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Increasing Computer Use in Early Childhood Teacher Education: The Case of a "Computer Muddler"

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How broadly will computers be used in PK-12 teaching? Reform efforts have often succeeded in getting many teachers to experiment in modest ways with some aspects of those reforms, although often only temporarily, and have also provided some stellar and enduring examples of transformed teaching (e.g., Dunn, 2000). However, in a century of American educational reforms, "we can produce few, if any, examples of large numbers of teachers engaging in these practices in large-scale institutions designed to deliver education to most children" (Elmore, 1996, p. 308).

Hoping perhaps that educational technology reforms will encounter greater success, technology advocates have turned some of their attention to improving the preparedness of preservice teachers, an approach supported by the United States Department of Education Preparing Tomorrow's Teachers to Use Technology (PT3) grants. As a university faculty member, I participated in a PT3 project that was aimed at increasing the infusion of technology in a teacher education program at an urban state university. The following is one description of the focus of this PT3 grant:

> Capitalizing on the documented condition that novice teachers teach as they were taught, the MIMIC Project provides technology mentoring for higher education faculty so faculty can, in-turn, model the effective use of instructional technology for the preservice teachers in their courses. One innovative aspect of the MIMIC Project mentoring process is that the majority of the mentors are K-12 classroom teachers who effectively integrate technology into

their teaching. Care is taken to match each participating faculty member with a mentor who shares content expertise with the faculty member and can address the faculty member's specific technology questions and needs.

During this project, and influenced by my background in motivation and educational reform, I became especially interested in one research question. That is, what factors are related to the incorporation of computers into teaching, by teacher educators with average computer skills?

RATIONALE FOR RESEARCH FOCUS

Why focus on teacher educators whose computer skills are quite average (in comparison to other teacher educators)? These teacher educators are important for technology infusion efforts for two reasons.

First, greater computer use in PK-12 teaching is much more likely if prospective and practicing teachers experience and practice a range of computer uses in the vast majority of their courses, rather than in just a few. Such broad usage of computers in teacher education increases the likelihood that teachers perceive computer use as a natural part of teaching, and will move beyond mere awareness of computer technology towards greater skill using computers in teaching. However, such opportunities are only possible if the majority of teacher educators with average computer skills make reasonable and steady progress in integrating computer technology into their teaching. This assertion is based on the assumption that teacher educators' computer skills and use of computers in teaching form roughly normal distributions.

Second, for most PK-12 teachers, these "average" teacher educators will often be more influential models (positive or negative), of computer use in teaching than are teacher educators with much greater computer skills. Of course, novices with respect to a reform are commonly given opportunities to observe and learn from exemplary models. Such exemplary models are important. Unfortunately, the more extraordinary the teaching of exemplary teachers, the more likely it is that teachers with average skills may conclude, "I could never do that." Indeed, research suggests that learners often discount the success of those models who are very different from the learners (Schunk, 1996).

More influential are those models who are similar to learners in many ways, including ability (Schunk, 1996). Observing highly influential models, learners think "Oh, if s/he could do it (or learn to do it), I can do it (or can learn to do it)." However, if these "average" teacher educators struggle greatly with computers, do not use them in teaching, or express great pessimism about their use, then the many PK-12 teachers with average computer skills may reasonably conclude that computer use in teaching "doesn't work," or is impractical for people like themselves.

Therefore, these teacher educators with average computer skills, referred to here as "computer muddlers," may be an important influence on computer use in PK-12 education. Understanding what promotes or hinders some muddlers progress at using computers in their teaching would allow reformers to better help other muddlers make more consistent progress. The focus here is not on individuals who are truly anxious about computers, nor on those who strongly oppose computer use in teaching children for other reasons (e.g., Cordes & Miller, 2000). Finally, the term "muddler" is not meant to be at all disparaging, for I am the computer "muddler" whose case is analyzed and presented here.

RESEARCH METHODS

Research Questions, Participant, and Setting

This study focused on two research questions. First, what changes, if any, occurred in a way in which I—a teacher educator with average computer skills—incorporated computer use and information about computers into my teaching? Second, what factors supported or undermined these changes?

