Professional Development in a Digital Age: Issues and Challenges for Standards−Based Reform

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Acknowledgments

Abstract

This paper discusses possible roles for online technologies in professional development begins by describing characteristics of professional development approaches that enable teachers to engage in standards−based teaching. Electronic technologies offer two leverage points that bridge time and place constraints imposed by onsite professional development: (1) ubiquitous access to resources that support student and teacher learning; (2) expanded opportunities for teachers' learning communities through electronic conferencing systems, whose common features, designs, and uses are described. Finally, challenges and potential solutions for making effective use of electronic technologies for professional development are described.

Keywords: Online Learning, Teacher Learning, Professional Development

Introduction

New standards for subject matter teaching and learning are changing expectations about school learning experiences and simultaneously raising expectations for the outcomes of schooling. These shifts in expectations are consistent with those arising from current cognitive and social theories of how people learn. To fulfill these new expectations, teachers need to rethink their own understanding of subject matter learning, instructional strategies, and assessment. As well, they need to reconceptualize their role in the classroom. Access to several different kinds of resources can facilitate teachers engagement in the standards–based reform process. These resources include:

- Visions and models of what the standards imply about teaching and learning in specific content areas;
- Materials and experiences to acquire in–depth subject matter understanding;
- Curriculum, instructional strategies, and assessment tools for implementing standards–based teaching and learning;
- Opportunities for feedback and reflection on implementation efforts [See for discussion Cognition and Technology Group (CTGV), 1999; and Shulman & Shulman, 1999]

Although access to such resources can facilitate change it does not insure progress towards standards–based reform. Indeed, standards–based reform of teaching and learning is a process that occurs over time in iterative cycles of thinking, doing, reflecting, and revising. What is needed are new models of the professional development process that are consistent with new standards for student learning. Professional development that merely delivers resources–even high quality resources–will fall short of providing the support teachers need to engage in the standards–based reform process.

New professional development models that are effective for standards–based reform agree on the importance of several process characteristics. The professional development process

- Is relevant to teachers' day–to–day classroom practices.
- Is sustained––Involves teachers in coherent sustained efforts to explore, question, debate, and integrate new ideas into their classrooms (Fullan, 1991).
- Is content–focused––Engages teachers in experiences that build their own content knowledge and understanding of what content is important for students to learn and why.
- Is community–focused––Engages teachers in reflection with their peers.
- Is collaborative––Builds on and values the diverse expertise and perspectives that teachers bring to professional development.

There are several "proof of concept" demonstrations of the effectiveness of professional development models with these characteristics. A major challenge is extending such models to much larger numbers of teachers engaged in the standards–based reform process. To meet this challenge many professional development providers are looking to the power and capabilities of electronic technologies. But, just as access to resources is not likely to produce the desired changes, access to technology will not by itself provide standards–based reform (CTGV, 1996; Tinker, 1996). Technology can just as easily support the status quo. The question is, How can the capabilities of electronic technologies work synergistically with professional development staff to create and implement effective models of standards–based reform? This paper provides a starting point for addressing this question and makes suggestions for development and research foci that will be important for realizing the potential of electronic technologies.

Overview of the Organization of the Paper

The first section of the paper sets a context for examining the role of online professional development in standards–based reform by considering what the standards have to say about student learning, the kind of teaching that supports such learning, and the characteristics of professional development approaches that enable teachers to engage in standards–based teaching. These professional development approaches are challenging to implement, especially on a large scale.

In the second section of the paper, roles are described for electronic technologies in contributing to the implementation of the desired professional development approaches. Two leverage points are presented, both of which bridge time and place constraints imposed by onsite professional development: (1) Technology can provide ubiquitous access to a variety of resources for support of student and teacher learning. (2) Technology expands teachers' opportunities for learning and increases the range of communities in which they might learn. Electronic conferencing systems create the infrastructure for these expanded learning configurations. We outline their common features, designs, and ways in which they have been used for professional development.

