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Integrating Technology Into Teacher Education: A critical framework for implementing reform

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Abstract

Teacher education programs around the nation continue to be challenged to prepare prospective teachers to use technology "meaningfully" in their instruction. This implies that university faculty in teacher education programs must become proficient at technology use and must come to understand content-specific, pedagogical uses of technology for their own instruction. In this article, we present a model for technological change driven by the notion of situated practice and communities of discourse in our school of education. In addition, we describe a critical framework for facilitating discourse among our teacher education faculty from which understandings of why, when, and how to use technology emerged. Several cases of situated practice are discussed with particular attention to how an understanding of meaningful technology use was negotiated through interactions between faculty and graduate students. Implicit in our model for technological change is a strategy for sustainability. This is elaborated as we discuss our results and further directions for our work.

Integrating Technology Into Teacher Education: A critical framework for implementing reform

Current educational reform efforts in the United States are setting ambitious goals for schools, teachers, and students (e.g., National Research Council, 1993; National Education Goals Panel, 1991; No Child Left Behind Act, 2002). Teachers are to help all K-12 students learn to value content, become confident in their ability to solve problems in specific content areas, and learn to reason and communicate from a content-specific discipline (National Council of Teachers of Mathematics, 1989, 1991; National Council for the Social Studies, 2000; National Council for the Teachers of English, 1996; National Committee on Science Education Standards and Assessment, 1996). Spanning across all of these goals is the recommendation that meaningful uses of technology be incorporated in all areas (International Society for Technology in Education, 2000). The new visions of classrooms called for by national and state standards pose great challenges for teachers, as they represent a substantial departure from the K-12 classrooms in which most of today's teachers and prospective teachers were students.

The challenges to programs that prepare teachers are also great. Pre-service teacher education programs are being called upon to provide models of authentic teaching and to help teachers develop their knowledge of the content, discourse of content, and content-specific pedagogy. They also must provide multiple perspectives on K-12 students as learners and offer meaningful opportunities for teachers to develop skills in technology use (International Society for Technology Education, 2000). Technology takes on increased importance as we continue to move from an industrial to an information-based society. Teachers must be skilled in technology applications and knowledgeable about using technology to support instruction and to enhance and extend student learning. The mere ability to operate various hardware and software does not constitute an acceptable level of proficiency. Rather, it is essential that all K-12 teachers be able to demonstrate an ability to use technology tools in their standards-based curricula to promote student learning, improve student achievement, and provide students with the skills they need in their future education and/or workplace careers.

In 1999, the U.S. Department of Education established the Preparing Tomorrow's Teachers to Use Technology[1] (PT3) program to "to support organizational change in teacher education so that future teachers are able to use interactive information and communication technologies for improved learning and achievement" (US Department of Education, 2002, par. 4). Since then, over 400 institutions of higher education have received funding to restructure their teacher education programs so that they can prepare prospective teachers to effectively use technology in their own K-12 classrooms.

We are currently in our final year of funding from the Department of Education for a three-year PT3 grant. In this paper, we share the strategies that have guided the professional development of faculty and instructors in the teacher education program at a large, public, level-1 research university. Our program's primary objectives are to assist teacher education faculty and instructors in developing (a) a *critical disposition* towards technology that includes an understanding of *why*, *when*, and *how* to use technology in education and (b) the capacity to model and deliver technology-infused curricula, pedagogy, and assessment. Our professional development focus on faculty and instructors in the teacher education program stems from the challenge of understanding how to "meaningfully" use technology in education. Our strategies for meeting our objectives center on collectively developing such an understanding through the process of working with our faculty and instructors in content-specific technological enhancements of their courses.

Contemporary Perspectives on Educational Technology

The National Research Council, in it's publication *How People Learn: Brain, Mind, Experiences and School* (1999), has argued that the use of technology in teacher education involves much more than simply adding technology to an existing course structure. They describe multiple uses of technology beyond the computational power of a computer as follows:

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[1] The University of Colorado at Boulder's Preparing Tomorrow's Teachers to Use Technology (PT3) Project is a three year professional development and research project funded in part by the Department of Education (DOE grant # P342A000115). The opinions and views expressed in this paper are the views of the authors and do not necessarily represent the views of the Department of Education.

> What has not yet been fully understood is that computer-based technologies can be powerful pedagogical tools—not just rich sources of information, but also extensions of human capabilities and contexts for social interactions supporting learning. The process of using technology to improve learning is never solely a technical matter, concerned only with properties of educational hardware and software. Like a textbook or any other cultural object, technology resources for education—whether a software science simulation or an interactive reading exercise—function in a social environment, mediated by learning conversations with peers and teachers (p. 218).

