Electronic Networking Technologies for TPD

ISSUES AND TRENDS CONCERNING ELECTRONIC NETWORKING
TECHNOLOGIES FOR TEACHER PROFESSIONAL DEVELOPMENT: A CRITICAL
REVIEW OF THE LITERATURE

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This paper to be submitted to Journal of Technology and Teacher Education. Please do not
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The author wishes to thank Sasha A. Barab for his thoughtful comments on a previous
version of this manuscript.
ABSTRACT

Recent educational reforms and research on teacher professional development (TPD) recognizes that if teachers are going to improve their practice, they need to have access to on-going, quality professional development that is situated in their everyday instructional environment that provides opportunities to communicate, collaborate, and reflect on their teaching. Within the last several years, network-based communications have recently begun to be touted as tools that can fundamentally reshape TPD. This manuscript examines recent research concerning how these new technological tools have been used to support both pre-service and in-service TPD. To this end, studies on network-supported TPD in peer-reviewed research journals concerning teacher education, science education, and educational technology as well as books, book chapters, and conference proceedings in the learning sciences are examined and critiqued. Through this critique of the research base, four major thematic issues emerge concerning how network based communications has influenced teacher professional development: 1) Networking technologies can reduce teacher isolation and support sharing. 2) Networking technologies can foster reflection on practice 3) Networking technologies influence teaching practice 4) Networking technologies support the formation of communities of practice. Each of these themes is critically examined along with the research base from which the particular theme emerged. Suggestions for future research are also presented concerning each theme.
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INTRODUCTION

Within the past few years there have been numerous calls for the reform of teacher professional development programs (Darling-Hammond & McLaughlin, 1995; Lieberman, 1995). These reforms emphasize providing teachers with on-going, quality teacher professional development (TPD) during the school year that takes into account the teachers context and needs (Lieberman, 1995; NRC, 2001). To date, however, there are relatively few TPD opportunities that provide teachers with on-going support that is situated in their everyday instructional environment (Schlager & Schank, 1997). To address this failing in current TPD programs, educators have begun to investigate how emerging technologies can be used as tools in supporting on-going and contextualized TPD programs. Specifically, electronic networks supported by e-mail, listservs, and synchronous and asynchronous video and text conferencing via the World Wide Web are being touted as technological tools that can fundamentally reshape TPD and in turn reform current teaching practices (Watts & Castle, 1992). The purpose of this manuscript is to examine recent research concerning how these new technological tools have been used to support both pre-service and in-service TPD. In particular, this review first discusses how these new information technology tools, coupled with recent educational reform efforts, have created a need for new models of TPD. Following this discussion, is a summary and critique of the research base and a discussion of what we have learned as a field based upon this previous research. This review closes with suggestions for future research concerning electronic networking and teacher professional development.

BACKGROUND: IS THERE A NEED FOR NEW MODELS OF PROFESSIONAL DEVELOPMENT USING NEW TECHNOLOGIES?

In the past twenty years members of the educational community have accumulated a wealth of information about improving teacher practice through professional development (Lieberman, 1995). However, this knowledge base is a significantly underused resource for teacher development because of the lack of a mechanism to facilitate sustained information sharing and access to a distributed expertise such as other teachers, university faculty and curriculum developers (Loucks-Horsley & Matsumoto, 1999). For example, the primary means
that most teachers have to distributed expertise are their brief experiences at in-service
workshops at their schools or universities, summer institutes, or through their own reading of
practitioner-oriented journals (Marx, Blumenfeld, Krajcik, & Soloway, 1998). However, during
the past decade, information technology tools have created new ways for individuals to
communicate and share information and experiences with one another (Dede, 2000). It is this
potential of networking technologies to enhance communication and sharing of teaching
practices that that many educators believe can fundamentally reshape the nature of teacher
training (Barab, et al., in press).

New educational reform initiatives recommend that networking technologies play a more
prominent role in K-12 classrooms (NRC, 1996). To this end, numerous projects have been
developed that support students engaging in discussions and sharing data with their peers and
professionals through electronic networks (Edelson, Gomez, & Pea, 1999; Songer, 1996). These
same reform initiatives also expect teachers to reconsider their own practice, to construct new
classroom roles for themselves and their students, and to teach in new ways (student-centered
rather than teacher centered) that they did not experience themselves as students (Darling-
Hammond & McLaughlin, 1995). However, an examination of K-12 teacher practices provides
little evidence of a shift in practice (Cuban, 1993; Simmons, 1998). Multiple reasons for this
slow change in teachers’ practice have been mentioned in the research literature. The two most
frequently reported are school culture and lack of quality, on-going TPD. For example, several
studies have found that even the most excited reform-oriented teachers typically alter their
practice to conform with the prevailing school culture once they are immersed into a school
whose culture does not value the sharing and discussion of innovative teaching practices (e.g.
Simmons, et al., 1999). As a result, many teachers become disenfranchised because they develop
the perception that there is little support for their new ways of teaching (Kagan, 1992). However,
there is mounting evidence that if teachers are provided access to on-going TPD they are less
likely to become disenfranchised, less likely to leave the profession, and more likely to be more
innovative and support reform based initiatives in their school (Bos, Krajcik, & Patrick, 1995).
Unfortunately, there are relatively few TPD opportunities that provide teachers with ongoing
support for change that are situated in their everyday instructional environment (Schlager &
Schank, 1997). As a result, the teaching profession has not had opportunities for meaningful
growth experiences that are so critical for continued development of the profession such as
defining what its own members should know and be able to do, or the responsibility for engaging in discourse with one another to evaluate and reflect on their practice (Ingvarson, 1998).