Capitalizing on technology's two leverage points is not without it's challenges. These are discussed in the third section of the paper. What emerges from the discussion is a clear need for a "person" infrastructure to complement the technology infrastructure that electronic conference systems provide. "Persons" are needed for moderating and facilitating online interactions as well as face–to–face interactions with teacher groups and with individual teachers in their classrooms. The challenges and issues provide a context for considering development and research directions needed to inform the use of electronic technologies in supporting professional development for standards–based reform.

Standards–Based Learning, Teaching and Professional Development

National, state, and local standards–based reform efforts designed to improve the quality of educational outcomes for all students converge on the importance of learning with understanding. Learning with understanding means that students organize information and ideas in meaningful patterns or conceptual frameworks, rather than remembering disconnected, isolated facts. Meaningfully organized information makes it more likely that people will remember what they have learned and use it appropriately in situations that are different from the original learning situation. The emphasis on learning with understanding reflects a shift from a singular focus on mastering a static body of factual content to content learning that supports flexible, adaptive thinking and problem solving. It develops through the active construction of knowledge rather than passive reception of transmitted facts. There has been a good deal of research focusing on the kinds of learning materials, tasks, and strategies that are important to knowledge construction [For further information on contemporary theories of cognition and instruction, see: Bransford, Franks, Vye, & Sherwood, 1989; Bransford, Brown, & Cocking, 1999; Brown, Collins, & Duguid, 1989; Bruer, 1993; CTGV 1990, 1994, 1996, 1997; Donovan, Bransford, & Pellegrino, 1999; Goldman, Petrosino, & CTGV, 1999; Greeno, Collins, & Resnick, 1996; Pea, 1993, 1994; Perkins, 1999; Resnick & Klopfer, 1989; Salomon, 1993; Schauble & Glaser, 1996] These are different in significant ways from traditional curricula and teaching practices (Borko & Putnam, 1996). Accordingly, teachers need models of standards–based teaching and learning.

Standards–based teaching places demands on teachers beyond the demands of teaching for mastery of a static body of facts. For standards–based teaching, teachers need in–depth understanding of content knowledge, instructional strategies, assessment tools, and their interrelationships. The interrelationships mean that teachers are continuously examining what students understand, why they understand it, and what might help them continue to develop understanding (Cooney & Shealy, 1997; Zech, Gause–Vega, Bray,

Secules, & Goldman, 2000).

Professional development that supports teachers in a standards–based reform process requires a departure from traditional delivery models of professional development. Standards–based reform is a process of teaching with understanding. As such, several process characteristics are important. The first, relevance, relates to motivation and commitment: professional development experiences need to be grounded in teachers' day–to–day practice. Teachers' perceptions of the utility of professional development increase if they can see how it relates to the challenges they face on a daily basis (Borko & Putnam, 1996; Cochran–Smith & Lytle, 1999; Corcoran, Shields, & Zucker, 1998; Corcoran, 1995; Loucks–Horsley, Stiles, & Hewson, 1996). Furthermore, grounding professional development in classroom practice has the added advantage of reducing the difficulty of transfer because teachers are learning in the same context in which they are expected to use what they learn.

Other important process characteristics of standards–based professional development include:

- involving teachers in coherent sustained efforts to explore, question, debate, and integrate new ideas into their classrooms;
- providing opportunities for teachers to build their own knowledge of the content they teach and an understanding of what is important for their students to learn and why;
- engaging teachers in reflection with a community of their peers in order to gain a deep understanding of the relationships among what is taught, how it is taught, and how learning is assessed (Cochran–Smith & Lytle, 1999; Lieberman, 1996; Little, 1993; McLaughlin, 1993; Talbert & McLaughlin, 1993);
- building on the expertise that teachers bring to professional development collaborations and valuing the diverse perspectives.

There are many challenges associated with creating models of teacher professional development that incorporate those characteristics, especially when considerations of scale and cost are taken into account (Corcoran, Shields, & Zucker, 1998). Creating these kinds of learning environments requires a variety of resources, especially ways to build content and pedagogical content knowledge. These resources include access to the latest theoretical and empirical work on learning, curriculum, instruction, and assessment; as well as access to curriculum materials and tools, programs, and instructional and teaching models. It also takes time and opportunities for sustained professional development, preferably in contexts that actively engage teachers in learning experiences and discussions about them (Darling–Hammond, 1997; Darling–Hammond & Ball, 1997; Lieberman, 1996; McLaughlin, 1993; Riel, 1998; Talbert & McLaughlin, 1993).