This perspective recognizes that integration of technology into a course by instructors may require significant change not only in their individual practices but also in their understanding of how technology can be used for legitimate pedagogical purposes. Accordingly, Hooper and Rieber (1995) proposed a model for the adoption of new technologies that consists of five specific phases: familiarization, utilization, integration, reorientation, and evolution. In the familiarization phase, the teacher simply learns how to use the technology. At the utilization phase, the teacher uses technology in the classroom but has little understanding of, or commitment to, the technology as a pedagogical and learning tool. During the integration phase, the technology becomes an integral part of the course in terms of delivery, learning, management or other aspect of the class. In the reorientation phase, the teacher uses the technology as a tool to facilitate the reconsideration of the purpose and function of the classroom. Finally, teachers who reach the evolution phase are able to continually modify the classroom structure and pedagogy to include evolving learning theory, technologies, and lessons learned from experience. According to Hooper and Rieber (1995) many teachers progress only to the integration phase and do not transform their philosophical orientation of how learning can occur in the classroom through technology. We focus our attention on the reorientation phase since this is the phase that our faculty and instructors seem to be developing a critical disposition toward technology allowing them to use technology as a means for rethinking course goals, methods, structures, and learning environments.

Realistically, the need for philosophical change is coupled with barriers to adopting technology for teaching and learning among educators. In a recent study at Ball State University, Butler and Sellbom

(2002) identified the following barriers to faculty adoption of technology for teaching and learning: (a) reliability, (b) time to learn the technology, (c) knowing how to use the technology, (d) concern that technology might not be critical for learning, and (e) perception of inadequate institutional support. In light of the general philosophy towards technology envisioned by the National Research Council in the quotation above, these barriers may mean much more than the words themselves suggest. For example, "knowing how to use the technology" involves the technical skill of operating the tool as well as understanding the pedagogical purpose of its use. The "concern that technology might not be critical for learning" could imply a need to learn more about technology as "extensions of human capabilities and contexts for social interactions supporting learning" rather than simply as information resources and computational tools (NRC, 1999). Also, "institutional support" points to the need for a technical support crew and the development of a set of obligations and expectations within a community that would lead to efforts to sustain funding and technological support.

This leads to the question of what type of support could produce a sustainable shift in teacher educators' technological skills and their views of technology and its pedagogical purposes. It is often left to the individual instructor or faculty member not only to develop skills in using the technology itself but also to construct an understanding of the pedagogical use of technology in his or her own classroom. In order to address this question, we propose an Educational Technology Resource (ETR) model of technological change driven by the theoretical perspectives of social constructivism and situated cognition. The purpose of this paper is to show how faculty and instructors at a level-1 research university made sense of educational technology through the process of interacting with graduate students who were supported by the Preparing Tomorrow's Teachers to Use Technology (PT3) project. We first present our Critical Framework and our Educational Technology Resource (ETR) Model for technological reform. Second, we review research and other scholarly recommendations that have informed our philosophy and strategy for technological change. Third, we describe our ETR model for technology integration and cultural change in detail through specific cases involving faculty and graduate

students. Finally, we summarize our experiences by sharing lessons learned and consider how these lessons will inform plans to sustain the progress made through the PT3 program.

Introduction to the ETR Model and the Critical Framework

The PT3 community at our university consists of three faculty members, four doctoral students and one masters student (all funded by the PT3 project), an internal evaluator, and one technology coordinator funded partially by the university and partially by the PT3 project, and a representative from a small, private university. Our efforts to negotiate a shared understanding of meaningful technology use within the school of education began with the development of an interactive ETR model of knowledge construction. This model is based on Jean Lave's notions of *situitivity* (Rogoff and Lave, 1984) where learning must be situated in known contexts. In this case the content to be learned is educational technology and the learning should be situated in classroom practice. Each graduate student (Educational Technology Resource-ETR) on the PT3 team was teamed up with several faculty members and instructors on the basis of mutual knowledge of specific content. For example, a doctoral student in educational psychology was teamed with instructors and faculty who were teaching courses in educational psychology that semester. The idea was that faculty and graduate students would work together to determine how technology could be used to enhance instructional practices and learning within their own courses. The faculty/instructor would work with the graduate student ETR to construct or modify lesson plans, check out equipment, load software, implement technological applications in the classroom and reflect on the technology aspects of lessons. Graduate students working with PT3 would provide content-specific knowledge of technology (which they often learned as they became aware of the needs of faculty members and instructors) as well as general technological skills. The faculty or instructor would provide pedagogical content knowledge, expertise and experience, and knowledge of his or her own students to negotiate meaningful uses of technology within his or her own classroom context.

The ETR model involved the graduate student (ETR) building a working relationship with the faculty and instructors to whom he or she is assigned. Typically, the ETR met with a faculty/instructor regularly and engaged in one-on-one discussions about course content and how technology can be used to

achieve or extend course goals. ETRs then provided assistance in the process of implementing technological changes in the classroom through actual technical support (in or out of class) for technology-based lessons and participate in reflections about the implementation. Over time, the ETRs shifted the nature of the support from interactions with individual faculty members to interactions with many faculty members who represent particular teacher education program areas. At this point, the type of dialog evolved from lessons particular to a specific course with a specific instructor to programmatic technology issues. Finally, the ETRs decreased the amount of support altogether to the extent that faculty, instructors and program areas can (and want to) implement and modify such lessons and program changes on their own. In all phases described above, the critical framework (described below) was used to maintain focus on the purpose and outcome of the technology use.