With the growing dissatisfaction toward TPD a number of educators have begun to explore differing approaches to TPD ranging from summer institutes to having teachers work with university faculty on curriculum development projects (Loucks-Horsley, Matsumoto, 1999). However, even the most exemplary TPD efforts have reported difficulties in maintaining support for teachers after an institute or workshop (Carey & Frechtling, 1997). With these concerns in mind, new models of TPD have been proposed that take advantage of the power of emerging electronic networking technologies (DiMauro & Gal, 1993; Shotsberger, 1997). In principle, these TPD programs provide teachers with greater opportunity to access and discuss exemplary reform-based materials, engage in dialogue and share their experiences with reform-based materials during the school year which is when teachers need access to professional development resources the most (Schlager & Schank, 1999; Shotsberger, 1999).

FRAMING THE REVIEW

In the past ten years, there have been many state and national efforts to study, encourage, and support increased use of information technology (computer-based networks) in schools to support students and teachers (see Willis & Mehlinger, 1996 for a summary). However, only recently have educational researchers begun to explore the advantages and disadvantages of networking technologies in supporting teacher professional development. As a result, research in this field of educational technology is still in its infancy, but is rapidly expanding. Hence, a review of this rapidly expanding research base is needed to not only summarize recent findings, but also to provide a guiding framework for future research that is grounded upon previous research findings.

The methodology employed for this review entailed a search of peer-reviewed research and practitioner-based journals, peer-reviewed conference proceedings in the learning sciences, teacher education, and educational technology since 1990. In addition, previous reviews such as the one conducted by Bos, Krajcik, & Patrick (1995) in which they only reviewed ten studies concerning how telecommunications can support teacher reflection and collaboration were also used to locate additional sources. This search focused on identifying studies that examined or
discussed the impact or influence of networking technologies on TPD. From these searches studies were selected that were based upon qualitative or quantitative empirical data collected from pre-service or in-service teachers participating in a project that involved the use of networking technologies to support their professional development. This selection process revealed 24 studies. These studies were then examined to identify common themes using the constant comparative method (Glaser & Strauss, 1967). Through this examination and coding, four major thematic issues emerged, and it is these themes around which this review is structured. Further, during this analysis each study was analyzed to determine the quality of the research reports. To this end, each study was examined for the characteristics of good empirical research as described by Wideen, Mayer-Smith, and Moon (1998). That is, each study was examined for a clear statement of intentions, a coherent theoretical framework, detailed information about the study and the study context, methods, sources of data, findings that emerge from data, conclusions that integrates the original theoretical framework, and interpretations of the findings. Through this examination and coding, four major themes emerged, and it is these themes around which this review is structured. In adopting this stance, it is acknowledged that the review presented here is probably not complete and may be leaving out innovative TPD programs. However, by choosing to only focus on those studies that are based upon empirically gathered data this review will be in a better position to discuss the design and use of networking technologies for TPD. Lastly, this review extends the previous review of Bos, Krajcik, & Patrick (1995) by not only focusing on a larger array of studies but also critically evaluates the research and makes suggestions for future research.

[Insert Table 1 about here]

RESEARCH ON NETWORK-BASED TEACHER PROFESSIONAL DEVELOPMENT

As stated previously, a number of issues emerged upon examination of the literature base. In this section each issue is discussed with its supporting research base and followed by an interpretive commentary that critiques the research findings in general and suggests areas for future research.
Theme #1: Networking technologies can reduce teacher isolation and support sharing.

Teaching has been characterized as a culture of isolation (Kagan, 1992). However, teachers who are attempting innovative teaching practices in their classroom need contact with mentors, access to resources, and support from their peers and other members of the educational community if they are to evolve their practice (Marx, Blumenfeld, Krajcik, & Soloway, 1998). In one of the earliest studies, Kimmel, Kerr, & O’Shea (1988) provided in-service teachers access to a computer networking conferencing tool that had both instant messaging capabilities and an asynchronous component. The researchers, after a review of the conference transcripts, found increased sharing of classroom materials and ideas and increased collaboration between teachers in developing activities for professional development workshops. Likewise, Jinks and Lord (1990) isolated 50 experienced rural K-6 teachers in a dormitory for a month to simulate their normal teaching environment, but provided them access to a computer network to communicate with each other and discuss teaching strategies and domain content. Mostly anecdotal evidence was gathered, but the evidence suggested that telecommunications tools could emerge into a powerful system of informational and moral support. Along similar lines, Merseth (1991) in a year long study with 39 first-year teachers participating in the Beginning Teacher Computer Network at Harvard University found that access to interactive computer networking was valuable in providing moral support for beginning teachers. Similarly, Souviney et al. (1995) found e-mail to be easier and more effective in increasing communication over more traditional methods of communication such as voice mail, print messages, and even face-to-face conversations despite the problems students encountered in using e-mail and the increased time they spent sending and reading e-mail. In general, Souviney and his colleagues reported that secondary education teachers tailored the use of e-mail to their personal needs based on their existing context. Likewise, Powers and Dutt-Doner (1997) in a content analysis of over 856 listserv postings in a pre-service teacher education course found that nearly 18% of all messages were focused on support and encouragement with another 35% focusing on sharing of information. In a recent study, Roddy (1999) found that beginning teachers who had access to and participated in electronic mailing list felt less isolated and more willing to engage in idea sharing and discuss classroom issues. However, Waugh’s (1996) study on group interactions and pre-service teachers’ questioning patterns using an electronic network found contradictory
results. Waugh’s results showed that the pre-service teachers posted questions that were predominately concerned with technical issues concerning the performance of the network and network strategies than with pedagogical and personal support questions.

