of PSTs across the range of gender, race, and ethnicity of the cohort population, as well as of the range of technology expertise. We selected PSTs for the primary sample to represent the age levels and disciplines of the cohort. Two of these PSTs were preparing for early childhood education and their case studies will be included in this report. Observations and semi-structured interviews were undertaken with the PSTs in the primary sample in their second and third year in the program, as well as a final interview during their fourth year. The interviews followed guides collaboratively developed by members of the research team, using questions that emerged from observations and reading of the literature about technology and teacher education.

Focus group sessions and interviews with secondary sample

Based on substantial attrition of students in the teacher education program and hence our primary sample, in the third year of the study we recruited a secondary sample of 45 PSTs. The goal in gathering data from this secondary sample was to triangulate findings from this sample with what we were learning from key informants in our primary sample. Seven of these 45 PSTs were preparing for early childhood education. Focus group sessions and semi-structured interviews were undertaken with these PSTs during their junior year in the teacher education program. This report focuses on the context, experiences, and actions of early childhood PSTs in the class of 2001. These PSTs were preparing for teaching assignments in the range of birth to eight years of age.

Data analysis of observations, interviews and focus group sessions

Data analysis was an ongoing process of the longitudinal study. For most of the study period, the team met on a weekly basis to discuss observations, plan the next data collection activities, and analyze available sets of data. Content analysis subjected to critical discussion by the team was the primary method of reviewing data. The content analysis and discussion were used to identify those aspects of the PST's experience and development that were common and those aspects that were individually unique as well as to judge when transformations were happening for the individual or for the cohort. Early on, we looked for evidence of technology use

and ways in which students showed valuing or resisting the use of technology. The early data sets led to questions for interviews and issues for observation. As the study progressed, we looked for evidence of transformation in technology usage, valuing, or resistance, as well as the emergence of new ways of using the technology or stances toward using the technology. As the study progressed, we gravitated toward seeing the data as biographies of individual development and as stories of program area issues and transformations within the program area cohort of students. Throughout the process, we strove to enhance external reliability by following the guidance of LeCompte and Preissle (1993), and supported internal reliability through a variety of strategies, including low-inference descriptors such as verbatim accounts of conversations, peer examination, and mechanically recorded data.

FINDINGS

Values and Beliefs Survey

Laffey and Musser (1998) reported findings from a pilot study with a sample from the class of 2000, who were the first cohort of PSTs to enter the reformed program. They found that a minority of these PSTs (34.8%) owned a computer before entering college. The majority of PSTs in the class of 2000 reported a low computing environment as their primary experience in school prior to college. Data from the class of 2001 show that experience with technology prior to entering college is rapidly becoming the norm for PSTs in the teacher education program. The majority of those surveyed in the second cohort (58.6%) reported computer ownership before coming to college. Access both at home and at school provided computer experience for nearly all entering freshmen in the class of 2001: only 4% of those surveyed in this second cohort reported having no computer experience prior to entering college.

Table 1 shows the responses to the values and beliefs questionnaire for the total PST student body (class of 2001) and the total number of early childhood majors who completed the instrument in the second and third years of the study.

The first three questions ask the PSTs to describe their beliefs about the value of using technology for themselves as a student. For each question in year two the ECE PSTs are lower than the total PST group but in year three become equivalent. The ECE students started at a lower base but became more comfortable in using technology while in the program. The next four questions ask the PSTs to describe the value of technology for general student achievement outcomes. Across the board PSTs see technology as having relatively low value for doing well on standardized achievement tests. The value of technology to help students learn in a way that they would understand and be able to apply what they learned advanced substantially from year two to year three and stood two points higher on a five-point scale than the value for achieving on standardized tests in year three. Questions 8 and 9 ask the PSTs to anticipate the type of classroom in which they expect to teach and then the one in which they would most like to teach. For the ECE students, this rating is approximately equivalent to the total PST sample in year two, but what they think will be expected of them goes down in year three while their own preference goes up. Their comfort level with technology appears to be going up but their understanding

Table 1. Values and Beliefs Related to Technology questionnaire

Questions (scale of 1 to 5)	ECE yr2	ECE yr 3	Total yr 2	Total yr 3
1. Likely to get a high grade	2.26	2.71	2.63	2.74
2. Likely enjoy the learning process	2.81	3.56	2.97	3.48
3. Learn things you could apply	3.10	4.00	3.37	4.01
4. Help students pass achievement tests	1.87	2.06	2.22	2.09
5. Help students understand and apply	3.13	4.28	3.21	3.96
6. Prepare students for college	3.19	3.39	3.20	3.29
7. Prepare students for work	3.84	4.00	3.79	3.94
8. Will be expected of you	2.68	2.33	2.62	2.60
9. You would most like to teach	2.77	3.83	2.97	3.45
10. You have spent most of your time	1.58	1.22	1.69	1.46
n	n=31	n=18	n=218	n=147