Because the ETR model hinges on the development of *relationships* between ETRs and faculty/instructors we have sought to dismantle the hierarchical relationship usually established in faculty/instructors interactions with graduate student teaching assistants. At the end of the first year of the PT3 program, we made the decision to refer to these graduate students as Educational Technology Resources (ETRs) rather than as "Technology Teaching Assistants" or "Tech-TA's" (a term that emerged during the first year of the PT3 program). We also referred to relationships between ETRs and faculty/instructors as ETR-faculty collaboratives. The role of the ETR was to actually *collaborate* with the faculty members by initiating dialog that centered on the critical use of technology. ETRs had the difficult task of becoming familiar with the syllabi for each of their assigned classes, setting up meetings with faculty/instructors, and leading reflective and critical dialog about why, when and how technology could, should, or should not be used in their course. In this new definition of graduate teaching assistant, the graduate student must be looked upon as a collaborator and not merely as an assistant.

After the first year of the implementation of the ETR model, we found that, overall, faculty and instructors felt that technology was being pushed upon them and that they were being expected to *add* technology to their course with little understanding of why they were doing so. We began the project with a central goal of developing an understanding of why, when, and how to use technology in

instruction but at the end the first year we realized that this was not happening. In response to this, we developed a critical framework to guide the PT3 project and its interactions and discourse with the broader school of education community. This critical framework consists of five key dimensions that frame discussions about how, when, and why to use technology in instruction, promoting the idea that if technology is used, it should be used for a content-specific, pedagogical purpose :

1. Technology used as a **cognitive tool** helps students understand concepts and solve problems.
2. Technology used as a **communication tool** fosters discourse and collaboration among educators, students, parents, and the community.
3. Technology used as a **management tool** increases efficiency for teachers and students.
4. Technology used as an **evaluation tool** helps teachers reflect on instruction and provides feedback on student learning.
5. Technology used as a **motivational tool** encourages and engages students in learning.

This critical framework was collaboratively constructed by the PT3 team and mapped to our state technology standards for teachers. The question that drove the development of the framework was, "What language can we use that can help us organize our own understanding of how, when and why to use technology in the classroom?" The critical framework is a broad categorization scheme that provides a common language among the PT3 team that could be used to develop an understanding of "meaningful uses of technology." The critical framework was also developed as a means for facilitating conversations with our faculty and instructors on how they can thoughtfully (or in the words of our project outcome objectives "critically consider") and appropriately use technology in their teacher education courses.

We further delineate the five dimensions of our critical framework through specific cases studies presented later in this paper. In the following section, we review some of the research literature that provides the theoretical grounding for the ETR model and the critical framework as a tool for framing discourse about technology use in teacher education.

Theoretical Underpinnings

Our goal of developing a critical disposition among faculty was central to our strategy for achieving lasting technological change. We used three related socio-cultural theoretical perspectives for framing our strategy: The Vygotskian notion of mediated action, Jean Lave's perspective on situated action and participation, and the notion of learning communities.

Vygotsky and Mediated Action

The theoretical underpinnings of the ETR Model are rooted in the work of Lev Vygotsky (1986) where learners actively construct concepts through the process of mediated action. According to the notion of mediated action, human beings use cultural tools (such as language as well as tangible features of the environment) and this fundamentally changes the structure of cognitive functioning and of the activity (Cole, 1996; Wertch, 1991). According to Vygotsky (1986), language mediates and structures our activities in very important ways. We developed the critical framework for the very purpose of establishing a shared language to structure our thoughts and beliefs about technology. In addition, we view technology as a tool that can mediate the reconceptualization of classroom practice. We utilize our critical framework to shape dialog between ETRs and faculty/instructors that can lead to the conception of technology as a tool that can, when used appropriately, facilitate learning, enhance instruction, and modify learning environments.

Professional development, situativity, and participation

Although most professional development literature refers to the professional development of K-12 teachers, we have applied it to the professional development of faculty and instructors in the school of education at a level-1 research university. We draw mainly on the ideas of situatativity and participation which drives the professional development strategies incorporated into our ETR model. A key theme in this domain of research is that professional development in the form of decontextualized workshops is not effective and does not result in long-term enhancement of teaching (Wilson and Berne, 1999; Ball, 1996). Research on K-12 teachers has shown that effective professional development must be situated in classroom practice and that professional development should be designed such that teachers are perceived

as active learners who construct their own understandings (Putnam and Borko, 1997). We draw on this K-12 professional development literature because it is consistent with our socio-cultural theoretical perspective on learning, our strategy for sustaining changes, and has been shown to be effective among K-12 educators. Grossman (2001) states, "We argue, therefore, for a vision of professional community that is located within the workplace, offering the possibility of individual transformation as well as the transformation of the social settings in which individuals work" (p. 948). We seek results similar to those present in the K-12 professional development literature, such as individual learning and reorientation among faculty members as a mechanism for achieving a community within the school of education. A shared language and vision toward technology to sustain the changes that are made through the professional development is offered by the ETR model.

Our effort to develop discourse that centers on meaningful technology use is informed by research that points to the effectiveness of individual participation. Rogoff (1994) argues that "learning is a process of *transformation of participation* itself," and that "how people develop is a function of their transforming roles and understanding in the activities in which they participate" (p. 209). Through working within faculty/instructor's own courses, we develop a context for faculty members, instructors and ETRs to participate in technological change. We believe that participants can only be affected by change if they are actively involved in creating the change that is taking place (Kezar, 2001; Beaufort, 2000). In addition, we move towards the situated and increasingly responsible participation of the learner (in this case, the faculty and instructors as well as ETRs[2]) as the nature of the relationship between ETR and faculty/instructor changes over time with the primary technological responsibility shifting from the ETR to the faculty/instructor.