One particular use of electronic networks that has shown great potential in encouraging participation and discussion has been teleapprenticeships (Levin & Waugh 1998). According to Levein and Waugh a teleapprentiship is a “framework that use electronic networks to create apprenticeship like learning environments without requiring the participants to be in the same places at the same times.” Levin and Waugh (1998) using a case comparison technique in which they compared and contrasted how different pre-service teachers used an electronic network to access expertise from their more experienced peers and subject matter experts found that beginning teachers could more accurately and completely answer their students’ questions the content under study after participating in the on-line discussions. Levin and Waugh (1998) also found that mediators (e.g. graduate students) were crucial in supporting and focusing their pre-service teachers’ discussion. Similarly, Weis (1997) matched up pre-service teachers with a content area mentor using e-mail and a listserv. Her results indicated that her students believed the content mentor was quite beneficial in helping them develop lesson plans and other classroom activities. In another on-going project, the Students and Teachers Electronic Productivity Systems (STEPS) network have developed a system in which in-service teachers have access through an electronic network with their peers, content experts and more experienced teachers. The participants in this project have reported that they found the mentoring relationships to be useful and gave them additional confidence to try new and innovative teaching strategies in their own classrooms. (Lehman, et al., 1992). Similarly, Waugh & Rath (1995) implemented teleapprenticeships in six elementary science methods courses and collected data concerning pre-service attitudes toward the use of electronic networks. The majority of students indicated that they perceived the networks as useful tools for enhancing teacher training programs and supporting work in their schools.

Interpretative Commentary: Issue #1

Generalizing across the studies, networking technologies appears to create favorable conditions for collaboration, sharing, and support that can aid teacher development. However, there are two major limitations to a majority of the studies presented here. One is technological
and the other is methodological. First, methodologically, most of the results presented above are based upon surveys and self-reported data with little triangulation (Lincoln & Guba, 1986) done to examine how teachers use networks in more detail. Further, most the studies reviewed have been of short duration usually lasting over the course of a single semester or course, which can impact how a new technology is used because it typically takes the average user time to not only learn the system, but also to trust the system and incorporate it into their everyday working culture. Second, technological constraints have limited the type of data collected because it is difficult to track all messages that are exchanged between participants. For example, participants can easily send private e-mails to one another without sending the e-mail to a researcher or posting their message on a listserv. Therefore, there is a need for rigorous research that examines what structures within an on-line environment support communication and collaboration, what are the characteristics of those teachers that do actively participate in electronic networks, and conduct longitudinal follow up studies to determine if teachers continue to use established networks and why they continue to do so. For example, do pre-service teachers who used the electronic networking systems in their undergraduate courses (in which use of the network is mandated by the instructor) continue to use the network after the course has concluded and there is no longer a mandate by the instructor to use the network? That is, do teachers continue to use electronic networks because they have access to expertise, or because a facilitator is particularly skillful in engaging teachers in discussing their practice, or is it simply because teachers desire to communicate with teachers outside of their local environment. In other words, what parts of the teachers’ existing social network influence their use of an electronic network?

Theme #2: Networking technologies can foster reflection on practice

It is widely believed that effective professional development must provide teachers with opportunities to reflect on their teaching practice with other teachers and educators. The opportunity to reflect on practice must not only occur during the summer when time is available but also throughout the year when professional development programs must compete with teachers’ other numerous and time consuming responsibilities (Darling-Hammond & Lieberman, 1995). Hence, a number of TPD programs have incorporated networking technologies to allow teachers to reflect on their practice when time permits throughout the school year. In one of the earliest studies on the use e-mail, Merseth (1991) surveyed first-year teachers who used an e-
Electronic Networking Technologies for TPD

mail network to keep in touch with their peer group. He reported that that the teachers primarily used the network for peer support rather than reflecting on teaching strategies or pedagogical practices. In later studies, this finding was supported by Gunn (1995) and Roddy (1999). Both Gunn and Roddy reported that when beginning teachers engaged in dialogue over an electronic network their conversations primarily focused on giving and receiving emotional and moral support rather than on curriculum and teaching concerns or other professional development related questions. In addition, Thomas, Clift, & Sagurmoto (1996) suggested that electronic communication is likely to influence the content of the message depending on who the messages were focused at rather than being reflective in nature. They found that most of their pre-service teachers posted responses only because use of their electronic forum was a course requirement. Further, Thomas and colleagues found that the instructors’ messages had the highest priority whereas their peers’ messages had relatively low priority unless a student sent a message that was specifically addressed to another student. Lastly, through extensive analysis of the interactions that occurred over the network the researchers determined that reflective exchanges typically only occurred between faculty and students and were not shared with their peers. As a result, there was little opportunity for developing a shared understanding of what it meant to be a deliberate practitioner, and perhaps reinforcing pre-service teachers’ perception that learning about ones practice only comes through private reflection rather than prolonged social discourse with other teachers.

A few studies have gathered evidence that electronic networks do, at times, support reflection on practice. For example, Casey’s (1994) study on TeacherNet at California State University reported that pre-service teachers using a telecommunication network spent more reflecting on what they were learning and felt less isolated in student teaching. In addition, in a preliminary study of ten teachers, McDonald & Songer (2000) found that when teachers collaborated with one another while planning the implementation of the One Sky Many Voices curriculum, they tended to reflect more on the pedagogical strategies that would be most beneficial to improve their student learning. DiMauro & Gal (1994) as part of the multi-year LabNet project examined the discourse between eight Teacher Liaison Consultants (TLCs) (teacher leaders) and practicing teachers. The ensuing dialogue was examined and categorized into one of three modes, informative, responsive, and reflective. They classified a reflective mode as a message that engages the authors self, is stated in a nonjudgmental manner, and
invites inquiry. However, they found that the reflective mode was rarely encountered in the network dialogue. They also found that reflective postings tended to be longest of any type of posting though the researchers did not investigate the reasons behind this phenomenon. In another recent study, Schlagel, Trathen and Blanton (1996) examined the on-line conversations between sixteen pre-service teachers and five professors in a pre-service teacher education course. They found that if reflective dialogue was to occur the participants needed open, thematic prompts, focused messages from one another, and time to reflect. However, when these conditions were met they found that most students engaged in an iterative reflective process of fine-tuning their thinking about their teaching practice. In an ongoing project, Barab and colleagues (in press) have developed a Web-based professional development system called the Inquiry Learning Forum (ILF) designed to support science and math teachers in observing other teachers’ classroom through on-line video vignettes of their classroom. Around the video vignettes is an on-line discussion system through which teachers can discuss and reflect upon pedagogical theory and practices shown in the video vignettes. However, research to date in the form of interviews with three ILF teachers has shown little evidence that teachers are unwilling to engage in reflective and critical discussion of each other’s classroom practices. Specifically, the sole pre-service teacher who was doing her student teaching practicum at the time of the interview believed the idea of having student teaching reflections posted on an ILF discussion board a good idea, but mainly viewed the exercise of posting a part of her instructor’s course assignment and did not engage in a prolonged reflective dialogue with her peers about her teaching practice.