There are examples of professional development models that successfully meet many of these challenges (Anders & Richardson, 1994; Featherstone, Smith, Beasley, Corbin, & Shank, 1995; Franke, Fennema, & Carpenter, 1997; Rosebery & Warren, 1998a; Zech, et al., 2000). They usually require substantial commitments of professional development staff who are knowledgeable about content and standards–based pedagogy. Professional development staff commitments are often manageable for small numbers of teachers in proximal location to the staff. But they become prohibitive as the numbers and geographic diversity of teachers increases because of the time intensive nature of these activities and the lack of people with the expertise to serve in these roles. In addition, the time teachers have to devote to professional development is limited and it is often difficult for teachers to attend meetings and workshops during the school year. Competing demands on after school and weekend time make scheduling face–to–face meetings extremely difficult. During the summer, teachers have more time to attend workshops but there is still a need for ongoing support during the school year.

At the same time, many forms of electronic technologies can overcome time and place constraints and provide the means to reach large numbers of individuals, potentially at costs lower than those associated with the physical presence of professional development personnel. Thus, in an effort to develop widely available, instructionally sound and cost–effective professional development models, professional

development providers are increasingly turning their attention to ways in which various electronic technologies can contribute. Some of the important issues involve identifying where face–to–face professional development activities and various electronic technologies can be integrated, where electronic technologies can substitute for face–to–face interactions, and where they cannot, at least given imaginable technologies. The claim is not that the use of electronic technologies insures lower cost or less time; rather, electronic technologies might make more effective use of available time and expertise.

Roles for Electronic Technologies in Teacher Professional Development

Electronic technologies can make powerful contributions to standards–based professional development efforts [The primary technologies discussed in this paper involve the use of the Internet as the backbone. Distance learning over satellite or cable are not considered; nor are telecommunications such as video conferencing] Indeed, the opportunities for professional development online are expanding so quickly that it is difficult to keep up with them. For example, the January 2000 issue of Technology & Learning listed about 40 different opportunities for online professional development. These opportunities included degree and certificate programs, online courses and workshops, and ad hoc learning communities organized around classroom projects (Mather, 2000). These varied opportunities reflect two leverage points for technology: (1) As an information provider, it can provide ubiquitous access to a variety of resources for student and teacher learning. (2) As an infrastructure for communication, it expands teachers' opportunities for learning and increases the range of communities and learning configurations in which they might learn. It is certainly the case that face–to–face professional development can provide access to resources, and diverse learning opportunities. Internet and WorldWideWeb (Web) technology, however, have made these resources accessible at any time and from any place, substantially altering the constraints set by physical space and time.

Access to Resources for Student and Teacher Learning

Technology provides access to the four kinds of resources that facilitate teachers engagements in the standards–based reform process: visions and models of standards–based instruction, materials for use in the classroom with and by students, subject–matter content, and opportunities for feedback. Some resources are targeted toward supporting teachers' learning; others are primarily for use with students. Nonetheless, teachers also learn in the context of using resources with students in the classroom.

Resources for Supporting Teacher Learning

Some resources can provide teachers with visions and models of standards–based teaching and learning. For example, Web–based case libraries that include classroom video, and commentary on that video by the classroom teacher and/or other educators, can provide teachers with models of the enactment of specific standards or groups of standards (Lampert & Ball, 1998). By watching and analyzing these cases, teachers can begin to see ways in which new standards can be realized in the classroom. They also can get a sense of the kind of student learning that occurs, especially if samples of student work are part of the case library. Furthermore, cases may include the instructional materials and assessments that were used in the video segment. Discussions anchored around the cases can provide opportunities for teachers to question a number of aspects of their practice, e.g., their assumptions about content understanding and the relationship between student work and instructional practices (Shulman, 1992). One virtue of these "prepared" cases is that they can be chosen to illustrate specific aspects of standards–based teaching and learning. In this way, individual and pairs of cases can target aspects of classroom process that are difficult but important for

teachers to notice and understand.