Sustainability and Discourse Communities

Movement towards sustainability of the infusion of technology in the larger teacher education program requires that faculty and instructors increasingly rely on each other as a means for obtaining technological support. This is a critical culminating step in any educational reform effort. Northouse

[2] The preparation of graduate student ETRs is the subject of an upcoming paper.

(2001) sees leadership as "a process whereby an individual influences a group of individuals to achieve a common goal" (p. 3). We draw on Northouse's notion of "common goal" as well as on Fullan's (2001) notion of "relationship building" and "shared knowledge" as a means for creating shared language and shared responsibility toward technology, a crucial step towards the development of a shared vision about technology in education and a coherent strategy in the school of education for meeting state and national technology standards. It has been argued that in order for meaningful and lasting educational reform to occur, teachers must collaborate around a strong—and commonly held and understood—shared sense of purpose (Little, 1990; McLaughlin, 1993).

As we move toward the end of our PT3 project and focus on sustaining the changes we have begun, we are shifting our strategy away from the development of relationships involving specific roles of individual faculty/instructors and ETRs and toward the development of relationships that involve different roles as these graduate students interact within the broader context of the teacher education program. This shift is in the direction of eventually removing the ETR from the discourse while building foundations that will sustain technology-based discourse within the program. This sustainability shift seeks to imbed practices and norms within the normal operations of the school of education and produce a shared vision necessary to maintain and expand on our work. The graduate students currently funded by PT3 and the intellectual and technological support they provide will be replaced by the faculty members themselves and by the discourse among faculty and instructors with the ultimate goal of developing a discourse community within the school of education where faculty rely on other faculty for technological support and dialog. The ETR model is not designed to foster the larger discourse community among the faculty within the school of education, but rather to help individuals develop skills, language and critical dispositions toward technology and to scaffold support from individual to small groups of program areas. It is anticipated that through this process, the emergence of a larger discourse community will take place, especially as department-wide focus on educational technology standards comes to the fore. In the remainder of this paper, we further illustrate the ETR model and how the critical framework was used

within the ETR model to mediate the development of critical dispositions toward technology among our faculty and instructors.

The ETR Model and the Critical Framework Illustrated

Using the critical framework to provide a common language, the ETR and faculty/instructor collaborated to determine the extent to which some of these goals could be more effectively addressed (and perhaps extended) through a particular use of a technological tool in the faculty/instructor's course. We wish to draw a distinction between the *use of a technological tool* as defined by the framework (i.e., cognitive tool, management tool, communication tool, motivation tool, and evaluation tool) and the software or hardware itself. For example, we do not believe that effective dialogue can be built on a faculty member's desire to "incorporate PowerPoint™" into his or her class. Instead, we ask the questions, "What are the conceptual and pedagogical goals? and what kinds of experiences can help to meet those goals?" "Can these goals be met more effectively by using technology to help prospective teachers to think or to help them communicate, etc.; and, if so, what software is best for helping achieve this goal?" This view is articulated in Hooper and Rieber's (1995) distinction between *idea technology* (such as simulations and visualization tools) and *product technology* (such as java applets and the computers through which these simulations are presented). In developing critical dispositions toward technology we focus on how idea technologies interact with product technologies and how product technologies can mediate the process of reconceptualizing the structure and function of the classroom. Several cases are described below to provide evidence to support the claim that faculty and instructors were beginning to critically consider how technology can help them reframe and restructure the course to meet or extend their goals.

Methodology and Data Collection

The cases below were constructed from data collected throughout the three years of the project. Three types of data were collected. First, each week, each ETR was responsible for creating an on-line weekly report. In these reports they described the nature of their interactions with faculty and instructors (e.g. whether the faculty continued to ignore ETR attempts for contact, whether the faculty himself

contacted the ETR, what types of ideas were discussed etc.), the lessons they co-constructed, the implementation of lessons, and the post-implementation reflection with the faculty/instructor centered on the critical framework. The second form of data was from semi-structured interviews with faculty and instructors at the end of years 2 and 3. The PT3 Team constructed a survey-style interview protocol that was used by ETRs to structure these interviews, focusing on what types of technologies were used and why they were used. Particular attention was placed on faculty/instructor's knowledge and ability to use the ideas in the critical framework to justify their use of technology. The interviews were audio-taped and transcribed. The third form of data was from minutes from weekly PT3 meetings. During these meetings, ETRs described problems, successes, and interactions with faculty and instructors. The three sources of data were analyzed for evidence of critical dispositions developed among the faculty and instructors and cases were selected for each dimension in the critical framework. Through these cases, we demonstrate how the critical framework was central in guiding discourse that has led to the development of critical dispositions toward technology through the collaborative development of technology enhanced lessons. These cases also demonstrate the full participation of faculty and instructors in the process of technological change and that the development of technological knowledge is situated in practice.

