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# CREATING SOCIAL RELATIONSHIPS

## THE ROLE OF TECHNOLOGY IN PRESERVICE TEACHER PREPARATION

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*In this article, the authors explore how the pervasive availability of technology allows for new social arrangements in teacher education by connecting preservice teachers, school-based personnel, university faculty, and others in deep and engaging ways. The authors illustrate this perspective and then propose four implications for teacher education institutions that build on this view. Specifically, the authors recommend that technology be used in teacher education to (a) create technically literate education professionals, (b) strengthen the practice–theory connection, (c) provide more practice-centered training, and (d) reflect deeply into the scholarship and practice of teaching. The authors discuss each of the four implications in turn and provide examples of institutional practices aligned with these goals.*

**Keywords:** *teacher preparation; technology; organizational relationships; practice-theory connections*

Starting in the late 1970s and gaining strength throughout the 1980s and 1990s, scholars and policy makers have trumpeted the benefits that technology would bring to the practice of teaching and learning. While by and large this remained a promise unfulfilled, recent research suggests that today's computing and networking technologies are beginning to penetrate educational venues (Becker, 1999, 2000, 2001; Gibson & Oberg, 2004; Ronnkvist, Dexter, & Anderson, 2000; Russell, Bebell, O'Dwyer, & O'Connor, 2003). As a result, now is an important time to revisit the potential of technology for education. In this article, we focus specifically on the

implications of technology for teacher preparation and the institutions that engage in it. Our main concern is to identify and explore how a more pervasive technological infrastructure might serve as a catalyst for schools of education to reconsider how teacher preparation is done.

The term *technology* is broad and can encompass many tools and applications. In this article, when we refer to technologies we mean to encompass the standard suite of desktop productivity tools including word processors, presentation managers, and spreadsheets. We also include what is emerging as the standard suite of networking tools: e-mail, Web browsers,

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synchronous and asynchronous<sup>1</sup> text-based conferencing, and synchronous video and audio conferencing. In addition to these, we explore the utility of tools that find extensive analytic use in various domains of practice, for example, simulation, modeling, and visualization tools in science and text analysis tools in literature. Finally, we believe it is important to add to this list technological tools that aid in reflection. A key member of this category is video tools that allow teachers and others to consider and analyze their personal practice and the practice of others.

In what follows, we begin by describing two approaches to the use of technology that have been popular in the past several decades. We then discuss a more recent perspective, one that we believe is critical for enhancing teacher education. Specifically, our emphasis is on the social and interpersonal affordances of technology for teacher learning. To conclude, we review four implications for teacher education that we claim take advantage of the social ways of knowing offered by technology today.

### THINKING ABOUT THE IMPACT OF TECHNOLOGY: THREE PATHWAYS

In this section, we argue, as have others, that technology today offers a way to connect learners, teachers, and others to the social fabric of communities of practice (e.g., Albon, & Trinidad, 2002; Gardner & Williamson, 2002; Putnam & Borko, 2000). To situate this perspective effectively, we will first characterize two other approaches that have typically been used to integrate technology into teacher education: the first being technology acquisition, and the second consisting of instrumental use of technology. These two pathways along with the third approach of using technology to support new social practices are a strategic suite. Together they create a frame to recast our thinking about technology and teacher preparation.

#### *Technology Acquisition*

It almost goes without saying that before technology can have a role in organizational

change, it has to be acquired. There must be a technical infrastructure that is rich and reliable enough for people to come to depend on it for their regular work. While it is a necessary developmental step, the acquisition of a technical infrastructure is not an end in itself.

Teacher preparation institutions and other organizations have thought about helping learners through technology by infusing the organization with technology (Means, Olson, & Singh, 1995; Office of Technology Assessment, 1995). It appears that at times, the goal of organizations in the past has been to purchase lots of technology and hope through its presence that learners will organically come to use it and, through this use, work differently. In schools of education this often looks like outfitting labs and classrooms with the latest in desktop and networking technology. Rather than creating fundamentally new forms of work, this strategy may lead to the same old work done on up-to-date and costly equipment (Landauer, 1995). We, and others (Gomez, Fishman, & Pea, 1998; Pea & Gomez, 1992), have argued that this is a necessary stage in an evolution to new forms of practice. At its core, this stage of organizational use of technology has the naïve theory that the presence of a tool, like a spreadsheet, will organically create better analysts. Teacher preparation institutions and other organizations are often troubled when they look back on large investments just to see that the classroom preparation of teachers occurred much as it occurred prior to those investments in technology (Becker, 2000, 2001). In hindsight, it is evident that the social fabric of teacher preparation is not likely to fundamentally change by the mere presence of technology. Again, in hindsight it is easy to conjecture that the simple acquisition of technology is not enough to encourage the faculties of teacher education institutions to teach differently and the administrators of teacher preparation institutions to conceptualize the task of teacher preparation differently.