I am a faculty member in early childhood education (PK-3) at a medium sized urban state university. I have a master's degree in early childhood education, a doctorate in educational psychology, and have spent the last 17 years teaching about and studying early childhood education. My perspectives on computer use in education are influenced by my background in educational psychology and early childhood education, and by my experiences researching educational reform efforts. I participated in a PT3 project from September, 1999 through June, 2001. On this project I learned about computer uses in early childhood teaching from a local second grade teacher, and learned about computer use in teacher education from other project participants.

There are several ways in which I qualified (and still qualify) as a "muddler" in my use of computers. I use computers for much of every workday, but in very limited ways (word processing, e-mail, occasional searches of library databases, or the Internet). I had never created nor modified a database nor spreadsheet, and had only modest Internet skills. My limited attention to and use of computers *in teaching* is described later, in the results section.

Data Sources and Data Analysis

Data came from multiple data sources, from as early as 1995, through January, 2002. Data sources included course syllabi, and written plans for, records of, and reflections on computer use in teaching; agendas for specific class sessions; and the reflective logs of my computer use in teaching that were completed for the PT3 project.

The design of the study contains features of case study and action research. A case study design was an appropriate choice for researching my research questions, because of the power of case studies for developing in-depth and contextualized understandings (e.g., Stake, 1995; Yin, 1994). As with most types of action research, I analyzed the data during and after its collection, to discern repeating or salient themes in my computer uses in teaching, and my related thoughts and beliefs. The exception to this is the data from 1995 through the beginning of my involvement in the PT3 project (Fall, 1999), none of which I considered to be "data" at the time. These data (class agendas, notes, reflections,) were only revisited beginning in 1999-2000, and the analysis of these data informed my "baseline" description of my thoughts about and uses of computers in teaching, prior to the PT3 project.

My own reflections on, and analysis of, computer uses in teaching were shared with, and influenced by two other individuals. During my first year on the PT3 project (1999-2000), I discussed my evolving thoughts and beliefs about computer use in teaching with my second grade mentor teacher. From 1995 through the present, I sporadically discussed my thoughts and beliefs about the appropriateness of computer use in early childhood education with another early childhood teacher educator whose office is adjacent to mine. Both of us had mixed feelings about computer use in early childhood education. We had more frequent discussions during the second year of my participation on the PT3 project (2000-2001), and this

faculty member and I began going together to visit the 2nd grade mentor teachers' classroom. Having these shared observations of computer uses in an early childhood classroom made our discussions about such computer use much more grounded and engaging, and led to a joint presentation at a technology conference (Volk & Wheatley, 2001) in which we addressed the potential advantages and disadvantages of computer use in early childhood education.

As is typical of small-sample research, especially practitioners' research into their own teaching, the validity and generalizability of this research are uncertain. Only those who test the findings in their own teaching or programs can know their usefulness. However, such reflective research on one's own teaching and learning has become increasingly common (e.g., Ball, 1993; Barton, 1999), and it has the potential for revealing critical details and advancing theoretical understanding of education-related phenomena.

RESULTS

Computers in Teaching, Before PT3 Project

Computer-related content. Prior to the PT3 project, the computer content in my courses was limited to discussing criteria for evaluating educational software (in one course), and one brief class discussion (in two courses). The examples that I used of computer uses in early childhood education were primarily from my own experiences using computers (Apple IIs) in teaching preschool, in the mid-1980s. I had little practical knowledge to share with classes about computer use in first through third grades, having never seen computers used in these grades.

My use of computers in teaching. Before my involvement in the PT3 project, my technology use in teaching consisted primarily of overhead transparencies and videotapes. Once or twice a year, I would briefly and reluctantly model the use of early childhood software programs (with a computer hooked up to a video projector), and facilitate discussions about the software's quality. This modeling was so infrequent that I always had to re-learn how to connect the computer and video projector, and how to work the video projector controls. I sometimes skipped this activity altogether, because it was too much trouble. I clearly could have been classified as being at the "survival" level of computer use in teaching (Holland, 2001).

This level of teaching about computer uses in education actually represented a regression in what my students experienced and learned about computers in class, for during the mid-1990s, the aforementioned early childhood colleague and I had annually brought in an early childhood software expert to do presentations for students. This expert demonstrated early childhood education software, discussed software evaluation and research on children's use of computers, and had students work at computers, evaluating software.

Students' computer use. Students were not required to use computers to complete course assignments. The only computer knowledge required in any assignment consisted of a few software evaluation criteria, required in one course. Because the early childhood education program has many students with little or modest computer skills, many students in our program made little use of computers unless required to do so by their instructors.