Note: In the first year of the survey (freshman class), no distinction was made between teachers preparing for ECE and elementary education, so ratings for ECE students could not be identified.

of what ECE classrooms hold and administrators and parents expect suggests lower levels of technology use. Question 10 asks PSTs to think back to their own K–12 experience and describe their level of technology use. It is curious why year three ratings would be lower than year two. One possible answer is that through the process of attrition and addition of students from year two to year three the general level of prior K–12 technology use diminished. In this case, it would make the gains in values and beliefs from year two to year three for the other questions even more striking. An alternative explanation is that in hindsight, after more experience using technology the PSTs prior experience seems even more meager. In either case the numbers show that the PSTs had very little experience using technology in their own time as a K–12 student.

Focus Group with Secondary Sample

A focus group was conducted toward the end of the fall semester of their junior year with Early Childhood PSTs in the secondary sample. In response to a request to describe their ideal Early Childhood teacher, the PSTs identified being certified, knowing development, and working well with children. Being certified was equated with having plans and activities with sufficient training to have multiple strategies that can be flexibly employed.

The Early Childhood PSTs described their ideal classroom as one in which there is a strong sense of community, with lots of books and activity centers around the room. Some describe the room in terms of having bright colors, lots of windows, and student artwork on the walls. They see the students as active learners who will spend a lot of time doing group work and hands-on activities. They see the teacher's role as a facilitator of student learning rather than the director of their learning. Thus, the teacher's job is to encourage the students to explore and discover on their own. One PST said:

> [The students would be doing] *c*enters, discussions, working together on projects, helping each other, lots of reading and writing. [The *teacher* would be doing] lots of observation, more facilitating than telling.

The Early Childhood PSTs emphasize that their job is to teach their students social skills and to focus on interpersonal development. They plan to engage students in active learning that they characterize as different from the traditional ways in which they were taught.

> My mom did a lot with me before I went to school. We did a lot of workbooks, we watched Sesame Street. … I was very prepared to do worksheets and work in a workbook and do that sort of thing. And I did well in school. A lot of people didn't. Um, they weren't prepared to do that and it's not the way a lot of kids learn, which is why I think they're teaching us a different way to teach—um, is that a lot of children weren't being reached in the traditional method of teaching.

Interestingly, in describing their ideal teacher, early childhood classroom, and ways of teaching, the PSTs did not mention the use of technology. These are students in a rich technology environment and in a teacher education program that has made substantial efforts to include technology in the PST experience. When the ECE PSTs were asked directly about the use of technology, most felt that their students would be too young to be taught how to use technology. Some had concerns about the appropriateness of technology for the young children:

> It would be *nice* to have the computers in the class, but they wouldn't have to be anything elaborate, because the children are only going to be three to five years old.

> I like technology, I'd use it anyway I can, but I am going to be in a preschool setting and I don't think that technology should be a big thing there, with the kids. I will use technology, like for planning and for doing activities and stuff. But I don't think that I will use it in my room.

> Children should have an actual experience rather than watching it on a computer. There's no need for children to learn about flowers on a computer if they can go outside and pick flowers themselves and dissect them in a classroom.

Interviews with Secondary Sample

Interviews were conducted in the late spring of the junior year with six Early Childhood PSTs in the secondary sample. By this time these students had been engaged in methods courses and had participated in a variety of field experiences. In addition, the program, after a year of delivering classes in a makeshift classroom and computer support facility, moved back into the renovated college of education building, which by now had new and more readily available technology in the classroom for the faculty and students.

When asked to describe what their classroom would look like if they could have any or as much technology as they wanted, the PSTs provided a variety of ideas for how technology could be used. The ideas included having smart boards (large interactive whiteboards for computer projection and touch-sensitive interaction), technology for special-needs children, game software for learning mathematics, computers in centers, and as many computers as space would allow. When asked to explain how important the technology was for their teaching, every student answered in a similar way: It would be nice to have technology because it could make contributions or be a supplement to their teaching, but technology is not essential for teaching early childhood.

Some of the teacher education program experiences helped PSTs come up with ideas for how they would use technology in ECE.

> The most recent thing we've done is the digital camera …. The assistant from the Reflector taught us how to do it, and then we got actual hands on experience like using the equipment and doing our own pictures and text. … I think that the digital camera thing is something that I would have to do (as the teacher). Like they've taught me how to use technology and I would be the one to operate the digital camera.

> Last semester we evaluated software for language and literacy in our classroom and that was really beneficial. We talked about, you know, what kind of things are good quality software programs and what aren't. What do you look for. Why is it developmentally appropriate. Why is it not. That sort of thing. So that was really helpful.