#### *Process/Product Relationships*

A more aggressive form of integrating technology into the life of a teacher preparation institution might be termed *process-product*

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*integration*, that is, thinking about the power of the technologies we use in terms of the products they create. For example, organizations often think the core value of a technology like a presentation manager is simply that it allows its members to create presentations. While it is true that presentations are important products for an organization, the impact of presentation managers as such has been much more pervasive (Parker, 2001). Presentation managers, like Power Point, have become new forms of communication within organizations.

Similarly, teacher preparation institutions in the past, and currently, have often thought that their task was to simply prepare teachers to know how to use technology (Flick & Bell, 2000). In the case of presentation managers for instance, the task would be to make sure that teachers know how to use one or another popular presentation manager tool. Yet, we would argue instead that presentation managers are a case where teachers should be helped to see that this tool can actually aid learners to display their knowledge and to display their knowledge in different ways. Thus, in addition to instrumental control of technologies, it is likely to be valuable for teacher preparation institutions to help preservice teachers to understand the role that a technology can play in the transformation of students' work in schools. Like acquisition, instrumental use is necessary but likely insufficient as a perspective on the conceptually proper role of technology use in the context of teacher preparation.

### ***Shaping Social Relationships and Social Arrangements***

A third perspective is that as technologies become a part of an organization they enable new social arrangements. For example, when word processors made their way into offices two decades ago, one of their most profound effects was not to make the typing pool more efficient but to ultimately eliminate it by placing the means to create documents in the hands of the people who needed to create documents. Similarly, we argue that thinking about technology in this way allows preservice institutions to reconceive how preservice education might be carried out.

Before discussing the implications of this approach specifically for teacher education however, we want to briefly introduce the reader to the range of new social practices that we believe current technologies afford the world of education more broadly. First, for example, it is clear that today's networks allow schools to have access to more information and people than was ever before possible. Internet browsers and the World Wide Web give students and teachers access to information that is highly situated in domains of practice. Second, today's networks and computers make it possible for teachers and children to, at various levels, join communities of people well beyond their schoolhouse doors. With synchronous and asynchronous conferencing, teachers and students can join with varied communities in the discourses of those domains (New London Group, 1996). Third, applications of technology, like scientific visualization and dynamic modeling, make it possible for people in schools to use tools that are the same or very similar to the tools that people in professional practice use in their own work (Edelson, Gordin, & Pea, 1997). Fourth, applications like visualization and modeling have the characteristic of making abstract concepts, like feedback, tangible and dynamic for learners (Jackson, Krajcik, & Soloway, 2000). Finally, computing applications that are readily available to learners, like multimedia authoring tools, allow learners to display what they know in a variety of ways that extend well beyond text and stand-and-deliver presentations (Mott & Klomes, 2001; Ripley, 2002). These tools are also a way for public and concrete reflection on what learners know.

So what does this mean for teacher education? We start from a premise that the primary mission of preservice institutions is to create a social fabric for teacher education and later professional practice and that this social fabric is built on relationships. In particular, preservice institutions might productively focus on strengthening three types of relationships—*intra*institutional, *inter*institutional, and *trans*institutional. In the *intra*institutional relationship (e.g., university classes), the goal is to coordinate a set of classroom experiences for the

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preservice teacher in the disciplines and in the practice of education such that the teacher as learner has an integrated experience of preparation. It is clear to us, and we will cite examples later, that preservice institutions can use today's networking and computing to build better community between faculties of education and faculties in the disciplines. For example, it should be possible to create networked communities jointly made up of the education faculties and faculties in the disciplines in which the focus is a seamless integration of content from the disciplines and pedagogy from education.

In the interinstitutional settings (e.g., between universities and schools), the preservice institution is seeking to coordinate social relationships between the experience that teachers have as learners in the context of a college or university and their experiences in local school communities. Schools of education have ample opportunities in this category of relationship building to use technology to, for example, support teachers to bring video and audio examples of their practice back to university classrooms and to use modern database technologies to create interesting and shareable ways to annotate and characterize important aspects of their practice.