Resources for learning content knowledge and about electronic technologies are often available over the Web in the form of online courses. As discussed below, online courses take a number of forms, with some including some face–to–face interactions and others being conducted entirely over the Web. As well, a number of Websites provide access to content experts who will answer questions submitted to them. It seems likely that the usefulness of course work and discussions with experts will be greater to the degree that it is directly relevant to issues that teachers are facing in the classroom.

Content learning may also be embedded in the feedback and reflection process. It is critical that teachers get feedback on their efforts to engage in standards–based instruction. If they do not, there is the risk of little impact on student learning. Without feedback, teachers may think they are "doing it" when in fact there has been little change in their practice. Teachers also need a means of reflecting on the feedback and revising their thinking and implementations. Without reflection and revision, teachers may "try it" once and focus only on what went wrong and never do it again.

A growing body of research on the use of video to document classroom practices suggests that videotaping and discussing teaching practices over an extended period of time is an effective form of teacher professional development (Pea, 1999). Another effective resource is student work samples, especially in conjunction with videos of the classroom instruction. Discussions of both classroom interactions and student work involve grappling with content and content pedagogy. This provides opportunities for teachers to deepen their own content understanding.

Current electronic technologies provide the means for sharing descriptions of classroom practices, digitized student work samples, and digitized audio. Technological capabilities for sharing digitized video are rapidly becoming more accessible. Through the use of digital video cameras that can directly connect to a computer and be transmitted over the Web, teachers will soon be able to share digitized video of their classrooms much more easily. These developments will facilitate feedback, reflection, and revision processes.

Resources for Student Learning

Currently, the Web provides access to numerous materials for use in the classroom with and by students. These materials include pedagogical tools (e.g., simulations, visualizations, and spreadsheets), project–based units (e.g., curriculum guides, lesson plans, and assessments), and the information needed to implement particular projects in the classroom (e.g., specific content resources such as videos, text and text references, and related Websites). Instructional strategies for using materials in the classroom can be illustrated and described through text–, audio–, and video–based information, including examples of student work. When teachers engage with these tools as learners themselves, especially as part of a group of similarly engaged teachers, the experiences can contribute to deepening content knowledge and exploring ways to assess and promote student learning. For example, they might learn how tools such as spreadsheets can help students think in terms of principles and variables. Teachers can then use these tools and other types of materials in their classrooms.

Materials for project–based activities in the classroom are amply represented on the Web. These are typically semi–structured projects with motivating questions posted on the Web. Project websites typically provide teachers with lesson plans or outlines, links to other websites or other locator information for related resources (e.g., text, video, CD ROM). When teachers engage their students in projects that use such tools and resources, both teachers and students experience different models of teaching, learning and content knowledge, at least potentially. For example, the use of tools such as simulations and modeling software can help students represent the same information in different formats. Students (and teachers) have the opportunity to see how different representations highlight different aspects of the same principle

or concept. This often leads to new ways to think about the concepts themselves.

Some projects are designed for students and teachers to share information with other students and teachers who are also participating in the same project. As well, by sharing their information with others working on the same project, they can see how others approached the project. One example of data sharing projects is The GLOBE Program (Global Learning and Observations to Benefit the Environment http://k12.cnidr.org/gsh/gshwelcome.html). GLOBE involves students in gathering data about the local environment and creating a global database open to the GLOBE community. At their local sites, students use instruments and observations to carry out investigations that have been designed by scientists. The students submit their data to the GLOBE student–data server so that all participating students and scientists can use a common and cumulative data set in analyses. Currently over 800 schools in more than 34 countries are participating, allowing for data collection around the globe. Projects are underway in several earth science areas (e.g., atmosphere, hydrology, land cover/biology, and soils). A letter and an interview introduce each investigation from the scientist who conducted the investigation. The letters describe the purpose and place of the investigation in the global and scientific world.