**Interpretative Commentary: Issue #2**

Many educators are touting that electronic networks can indeed foster the development of reflective practitioners. Their belief is based in the premise that by engaging in discussions with their peers teachers can make their implicit beliefs about teaching explicit and public and through this process develop a better understanding of their teaching practices. However, the research findings are mixed regarding the power of electronic networks to support reflection. This is not surprising, when one considers the number of variables that need to be taken into account such as the context in which the teacher is teaching, the personality of the teacher (are they reflective by nature?), the time during the school day when the teacher uses the network, and how much time
they have to dedicate to the time-consuming process of articulating their teaching beliefs. The reviewed studies did bring up critical issues, but, with the exception of the DiMauro and Gal study, to date most studies are of short duration typically only lasting about a single 15 week term. In addition, there needs to be a more rigorous discussion concerning what constitutes reflection in an on-line environment. DiMauro and Gal begins to address this issue, by defining reflective dialogue, but the other studies do not describe how they determined which statements in the on-line dialogue were reflective. Considerable research is needed to understand how telecommunication tools can be used in pre-service classrooms to support pre-service teachers in becoming reflective practitioners rather than simply using the system to meet course deadlines, and how pre-service teachers’ needs differ from in-service teachers’ needs when communicating through electronic networks. Lastly, there is a great need for design research that examines how networking technologies can be designed that not only supports, but also promotes teachers in reflecting on their practice. That is, will teachers reflect in an open forum where their thoughts are visible to all members of the network or do they need a private workspace where they can share their reflections with a smaller group, as DiMauro and Gal (1994) suggest? These questions need close examination in the design of any on-line environment to support teachers in sharing their teaching practice.

**Issue # 3: Networking technologies influence teaching practice**

Eventually, the goal of professional development activities is its impact on actual teacher practice. With this goal in mind TERC’s (http://www.terc.edu) two-year Star Schools Project set out to examine if access to telecommunications tools could support teachers in changing their practice from teacher-centered to practices more aligned with current national standards (i.e. inquiry-based and learner centered). Specifically, Star Schools provided teacher support and training in technology and telecommunications software, along with curricula and on-line projects. In all, 932 teachers participated in a survey evaluation and reported that they had actively changed their teaching style from more traditional to more cooperative based and student-centered. However, the study did not report on any classroom observations of actual teachers or interviews with teachers, and did not describe the context in which the teachers were teaching. Understanding the context in which teachers are teaching is crucial to understanding if telecommunications tools can impact teachers’ practice as was found by Sunal and Sunal (1992).
Sunal and Sunal (1992) grouped fifty-eight pre-service teachers into control and experimental groups by placing them in schools with varying administrative schemes for incorporating local area networks. They found that in school sites where the administration supported (experimental) network use, the pre-service teachers communicated more often (5 more message per week) than those in non-supportive (control) schools. In addition, the pre-service teachers in the administrative supportive schools communicated more with their peers than with university faculty, and the discussions focused on seeking help and approval in lesson planning, selecting alternative classroom activities, and implementing those lessons within their specific teaching context. Generally, the authors concluded that participants in schools with administrative support developed a more favorable attitude toward use of technology in schools, communicated more frequently with their peers, and were more willing to try innovative practices in their classroom. The authors also examined the teachers’ lesson plans and found those of the experimental group tended to be more student-centered than those in the control (non-supportive) group. Therefore, the electronic network in Sunal and Sunal’s study served as a tool to support the evolution of teacher practices who were placed in schools with administrators who supported the use of electronic networks for teacher professional development.

In a new project, the Secondary Teacher Education Project (STEP) uses web-based video cases to demonstrate innovative teaching practices (i.e. inquiry-oriented teaching). In this project, pre- and in-service teachers are expected to discuss and argue about possible solutions and search the STEP database for relevant information to support their point of view on what the teacher in each case is trying to do and what they would do in that particular teaching situation (Siegel, et al., 2000). Preliminary results suggest that through this discussion the pre-service teachers were encouraged to consider how they would teach in their own classroom and the system supported making teachers’ implicit beliefs about teaching more explicit and hence facilitated teacher reflection on their epistemological beliefs about teaching. In a similar vein, Bliss & Mazur (1996) examined the interactions between six experienced history teachers and six student teachers as they used computer videoconferencing to discuss history teaching in actual classrooms. Through interviewing and analysis of the dialogues they found that participants valued talking with someone not connected with their immediate school situation and that the in-service teachers liked having the opportunities to actually discuss instructional strategies concerning how to teach history in the context of real classrooms. The mentors also
found the mentoring experience beneficial because it provided them the opportunity to think more deeply about their practice and how they could improve their teaching. Similarly, Barab, et al. (in press) reported that teachers believed that participation in the ILF was helpful to them in thinking about their practice, but that participation in the ILF had yet to have any impact on how they actually teach.