In the transinstitutional setting (e.g., joining broader professional communities beyond the local university and school), the preservice organization seeks to help teachers learn to initiate and sustain contact with professionals, such as a chemist or member of a professional organization of practicing teachers. One important way that transinstitutional connections are created and sustained are through the tools of practice. For example, visualization technology is a key tool in the day-to-day work of many scientific disciplines. An important role for preservice institutions is to ensure that as teachers develop they understand both how to use technologies like this fluently in their classrooms and how this classroom use is similar to and different from uses of these technologies by scientists in their day-to-day work.

In sum, we claim that a new technical infrastructure allows preservice organizations to see their role as creating a social fabric for teachers both in preparation and when they leave to join

school communities in new and perhaps radically different ways. To be clear, this social way of knowing has been emphasized for many years by scholars like Dewey, Bruner, and Vygotsky. Yet it has generally been given cursory treatment in characterizations of the practical preparation of teachers, perhaps because the implications of their ideas for day-to-day practice have been underarticulated. For example, like Dewey, many modern educators would argue that the education of children should not be isolated from professional practices as they occur in everyday living and work. Still, programs that prepare professional educators are, in general, short on advice and specific practices to help teachers understand how to do this. As our argument unfolds we will offer examples of efforts that try to make progress on two important aspects of this problem. First we will see how preservice teachers engage in creating new intellectual partnerships that span classroom boundaries. We will also explore examples of the ways that technology can be used to help new teachers gain insight into the organizational concerns of the school districts they are about to join.

In a similar vein, modern educators would agree with Bruner (1990) that learning for students is a process of inquiry and exploration that allows them to build narratives and other detailed expositions of their growing understandings that are coupled to the broader domains of practice beyond school. This way of knowing stands in sharp contrast to simply being engaged in the process of finding correct answers to preordained problems. Here too, we find a general proposition that is likely to find little disagreement in the community of teacher preparation but is buttressed by little practical advice for teachers in preparation about how to practically accomplish this goal. While there are probably many reasons for the underarticulated nature of this socially centered way of knowing in teacher preparation programs, we suspect that the lack of good tools to couple to communities of practice within, between, and beyond schools is one important reason. The coming wide-scale availability of computers and networks in schools will, perhaps, mitigate this concern.

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## IMPLICATIONS FOR TEACHER EDUCATION

Given our perspective that technology can and should be used to support new social arrangements in teacher education, we now consider in more specific terms, what does this mean for schools of education? What kind of learning environments might teacher education programs strive to create in light of a vision of technology as enabling new social arrangements? In response, we explore four implications for institutions that prepare teachers, all of which draw on this vision of technology as shaping social relationships: (a) create technically literate education professionals, (b) strengthen the practice–theory connection, (c) provide more practice-centered education, and (d) deeply reflect into the scholarship and practice of teaching. That these implications, especially the last three, are important concerns for the teacher preparation enterprise is not news. Here we aim to shed new light on the ways that technology is being used to respond to them. We begin with the first implication.

### ***Technically Literate Education Professionals***

The soon-to-be pervasive presence of computing and networking in schools places obligations on schools of education to develop new fluencies within the skill sets of preservice teachers (Brush et al., 2001; Dexter & Ridel, 2003; Doering, Hughes, & Huffman, 2003; Office of Technology Assessment, 1995; Resnick et al., 1998). We find it useful to think about the problem of teacher preparation with respect to the use of technology as a problem in literacy development (Selfe & Hawisher, 2004). In other words, it may be useful for teacher preparation institutions to think of one of their responsibilities as the need to produce technically literate teaching professionals (Dexter & Riedel, 2003). At the core of all communities are their literacies. In each of these communities and sometimes across them we speak, write, and compute in certain ways because we share common literate practices (Cope & Kalantzis, 2000). So too with technology, communities have specific ways they use technologies to get work done. We conjecture that

schools will now have to develop school-specific uses of technology (Pellegrino et al., 2006; Topp, Mortensen, & Grandgenett, 1995). The tasks of teacher preparation should be first to recognize and include these literacies and second to deepen and articulate these emerging literacies.

The technology infusion that we described earlier suggests that the teacher's workplace will demand at least two forms of technical literacy. First, we believe that teachers in the early 21st century will need to be fluent in the school-centered uses of general productivity tools. Second, teachers will need to be fluent in the distinctive technologies that are in use in their specialized communities of practice (e.g., mathematics). We now turn to these general and distinctive technical literacies.