Other aspects of the teacher education program detracted from PSTs' interest in using technology in their teaching. Only a few of the faculty actually used technology in any substantial way in their own teaching, and most faculty were reluctant to make students use technology in advanced ways. When assignments promoting the use of technology are made, the instructors often provided options for how the work could be done without using technology. Similarly, some of the attempts on the part of the college to encourage the use of technology have met with resistance from students.

> I would say the more they try to teach us, the worse it gets—then I don't want to learn it because it is horrible. I mean, they tried to teach us to make these portfolios on the Web, and that was like the scariest thing ever…

> If they did a better job, I think I would be more apt to try things with technology, whereas I'm kind of stand-offish with that kind of stuff, because it seems to blow up in my face and I don't want that to happen, nor do I want it to become a huge stress and problem.

> We did the journaling tool for a while, too, which was a flop.

PSTs point to some field experiences as poor lessons for using technology.

> This semester, we have a computer in the classroom, but the teacher used it once to show them a Web page on snails, I think it was. Other than that she uses it for her own personal stuff, just to make signs for the bulletin boards or things like that, but it's really disappointing that I don't see technology really at all. I think that… They think that it's more for older children, and I don't work with older ones, but I think that it can be used with younger ones.

> I've seen things I don't want to use in my class. I was in a class last semester, and it was a *great* class, but part of the station time was based around computers, and I didn't think that the software was specific for each child. …I don't think that how it was set up was really teaching them, really. I mean they know how to use computers, but they weren't really learning anything from the software that was supposed to be helping them learn. It was just like a game to them. So that's what I wouldn't do.

Field experiences have also provided inspiration and lessons for using technology.

> In my field experience, I have seen a lot of the children using the computer other than just software. Some of them have used the library as their card catalog on a computer. So the kids used the computer to look up books in the library. I would… I think that that's beneficial, and the kids love to do it. Anything that they can do on the computer. They think that's neat.

> Yeah. My first grade classroom right now. They have a *ton* of software programs that focus on math, science, social studies, language, whatever. And they're *great! A lot* of them I *really* like. Now, there're a few that I'm not so sure that I would want in my classroom. But there're a *lot* that I really enjoy. Our teacher—my cooperating teacher this semester, she uses *a lot*, like, she uses it as a supplement, which is the way it's *supposed* to be used.

> The program was called writing to read—and um, they went into this computer room, and the kids typed instead of wrote. And I think it kind of made them feel like, cool, like grown-up, you know. But um, they, they typed their stories or letters or whatever they wanted to write. And just for maybe a half hour a couple of times a week, got to go in there and do it. And I thought that was neat, just because a lot of the kids couldn't really write very well yet, so that was definitely a way to get them writing, even if, you know, they weren't writing. But, to me, that seemed like a very good outlet for them to at least get started on.

In summary, the ECE PSTs value flexibility, fluidity, creativity, and building interpersonal skills among the children. On the surface these do not appear to be associated with computer use. The PSTs see the value in their using computers to prepare materials, find resources, and communicate with administrators and colleagues, but while they believe computers would be nice to have, they do not believe that computers are essential to ECE. Computers are most frequently considered as supplements. However, field experiences in which they see or have personal experience with children using computers impresses them with how much the children love working on computers and how the computers can provide learning experiences that may be hard to achieve without them.

CASE STUDY: DENISE

Denise is a white female early childhood education major. When Denise heard about the college of education laptop program, she was excited, because she did not own a computer of her own. Because the program provided her with a laptop, she didn't have to buy one. In the end, however, Denise decided not to keep her laptop for a number of reasons. She felt that it was too slow. She believed she would get a better return on her investment if she bought a faster IBM desktop computer, because she would have better access to software and because she would have access to people who would know how to fix her computer if she had problems with it.

Denise used her laptop at least once a day to type papers, do Internet searches, and communicate with people through e-mail. In her portfolio, Denise listed an e-mail interview, use of Merlin, Web surfing to locate sources for a paper, and word processing as examples of her "extensive use of technology in learning." As she said, "I know that everyone else really doesn't use it that much, but I would be kind of lost without it. I really do use it a lot, and I am very thankful for it." In her sophomore year, Denise gave herself a 5 on a 1–10 scale for computer expertise. As she said, "I know how to do the basics. I really don't know that much more."

In the fall of her sophomore year, Denise described computers as a potential barrier between teachers and students.

> I don't think it's really gonna help if you've got something in between like the teacher and the student. Because if you're using it as the computer being a tool or the students learning from that, then they're not learning. I mean, I don't think they're learning from the teacher. They're more learning from the computer. So, in my opinion, I think that the teacher is more away from it.