Background and Case Studies: Evidence of Reform

ETR-Faculty collaborative relationships evolved over time. Initially, the ETR would contact the faculty/instructor to which he or she was assigned (through email, knocking on the door etc.) in attempt to set up meetings and create dialog involving course goals and how technology can help to meet or extend those goals. As the ETR-faculty collaborative relationship developed and as the faculty/instructor's understanding of meaningful uses of technology developed, the faculty/instructor began to contact the ETR for assistance in working through novel ideas for course modification. In such a situation, the faculty/instructor recognized a problem currently existing in his or her lessons, constructed a possible, often vague solution, and contacted the ETR for help in further developing the idea and bringing the idea to fruition. This type of situation was typical for faculty/instructors that can be thought of as being at Hooper and Rieber's (1995) reorientation phase-faculty/instructors who had developed a critical

disposition toward technology. Some of these faculty/instructors started with strong technological knowledge and confidence and others did not. In Case 1, Pat began lacking technological knowledge and lacking confidence in her ability to implement technology in the classroom. By the middle of year 2, she had developed an understanding of how to critically consider, and reflect on, educational technology.

Faculty/Instructors that developed critical dispositions tended to spend more time with their ETRs discussing and developing technology enhanced lessons than faculty/instructors that were still trying to learn how to use technology. For example, Pat (Case 1) stated that she spent approximately 10 hours discussing and developing the lesson. Interviews suggest that this was due to her belief that the lesson was worthwhile and could achieve goals that she could not previously achieve. Other faculty/instructors who had developed critical dispositions believed that the trade-off of time spent in developing the lesson would be worth it in the long run, as the lesson would eventually make the meeting of course goals more efficient. ETR weekly reports suggest that those who remained unsure about the value of technology for education spent less time with their ETRs and in discussions about how technology could be used to enhance their courses.

Case 1: ETR-Faculty Collaborative Implementation and Reflection

Pat, a faculty member who teaches general methods used a mid-term exam that served a dual purpose. The exam itself consisted of a mix of multiple choice questions, essay, and open ended questions about the content of the course. The secondary purpose of the exam was to provide a context through which students could construct an understanding of the value of collaborative learning. In its standard implementation, the students first took the exam themselves then made a copy of the exam and took it to a larger group of two or more students. The group of students then reviewed their completed exams and used scissors, tape, and glue to construct collaborative answers to the same exam by drawing on the answers of all the members of the group. At the end of the activity, each student had the option of turning in their original independent exam or putting his or her name on the exam that was constructed collaboratively by the group. Most students opted to put their names on the collaborative exam. Following the exam there was a reflective discussion about the value of collaborative construction of

knowledge. Pat had used this mid-term exam format for several years but had noticed that it was limited by the cut and paste aspect. Because students were cutting and pasting hard copies of their original exams, they were not *generating* new knowledge as a result of their collaboration. The new statements that were generated were typically compilations of the original exams and not new knowledge that emerged through the dialog. Pat wanted to provide students with a context that made the act of generating new knowledge more straightforward. She concluded that technology could be useful toward this end. She contacted her ETR with the idea that she would like to transform the literal cutting and pasting to computer-based cutting and pasting with a text editing program. She called her ETR and said, "Here's an idea, how can I make it work?" Together, the ETR and faculty member worked out a scheme through which students could first take the exam electronically and then use a single computer for the collaborative part of the activity. They reasoned that the computer could be used as a cognitive tool that made the process of editing statements more straightforward and thus facilitating the *generation* of new ideas through the collaborative process in a shared, modifiable space (the computer screen). Together, the ETR and faculty member worked to develop the skills necessary to create the electronic exam and a means for editing multiple exam answers on the computer screen.

There are two important elements of the case described above. First, it illustrates how the ETR model, based on the concept of situating the learning of technology in the collaborative relationship and in the faculty member's own class design, helped the faculty member develop a critical disposition toward technology. The second important aspect of the case is found in the ETR and faculty member's reflection on the activity. The lesson described in the case above was a flop. This is evident in the weekly report of the ETR and in the interview with Pat by ETRs at the end of year 2 of the project. After reflecting on the activity, the ETR and faculty member concluded that, "the power of the learning process got lost in the frustration over the technology." They concluded that the frustration could be linked to three things: (1) the activity was done on Macintosh computers and many students only had experience on PCs, (2) the size of the computer screen did not allow for the presentation of multiple documents simultaneously. This got in the way of moving seamlessly through the original, individual exams of each student in the

group, (3) when designing the lesson, the ETR and faculty member had assumed that the students would be comfortable "thinking on the computer." It turned out that many of the students in the class wrote reports and did their thinking using paper and pencil and then transferred finished products to the computer rather than actually doing their thinking during the process of typing into the computer. As a result, much class time was wasted in the implementation of this activity. Both Pat and her ETR felt that the lesson was not as effective in meeting the goal of demonstrating the value of collaboration as was the traditional glue and scissors format. Pat reported that she felt that the trial implementation was important nevertheless, stating that, "If I didn't do it, I would still be wondering whether my idea would work." In addition, Pat stated that these types of trials must take place in order to continue to learn how to effectively use technology. Although the lesson was ineffective for a variety of reasons, an important aspect of the case is that Pat engaged in reflective practice regarding technology. Pat did not abandon the idea completely. Rather, she is still trying to figure out how to deal with the problems that she and her ETR identified so that she can streamline the *generative* element of the lesson. It is important to note that Pat did not give up on thinking about how technology could transform her instruction. In fact, she continued to modify and extend her instruction in collaborations with ETRs, using various technologies, including 3-way video conferencing for remote student teacher field placements.