Obstacles to Computer Infusion

Miscellaneous obstacles. These obstacles included difficulty getting hardware and software to work, lack of technical support, difficulty scheduling computer labs, and the enormous time and effort it took me to prepare for using computers in class. These obstacles exist for those with greater skill with and interest in computers, but they are especially problematic for a computer muddler.

Teacher efficacy beliefs. The most profound obstacles to my infusion of computers into my teaching related to "teacher efficacy," which refers to teachers' beliefs regarding their ability to teach skillfully and affect valued student outcomes. There are various models of teacher efficacy (e.g., Soodak & Podell, 1996; Tschannen-Moran & Woolfolk Hoy, 2001), each focusing on slightly different teacher efficacy beliefs.

Because of the many studies in which greater teacher efficacy (i.e., greater confidence) has been found to be associated with use of more desirable teaching strategies, or other positive teacher characteristics, teacher efficacy has been of interest to researchers and policymakers for over two decades. The usual assumption is that "Greater efficacy leads to greater effort and persistence, which leads to better performance, which in turn leads to greater

efficacy" (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998, p. 234). In contrast, "Lower efficacy leads to less effort and giving up easily, which leads to poor teaching outcomes, which then produce decreased efficacy" (Tschannen-Moran, et al., 1998, p. 234).

My case is best understood through a modified version of the categories of teachers' efficacy beliefs regarding using computers in science teaching, introduced by Enochs, Riggs, and Ellis (1993). This modified conception of "teaching efficacy" focuses on teachers' outcome expectancies, efficacy expectancies, and their beliefs about their ability to learn to teach in new ways. As used here, "outcome expectancies" are teachers' beliefs about the likely student outcomes that would result from particular teaching actions, if those teaching actions were executed skillfully. "Efficacy expectancies" are teachers' beliefs about their ability to skillfully carry out the teaching actions in question. The concept of teachers' "beliefs about their ability to learn to teach in new ways" refers to teachers' confidence about their ability to master new teaching methods or curricula, with or without assistance. These three types of efficacy beliefs can be thought of, respectively, as "Does such teaching work, if done well," "Can I do it well," and "Can I learn to do it well?" For me, obstacles to increased computer infusion into teaching appeared, and continue to appear, in my lack of confidence in each of these three areas of efficacy beliefs, as described next.

Outcome expectancies. Knowing of no research identifying positive outcomes of computer use in PK-3 teaching or teacher education left me unsure of the efficacy of such teaching (aside from supporting technological literacy). This uncertainty provided me with little motivation for such teaching. I also wondered if early childhood computer use contradicted a fundamental assumption in early childhood education, that concrete learning experiences (e.g., involving real three-dimensional objects) should precede more abstract experiences (e.g., with representations of those objects, as in computer programs). Many early childhood professionals have voiced concern that the abstract nature of computer activities may make them inappropriate for young children. Although I recognized that this "concrete-to-abstract" issue was more complex than some realized, my concerns remained. This concern was reinforced when the director of our PT3 project voiced similar doubts about early childhood computer use.

Furthermore, although I was skeptical of the claims some made about negative effects of computers on young children (e.g., Healy, 1998), I believed that software could undermine children's learning in two important

ways. First, I believed that the strong audiovisual appeal (e.g., cartoon characters) of many programs could actually undermine children's learning. This potential negative side effect of educational software was consistent with research I had read, in which highly interesting elements in "text" sometimes detract from children's learning of core content. It was also consistent with my own learning experiences, for example, when I have found myself attending to the interesting moving graphics in *PowerPoint* presentations, instead of focusing on the content. Second, I believed that the high level of sensory stimulation in software might make children "stimulus junkies," with a kind of "addiction" or dependence on experiences with high levels of audiovisual stimulation. If so, children's computer use might make focusing on learning experiences with less stimulation (e.g., reading books, listening to teachers) increasingly difficult. Such attention to the possible long term negative effects of learning experiences, regardless of their apparent immediate effectiveness, is one key consideration in "developmentally appropriate practice" (Bredekamp & Copple, 1997), the authoritative statement in the early childhood field regarding quality education. These concerns, or "negative outcome expectancies," were only modestly balanced by some vague faith I had in the potential benefits of computer use in teaching.