In the spring semester of her junior year, Denise further described her view of technology in ECE. She felt third grade would be a good time to start teaching children about computers. She said that she could also see herself using computers to facilitate science labs. For the most part, however, she is waiting for someone to teach her how to do things with technology. Speaking specifically of PowerPoint, she had not used the program because no one had ever taught her how to use it.

> I don't want my classroom to be a computer for each child where I'm like teaching stuff and they're typing stuff. I just—I feel that they're missing something with that. … I guess I really don't know right now how I would use the computer aspect in the classroom.

In the fall of her senior year, Denise for the first time describes an interest in having computers in her classroom for student use, but says her preparation in the teacher education program and field experiences have not prepared her well for knowing what to do with computers or knowing how to use them with students.

> I guess in Kindergarten or first grade, it would be used as like a center tool. Kind of for kids to go around and use like in pairs or whatever. And use for like word-processing for like their work and kind of publishing and stuff like that. I don't really—I don't know. I haven't had those kinds of experiences with it, so I guess I'm not quite sure how I would use it. … But if someone like had ideas or good training, I'd be okay with it. Like, you know, like if someone gave me some ideas, I think it would be good.

> Well I guess if I had the technology, someone could give me the ideas. Someone would be there, you know. I would think that I probably wouldn't be the only teacher with the equipment or something. So I'm thinking that it would be other people. If we're given technology, I would assume that someone would be like in charge of the technology or something, you know.

In summary, Denise is an active computer user as a student and communicating with her peers, but resists envisioning or taking responsibility for having children use computers as part of her teaching. The resistance can be partly explained by a conflict between how she sees the role of computers in a classroom as something that you type on and that comes between the student and teacher, and her love for children and desire for a strong interpersonal bond with students, which is her reason for becoming a teacher. Her experiences in the program of learning some things about computers, seeing them in schools, and having a few field opportunities to learn about how teachers can use computers have begun to help her see a role for computers in her classroom. However, she seems far from appropriating the technology into her repertoire as a teacher.

CASE STUDY: CARRIE

Carrie is a white female early childhood education major. When she came to visit the university, Carrie was excited at the thought of getting a laptop, kept it for three years, and then purchased an iMac. In her first few years in the program, she mainly used the computer to do word processing, e-mail, and Web-based research. By the spring of her junior year, she felt comfortable using technology, but did not see herself doing much with technology unless it was handed to her.

> Unless somebody really handed it to me at my school, I don't think I would use a lot of technology, like within my teaching. … I'm not going to go out and buy technology stuff, you know what I'm saying? If it is there for me to use, of course I will try to use it. But I think, to be practical, … you can't always have everything on the computer. I mean every student doesn't have a computer.

Despite the fact that she didn't see computers as central in her class in March 2000, she did envision using them for a number of basic things.

> I think maybe like at center times, when the kids rotate around the room doing different things, I would probably have like a computer station for the kids to rotate and to take turns using new games or, you know, literature activities on the computer. As far as like when I'm teaching, I don't think like I'd have a PowerPoint or anything teaching little kids. … I'm not that comfortable with it. I'm comfortable with using the basic Internet and word processing features and e-mail. … As far as outside communication, I'd probably use e-mail, … if parents have e-mail addresses. You know, to update them—'This is what our class is doing. This is blah blah blah.' But I mean realistically, you'd be lucky if maybe, maybe half of your class' parents had e-mail, depending on what kind of school district you are in. …. I know a lot of teachers e-mail each other ideas, and I know that sometimes they will keep in contact with administrators that way.

By May 2000, Carrie had learned more about how teachers are using computers with young children. At the time, she said that she planned to be prepared to teach students to do some things with computers, but that she thought most computer use will be taught in computer classes.

> I found more this semester that they are teaching younger kids a lot. A lot more of my kids … were doing PowerPoint presentations, and I thought that was great. You know, a kid was asking me how to do something, and I was like, 'I don't know. Let me try to figure it out.' So, I realize they're teaching Internet use and typing and things like that, so I'll definitely be very involved in that, but a lot of that too is through their computer classes they have. I don't think, unless it's this extremely wealthy school, I doubt each kid is going to have a computer where I'm getting to teach these things in my classroom. It's probably not likely.

Because she did not think she would have very many computers in her classroom, she said she would encourage the use of a computer lab in a school. She said that she had acquired basic computer skills, and that limited what she would do with technology in a classroom.

> I definitely … think I would encourage, you know, the use of the computer lab, depending on what's available. It depends upon where

> you are school-wise. Um, but I would. I think I would encourage it, and I just—I think realistically you're not going to teach second graders to do computer programs or whatever. Um, but, I think the things they're doing now, I definitely would support and do. I just—I personally—I'm probably guilty. I probably need to learn more. I can use the Internet and word processing, and that's probably about it, you know. I think that's a lot of my own personal stuff, but I think that would be one of the things that I could teach kids.