Interpretative Commentary: Issue #3

How professional development impacts teachers’ practice is crucial in evaluating the effectiveness of a TPD program. However, to date, very little rigorous research has been conducted concerning how electronic networks impact actual classroom practice. To date, with the exception of TERC’s Star Schools most electronic TPD programs have relied on self-reports from teachers concerning how the TPD impacted their practice or brief interviews asking teachers to reflect on the value of the network in which they were participating. While, teachers may indeed be gaining useful knowledge from electronic networks it is crucial to conduct more site-based research concerning how teachers have changed their practice because there are numerous accounts of teachers believing that they are student-centered when in fact their actual practice is still teacher-centered (Simmons, et al., 1999). There is also a critical need for longitudinal studies that examine how teachers’ beliefs, reflective activities, and practice evolve over time as they use electronic networks through their student teaching and into their first two to three years of in-service teaching. Further, research is needed that examines teacher practice from multiple perspectives. First, researchers need to conduct pre-interviews and pre-classroom observations of teachers to develop a grounded account of teacher beliefs and practices prior to participation in an electronic network. Then over time the researchers need to observe the teachers’ on-line dialogue, conduct follow-up field observations and interviews with the teachers to determine how teacher believe participation in the network has impacted their practice and how their practice has actually changed or if the network simply amplified their existing practices (Miller & Olson, 1994). It is only through these longitudinal, in depth studies that we will develop an understanding of how electronic networks can support teacher change and educational reforms.
Electronic Networking Technologies for TPD

**Issue #4: Networking technologies support the formation of communities of practice**

The concept of community of practice [see Wenger (1998) for a more complete discussion of Community of Practice] has become a major theme of teacher professional development during the last decade (Lieberman, 1995). This emphasis on building communities of practice has recently begun to be explored using on-line environments, which many educators believe can lead to virtual communities for TPD (Guzdial & Weingarten, 1996). For example, Levin & Waugh (1998) claimed that a community building process emerged when students in a pre-service classroom could communicate with their off-campus colleagues because the network provided the opportunity for participants to discuss their situations and develop a joint understanding of each other’s teaching context. They found that the off-campus students, who were usually teaching in a K-12 classroom, could request help from their own campus colleagues and discuss how the strategies employed in the classroom worked and then reflect on the process. Over time, the researcher postulated that a sense of collegiality, history, and trust pervaded the system, which are the beginning foundations for community development (Barab & Duffy, 2000).

In an on-going multi-year project TAPPED IN (an on-line WWW professional development site for teachers) researchers have been examining the role that technology has in transforming and sustaining a TPD on-line site grounded in the community of practice concept (Schlager, Fusco, & Schank, in press). Much of TAPPED IN’s work has focused on how to design an on-line TPD site, and through this work they have made several interesting observations and findings. First, they have concluded that for an on-line community to develop their first must be a “critical mass” of users actively participating (Schlager & Schank, 1997). In addition, by observing the interactions of TAPPED IN’s members over time they have concluded that, in order for a community of practitioners to appear, the member teachers must be engaged in thoughtful, reflective discussions surrounding actual teaching experiences (Schlager, Fusco, & Schank, in press) or as Schlager calls it “a community of purpose”. However, Schlager and Schank (1997), upon detailed analysis of the evolution of on-line messages, concluded that it takes considerable amounts time for teachers to become familiar and comfortable conducting discussions within the TAPPED IN environment. Hence, the formation of a community of teachers is not something occurs over the course of a single year and may take a number of years as teachers slowly develop familiarity and trust with the TAPPED IN system. In another
Electronic Networking Technologies for TPD

innovative on-line project, LabNet focuses on building a community of practice through engaging science teachers in discussions about innovative approaches (project-based) to teaching science. Research on LabNet participants, presented in the form of case studies, shows that member teachers were in a better position to keep up to date on school changes, were more willing to experiment with innovative teaching practices, and even encouraged their non-participating peers to try innovative teaching methods (Ruopp, Gal, Drayton, & Pfister, 1993).

The Inquiry Learning Forum (ILF) project was designed around the metaphor of allowing teachers opportunities to visit one another’s classrooms through the viewing of on-line video clips, critique one another’s teaching, and participate in a supportive community of practice. Based on findings from their formative research, Barab and colleagues found that teachers wanted a place to share resources (such as curricula and lesson ideas) and learn from the successes and failures of their colleagues’ implementation of various curriculum materials. Barab and colleagues (Barab, et al., in press) found that teachers’ desires for professional development were located strongly within their local teaching contexts such as their subject matter expertise, student demographics, local demands, and school culture and that the development of a community of practice extremely challenging and to date has not occurred. Through these results the ILF has been redesigned with the goal of enhancing the sociability of the ILF site through facilitation of sustained participation and by providing teachers a sense of ownership over their professional development rather than supporting occasional visits to the ILF to simply gather information.

**Interpretative Commentary: Issue #4**

The use of electronic networks for building a community of practice to support teachers is truly in its infancy and to date the research has primarily focused on how to design an on-line environment that supports the building of a community of practice. These studies have focused on determining what structures of on-line environments teachers find useful and how to improve them to meet teachers’ needs. This research goal is quite valuable; however, there is a real need for research that examines how to employ on-line technologies to achieve the goals of recent TPD reforms and to cultivate communities of practice.

There are also a number of questions regarding what a community looks like on-line. That is, do the characteristics of an off-line community transfer to an on-line setting or do on-line
Electronic Networking Technologies for TPD

communities have distinct and unique characteristics? Schlager et al. (1997) suggested that for TAPPED IN to be a community of teachers the number of participants must reach a “critical mass”. However, the concept of critical mass was not defined and Schlager et al., (1997) did not believe that TAPPED IN had not reached a critical mass of participants. In addition, much of a teachers’ development occurs in the context of their own classroom and everyday activities, so there is a real need to examine how on-line environments can support teachers in meeting their individual needs yet still be useful in assisting teachers to meet the requirements of state and national reforms. Further, if a viable and vibrant on-line community of teachers is to form, is it necessary for the on-line participants to have an established a sense of trust first through off-line face-to-face meetings or can trust between participants develop in the absence of off-line face-to-face meetings. In addition, are differences in the type of interactions between on-line participants that have a pre-established relationship than those who do not already have a pre-established relationship. There are also technological issues that have not been examined in great detail to date. In working with TAPPED IN teachers, Schlager Fusco, and Schank (in press) have come to the conclusion that traditional web sites and traditional discussion boards are not sufficient to achieve the desired objectives of on-going professional discourse so crucial to teacher development. Therefore, researchers and designers must consider how new and emerging network technologies might be used to support on-going TPD, particularly how to foster reflective discourse. There is a need for a comparative analysis of the factors that contribute to the success or failure of on-line teacher communities, particularly concerning how they support the evolution of teaching practice so that guidelines concerning how to design on-line environments can be developed. Lastly, there is a critical need for longitudinal research that examines teacher’s interactions through an on-line network over time. For example Levin and Waugh study was conducted over the course of a single semester, which makes the claim that a community of practice was truly formed questionable since community formation is a long and tumultuous process (Palinscar, Magnusson, Marano, Ford, & Brown, 1998; Thomas, Wineburg, Grossman, Myhre, & Woolworth, 1998). Similarly, Barab and colleagues (in press) data consisted of only three interviews rather than long term observation, and analysis of their beliefs toward their feeling of being part of a community of teachers.
CONCLUSIONS: WHAT WE HAVE LEARNED