*General technology literacy.* The National Research Council's (Snyder, 1999) report on information technology fluency suggested that most, if not all, college graduates need to use information technology effectively to participate in work. In the world of teaching, general fluencies are probably best thought of as a deep, workable understanding of the use of standard productivity tools for the work of teaching. Clearly, general technical fluency is an important part of day-to-day schooling. For example, many school districts, large and small, use information technology for the data-intensive clerical functions of school district operations, including attendance and grading. Yet schools of education by and large do not take it as their responsibility to prepare teachers to use data from systems like these to analyze teaching and student achievement. In a world in which teachers are generally technically fluent, they would be able to use data from district systems to analyze their own practice and their students' achievement and perhaps, for deeper analysis, to compare their practices and student classroom achievement to that of other teachers in their buildings and across the school district. Patterns in attendance data are pedagogically relevant. The information infrastructures that are making their way into schools bring this information to teachers' desktops quickly (Wayman & Stringfield, 2004, 2006; Wayman, Stringfield, & Yakimowski,

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2004). But to be useful, these data will need to be analyzed by teachers who are sufficiently fluent to use them pedagogically (Thorn, 2002). This implies that teachers, and the school districts that employ them, should have the expectation that when teachers arrive on the job they already know how to use general desktop productivity tools, including spreadsheets and other applications like general search tools, in ways that are coupled to the practice of teaching.

*Specialized technology literacies.* In addition to fluent use in general productivity tools, today's computing and networking also connects teachers to specialized communities of practice whose work is relevant to instruction (e.g., mathematics). As several scholars before us have noted, the tools people use carry important information about their specialized communities (e.g., Engeström & Middleton, 1996; Orlikowski, 2000; Rose, 2004). Several readily available technologies like multimedia composing technologies, visualization technologies, and database search technologies are important tools of the content disciplines. An important component of technical fluency is an understanding of how to use the technical tools of the discipline in ways that are consistent with the broader community of practice. For example, visualization technology is important to several content disciplines in science (Edelson et al., 1999; Edelson & Reiser, 2006; Pea & Gomez, 1992), yet their genres of use vary from chemistry to biology to physics. Technical fluency for teaching therefore requires an understanding of the technical genres of use for the appropriate disciplines. Chemistry teachers, for example, need to understand and be able to explain how chemists use visualization. They should also understand that this use of visualization may be different than the use of visualization in biology. In a similar vein, the teaching of social studies calls for deep technical fluency with database tools that allows one to explore original documentation for argument in the social sciences. It follows that technically fluent teachers need to be aware of the existence of visualization and database tools—but they

should also understand how the use of these tools is shaped by the disciplines of their expertise. A central point of this article, therefore, is to argue that teacher preparation institutions need to ensure that teachers are exposed to and know how to use the technologies that are part of their professional communities of practice.

### ***Strengthening the Practice–Theory Connection***

The second implication we propose relates to what we refer to as *strengthening the practice–theory connection*. This critical need has been recognized by, among others, Shulman (1987, 1996). The key idea is to better connect those involved in creating practical knowledge for teacher education with those involved in creating theoretical knowledge for teacher education. This would include, for example, the manner in which university researchers on one hand and school personnel on the other hand work together to support the education of preservice teachers. Technology has the potential to be an important partner in this endeavor by facilitating communication among groups of people who often work at a distance from one another, whether this distance is geographic, conceptual, or both.

To illustrate this claim, we discuss several examples of programmatic efforts in which teacher preparation organizations have engaged. Consider first a recent Wayne State University effort. In the fall of 2001, Wayne State University began a project to focus on the development of future teachers' use of technology in the classroom. In it, 325 iBooks were given to preservice teachers and an additional 40 were given to faculty who would be working with those students. By providing this cohort with the technology, the university was able to support the connection between the cohort and university-based faculty. Furthermore, a community of practice developed around the use of the computers. Specifically, students organized a group called "Teachers on the Go" through which they could discuss issues related to learning and to using the technology (Sakely, 2002). An unexpected consequence of the initiative was that students' and faculty members' struggles to learn and teach with the new technology provided preservice teachers with a

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model of effective teachers as flexible problem solvers who are open to learning through exploration and discussion (Waker & Roberts, 2005).