In May 2000, she envisioned herself taking continuing education classes to learn how to use computers after a couple of years of teaching. One of the things she plans to learn about before she graduates is how to use digital cameras, because she would use them in a classroom. What she would do with technology would ultimately be dependent on what the school had available.

> You can't just go out—I mean, I guess you could—but go out as a teacher and buy technology for your class. I think it depends on what your school has available in the district.

In the May, 2000 interview Carrie said that she doubted that she would have more than 1–2 computers in her classroom. She would use them for games and activities with the students, but primarily she would use the computers for personal record keeping. In general, Carrie saw the value of having the teacher use the computer for record keeping, materials development, and communication with administrators and other teachers, and whereas she was beginning to see the potential of having students use computers, she expected that to be done by another teacher or the librarian in the computer lab and that what she would be able to do would depend on what the school provided.

Carrie felt that she had learned a number of technology-using skills and represented this in her portfolio, but also felt that her skill level was fairly brittle.

> I guess it would maybe show technology skills. You know, Web page building kind of skills, but still, at the same time, I'll have to admit I probably couldn't go back and do it now if I had to. Like, it was kind of one of those [things where] they pulled us through it and then it just went—you know, it was kind of gone. Maybe it would come back to me if I had a refresher course or something.

In December 2000, Carrie talked about how her ideas for using technology had changed

> I've seen more in field, and so I've seen what other teachers do. You know, it's hard to decide based on just not having seen anything—what kids can really do. I think I've realized, you know, because I baby sit for kids and classrooms, but they do know a lot about computers. And they're excited to work with them, and so I think it is really important. But, you know, I've also been in placements where, such as the lab, where they have like an old Mac. Like it's really old. It's a … Apple IIa or whatever. Anyway,

like a really, really, old, old computer. And, you know, they didn't really make computers a huge part of their program, so I think as long as you're using them appropriately and not just using them as entertainment, as far as CD-ROM games or just kind of generic little cartoon things, I think it's definitely very appropriate and necessary.

Carrie mentioned doing PowerPoint presentations, spending time in the Reflector, and doing software evaluations as things from her education classes that influenced her use of technology, but declared that the field placements were the most influential.

> …because then you really see the kids working with it. It's hard to talk about it in classes—visualize it sometimes. And when you actually see it in your field that makes a huge difference.

Although Carrie still had reservations about her own abilities to use technology with her students by her senior year, she now envisions computers in her classroom and calls them an essential part of education for preschool. When asked about what she would envision for her class she responded,

> Oh wow. Um, if I could have everything I wanted in my classroom, and I was teaching like K or one…..I think it would be great to have a huge area of computers. One for maybe every couple of students to work on and use it as centers …. Where they go and work at different centers independently. So you can have a huge computer center, which would be awesome for um, you know, with guided help with the teacher doing Internet explorations [and] even word processing for more advanced students. And so it would be great, you know, to get that letter recognition and stuff. Um, and then, you know, and maybe even some kids could do PowerPoint. Like I was talking about or, you know, some CD-ROM games I think are appropriate. And I guess a Smart Board would be really cool. I think those are great, you know, to do whole classroom instruction.
>
> I think computers are [essential] in this day and age, because, I mean, a lot of kids come to Kindergarten or first grade technology literate, because they have a computer at home. But a lot of kids don't. And I think, anymore, you need that early exposure. It's just like anything else. It's like computer learning, or a second language, or, you know, anything. If you're exposed to it early, the earlier you're exposed to it the better you are at being comfortable with it and learning it quickly. So I think, if you have the computer there and you allow children the option to interact with it, and even if it's just, you know, play some games or play around with the word processor, I think it's still part of knowledge that they can take with them to the higher grades where they probably are learning more specific skills as far as, you know, keyboarding and stuff like that. Um so yeah, I think computers right now are very essential in this day and age.

In summary, Carrie—starting from essentially the same point as Denise, having the same education courses, and with fairly equivalent skills and use patterns as technology-using PSTs—seems to have moved toward appropriation of computers in her classroom to a much greater extent than Denise. Her field experiences, which she describes as fairly rich in seeing teachers and students use computers, has helped her craft an image of her own classroom in which the kids already know a lot about computers, are excited about using computers, and in which the computers meet needs of children (digital divide) that she feels are critical. Carrie has appropriated computers as a tool in her role as a teacher and in her vision for her classroom. There are still two substantial constraints to be overcome: her lack of mastery in some areas, and her need for a school environment that provides computers and support for using computers.

DISCUSSION

The findings show that ECE preservice teachers appropriate technology in their role as students. They use technology to communicate with peers and teachers, to prepare lesson plans and teaching materials, to create multimedia presentations for their university coursework, and to meet university requirements for technology proficiency. The findings also show that the preservice teachers plan to use technology as teachers outside of the classroom (research, communication with peers and administrators, materials preparation), but resist seeing technology as a part of their relationship with children.