Other projects not only involve students sharing information but also involve teachers working with other teachers. The Learning Circles project (http://www.iearn.org/circles) forms project–based partnerships that a small number of schools co–develop and work on together. The initial incentive for many teachers is the focus on learning in their classrooms. Project ideas are contributed by teachers, developed, and facilitated by teachers, with assistance of project staff. As teachers work with other participating teachers to develop the project concept and exchange information with them about what is going on in their classrooms, they tend to become more involved in inquiring into their own practice (M. Riel, personal communication, 2000; Riel, 1992).

Projects like GLOBE and Learning Circles expose teachers and students to multiple perspectives on learning and understanding. This process has the potential to stimulate an examination of assumptions about teaching practice and understanding of specific content. Content resources are often provided to help teachers guide their students' learning and, in the course of working with their students and their colleagues, teachers frequently deepen their own understanding of the content. Table 1 contains a listing and brief descriptions of a number of other websites that provide project ideas and resources for teacher and student use.

Table 1. Selected Web sites that Provide Resources for Teacher and Student Learning, downloaded March 26, 2000.

Annenberg/CPB Exhibits (http://www.learner.org/exhibits/)

- Text resources, related web sites, and video resources
- Organized by exhibits (e.g., rise and fall of specific civilizations, amusement park physics, math in daily life, renaissance, personality, weather, garbage, literature, medical ethics, and volcanoes)

Public Broadcasting System (PBS) (http://www.pbs.org)

- Specific experiences, such as an exploration of Khufus pyramid (http://www.pbs.org/wgbh/nova/pyramid/explore/).
- PBS Teacher Source site connects to state standards and provides lessons indexed to these standards (http://www.pbs.org/teachersource/).
- PBS Mathline (http://www.pbs.org/teachersource/mathline/about/about.shtm) for professional development.

National Geographic (http://magma.nationalgeographic.com/education/index.cfm)

- Online adventures with audio narration.
- Search organized by subject matter area, grade level, and type of resource (e.g., lesson plans, online adventures, video resources, maps, software, books, etc.)

Math Forum (http://forum.swarthmore.edu/)

- Interactive learning possibilities
- Online discussions on a variety of mathematics topics
- Math content resources

A Resource for Managing Learning Resources

One of the dilemmas of the information age is the quantity of information that is accessible. Finding ways to keep track of information and evaluations of its utility are increasingly important. This need is felt at every level of the educational system from government departments of education to students in the classroom. Technology can provide support for systemic standards−based reform by providing knowledge

management tools. Knowledge management systems keep track not only of information but also of how that information has been used, who used it, when, and for what reasons. The resulting database serves as the "intellectual" history or group memory for the organization [Thanks to Mark Schlager for pointing this out] As such it can be used to acquaint new members of the organization with prior efforts, and can help eliminate redundancy and reinventing solutions because of staff turnover, distance, and other discontinuities in work.

In the educational context, knowledge management systems could provide districts and schools with ways to keep track of plans for content units, assessment tools, information resources that supported students' learning of the material, their projects and even some classroom videos. There are at least three ways in which such databases could serve valuable roles in teacher professional development, in the broader educational community, and in systemic reform efforts. First, teachers would have a way to reflect on their own learning and that of their students by reviewing the data "historically." Second, databases such as these could inform professional development providers of the experiences and backgrounds of specific groups of educators (e.g., the history of a staff's professional development experiences). Finally, school systems and individual sites could examine their own histories and use them for assessing the outcomes of past school improvement efforts. Indeed, Pepperdine University is using a knowledge management system for documentation of their online teacher education programs. They view it as extremely useful for program coherence and continuity (L. Polin, personal communication, 2000).

Infrastructure for Expanded Learning Opportunities: Conferencing Systems

Electronic technology can, of course, support the learning of individuals working by themselves. However, technologies for electronic conferencing provide the infrastructure for a much wider range of learning configurations and communities. Conferencing environments allow for information exchange among two or more participants computing at a distance (Tinker, 1992; Woolley, 1996). Conferencing systems support many of the processes of effective professional development by providing a vehicle for collaborative communities to communicate and to engage in sustained reflection. The focus of reflection can be any artifact that the participants wish to discuss (e.g., student work, a classroom lesson, an assignment in an online course, revisions to standards, or instructional materials). Participants in a conference could range from the teacher in the room next door to staff development or content experts located half–way around the world. These capabilities broaden the configurations of expert resources accessible to teachers.