To date, research on TPD programs supported by electronic networks has shown great potential for supporting teachers’ professional growth. In fact, these studies have lead to a number of issues that professional development designers should attend to when choosing to use electronic networks as a central feature of their professional development program. This section presents what has been gleaned from the research on the use of electronic networking technologies for TPD.

Trust: Teachers generally lack opportunities to share their thinking and to construct new knowledge about their teaching practice through discussion with teachers outside of their school (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Across studies the necessity of face-to-face meetings was crucial in developing a sense of trust between participating members. This could be due to the prevalent culture of teacher isolation in schools (Kagan, 1992) because teachers are not accustomed to making their reflections about their practice public with their peers and as such are frequently at a loss on how to engage in meaningful discussions with one another concerning their practice. However, when teachers had face-to-face meetings (i.e. class for pre-service teachers and workshops for in-service teachers) with each other to discuss their concerns before using the electronic network the discussion on the network was much more likely to push teachers in thinking about current reforms and how to improve their practice. For example, According to Watts & Castle (1992) through their work with the School Reform network found face-to-face meetings between participating members served as the central means through which their electronic network could then be used to support further community building. Hence, it appears that if an electronic network is to be successful in supporting teacher professional development there first needs to be an off-line component where teachers meet and discuss their situations, hopes, and fears. It is only through this off-line component that sufficient trust will be developed between participants which will allow for the growth of a vibrant on-line professional development program.

In general, through the use of electronic networks teachers in different geographical regions can share their experiences, reflect on how new teaching standards are impacting their practice, and reflect-in and reflect-on their practice. However, the professional development process of teachers participating in electronic network based TPD programs was slow and complex process as the teachers gradually came to trust the network and began to see the value
of reflective discourse and how such discourse would not only improve their students’ learning, but how it would also improve their teaching. That is, teachers must trust that their time spent in the electronic network will directly impact their student learning and improve their students’ scores on standardized tests. Hence, in the design of an electronic network for TPD designers must be aware that discussion and in depth reflection concerning teaching practice will not occur instantaneously. Rather, it is a long, slow, and complex process which requires time for teachers to become comfortable with sharing their thoughts and ideas over a network that has a memory of all interactions. That is, every interaction (i.e. discussion post) leaves a permanent historical trace and most teachers are used to and comfortable with transient interactions (discussions in the teachers lounge and phone calls) that do not leave a record of their beliefs and opinions. Building trust in the system should be the first and foremost concern of TPD designers who plan on using electronic networks in the professional development programs.

**Skilled Facilitators and Moderators.** Whether participating in an electronic network, a pre-service course, or a face-to-face session, the skill of the moderator or facilitator can “make or break the professional learning experience (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Simply viewing and discussing lesson plans, teacher videos, and other resources is not necessarily supportive of transforming teachers’ practice. Although, searching electronic network for information has the practical value of locating classroom tools and ideas for lessons or taking part in discussions in chat rooms can beneficial, however for electronic networks to be effective TPD tools a skilled facilitator or moderator is needed to guide and encourage discussion. That is, it is often the skill and expertise of the moderator in fostering provocative and thoughtful discussions that leads to deeper and more reflective learning on the part of teachers (Levin ref, 1998; Grossman ref, 1998). Conversational facilitation is particularly important in electronic networks that are grounded upon the exchange of dialogue among its participants because the network’s strength rests in the regular, reflective contributions of each participant (Guzdial & Turns, 2001). If there is not timely feedback or encouragement conversation will stagnate and participating teachers will grow frustrated because they will likely perceive that that their work and opinions are not valued by their peers.

**Pre-Service and Novice Teachers.** Electronic networks appear most helpful for beginning teachers. Through electronic networks novice teachers can access a wide range of distributed expertise ranging from more experienced teachers to university faculty (Levin, ref here).
Further, through on-line discussions pre-service teachers can develop a better understanding of the complexity of real classrooms (Schlagel et al., 1996). This can be of particular help in those institutions whose pre-service teachers are not afforded significant amounts of teaching time before they begin their student teaching practicum. In addition, through using electronic networks beginning and novice teachers can learn more about technology and how it can be used to support their students’ learning. For instance, in the One Sky Many Voices Project (Songer, 1996) students use e-mail and an on-line WWW forum to share and discuss their scientific procedures, findings, and argue over the meaning of their collected data. However, if teachers are not comfortable with using electronic networks themselves then it is reasonable to assume that their studies will not be afforded the opportunity to participate in innovative programs that use electronic networks as their central of means of communication.

Perhaps the greatest strength of electronic networks for beginning and novice teachers is that participants in the network make their reflections on their teaching public (DiMauro & Gal, 1994). That is, most new teachers are just trying to survive their first few years (Kagan, 1992) of teaching. However, through the use of electronic networks novice teachers can view more experienced teachers’ reflections on their classroom practice (i.e. behavior management techniques, inquiry vs. didactic based teaching). Through viewing and discussing with experienced teachers novice teachers can make their reflection-on-action public and begin the process of becoming a deliberate practitioner (Dunn & Shriner, 1999). That is, electronic networks rather than simply supporting discussion about current practice the teachers engaged dialogues over such a network should be encouraged and supported in becoming a researcher inquiring in their particular teaching style within their particular context. This discussion can then lead to teachers’ reflecting-in-action which can support practitioners in coping with the troublesome situations that arise out of their practice (Schon, 1983).