Next, consider the Teaching Tele-apprenticeship (TTa) program, which is similar in spirit to the Wayne State effort. TTa uses e-mail and the Web to go beyond the typical face-to-face apprenticeship model (Thomas, Larson, Clift, & Levin, 1996). In particular, the program offers preservice teachers an online network consisting of university faculty, supervisors, and mentor teachers. Preservice teachers use the network to receive timely responses to their questions, engage in extended discussions around issues related to teaching and learning, and share their own technological, pedagogical, and subject-matter knowledge. By providing a real audience for their learning, the TTa model resulted in increased motivation on the part of preservice teachers to produce high-quality coursework (Levin & Waugh, 1998).

The Inquiry Learning Forum (ILF) also aims to support communication among these different professionals but provides a variety of contexts in which participants can do so (Barab, MaKinster, Moore, Cunningham, & the ILF Design Team, 2001). ILF is developed around the metaphor of a school in which users enter different "rooms" to engage in activities. In the "library," for instance, participants can access lesson plans and unit materials. One can also visit "classrooms" to view video excerpts of lessons from teachers who have chosen to make these materials available to others. In the "lounge" participants take part in discussions concerning inquiry-based teaching strategies. Research has shown that preservice teachers particularly appreciate the inclusion of in-service teachers in the ILF community as their input provides preservice teachers with a vision of how theoretical ideas about teaching and learning play out in real schools and classrooms (Barnett, Harwood, Keating, & Saam, 2002).

Along the same lines, though not an effort that grew out of a teacher preparation institution, Tapped In (Schlager & Schank, 1997) is a Web-based community that also attempts to inculcate a sense of personal and community space for communication among teaching professionals.

The Tapped In community caters to diverse professionals by creating a transinstitutional context for problem solving and discussion. Tapped In's creation by a third party (SRI International), which is not a teacher preparation institution, may have facilitated its ability to create a transinstitutional context for learning. Because the Tapped In community cannot, by design, be viewed as the proprietary space of any particular institution, it, and communities like it, may evolve into online communities that can be seen as owned by all segments of professional education community. Interestingly, one set of university instructors found that some preservice teachers "talked" more during asynchronous communication through Tapped In than during face-to-face class meetings (Alvarado, 2006); this finding suggests that participation in online communities may be beneficial even for preservice teachers who already have ready access to the same sorts of communities offline.

Finally, we want to describe one more example that is taken from Northwestern University's Alternative Certification program (NU-TEACH). This example is centered on the use of video rather than on networking technology. In NU-TEACH, preservice teachers participate in an intensive 8-week summer program before beginning work as intern-teachers the following academic year. Because of the fast pace of the program, coordination between university faculty and mentor teachers in the training of the interns is particularly critical. Toward this end, interns complete a series of video-based assignments that draw on explicit feedback from mentor teachers, university faculty, and program peers. In the context of these assignments, video excerpts from the interns' summer teaching placements literally cycle between the school and the university, becoming a resource for learning about and reflecting on teaching and for constructing multiple interpretations of classroom practices. In this way, the video technology provides an important media through which participants in teacher education become better connected and better prepared for creating a professional discourse about teaching and learning.

The foregoing examples show how strengthening the connection between theory and practice can be seen as an interpersonal task for

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teacher preparation institutions. Furthermore, these examples suggest how technology that is readily available can provide practical scaffolding for communities of practice to make the connections.

### **Practice-Centered Preparation**

Up to this point, we have discussed the need to connect theory and practice and the role that technology can play in doing so. In addition, we suggest that technology can help to strengthen the practical knowledge needed by preservice teachers. As prior research suggests, the isolated university classroom is not ideally suited to the display and deep consideration of practice (Zeichner, 2006). At the same time, practica of various sorts as traditionally executed in teacher preparation organizations are often too short and episodic to offer learners the kind of extended window into practice they need to leave the teacher preparation context with a realistic and useful introduction to practical knowledge (Johnston, 1994). We conjecture that for practice to be genuinely featured at the center of teacher preparation, schools of education and other teacher preparation institutions will have to discover ways to rethink the opportunities they provide for teacher-learners to develop practical knowledge.

Here, we highlight a few examples of how some schools of education have used technology to allow teacher-learners more situated opportunities to gain a more integrated and practice-centered sense of teaching. In our examples, we highlight two forms of placing practice at the center of instruction. First, we turn our attention to attempts to connect content area instruction to methods instruction. This focus recognizes the intrainstitutional coordination role that is, from our perspective, inherent in organizational responsibility of teacher preparation. Following that, we turn our attention to the ways that video-based technology has been used to support practice-centered preparation in interinstitutional settings by offering teacher-learners access to venues of practice that, because of distance and other factors, they might not otherwise see.