Case 2: Meeting Cognitive Goals

Leslie, a graduate student instructor explained to an ETR that one of her goals was to help prospective teachers critically analyze complex and controversial texts such as Jonathan Kozol's *Savage Inequalities* (1991). In the past, Leslie has found that prospective teachers have great difficulty developing connections between specific issues raised in the text and their own beliefs and experiences. She hoped to develop a lesson that would provide some type of mediation between the issues in the text and prospective teachers' own beliefs and experiences. Additionally, Leslie wanted prospective teachers to share their ideas so they could draw on the ideas of others while working towards a general consensus and understanding of the educational relevance of the central themes in the text. Leslie and her ETR collaborated, bringing their content and technological expertise. They decided to use the software package

Inspiration™ to facilitate discussions that focused on connections between central themes of the text and prospective teachers' own beliefs and experiences. In small groups, prospective teachers constructed electronic concept maps to create representations of a conceptual model of the ideas in the text and how these ideas related to their own experiences. They developed and shared their models of the immediate relevance of the issues raised in the text with the rest of the class. The software package *NetAssistant*™ was used to allow each group to share their conceptual models with a central computer that projected the computer display in front of the class. *Inspiration*™ together with *NetAssistant*™ were used as a cognitive tool to mediate the development of a sophisticated understanding of the impact of the issues raised in the text and further help the class as a whole construct a new conceptual model based on the shared views and experiences of each group.

Following this activity, the ETR and the instructor reflected on in its implementation. In this case, the technology was seen by the instructor and the ETR as effective in restructuring the learning environment in a way that fostered in-depth discussion that previously was not taking place in the classroom. The critical framework was used in this case to guide discussions about the learning needs of the students, and here technology was used as a tool to facilitate learning or cognition. In contrast to Case 1, the use of technology was effective in meeting the goals of the instructor. In both cases however, the critical framework served the central role in facilitating discussions where faculty critically considered the value (or lack of value) of technology for specific purposes. The role of critical framework within the ETR model is further illustrated by comparing Case 2 to Case 3.

Case 3: Meeting Management Goals

Victoria, a science education faculty member, often used large dry-erase boards for groups of prospective teachers to construct and present their ideas about the nature of science and technology. She used the ideas expressed on the dry-erase boards to track conceptual development about issues in the nature of science throughout the semester. She strongly favored dry-erase boards over large sheets of paper because she believed that the dry-erase boards provided a shared space for prospective teachers in

small groups to draw on the ideas of others for the purpose of articulating, representing, and *modifying* their own ideas as they were being constructed on the board. One of Victoria's instructional goals was to provide opportunities for prospective teachers to modify their own ideas in the face of evidence and the ideas of others. The "erase" feature of the boards provided this opportunity. She expressed to the ETR that prospective teachers did not have time in class to reflect on the ideas expressed on the boards or to compare their own group's ideas as they evolved over the semester (the boards had to be erased each time they were used). The ETR introduced her to the digital camera available through the PT3 project and showed her that digital photos could be taken of the dry-erase boards and then uploaded onto *WebCT*™, the online course tool supported by our university. All students then had access to representations of their own ideas as they evolved over time as well as to the ideas of others. In this way, technology was used as a management tool to make it possible for Victoria to effectively manage the large amount of information provided by prospective teachers. The digital camera together with *WebCT*™ made it possible for the instructor to meet her goals of making information available to the class while still maintaining the instructional tools that she believed were useful.

In Case 3 and in Case 2 different tools were used to achieve the same result. In the case above, the dry-erase board was used as a cognitive tool, where students were expected to generate collaborative knowledge through the process of representation and modification of ideas that emerged through the discussion. In Case 2, *Inspiration*™ was used for the same purpose. The question of "why dry-erase boards in one case and *Inspiration*™ in the other?" is central to our argument of the value of the critical framework and the ETR model. The value of the ETR model and the use of the critical framework is not in teaching faculty how to use a specific tool to achieve a specific result, but in creating relationships, dialog and the experiences necessary for faculty to develop and maintain a critical view of why, when, and how they should use technology in instruction. In interviews with Victoria, we found that she continued to incorporate technology, keeping technology applications that promoted learning in her syllabus (such as the digital camera and *WebCT*™) and rejecting or changing those that did not seem to

add significantly to course goals involving both content and technology (such as an internet science curriculum that she and her ETR once tried). In addition, she modified her syllabus to include specific technology standards that could be addressed explicitly while meeting the nature of science standards for her course. The development of such a disposition can ensure that after ETR support is gone, the faculty themselves can target their use of technology toward technology for a pedagogical purpose and engage in discussions about pedagogical uses of technology with other faculty and instructors. Our goals for critical dispositions toward technology reach far beyond the instructors' ability to use technology in a meaningful way. Our goals for critical dispositions involve the instructors' abilities to critically consider when they need it, why they would use it, and when they would not use it to achieve a learning goal. As described in section 2, mediated action, situativity and participation underlie the work we do with faculty through our ETR-faculty collaboratives. Cases 1 through 3 above show how this process takes place. The desired result is found in the faculty members' attitudes and dispositions toward technology. Because our work is situated in practice, the process for achieving this result looks different in different cases but is always mediated by the language of the critical framework.