Conferencing Systems: Basic Information on Common Features and Designs

Conferencing systems for information exchange must be located on a physical computer, called a server. The server hosts the system software and is the "permanent" home of the information that is exchanged. Some host systems are centralized with all information located on a single server. To access these systems, the user "logs on" to the host server, which may be located in the same room or building or may be located remotely. Examples of these systems include conferencing systems such as Lotus Notes. Other forms of conferencing systems are distributed but linked through communications protocols that permit servers to exchange information. Users send messages from their own servers to other servers. The name of the "sending" server is included in the user's address; the name of the "receiving" server in the addressee's. Email is an example of a distributed server system, with the servers located in the email addresses of each user. Similarly, the WorldWideWeb is a gateway to many different servers. Each website or page is physically located on a computer somewhere. The website address (the URL, short for Uniform Resource Locator) specifies the server.

Increasingly, conferencing systems are addressable through the Web, making access easier. If a conferencing system is not addressable over the web, the user needs to connect locally, either through a

modem connection or through a local network. As security (firewall) systems are developed for the Web, more and more conference systems are moving to Web–addressable formats. Whether a conferencing system is resident on the Web or on a local network, users typically must log in with a user name and password that are registered with the system.

All conferencing systems require a systems administrator who is responsible for maintaining the operation of the server and responding to technical issues that arise. One of the key functions of the systems administrator is to "reboot" the system if it goes down. A barrier to use of conferencing systems, especially for new users, is not being able to connect. One reason for this is if the system "goes down" frequently. Another reason is if users attempting to connect during the same time period overload the server. If this happens too regularly, it indicates need for a server with larger capacity. Both of these issues are the purview of the systems administrator. As well, the systems administrator typically is responsible for assigning or verifying user names and passwords.
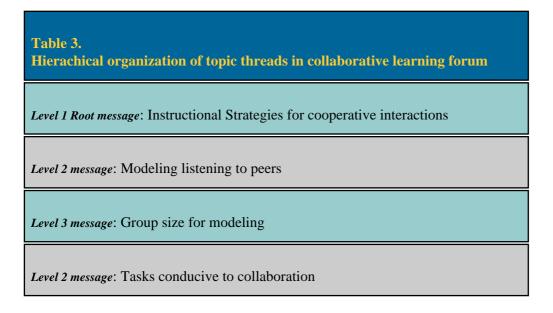
Designs of Conferencing Systems

Conferencing systems differ along several design dimensions and functionalities. One basic distinction is whether the system is designed for asynchronous or synchronous communication. Asynchronous environments are ones in which participants can go on–line "any time, any place" and have access to all the messages or other information posted previously. The basic unit of discourse in asynchronous systems is the message. Synchronous on–line environments are ones in which participants are present at the same time in the electronic environment. The "conversation" is much like a face–to–face conversation in that individuals respond in real time to each other's comments. In synchronous systems, the basic unit is an utterance or speech burst, although the most common forms of synchronous environments use text messages. In the near future, the technology will make it possible to post digital audio and video messages that can be accessed and shared in both asynchronous and synchronous environments. For conceptual and expository purposes, asynchronous and synchronous systems are described separately, however, conferencing systems are designed increasingly to support both forms of online communication.

Asynchronous conferencing systems are of several types. Table 2 summarizes these. The simplest and most familiar form is a "point–to–point" system such as email. A user sends a message to another user, or multiple users, as specified in the address line. By using mailing lists, email allows for primitive conferencing: all users who subscribe to the mailing list (are members of the list) will receive any message sent to the list. Typically, messages are organized chronologically, but can be resorted in most email software on the basis of the topic as specified in the subject line, or the sender. In addition, some email software permits the individual user to create organizational strategies using separate folders for messages on different topics. Depending on the design of the system, messages sent via email will reside on the sender's and receiver's servers until they delete them. In some cases, systems administrators will delete email from the host server. Some email systems automatically remove mail from the host system when users download and read their mail.