*Intrainstitutional coursework coordination.* At Wake Forest University in North Carolina, the integration of technology into all aspects of the teacher preparation program has been supported by the university leadership. Specifically, faculty and undergraduate students are provided with laptops in addition to ubiquitous technology access on campus, including network access, technical support, and access to technology-enhanced classrooms. Moreover, the university has begun to align its methods classes and educational technology courses as well as to integrate technology into all aspects of the teacher education curriculum (Howard & Cunningham, 2000). This approach provides robust opportunities for students to use their technological skills across several courses and helps them to develop multiple resources for the appropriate use of technology in the classroom. For example, students complete one instructional design project that is submitted to both their methods class and their technology course. Both the content area faculty and a technology faculty member work with the candidate to develop appropriate technology strategies that can enhance the instructional goals of the candidate's project. This course alignment has also created opportunities for faculty to collaborate in meaningful ways around the integration of technology into the curriculum.

In a similar fashion, Vanderbilt's Peabody College restructured many of its courses so that the students can experience how information technologies can support teaching and learning (Pellegrino & Altman, 1997). To do this, faculty have redesigned their courses so that students make extensive use of technology resources both inside and outside of class. For instance, faculty regularly give assignments that require the use of technological tools such as networking, multimedia programs, or research using the World Wide Web. Furthermore, by modeling effective teaching strategies that call for technology use on the part of their students, Peabody professors are then able to analyze their use of technology with their students and discuss with them why it was included in the lesson. The courses that students take have also been sequenced so that the technology-based applications increase in sophistication and complexity over a series of courses. Importantly, students have found this infusion

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of technology into their own university classes to be valuable preparation for teaching with technology because the Peabody program not only exposes them to a variety of technologies but also shows them how technology can be effectively integrated into the classroom (Struder & Wetzel, 1999). This example illustrates how, in the spirit of technology as a social fabric, technology has become a vehicle for connection across the entirety of the teacher education program.

*Broader access to diverse classrooms.* In the 1960s when portable video equipment first became available to teacher education, one of its main advantages was thought to be the time it would save supervisors traveling to and from classroom observations (Olivero, 1965). Today, the advantages of video for teacher education are seen as farther reaching, yet video's ability to provide virtual access to classrooms continues to be viewed as one of the central contributions of video to teacher education (Sherin, 2004).

Consequently, videotaping preservice teachers' field experiences has become a common part of teacher education programs (McIntyre, Byrd, & Foxx, 1996; Willis & Mehlinger, 1996). In addition, a number of universities make use of remote video technology to provide preservice teachers with access to classrooms that they would otherwise be unable to observe. For example, the Virtual Campus School (VCS) at Montana State University provides live Web casts from classrooms to the university to avoid having to place students in field placements that can be up to 250 miles from campus (LaCounte, 2003). In addition, each 30-minute Web cast is followed by a 15-minute live question and answer period with the classroom teacher. LaCounte, Zentz, and Knuth (2003) emphasized the benefits for teacher candidates of receiving such "just-in-time answers to the questions they pose to teachers" (p. 1968).

In Indiana, preservice teachers at Purdue University are connected through two-way video conferencing to rural and urban classrooms in other parts of the country, contexts to which they do not have access locally (Lehman & Razzouk, 2002). Not only do the preservice teachers observe these classrooms, they also

prepare and present mini lessons to small groups of students in these classrooms in a video conference format. While these remote observations cannot replace live classroom visits, they extend preservice teachers' classroom-based experiences in valuable ways. In particular, preservice teachers' self-reflections (in the form of journal entries and questionnaires) indicate that exposure to a diverse array of classrooms led them to view these different settings more positively than they had before (Phillion, Johnson, & Lehman, 2003).

In other work, Lampert and Ball (1998) used technology to bring aspects of classroom practice directly to students' university coursework at Michigan State University. Specifically, they developed a multimedia system that provides access to a variety of data collected during 1 year of teaching, including classroom video excerpts, students' daily work, and reflective teaching journals. Preservice teachers use the multimedia system during their methods classes to investigate specific questions of teaching and learning that they have identified. In this way, the system becomes a mechanism both for learning about teaching and for learning about reflection on teaching (Ball & Lampert, 1999).