Finally, based on past experiences, I sometimes anticipated feeling negative emotions (frustration, embarrassment) when I used computers in teaching. Embarrassment appeared as "I ought to know how to do this," and frustration, especially about the time it took to resolve computer problems in class, appeared as "I'm wasting students' time." These negative outcome expectancies further undermined my motivation to use computers in teaching.

Efficacy expectancies. I also doubted my ability to skillfully use computers in teaching (e.g., setting up and navigating the hardware or software). These negative efficacy expectancies appeared in variants of the thought "I'm not sure I know how to do that." Unfortunately, such thoughts were often accompanied by other negative efficacy expectancies in the form of "I'm not sure I know how to fix it (or figure it out) either." These doubts were grounded in my past struggles (and failures) to get hardware and software to work as hoped. These two types of negative efficacy expectancies strongly undermined my motivation to use computers in teaching.

I certainly bore some responsibility for these doubts, as I typically spent little time learning the computer technology involved. Although investing

more time sometimes resulted in much more confidence about using computers in teaching, I was typically not motivated to spend this time, given my doubts about the effects of computer use (negative outcome expectancies), and due to other time constraints.

Efficacy beliefs can create "self fulfilling prophecies." For example, when individuals doubt the effectiveness of particular actions (negative outcome expectancies), or their skill at executing those actions (negative efficacy expectancies), or both, motivation and performance often suffer. In such cases, they simply may not attempt those tasks. Even if they do attempt them, they often put less energy and thought into the tasks, think less strategically when they encounter obstacles, and are less likely to persist when obstacles appear. Such behaviors make failure more likely, thus reinforcing the initial efficacy doubts. This pattern of self-fulfilling prophecies was often manifested in my case.

Efficacy beliefs regarding learning. Fortunately, negative efficacy expectancies regarding current skills may not undermine motivation, if one has confidence in one's ability to learn the skill in question (positive efficacy beliefs regarding learning; see Schunk, 1994). Unfortunately, before my involvement on the PT3 project, I doubted my ability to learn much about using computers in teaching, given my professional focus, and time constraints. Thus, I lacked this alternate support for my motivation.

Computers in Teaching, During and After the PT3 Project

My first research question was, "What changes, if any, occurred in way in which I—a teacher educator with average computer skills—incorporated computer use and information about computers into my teaching? Despite the many obstacles noted earlier, there were quantitative increases and qualitative improvements in the infusion of computers into my courses, during my project participation and afterwards. These changes appeared in three areas: (a) content changes, (b) changed computer use in teaching, and (c) changed assignments.

Content changes. Changes in course content included additional information about software evaluation criteria. This information was added to my early childhood foundations and curriculum courses, with specific attention

to curriculum issues in the latter course. Previously, I neither used computers nor covered any computer content in the curriculum course. Other new content included the national technology foundations standards for teachers developed by the International Society for Technology in Education (ISTE) (1999), and the national education technology standards for students (ISTE, 2000), now addressed in both courses. Also, the technology standards for teachers (ISTE, 1999) were added to my foundations course. Information from various websites and numerous website resources were added to course readings and references in both courses.

Perhaps the most enriching content additions came from observing and interviewing my mentor teacher from the PT3 Project, which provided me with information about current classroom uses of computers. The detail and real-life examples thus gained were a substantial improvement over my outdated anecdotes. This information also allowed for more detailed discussions of computer uses in early childhood education. Information about scheduling computer use in primary grade classrooms was particularly important, because most of my students planned to teach in grades K-3, and found it difficult to grasp how the use of a few computers would fit into the daily schedule in primary grade teaching.

My public stance towards using computers in PK-3 education changed in some ways, but not others. One change was my increased emphasis on the importance of children's technological literacy. One unchanged element was that I remained a "cautious optimist" (see Cuban, 1993) about the effects of using computers to teach children and adults. I was most convinced about computers' capacity to help students acquire computer literacy, practice academic skills, research topics, and receive additional feedback. However, limitations of current software, or my ignorance of better software, left me with doubts about the efficacy of educational software. I also remained uncertain about the effects of Internet use in PK-3.

Changed computer use in teaching. The most dramatic change here was my increased use of e-mail to communicate with students in my curriculum courses, after rarely using e-mail for such correspondence before the PT3 project. This was very useful for corresponding about students' multiple revisions of sections of lesson plan assignments. This was my area of strongest confidence about computer use in teaching.