Case 4: Assessing the Effectiveness of Technology as a Communication Tool

One of the goals of our teacher education program is to confront and address prospective teachers' beliefs and biases, as well as broader systematic prejudice that influences teaching in American schools. In the past, instructor Sara found that many prospective teachers were quite uncomfortable discussing their own prejudice as well as prejudice observed in their field placements. Sara explained to her ETR that she wanted to find another way that students could express their views, beliefs, and biases in a more comfortable way while still having the opportunity to engage in discourse about these issues. Sara also wanted to provide the opportunity for prospective teachers to deepen their understandings through exposure to multiple perspectives and experiences. The ETR introduced Sara to online, threaded discussion boards that could provide an opportunity for prospective teachers to express their views and have exposure to the views of others without face-to-face interaction. Sara was concerned that her students feel protected from the fear of embarrassment or up-front, personal attacks. In collaboration with

her ETR, they developed a forum for students to state their views online anonymously. In addition, the ETR-instructor collaborative generated the idea that this type of anonymous forum might provide prospective teachers with the opportunity to be more reflective about these issues since it allowed for time to craft an expression of their views through writing.

This experience working with the ETR to modify the course structure using technology resulted in Sara's interest in assessing the effectiveness of various forms of student reflection. Sara and her ETR engaged in a research study which compared individual reflections intended only for the instructor to online discussions. They found that the students' arguments and reflections were more sophisticated in the online discussions. For example, in many individual reflections students engaged more in *reporting* than in *synthesizing*. In the online discussions more instances of synthesis were measured. This case points to the fact that the instructor had established a critical disposition toward technology because instead of simply utilizing the technology without an understanding or concern for its effectiveness, she and her ETR actually measured and analyzed the data derived from various forms of discussion. They used this analysis to inform future instructional decisions.

Case 5: Expanding the Critical Framework through an ETR-Faculty Collaborative

Pedro, an instructor for Social Studies Theory and Methods, had the goal of helping prospective teachers to learn to critically evaluate current events. One of his methods for accomplishing this goal involved classroom discussions that centered on critical evaluations of published articles that prospective teachers brought into the class. In the past he found that prospective teachers did not seem motivated to engage in discussions about these articles. He told his ETR, "If only I can get them talking, I can help them see the relevance of interpreting the articles, the author's agenda, and the social, political, and economic controversies contained in the articles." Pedro and his ETR established that the problem was in motivation and sought to find a technology that could be used as a motivational tool. The ETR introduced Pedro to the internet version of the software program *Decisions, Decisions*™ which presents several different perspectives on a current controversial issue through text and video clips with particular content obtained from current and historical social and political events. They developed an activity that

utilized this program as a means for motivating students to engage in discussions and recognize the relevance of controversies contained in many articles published by the media. The resulting classroom discussions generated a level of discourse not realized by Pedro before.

The multi-media element of the video representations provided motivation for students to discuss controversial issues. In discussing these issues, students realized that social and political issues are interesting and worthy of discussion. This set the stage for later analysis of media articles that students brought in on their own. The motivational element of the tool sparked the students' interest, provided an example of discussion structure (through targeted questions), and impacted their belief in their ability and authority to critically evaluate current events. Following the activity, students brought in more articles and engaged in richer discussions about news paper and magazine articles.

The important aspect of this case is that by engaging in dialog about instruction, the ETR-faculty collaborative generated the idea that technology could also be used as tool for motivating students. Before this time, the critical framework established by the PT3 team did not include a dimension for technology for the use of motivation. As a result of the ETR-faculty collaboration described in the case above, the critical framework was modified to include Technology as a Motivational Tool. This addition to the framework expanded the range of the PT3 team's understanding of meaningful uses of technology.

Lessons Learned and Future Directions

Clearly in all cases reported in the previous section, the particular dimension of the critical framework (motivational tool, cognitive tool, etc.) used to exemplify technology integration described in the cases is not the only dimension that could be applied to that particular case. Indeed, technology can serve many functions simultaneously. Our purpose here, however, is not to argue that the framework itself accurately and completely accounts for the way technology was—or should have been—used in that particular situation. Instead, we wish to demonstrate that the framework itself provided ETRs with a language necessary to create rich discourse about philosophical issues and commitments leading to effective content-specific, pedagogical uses of technology in their cooperating faculty and instructors' classrooms. This is contrasted to our initial experiences where discussions tended towards the *addition* of

a particular technological program or package (e.g., *PowerPoint*™) on top of what was already being done in the course. The critical framework helped ETRs conceptualize questions that would lead to discussions about why, when, and how the faculty or instructor *intended to use* a technological tool as an integral part of their instruction to help achieve meet or extend the learning goals for the class.