**Experienced Teachers:** Electronic networks, unlike other TPD programs, do require a specific time commitment. For instance, if a teacher is to attend a workshop during the school year they first must make sure they can get the day off, then find a substitute, and then by the time they have time to implement what they have learned in the workshop more immediate concerns have subsumed what the teacher learned at the workshop and the teacher’s practice remains much the way it was before the workshop. However, since electronic networks leverage the communicative power of the internet teachers can log on to a network anytime and anywhere
they have an internet connection as their individual needs and time constraints allow. That is, electronic networks have capability of allowing teachers to share their teacher experiences and get feedback immediately so they can make modifications to their lesson as well as their teaching practice. This type of interaction is particularly crucial for teachers, particularly experiences who have been teaching in the same way for years, who are attempting to change their practices to better match current national reforms (Lehman, 1992; Schlager et al., 1997), because many teachers are unsure of their ability to teach in ways that meet current reforms. Hence teachers need reassurance that their teaching is reform oriented and that they are doing no harm to their students. Electronic networks are well-suited to provide this much needed reassurance, because without reassurance many teachers abandon attempts at reform-based teaching and revert back to their previous ways of teaching (Simmons, et al., 1999).

Equity: Despite the advantages that electronic networks have in supporting teachers communicating with each other, it is important to note that technology enhanced professional development can have important and sometimes unanticipated side effects. For example, in many on-line discussion systems all users have equal voice, therefore, their opinion and ideas take on an authority that may have little evidence to support them. An interesting and unanticipated outcome of this leveling of the playing field is the lack of quality control. That is, people with more time to communicate can appear to know more and be perceived as an expert whereas those with more experience and expertise but less time can be marginalized depriving the network of a valuable resource. In addition, to these social problems there is the technology itself. Lack of appropriate hardware, software, or technology (i.e. high speed internet connection) can impeded teachers’ access to the medium. For example, the ILF uses streaming QuickTime video for their video clips, but there are a number of teachers who have reported that they are unable to view the videos at their school due to bandwidth issues or they could not install the QuickTime plug-in on their local computer. Even though most teachers highly valued being able to view other teacher’s classroom, some teachers were unable to view the videos because their school’s technological infrastructure was ill-equipped to handle the bandwidth required for viewing of the on-line videos.
Electronic Networking Technologies for TPD

IMPLICATIONS

Electronic networks have evolved from simply a focus on the exchange of information to engaging teachers in curriculum development, reflection on their teaching practices, and their professional growth. This shift in the goals of electronic networks has occurred in part because of current national reforms and from research on teacher change. From research on teacher change, it is clear that a one-time workshop, class, or seminar is unlikely to result in significant, long-term change in teachers’ practice (Richardson, in press). Further, even the most exemplary TPD efforts have difficulties in maintaining support for teachers over time (Carey & Frechtling, 1997). Teacher change requires multiple opportunities to learn, to practice, and to interact with other teachers inquiring into their own practice which is a central component of current national reforms (Stokes, 2001). Current research has shown that electronic networks have the potential to dramatically impact the way teacher education and TPD programs are conducted. Traditional TPD is based upon a hierarchical model of the expert. That is, teachers go to workshops, institutes, or seminars in which “experts” transmit pedagogically sound teaching skills to the teachers (Loucks-Horsley, et al., 1998). Historically, this model has disenfranchised teachers from their own development and lead to considerable criticism of existing professional development programs from teachers, researchers, and administrators (Guskey & Huberman, 1995). However, with the advent of electronic networks teachers can begin to be active participants in their own development and discuss teaching strategies with their peers as well as university based teacher educators and researchers. This is a radical shift from current TPD models, but a necessary one in this current age of reform. That is, if current reforms are to take hold it is necessary for the voice of teachers to be on equal footing with researchers and professional development designers because if teachers’ voices are muted the current reforms are most likely to be unsuccessful (Keys & Bryan, 2001). Hence, we as a teacher education community need to develop ways that teachers’ voices remain a strong and vibrant part of the reform movement and electronic networks have significant potential to bring teachers’ voices to the forefront. Yet, there are some fundamental questions remaining concerning the use of electronic networks for TPD. Namely, how, if, and in what ways does participation in an electronic network impact teacher practice? What are the design principles that underlie an electronic network system that allow teachers’ voice to emerge? Are teachers who participate in an electronic network more likely to take-up reform-oriented practices? What factors underlie the
Electronic Networking Technologies for TPD

effective use of electronic networking technologies to foster and sustain on-going TPD? It is through investigation of these questions that we as a research community can not only support teachers’ professional growth, but also become more cognizant of teachers’ voices.
REFERENCES