Emerging video libraries, currently becoming more available to teacher education, represent a similar approach to the use of video. For example, the Annenberg/CPB<sup>2</sup> materials include sets of half-hour videos on issues in literacy, science, and mathematics. In addition, the TIMSS materials offer preservice teachers the opportunity to view international lessons in mathematics and science (Hiebert et al., 2003). Recently, increased attention has been paid to the creation of a national library of classroom video case exemplars that would be made available to teacher educators. While still in the development stages, such a collection could be an important step in shifting the focus of teacher education from learning about content, theory, and practice to learning to construct practice, develop theories about practices based on evidence, and implement changes to practice—all in the space of preservice education.

In this section we reviewed several examples where teacher-learners have had opportunities

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to learn to see practice in connected settings. We have conjectured that to develop practical knowledge, learners must have opportunities to learn that are situated in practice. Furthermore, the programmatic interventions in teacher preparation that we have discussed here made use of a variety of approaches to connect preservice teachers to practice. These include cases of simple access to classroom observations to those offering teacher-learners the chance to practice the tasks of teaching in inter- and intraorganizational contexts that make it more likely that the teacher-learners will understand how what they are learning fits into social fabric of teaching.

### ***Reflection on Teaching***

Hutchings and Shulman (1999) encouraged the educational community to think about teaching as scholarship. In this conception, teaching is a process of design, evaluation, and redesign. Scholarship is the creation of arrangements where it is possible to capture and review teaching and to build on teaching based on these understandings. In terms of the implications suggested here, teaching as scholarship requires that teaching be a fundamentally reflective process. This stance suggests that teacher preparation organizations have at least two responsibilities: (a) to prepare teachers to think about themselves as engaged in scholarship on practice and (b) to provide the conditions where this sort of reflection is possible. Creating the conditions for reflection within practice is often difficult. Recently, Loh (2003) suggested three criteria necessary to create the conditions for reflection. First, he suggested that reflection needs a referent. There must be something to reflect on. Second, reflection needs to be triggered. Some condition has to interrupt practice to allow practitioners to reflect. Third, reflection has to be situated within a culture of practice that values reflection as part of ongoing work. In this section, we will highlight ways in which teacher preparation institutions can use multimedia technology applications to encourage and sustain such reflection.

Video technology can support a view of inquiry into teaching through preservice teachers' examination of their own teaching

and learning. Research suggests that a key component of preservice teacher learning is the development of habits of inquiry (i.e., the ability and inclination to substantively reflect on one's teaching practices) and to view one's teaching context as an object of investigation and contemplation (Wilson & Berne, 1999). To be an object of reflection and contemplation, teachers not only need public records of teaching, they must also develop a discourse to share their thoughts about teaching.

In the past decade, many new multimedia technologies have become available that provide teachers with the opportunity to engage in such practices. At the most basic level, these technologies take advantage of the lasting record of teaching that video provides. For example, in video clubs, groups of teachers watch and discuss excerpts of videos from their classrooms (Sherin & Han, 2004). In the video club environment, questions that arise during a lesson serve as an opportunity for reflection rather than as problems requiring immediate action or solutions by teachers. As such, these records afford preservice teachers time to consider a range of pedagogical responses. In addition, they also can motivate preservice teachers toward deeper understandings of student thinking, for instance, to consider the prior knowledge that underlies a specific student question or idea. Furthermore, because video clubs are a social event they can help teacher-learners to develop a common language to talk about practice. A public way to talk about practice helps learners to both share practice and build on the practice of others (Frederiksen, Sipusic, Sherin, & Wolfe, 1998). New social norms to critique practice in public, but safe, settings could alter the landscape of teacher preparation. Imagine environments where preservice teachers, master teachers, and university faculty all have sharable records of practice for discussion along with a language that makes it clear how their perceptions of practice vary with expertise and other aspects of the context of their work. Clearly this is an element in enabling preservice teachers to come to see teaching as scholarship.

Moving beyond the use of simple video records of practice, both research-based and for-profit multimedia systems are emerging

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that encourage teachers to inquire into teaching by placing video in rich hypermedia settings. One example is video papers. Video Paper Builder allows preservice teachers to create video papers in which they annotate digitized video of local practice and link the video and annotation to Web- and text-based materials. The video papers can be shared with teachers and university faculty. Developed at TERC (Carragher & Nemirovsky, in press; DiMattia, 2002), video papers have been used in Tufts University's teacher education program with several cohorts of preservice teachers. Faculty at Tufts report that Video Paper Builder's structure, which directly connects self-reflection to video-based evidence, has led students to reflect more deeply than they had with more traditional video assignments (Beardsley, Cogan-Drew, & Olivero, 2007).