Another satisfying change was my improved use of computers in classes. First, I reached a reasonable comfort level in demonstrating and evaluating

early childhood software using a computer hooked up to a video projector, an activity I then added to my curriculum course. Second, my emphasis during these sessions shifted, from primarily software evaluation (e.g., ease of use), with very modest attention to the software content, to analyzing primarily the curriculum potential of particular software. Although this was a move toward treating computers as less of a novelty and more of an integral curriculum tool, this process only sustained many of my existing negative outcome expectancies regarding use of computer software. Third, students in my class, for the first time, explored Internet sites during class time, in a session that I helped arrange, but which students facilitated. Fourth, I began bringing my laptop computer to class frequently, and using it both as an instructional tool and to record assessment data on students' performance on class assignments. This then led to more conversations with students about the ways in which computers can help teachers organize information, and be more productive. More modest changes that were still satisfying to me included greater use of software tools (e.g., different fonts, color printing, landscape view for documents, and clip art).

The most promising (and perhaps surprising) change is underway, as I am overseeing the creation of a small computer lab (5 computers, printers, a scanner), in a former storage room connected to the early childhood teaching room. This facility will help me and other early childhood faculty overcome a host of obstacles to using computers in teaching, all associated with having no easy access to multiple computers during class time. When the lab is completed, regular student and instructor use of computers during class time will be vastly easier. This change appears especially important. My infrequent the computer use in teaching, and the lack of student use of computers during class, may have sent the implicit message to students that computers cannot be easily used in instruction, despite whatever I said to the contrary.

Changed assignments. Knowledge about and use of computers became necessary in new and altered assignments for my courses. In my curriculum course, students corresponded by way of e-mail with me about lesson plan drafts, and were required to write lesson plans incorporating computer literacy outcomes, and to justify these outcomes in relationship to developmental appropriateness, and to the national education technology standards for students (ISTE, 2000). Also in that course, I required students to write detailed lesson plans centered on websites or educational software. Students in all of my courses were required to use resources accessed by way

of the Internet in research assignments and group presentations. This is modest computer use. However, I had become aware that some students had been completing these assignments without using either the computerized library databases or conducting Internet searches. Finally, I added more content regarding computers to final exams in two courses.

Factors Affecting Computer Infusion

In relation to my second research question, various factors supported my increasing infusion of computers into my teaching. These fell into three broad categories: (a) PT3 project factors, (b) outcome expectancies, and (c) reconceptualized efficacy expectancies.

PT3 project factors. As a junior faculty member focused on my own research and on promotion and tenure, I would have never participated in the PT3 project if there were no stipend. In turn, without the PT3 project, I was absolutely certain I would have *decreased* my attention to and use of computers in teaching during the time period in question. Also important was the expectation that project participants try out new technology uses in teaching, and share them publicly at meetings or conferences. These expectations kept me thinking about and experimenting with ways to infuse computers into my teaching, despite my persistent doubts about computers. These expectations were much more manageable for me because the PT3 project administrators exerted little pressure on participants, and were supportive of various uses of technology in teaching.

Preparing for presentations at the 2001 Society for Information Technology & Teacher Education (SITE) conference (Wheatley, 2001a) and a local technology summit (Volk & Wheatley, 2001; Wheatley, 2001b) kept me thinking about computers in teaching much more than I would have otherwise. The computer lab idea developed out of this sporadic but continuing reflection. Project participation clearly promoted this reflection, for if it were not for the PT3 project, I would have otherwise been perfectly content to have spent virtually none of my time since 1999 thinking about computer use in teaching.

Also helpful was observing a mentor teacher who used computers in seemingly meaningful, but not highly sophisticated ways, and at a grade

level where I lacked knowledge of computer use. As computer muddlers, such modeling seemed more convincing and attainable for me and for most of my students than more sophisticated computer use would have been. However, a few students were practicing teachers who reported using computers in more sophisticated ways than the mentor teacher was, and they seemed to benefit little from the examples of computer use in the mentor teacher's classroom.

Finally, I found involvement with the PT3 project much more palatable because of the PT3 project director's own skepticism about computer use in early childhood education. In contrast, I often struggled to have productive discussions about computers with strong technology advocates, finding their zeal and use of technical language frustrating.