Electronic Networking Technologies for TPD


Electronic Networking Technologies for TPD


Electronic Networking Technologies for TPD


<table>
<thead>
<tr>
<th>Authors</th>
<th>Purpose of Study</th>
<th>Methods</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Bliss &amp; Mazur (1996)</td>
<td>Examined the potential of combining teaching cases with telecommunications tools (computer video cases)</td>
<td>Interviews, analysis of on-line transcripts</td>
<td>Teachers engaged in rich dialogue around actual classroom issues rather than CD-ROM based cases.</td>
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<td>Gunn (1995)</td>
<td>Use of electronic mail to support communication between pre-service teachers and faculty</td>
<td>Mostly anecdotal evidence and reading of postings.</td>
<td>Little reflection on the teaching process was identified. More messages revolved around need for resources and support questions.</td>
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<td>Jinks &amp; Lord (1990)</td>
<td>Do networks support teacher communication?</td>
<td>Anecdotal evidence, examination of teacher work</td>
<td>Evidence suggested that telecommunications systems could well emerge into a powerful system of informational and moral support</td>
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<td>Kimmel, Kerr, &amp; O'Shea (1998)</td>
<td>Does computer conferencing support increased communication and sharing?</td>
<td>review of the conference transcripts</td>
<td>Increased in sharing of classroom materials and ideas and increased collaboration in developing activities for workshops.</td>
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<td>Levin &amp; Waugh (1998)</td>
<td>How teleapprenticeships can foster collaboration, communication and how the network is used.</td>
<td>Case comparison, analysis of on-line dialogues</td>
<td>Beginning teachers could more accurately and completely answer their students’ questions after participating in a electronic community.</td>
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<td>McDonald &amp; Songer (1996)</td>
<td>Do teachers when working on a collaborative curriculum project reflect on their teaching?</td>
<td>Analysis of on-line dialogues</td>
<td>Preliminary data suggests teachers reflect on their teaching.</td>
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<td>Merseth (1991)</td>
<td>What is the nature and type of support beginning teachers receive over an electronic network?</td>
<td>Surveys, post interviews, and frequency of computer use data</td>
<td>Interactive computer networking was valuable in providing moral support for beginning teachers.</td>
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<td>Powers &amp; Dutt-Doner (1997)</td>
<td>Does access to a list serv promote communication between pre-service teachers?</td>
<td>Frequency analysis of postings</td>
<td>Students used the electronic network for peer support, sharing information, and reflecting on their field experience.</td>
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<tr>
<td>Roddy (1999)</td>
<td>Does an e-mail list help maintain contact between student teachers and the university</td>
<td>Analysis of e-mail exchanges</td>
<td>The mailing list can serve as a useful tool to support student teachers in feeling less isolated and help build their understanding of teaching.</td>
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<tr>
<td>Schlagal, Trathen, &amp; Blanton (1996)</td>
<td>How telecommunications can support conversations about student teaching experiences</td>
<td>Examination of on-line conversations</td>
<td>If reflective dialogue was to occur the participants needed open, thematic prompts and focused messages, and time to reflect.</td>
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<tr>
<td>Schlager &amp; Schank (1997)</td>
<td>What are design issues to develop an on-line TPD environment that supports the formation a community of practice?</td>
<td>Surveys of TAPPED IN members</td>
<td>Preliminary study reported that teachers wanted access to resources such as useful websites.</td>
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<tr>
<td>Schlager, Fusco, Schank (in press)</td>
<td>Would TAPPED IN members conduct their activities using the system.</td>
<td>Analyzed on line dialogue, comments from teachers</td>
<td>Teachers wanted activities that were situated in their everyday experiences. Teachers would develop their own activities.</td>
</tr>
<tr>
<td>Shotsberger (1997)</td>
<td>Examined how teachers used an on-line WWW professional development site</td>
<td>Analysis of on-line dialogue</td>
<td>Preliminary findings suggested that teachers use the network for sharing and access to information.</td>
</tr>
<tr>
<td>Siegel, Derry, Kim, Steinkuehler, Street, Canty, Fassnacht, Hewson, Hmelo, Spiro (2000)</td>
<td>How to most effectively support learning within complex web sites that contain large amounts of information but still tied to teaching cases.</td>
<td>Analysis of student work</td>
<td>Preliminary results show that teachers are thoughtful and reflective regarding what the teacher in the vignette should do, but also brings the classroom to the pre-service teacher and encourages them to consider how they might actually conduct their own classroom</td>
</tr>
<tr>
<td>Star Schools (TERC) Lehman,</td>
<td>Measure teachers changes in practice</td>
<td>Surveys</td>
<td>78% of teachers reported experimenting with new methods of instruction in their class.</td>
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<td>Campbell, Hall, &amp; Lehman (1992)</td>
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Table 1: Summary of Studies Reviewed (cont)

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<tr>
<th>Authors</th>
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<tr>
<td>Sunal &amp; Sunal (1992)</td>
<td>How does access to local area network resources impact pre-service teachers lesson planning</td>
<td>Analysis of on-line dialogue and analysis of teacher constructed lesson plans</td>
<td>Pre-service teachers in the administrative supportive schools communicated more with their peers than university faculty and the discussions focused on how seeking help and approval in lesson planning, in selection alternative classroom activities and how to implement them within their specific context.</td>
</tr>
<tr>
<td>Thomas, Clift, Sugimoto (1996)</td>
<td>How university-based instructors and novice teachers integrate electronic mail in their educational coursework.</td>
<td>Interviews and examination of e-mail messages</td>
<td>Students posted responses to strictly meet course requirements, and the instructors’ message had the highest priority with their peers having relatively low priority. The exchanges that were considered reflective by the researchers typically occurred between the faculty instructors and was not shared with their peers.</td>
</tr>
<tr>
<td>Waugh &amp; Rath (1995)</td>
<td>How preservice teachers use computer networks and telecommunications</td>
<td>Pre-post survey</td>
<td>Students believed network tools would be helpful in their development as a teacher and serve as a support mechanism</td>
</tr>
<tr>
<td>Waugh (1996)</td>
<td>Examine the type of group interactions and student questioning patterns in an on-line environment</td>
<td>Analysis of on-line dialogue</td>
<td>Students posted questions predominately concerned with technical aspects and network strategies than with pedagogical and personal support questions</td>
</tr>
<tr>
<td>Weiss (1997)</td>
<td>Does telementoring encourage discourse about teaching</td>
<td>Analysis of student reflections</td>
<td>Preliminary findings suggested that students did not feel comfortable with electronic mentors, but believed having mentors was a good idea.</td>
</tr>
<tr>
<td>Williams &amp; Merideth (1996)</td>
<td>Investigated student’s online communication patterns</td>
<td>Frequency analysis of postings</td>
<td>Most postings were classified as chatting, but the discourse gradually shifted toward technology and content. Very little reflection on teaching strategies was reported.</td>
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