The teacher education program that provided a context for this study made substantial investments and efforts to infuse technology into the program, including laptops for all students and an extensive support system for faculty and students. The findings show that this effort had payoffs in a number of areas: (1) The PSTs used technology frequently and appeared to readily appropriate technology as a tool for themselves as students. (2) Certain competencies, such as software evaluation, were developed, appreciated, and were anticipated to be valuable tools in teaching. And (3), students had exposure to a wide range of technological applications, including network services, building Web pages, PowerPoint presentations, and digital cameras that have potential to contribute to an expanded repertoire of teaching strategies. This third point is tempered by the recognition that the ability to use these applications seems fragile and is likely to be highly dependent on the support available in the school where the PSTs will find employment. The findings also show a number of weaknesses in the support for technology: (1) The use of technology by faculty in the curriculum was inconsistent, and students expressed disappointment that the "supposed high tech experience" fell short of their expectations. (2) Although the use of technology by students was widespread, for most students this use did not achieve much depth. Using word processors, sending e-mail, doing Web-based searching or preparing PowerPoint slides as a PST or as a prospective teacher are fairly rudimentary accomplishments when compared to a vision of teachers helping students use technology for representing, analyzing, and communicating about their world.

It is clear that the ECE PSTs grew in their mastery of technology and developed a different stance toward using technology as a teacher as they advanced through the program. From a starting point of almost no experience using technology as K–12 students (aside from typing papers), little expectation that early childhood classrooms would have technology or that they would be expected to use it, and little desire to use technology with children (and for some, an aversion to it), these ECE PSTs grew to see the value of computers as a supplement to their teaching (primarily in centers). The two PSTs in the case studies provide illustrations of how the field experience can advance the appropriation of technology for ECE. Carrie had some good role models and experiences with children using technology. From these experiences she saw how the technology could be her tool for achieving her goals in the classroom. She saw that the children brought knowledge and skills with technology to the classroom or easily picked up on it. She saw the children excited and engaged, and she saw how technology was essential for her goals of giving all her students a good start in life. Denise, on the other hand, did not have the same rich experiences, and although she sees value in having computers, she sees them as someone else's tool or responsibility. This study highlights the critical nature of rich and meaningful field experiences for helping PSTs appropriate technology in their teaching interactions with children. Field experiences that have the preservice teachers interacting directly with children using technology have potential for overcoming the resistance to teaching with technology.

The findings suggest that the pathway to appropriation of technology as a teacher is not uni-dimensional and has a varying set of contributors and constraints. The preservice teachers in the program seem to simultaneously appropriate and resist using technology. Most of the PSTs were seeking to become better technology using students, both gaining mastery of technologies and building a self-image as technology users. As Carrie described in her statement about her portfolio, "Hopefully, maybe it would tell them that I can work with technology." At the same time, many students were struggling with the seeming incompatibility of the classroom they had always envisioned teaching in and their fear of having the computer come between them and the children they wanted to teach. Similarly, when confronted with requirements to use technology and encountering technical challenges or risks of looking incompetent (such as in the portfolio development or use of the journal tool), they sought more familiar ways of working.

Traditionally, we have thought of mastery and appropriation as steps along a continuum of adopting technology. Our findings show both mastery without appropriation and appropriation without mastery. Mastery without appropriation is shown in those instances where PSTs complete tasks with technology, but do not see the technological accomplishment as personally valuable. Typically we see this when students are asked to complete assignments that they see as important to others but not to themselves. For example, students were required to complete a Web-based portfolio. The college did not have the resources to help each student build a personally meaningful and expressive portfolio, so it built a template and mechanism that was a lot of work, tedious, replete with technical challenges, and what students came to view as a hurdle rather than as a demonstration of their competency. In the language of the university, the student has mastered the competency

by having completed it, but just as Carrie described the fragility of her ability to build a Web page, the mastery did not provide empowerment.

Appropriation without mastery, on the other hand, refers to coming to value a practice, but not yet having the competency to carry it off. Carrie's stance toward technology in the last interview indicated an appropriation in the sense of valuing and seeing technology as part of her image of her teaching and classroom, but still lacking in mastery. Carrie did have confidence, however, in her vision, because she could see herself taking continuous education to advance her abilities, and she felt that the schools would provide a computer support person. The picture that PSTs had of what schools would be like seemed a very important part of their stance toward being a technology-using teacher. They saw schools having computers in growing numbers, and some had a belief that they would find collaborators or computer teachers in the schools to help them, while others may not have had sufficient time and interaction to both see what was done and how it was supported and made possible.