Outcome expectancies. My concerns about likely outcomes of computer use in teaching, which can be thought of as either "negative outcome expectancies" or concerns about the "developmental appropriateness" of such teaching, continued throughout the PT3 project and afterwards. These concerns kept me cautious about computer use, but they were balanced by a slightly increased confidence in certain uses of computers.

I became slightly more confident about some uses of computers in early childhood education, for two reasons. The first reason was my increased recognition of the importance of computer literacy skills. I was persuaded of the importance of this by observing preschool children with and without computer experience, and by the mentor teacher's comments on the differences between second graders with varying levels of computer experience. The second reason was the mentor teacher's conclusion that students' computer use benefited their subject matter learning. I may have found the mentor teacher's conclusions reasonably convincing because I judged her to be a quite good teacher, and she was reflective and balanced (in my eyes) in evaluating the merits of computer uses in teaching. Furthermore, the software programs that the mentor teacher's students used were not as "cartoonish" as some programs I had encountered, and they seemed to provide students with reasonable learning opportunities.

I also became more convinced that some computer uses in *teacher* education could be beneficial. My changed assignments clearly supported increased computer literacy for many students. Decreased "turnaround time" on drafts of students' work, made possible by e-mail, allowed me to give

students more rounds of feedback than previously. What was most satisfying was that this allowed me to help students revise their work until they achieved a higher level of mastery. Unfortunately, my own lack of computer skills probably limited the types of computer uses I attempted and succeeded with in my own teaching.

Also, I doubted that the computer uses that I considered most successful with adults would translate well to most grade levels of early childhood education. Thus, I had doubts about young children effectively conducting Internet searches or using e-mail to correspond with teachers about their work. These doubts may have reflected my ignorance of what young children are truly capable of with computers. Such ignorance may be common among early childhood teacher educators.

Reconceptualized efficacy expectancies. One striking development was my reinterpretation of my teaching efficacy when using computers. This reconceptualization was motivated by my conclusion that my current thinking about my teaching efficacy when using computers was simply irrational and counterproductive.

This reconceptualization involved three changes. First, the belief "I should be able to skillfully use this computer technology (or fix it) by myself" was largely replaced by "Computer technology is so complex, and I have so little time, there's no reason to expect myself to know how to use it or fix it alone." Instead, I shifted towards believing that I should expect that I could often only use computers *with assistance*, and would often need others to simply fix things for me—and that this was a permanent state of affairs, given the rapidly changing technology and my status as a computer muddler. This was a significant reconceptualization of my efficacy expectancies. Second, there was a shift in my efficacy beliefs regarding my *learning*, from the belief "I can't *learn* how to use this computer technology alone," to "I can learn how to use this *with help*." Third, there was an affective change, from feeling badly about my lack of computer skill, to feeling that this situation was just fine, and in fact, was normal for a muddler for whom computers and computer uses in education would never be a central focus.

It is important to note that from the traditional perspective, teacher efficacy beliefs refer to teachers' beliefs about their ability to act skillfully and affect outcomes on their own. Thus, asking for help can act as a "double-edged sword" for although it may improve results, seeking help inherently signals

lesser ability, and thus, can reinforce one's doubts about one's individual competence (i.e., efficacy). Thus, as in my case, my desire to feel individually efficacious, or to appear so to others, often provided a disincentive to seeking help, even when I truly needed it.

The changes described were neither total nor permanent, as the old beliefs and feelings often reappeared. As someone for whom most of my academic successes were individual accomplishments (or so I liked to think), succeeding without help was an important part of my sense of self, and my conception of what competence meant. Nevertheless, I was often able to convince myself that the new ways of thinking and feeling about "my" computer competence was vastly more rational and productive.

I made the most progress in learning about and using computers when the new beliefs and feelings were most salient, and little or no progress when the old ones were most salient. I sometimes got stuck for days or weeks when I didn't know how to do something with hardware or software, thinking I should be able to solve the problem myself. Reminding myself of this more rational way of thinking about computer competence was usually enough to get me to ask for help, and make progress once again.

These new beliefs and feelings represented an alternative conception of teaching efficacy, one that I used to regulate my own motivation, learning, and performance. For example, I began to ask myself "Who can help me set up or learn to use some new computer technology today?" and "How could I use others' help to better infuse computers into my teaching?" As a computer muddler with serious time constraints, this felt like a much more sane and motivating way to approach my own computer learning and performance than my old ways of thinking. With others' help, hardware and software issues were often quickly resolved, or I learned new computer technology to use in my teaching (e.g., new software). Thus, somewhat paradoxically, one critical step to improving my teaching efficacy with computers was for me to become less focused on and concerned about my individual teaching efficacy with computers.