In addition to its use in fostering discourse between ETRs and faculty, the critical framework was used more generally as a tool that could lead to the *construction* of an understanding of meaningful technology use among all members of the community, including the PT3 team. We realized early on that we were not in the business of providing faculty with a definition or understanding of "meaningful, content-specific, pedagogical uses of technology," but instead we expected that such understandings would emerge through the relationships, discourse, and ideas that evolved through situated practice and reflection. Hence, we ourselves needed a framework for developing a shared discourse that could facilitate the collaborative construction of definitions and ideas *that were yet to be developed*. The use of the terms cognitive tool, communication tool, management tool, evaluation tool and motivational tool helped to foster discourse among the PT3 team that focused more on the purpose of technology use in the school of education rather than on whether or not faculty and instructors were actually using it. This was extremely helpful because the PT3 community had much to learn. Lessons learned about our discourse-based strategy, the role of barriers to technology reform within our strategy, and our on-going work to sustain changes are described below.

A faculty member and an ETR studied the different relationships between ETR and faculty/instructor that emerged throughout the first two years of the project. They found that although the ETR-faculty/instructor collaborative was intended to take the form of a collaborative relationship in which knowledge is jointly constructed through interactions between both members this was not the case in all ETR-faculty collaboratives. Salinas and Robinson (2002) found that any particular ETR-faculty/instructor collaborative can be described by one of three different relationship models. The first model is a uni-directional model which is evidenced by an ETR actually teaching the technology portion of the course in the absence of the instructor. For example, an ETR joins a language arts class on a

particular day and actually teaches the class how to critically examine electronic picture books. The problem with this model is that it fails to work towards our second primary objective of helping teacher education faculty to develop "the capacity to model and deliver technology-infused teacher preparation curricula, pedagogy, and assessment." We were not surprised that this model emerged through the first year of the project since the ETR model was not supplemented with a dialogical, critical framework that could help facilitate discussions about the purpose of technology use. As a result, ETRs did not have these discussions and may not have been aware of the importance of such discussions themselves. A second type of uni-directional model is evidenced by an ETR teaching a faculty member or instructor how to use a particular technology outside the context of the course objectives. For example, an ETR meets with a faculty member and shows her how to use *PowerPoint*™ with no discussion about how, when, why, or whether this software package is going to be used in the course. The limitation of this model is that the relationship between faculty and ETR fails to foster the development of a critical disposition towards technology, our first primary objective. We continued to use this model throughout years 2 and 3 because we felt that it provided faculty with the skills necessary to move to the next phase of using and critically considering educational technology. The final model for ETR-faculty/instructor collaboratives is the intended model where the ETR and faculty/instructor engage in bi-directional discourse with both parties participating in the design of content-specific, pedagogical use of technology that helps to meet or extend the goals of the course. This model for ETR-faculty/instructor interaction, as described in the previous section, increasingly appeared in our community as we became aware of the existence of the various directional models. In addition, we began to understand the different nature of the roles taken on by faculty, instructors, and ETRs, and how these roles were influenced by one or more of the barriers to faculty embracing and thinking critically about technology.

We faced a variety of barriers as we tried to integrate technology into the teacher education program. Earlier we discussed the five barriers to faculty adoption of technology described by Butler and Sellbom (2002). Through interviews with faculty and instructors, we found that the barrier that was most detrimental to technological reform was Butler and Sellbom's barrier (d), where certain faculty members

and instructors did not believe that technology could provide assistance in meeting the goals for the course. As a result, they were not willing to even begin discussions with ETRs about the role of technology in helping to enhance instruction or extend those goals. Without these discussions, it was difficult to meet our objectives, which in accordance with our strategy, require dialogue, relationships, and shared language for ultimately generating a shared vision that would facilitate sustainable change.

Other faculty members and instructors were more concerned with reliability and knowing how to use technology. These faculty members and instructors expressed that they feared that unreliable technology coupled with their inexperience using technology would lead to an instructional disaster in the classroom. This was the case in some situations; however through ETR-faculty/instructor collaboratives, we learned that although such situations might (and often do) occur, part of understanding some of the broader issues associated with educational technology in the classroom involve the instructor's ability to manage, plan for, and seamlessly move on with instruction when such situations occur. Further, these situations have given rise to rich opportunities for situated learning that were not otherwise anticipated by the faculty member or the PT3 team. Additionally, the PT3 team concluded that it is important to explicitly address the issue of how to deal with technology when it does not work. This often-tacit knowledge is central to any community learning how to adopt technology and ultimately meet state and national content standards. We found that barriers of reliability and knowing how to use technology did not prevent faculty and instructors from using technology with the help and encouragement of an ETR.

Finally, our strategy of creating a discourse community that includes technology as central and useful for teacher education has been successful at the level of individual instructors and to some extent, within program areas. We are not convinced, however, that a shared vision about the role of technology in teacher education has yet emerged in our university's school of education. As mentioned previously, we have shifted our efforts from developing ETR-faculty/instructor collaboratives to developing ETR-program collaboratives. In this way, we seek to generate and sustain dialogue among faculty and instructors in each program area. We continue to utilize the critical framework as a tool for achieving shared language because we believe that it brings to the fore issues that can help to generate discussions

of critical and meaningful uses of technology. As ETR assistance begins to disappear, faculty and instructors will have to rely on each other for technology expertise and philosophical discussions and commitments from which content-specific, pedagogical uses of technology can emerge. The stage has been set for a transition of educational technology support and maintenance, currently provided solely by the PT3 team, to within the normal operations of our University. The development of a mechanism for the programmatic adoption of the state and national standards across our teacher education courses is currently underway.

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