Engeström (1987) and Mezirow (1990), arguing from an activity theory perspective, have suggested that the type of transformations involved in appropriating new ways of working and new ways of understanding are a result of critical reflection on past experiences. These reflections have the potential to change the subject's response to the environment. Following Wertsch's (1998) lead, discussed earlier in this paper, that appropriation should not be thought of as an individual attribute but rather as an interaction of an individual with a context, it is clear that field experiences and the ability to reflect upon them are pivotal in appropriating technology into teaching. This is not news, but may be sobering to organizations that are investing in computer laboratories as a means to develop teachers who will use technology.

One must be cautious in using descriptive data to make suggestions for practice, but the implications I draw for important areas for additional attention and investigation are the following:

1. The technology environment and support for using technology in the setting of this study are substantial, yet the integration of technology into methods and other education courses is described by the ECE students as limited and disappointing. How can PSTs learn about the use of digital cameras in the same context as learning about the value of having children express themselves and communicate about their experiences, or learn about the interest that students have in interactive digital environments while they are learning to engage children in numeracy and other early learning skill opportunities? There is little if any research on how university faculty come to appropriate technology in their teaching. Hopefully, lessons generated from the numerous U.S. Department of Education Preparing Tomorrow's Teachers to Use Technology projects may address this issue. Extrapolating from the students' experiences represented in our study one might suggest that faculty need more field experience in technology using K–12 schools. Faculty must integrate technology into methods courses so that as the PSTs are learning how to select appropriate learning goals, design meaningful lessons, and arrange necessary materials to

accomplish the expected goals, the potential of technology to enhance the learning is considered.

2. One of the distinctions between Carrie and Denise might be expressed in Margolis' (1993) framing of two roles the computer can play in schools: as a tool for the acquisition of knowledge and empirical facts, or as tools for the development of children's thinking. Similarly, Bruce and Levin (1997, 2001) proposed a taxonomy of uses of technologies for learning based on Dewey's (1943) description of the natural impulses of a child: inquiry, communication, construction, and expression. Given the importance that the teacher-child relationship has for ECE teachers and the controversy about using technology with young children, teacher preparation programs may find it beneficial to frame teaching the use of technology as a way to mediate the expressions, performances, and activities that we value for children.

3. The findings in this report confirm that field experiences, especially those that structure first-hand experience with children successfully using technology, are critical to appropriating and overcoming resistance to using technology in teaching. However, the findings also suggest that it may be important to extend the field experience beyond simply having classroom experiences. PSTs need help to plan for how to successfully implement and manage technology in their teaching, such as knowledge of support from peers, working with computer teachers or media specialists in schools, taking continuing education, or developing strategies to let the children help other children. Further, following the guidance of Engeström (1987) and others on how to support deep transformation and appropriation, teachers need to talk about their field experiences and reflect on the use of technology with children and the conditions that make it desirable and possible.

The stories represented in this report suggest that appropriation is driven by seeing how and what teachers do with technology for accepted goals (e.g., special education or basic skills) by seeing the engagement of children and their levels of accomplishment with technology, and by seeing technology as essential to closely held values for becoming a teacher, such as overcoming the digital divide to give students a fair start in their educational journey.

ACKNOWLEDGEMENTS

The work described in this paper was supported by NSF Grant REC 9725214. The author would like to thank Brad Wing, Christine Patterson, and Yimei Lin and the entire STI research team for their contributions to this work, as well as the teachers and students in the MU Teacher Development Program for their cooperation and feedback in this research.

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References

Alliance for Childhood. (2001). *Fool's gold: A critical look at computers and childhood.* Available: http://www.allianceforchildhood.net/projects/computers/computers_reports_fools_gold_contents.htm

Bakhtin, M. (1981). *The dialogical imagination: Four essays by M. M. Bakhtin* (M. Holquist, Ed., C. Emerson & M. Holquist, Trans.). Austin: University of Texas Press.

Becker, H. J. (1999). *Internet use by teachers. (report #1).* University of California–Irvine: Center for Research on Information Technology in Organizations. Available: http://www.crito.uci.edu/TLC/html/findings.html

Becker, H. J., & Anderson, R. E. (1998). *Teaching, Learning, and Computing: 1998. Teacher's Survey: Combined Versions 1-4*. University of California–Irvine: Center for Research on Information Technology and Organizations.

Blanton, W., Moorman, G., & Trathen, W. (1998). Telecommunications and teacher education: A social constructivist review. In P. Pearson & A. Iran-Nejad (Eds.). *Review of Research in Education* (pp. 235–275). Washington, DC: AERA.

Burke, K. (1969). *A grammar of motives*. Berkeley: University of California Press.

CEO Forum Reports. (1999). *School technology and readiness report*. Available: http://www.ceoforum.org/reports.cfm

Bruce, B. C., & Levin, J. A. (1997). Educational technology: Media for inquiry, communication, construction, and expression. *Journal of Educational Computing Research, 17*(1), 79–102.