DISCUSSION AND IMPLICATIONS

What can be learned from my case study? The following discussion analyzes the factors that affected computer infusion in this case, and

identifies possible implications for working with teacher educators, especially those with average computer skills. Because this study was limited to one case, the following analysis also relies substantially on the areas of motivation research and theory that relate to factors that were salient in this case, especially self- efficacy research.

PT3 Project Factors

Many of the project-related factors that were influential in this case may be influential for a substantial percentage of muddlers (with computers or other technology). Stipends may be especially important for eliciting the participation of faculty with average computer skills, especially given the time it can take muddlers to master new computer technologies. Stipends for participation may be especially important for those who are skeptical about computers in teaching, and have modest intrinsic motivation for attempting such teaching.

Also, a low level of pressure from the PT3 faculty, representing more of an "autonomy supportive" model of interaction (e.g., Deci, 1995), may often be helpful, and may support well individual's intrinsic motivation to infuse computer technology into their teaching. In contrast, use of external controls, (e.g., rewarding teacher educators for specific computer uses in teaching), may seem appealing to some. However, it is enormously complex to design effective reward systems for teaching (Cohen, 1996). Furthermore, extrinsic reward systems may undermine some faculty members' intrinsic motivation to use computers in teaching and result in only superficial and temporary compliance with expectations for computer use in teaching (e.g., see Kohn, 1993).

Having mentor teachers model computer uses in teaching that are slightly beyond faculty members' current abilities might be expected to be universally effective. For muddlers, this often means fairly simple computer uses in teaching. Faculty muddlers with more confidence than I had about the efficacy of computers in teaching might benefit more from mentor teachers whose use of computers in teaching is fairly sophisticated, and from greater optimism about computers among project personnel and participants.

Finally, time is an especially critical issue for muddlers, as they often take much longer to integrate computers into teaching than do those with more

skill. Patience with muddlers may pay off. For example, my biggest step with computer infusion (the computer lab) only got underway in earnest six months after I stopped participating in the PT3 project, then was delayed for seven months, and only now is being set up.

Outcome Expectancies

My doubts about the effects of computer use in teaching and teacher education (i.e., negative outcome expectancies) were a key obstacle. They reduced my motivation to use computers in teaching. For technology advocates aiming to change such doubts, research provides some guidance. Three of the primary influences on efficacy beliefs (mastery experiences, vicarious experiences, and social persuasion; see Bandura, 1997) merit discussion.

Mastery experiences refer to an individual's history of successes and failures, are the strongest influence on efficacy beliefs. To promote teacher educators' robust confidence regarding the effects of computer use in teaching and teacher education (i.e., positive outcome expectancies) they must experience teaching successes with computers. Because efficacy beliefs are context specific (Pintrich & Schunk, 2002), teacher educators should experience these successes both in teacher education and in the grade levels and subject matter areas their courses address.

Vicarious experiences are observations of others' performance, successes, and failures. Models are more influential if they are similar in many ways to observers. Technology advocates could better influence outcome expectancies if teacher educators observed teacher education models with skills similar to theirs, and in teaching contexts similar to theirs.

Social persuasion refers to others' efforts to influence individuals' efficacy beliefs. Social persuasion was exerted here, as a credible mentor teacher's conclusions about the benefits of early childhood computer use promoted my increased confidence in such teaching. This seems promising for technology advocates, as fairly weak evidence quickly influenced my beliefs. However, positive effects of social persuasion on efficacy beliefs can be easily undermined (Bandura, 1997), for example, if the mentor teacher's conclusions were contradicted by research studies or by other

respected teachers. Thus, self-efficacy theory predicts that increased confidence in outcome expectancies that is due to social persuasion needs to be buttressed by actual successes teaching with computers, or by other supporting data.

I do not recall social persuasion ever supporting my confidence about computer use in *teacher education*. Many colleagues had excitedly reported the *features* of their uses of computers in teaching, but I recalled no reports of the *benefits* of such computer use. As a computer muddler, I especially wanted efficacy research on computer-based teaching methods (for early childhood and teacher education) that were cheap, and easy to learn and use. Revising this manuscript led me to read far more educational technology literature than I would have read otherwise, and yet, I remain unsure about the research evidence regarding computer uses in higher education.