Another genre of a multimedia system meant to encourage inquiry in practice is exemplified by Teachscape and the Knowledge Media Laboratory. Unlike video papers where the video is unfinished, in the sense of not highly produced, both of these systems rely on more highly refined video. Teachscape is a for-profit system that offers narrative video of teaching practice in connection with asynchronous conferencing tools to encourage learners to create a sense of community around examples of teaching. It uses video that shows the use of specific curricula by teachers in action. The Teachscape system has been used in science methods courses at Northwestern University as a way of allowing preservice teachers to see, and critique, the enactment of published curricula that have been adopted by states and localities. Systems like these are also beginning to be part of professional development in statewide and citywide settings. For example, the Teachscape system is being used to support a statewide reading adoption in California. We believe that there will be important opportunities in having the same applications that are used as part of in-service municipality-wide professional development used similarly in preservice teacher education. This sharing of multimedia records of teaching practice may be a route to intraorganizational connection worthy of exploration. If teachers in preservice programs had access to

localized multimedia-based professional development, they might better appreciate the settings and problems of practice they are likely to encounter in the school communities they will join at the completion of preservice teacher education.

We complete this section with a brief discussion of the Knowledge Media Laboratory (KML)<sup>3</sup> from the Carnegie Foundation for the Advancement of Teaching. KML has been used to capture personal narrative of virtuoso teachers who have been scholars at the Foundation. It is unique among systems that present multimedia records of practice because it contains extensive reflections on teaching in the teachers' own voices. KML pieces offer a kind of first-person biography of teaching. From tools like KML, the preservice teacher can understand the personal voice and metareflective choices that accompany practical knowledge. In addition, teachers who create KML portfolios go through a valuable learning process as they make decisions about which collection of artifacts and personal reflections will give an accurate depiction of their teaching. In fact, some teachers have reported that preparing a portfolio for KML has led them to rethink key aspects of the lessons they are portraying (Hatch, Bass, Iiyoshi, & Mace, 2004).

Teaching is scholarship. For scholarship to proceed and to have impact it must have concrete and practical tools. In this section we have mentioned just a few of the growing number of multimedia systems that can aid preservice teacher preparation organizations in making reflection part of their culture of practice. Our selection of examples was meant to show the range in these applications. Encouraging reflection in the lives of teachers, the life of teacher preparation institutions, and in the commerce between education organizations will, in all likelihood, require such a range of reflection tools. While many of these tools are only now making their way into preservice teaching, we suggest that they will find homes in different aspects of preservice preparation. And as they take root, they will change the conversation about teaching, and the social network that supports it, in preservice and beyond.

## CONCLUSION

The philosopher Heidegger (1977) wrote that the essence of technology is by no means anything technological. We have argued here that part of its essence is social. When technologies are well designed and work well, they become part of the fabric that supports our ways of being and ways of knowing. We have suggested that when technologies become embedded in the lives of organizations they have the potential to both support existing social arrangements as well as introduce new social arrangements. In either case, this is important because social arrangements sustain and deepen the work of individuals and organizations.

This, we have argued, is particularly important for teacher preparation organizations. Like others, we see the enterprise of education in the United States as too disconnected to serve its constituency of teachers, students, and parents as well as it might. The slow, but inexorable, trend of technology toward pervasiveness in schools might serve as one connective mechanism for schools of education. Specifically, new technologies present the potential to create social arrangements and to deepen organizational relationships that improve the practice of teaching and ultimately the education of children. Furthermore, we have suggested that for technology to serve this role, it would be productive for schools of education to take a strategic stance to manage and plan their commerce with new technologies. Our desire is that this article serves as a useful part of the conversation that teacher preparation institutions will have over the coming years about which technologies to purchase and use in the context of the teacher preparation enterprise. Moreover, we hope this discussion will help to spur useful conversations in teacher preparation institutions about how today's technologies can serve as a catalyst in their efforts to create a community of scholarship around the practice of teaching that extends well beyond the geographic confines of any given school of education or teacher preparation institution.

## NOTES

1. Synchronous technologies involve communication at the same time, as in a telephone conversation. Asynchronous

technologies involve communication at different times, as in e-mail exchanges.

2. See, for example, [http://www.learner.org/view\\_programs/view\\_programs.html](http://www.learner.org/view_programs/view_programs.html).

3. See <http://gallery.carnegiefoundation.org/> for information on the Knowledge Media Laboratory.

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