Bruce, B., & Levin, J. (2001). Roles for new technologies in language arts: Inquiry, communication, construction, and expression. In J. Jenson, J. Flood, D. Lapp, & J. Squire (Eds.), *The handbook for research on teaching the language arts*. New York: Macmillan.

Clift, R., Thomas, L., Levin, J., & Larson, A. (1996, April*). Learning in two contexts: Field and university influences on the role of telecommunications in teacher education.* Paper presented at the annual meeting of the AERA, New York City.

Dewey, J. (1943). *The child and the curriculum: The school and society.* Chicago: University of Chicago Press.

Dwyer, D., Ringstaff, C., & Sandholtz, J. (1991), Changes in teachers' beliefs and practices in technology-rich classrooms, *Educational Leadership, 48*(8), 45–54.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta–Konsultit.

Laffey, J., & Musser, D. (1998). Attitudes of preservice teachers about using technology in teaching. *Journal of Technology and Teacher Education*, 6(4), 223-242.

Laffey, J., Musser, D., & Wedman, J. (1998). A technology infrastructure for teacher education. *Proceedings of AACE World Conference of the Society for Information Technology & Teacher Education*.

LeCompte, M. D., & Preissle, J. (1993). *Ethnography and qualitative design in educational research* (2nd ed.). New York: Academic Press.

Mezirow, J. (1990). *Fostering critical reflection in adulthood*. San Francisco: Jossey-Bass.

Moursund, D. (1999). *Will new teachers be prepared to teach in a digital age?: National survey on information technology in teacher education*. Santa Monica, CA: Milken Exchange on Education Technology. Available: http://www.milkenexchange.org/research/iste_results.html

National Center for Educational Statistics. (2000). *Internet access in U. S. public schools and classrooms: 1994–1999.* (NCES 2000086). Washington, DC: Author. Available: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000086

President's Committee of Advisors on Science and Technology. (1997). *Report to the President on the use of technology to strengthen K–12 education in the United States*. Washington, DC: Author.

Tierney, R. (1996). Redefining computer appropriation: A five-year study of ACOT students. In C. Fisher, D. Dwyer, & K. Yocam (Eds.), *Education and Technology: Reflections on Computing in Classrooms* (pp. 169–184). San Francisco: Jossey-Bass.

Web-based Education Commission. (2000) *The power of the Internet for learning: Moving from promise to practice* (Report). Washington, DC: U.S. Department of Education.

Wedman, J., Laffey, J., Andrews, R., Musser, D., Diggs, D., & Diel, L. (1998). Building technology infrastructure and enterprises in a college of education: Increasing performance capacity. *Educational Technology*. September-October, 12–19.

Wertsch, J. (1998). *Mind as action.* Oxford University Press.

APPENDIX

Please read the three scenarios and then answer the following questions:

A. Students learn by reading textbooks, classroom exercises, and teacher lectures. Students write reports and take tests using paper and pencil or word processors on a computer.
B. Students learn by reading textbooks, classroom exercises, computer-based tutorials for important skills and teacher lectures. Students write reports using word processors.
C. Students learn extensively through computer tools, such as simulations and internet-based research. Students present their ideas about the curriculum by creating multi-media reports which are the basis for assessment.

1. Which of the scenarios depicts a classroom in which you would most likely get a high grade? A B C
Why?

_____
_____

2. Which of the scenarios depicts the classroom in which you would most likely enjoy the learning process? A B C
Why?

_____
_____

3. Which of the scenarios depicts the classroom in which you would most likely learn things that you would be able to apply outside of the classroom? A B C
Why?

_____
_____

4. Which of the scenarios depicts the classroom that will most likely be successful in preparing students to pass standard achievement tests? A B C
Why?

_____
_____

5. Which of the scenarios depicts the classroom that will most likely be successful in preparing students to understand and apply knowledge to solve problems? A B C
Why?

_____
_____

6. Which of the scenarios depicts the classroom that will most likely be successful in preparing students to do well in college? A B C
Why?

_____

_____

7. Which of the scenarios depicts the classroom that will most likely be successful in preparing students to do well in a work environment? A B C
Why?

_____

_____

8. Which of the scenarios depicts the classroom that superintendents, principals and parents will expect of you when you take on your first teaching assignment? A B C
Why?

_____

_____

9. Which of the scenarios depicts the classroom in which you would most like to teach? A B C
Why?

_____

_____

10. Which of the scenarios depicts the classroom you have spent most of your time as a student? A B C
Why?

_____

_____

Note: Since many of the students chose to mark the spaces in between the nominal items (A, B & C) we converted the scoring to a 1–5 scale for analysis (A=1, between A&B=2, C=3, etc.).