Affecting students is central to the motivation to teach (e.g., McLaughlin, 1991). Thus, what if research support for using computers in teaching never materializes, or is not well known, and if teacher educators doubt the effectiveness of computer use in their own teaching? Then, many teacher educators might have little motivation to use computers in teaching. Perhaps this has already occurred, for despite the billions of dollars invested in educational technology, little or no computer use in teaching or teacher education is still common, even for example in Silicon Valley high schools with ample computer resources (Cuban, Kirkpatrick, & Peck, 2001).

More teacher efficacy research addressing computer uses in education is needed, for the experience of many muddlers may be that using computers in teaching often does not really "work," or does not work well enough to justify the time and effort involved. However, if it were clearer that such computer uses could yield important student outcomes, then even computer muddlers would have more incentive to invest the extra time and effort necessary to improve their skills at teaching with computers.

Efficacy Expectancies

Even if convincing research regarding the potential efficacy of teaching with computers exists or existed, an important hurdle remains. Like me, many muddlers will have negative efficacy expectancies, believing they cannot use

computers effectively enough to yield the kinds of results reported in research. The alternate way of thinking about one's efficacy at teaching with computers, described earlier, can help end this cycle. This new way of thinking, reflecting an "I can do it with help" or even "We can do it together," clearly helped me substantially. If teacher educators (especially muddlers) can become convinced that this is a more rational way of thinking about computers and computers in teaching, then increased motivation, improved performance, and faster skill development are all more likely.

Focusing on succeeding with help is a way of perceiving teaching efficacy that fits well with Vygotskian conceptions of scaffolded performance (e.g., Vygotsky, 1978). Moreover, a focus on one's efficacy at using computers in teaching *with-help* may influence the perceived ease of use of computer technologies, a factor that is related to teachers' acceptance of computers in teaching (Yuen & Ma, 2002). There is little research on this alternative conception of teaching efficacy. However, believing that teaching with computers is something that one often succeeds at only with help is consistent with the frequent finding that support is one key to the success of technology infusion efforts (e.g., Lee, 2001).

Thus, technology advocates might aim to convince teacher educators to try to think more in terms of the probability that they can use or learn to use computers *with help*, that they can trouble shoot computers problems *with help*, and that they can use computers in teaching *with help.* Based on self-efficacy theory, changing teacher educators' efficacy expectancies would entail giving them many opportunities to succeed with help when using computers in teaching, and to reflect on the important role that help played in achieving these successes.

Kersaint and Thompson (2002) noted that it is important to explore the role that beliefs play in technology integration. Although their specific focus was mathematics teacher education, technology infusion efforts in many areas may be affected by whether or not teachers' efficacy beliefs center on succeeding alone or if they also encompass the idea of succeeding with help.

There may be gender differences in teacher educators' tendency to try to succeed with computers and in teaching with computers "by themselves" versus trying to succeed with help. Although the usual assumption is that women find it easier to seek help than men do, both experience and research

suggest that many women teachers and teacher educators do not ask for help or collaborate, even when doing so would be more effective. The culture of teaching often reinforces the ideal of succeeding alone. Thus, the alternate conception of teaching efficacy may have utility for both male and female teacher educators.

Researchers should study teacher educators' beliefs about succeeding *with help* when using computers in teaching. This would mark a fundamental shift in teacher efficacy research, a field in which both the definitions and measures of "teacher efficacy" have heavily emphasized beliefs about *individual* competence, and largely ignored teachers' beliefs about succeeding with help, or through collaboration.

CONCLUSION

While my thoughts and beliefs may be very different from those of teacher educators who are fluent with computer uses in teaching, they are one example of the thoughts and beliefs of a teacher educator who is a computer muddler. Due to their numbers and importance as influential models, the many teacher educators who are computer muddlers have been and will be an important influence on in efforts to infuse computers into teaching. In this case, various project-related factors and my own outcome expectancies and efficacy expectancies played important roles in my motivation, learning, and computer infusion efforts. Many of these factors may also be critical for supporting the computer infusion efforts of the many teachers and teacher educators who have average computer skills. Thus, these factors merit serious attention in future research and faculty development efforts.

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