Table 2. Types of Conference Systems	
Asynchronous	E–mail Bulletin Board Threaded Discussion Forum
Synchronous	Chat Rooms Multi–user virtual environment spaces GroupWare

More popular forms of asynchronous conferencing systems provide a centralized location for the information. An early form of centralized system was the Bulletin Board, appearing in the 1970's. Users posted messages to the board and these were listed chronologically. A reply to a message would also be listed chronologically, making it difficult to connect messages and replies together. Recent updates of Boards provide some capacity to categorize and group messages. Spinnaker, WebLines, and Worldgroup are examples.

Currently, more typical forms of centralized conferencing systems organize messages as parts of ongoing conversations, specifying different topics in the conversation as "threads" in the discussion. Users enter messages under the appropriate topic and other users reply to these messages or enter new ones. Threads are embedded in Forums or Conferences that define the larger focus of the conversation. For example, in a Forum on Collaborative Learning, specific threads might deal with instructional strategies for encouraging cooperative interactions, tasks conducive to collaboration, dealing with reluctant group members, and the like. The structure of the threads is provided by hierarchically organizing the messages, usually indicated by indenting. The "root" or starting message is at level 1, a message responding to it at level 2. A message at level 3 would be one that directly responds to a level 2 message, as shown in Table 3.

Table 3. Hierachical organization of topic threads in collaborative learning forum
Level 1 Root message: Instructional Strategies for cooperative interactions
Level 2 message: Modeling listening to peers
Level 3 message: Group size for modeling
Level 2 message: Tasks conducive to collaboration

Participants in the discussion access messages in centralized asynchronous forums by selecting the message. Frequently, other messages "above and below" the accessed one are readable by scrolling in the message window. Examples of commonly used asynchronous conferencing systems are Allaire Forums, O'Reilly's Webboard, and Hypernews. Further information and demonstrations of these systems are

available at the home page for Oreilly's Webboard: http://webboard.oreilly.com/, the Allaire Forums HomePage and Tutorial: http://www.aln.org/alntalk/allaire_forums.htm, and the HyperNews Home Page: http://www.hypernews.org/. The HyperNews Home Page provides access to a number of ongoing discussions as well as online help for how to use the system.

The operation of centralized forums requires that a systems administrator create the Forum or Board, specifying those users who have moderator or manager privileges. Moderators or managers can set up new threads (Allaire Forums, HyperNews) or conferences (Webboard) and enter the names of users who have access to the thread or conference. There are also mechanisms for making conferences "private." For example, Webboard allows the administrator to restrict access to the Board, and the manager to restrict access to specific conferences. Many Boards and Forums have options that permit file attachment, hotlinks to web locations by embedding URLs in the message, email notification when new messages are posted, email response options for posting replies, capabilities for customizing the layout (look and feel) of the conference page, and online help. Email notification and response options are particularly helpful to participants who regularly check email but do not necessarily log onto their web–based conference systems. Performance of webbased asynchronous conferencing systems is best when ethernet or cable modem connections are in place. As with access to the Web in general, accessing conferencing systems via modem, even high speed modems, can be frustratingly slow and subject to unanticipated disconnects. Messages are best composed off–line in any word processing system and then transferred into (pasted into) the message box provided by the conferencing system.

Synchronous conferencing systems are those in which users must be simultaneously present to engage in conversation, currently text–based (See Table 2). A basic form of synchronous conferencing system is the chat room, a virtual space in which multiple users can be present at the same time. Users log on and converse with whomever is also logged on. Chat rooms have been popular for various special interest and social groups. Multi–user virtual environment spaces (MUVEs) are another type of synchronous conferencing system. In these systems, objects and locations can be specified as permanent features of the particular MUVE. As well, and unlike Chat rooms, users have persistent identities, meaning that users know to whom they are talking. Furthermore, in MUVEs messages, documents, or other artifacts can be left in locations for subsequent asynchronous access.

GroupWare is designed to support collaborative teams and supports team members sharing documents, online discussions, data files, scheduling issues, etc. GroupWare creates a virtual place occupied by team members and the documents and artifacts to which the team needs access. Often members are "present" at the same time but like MUVEs, artifacts can be left behind for subsequent asynchronous reference. GroupWare packages have typically been designed for businesses and are highly customizable (e.g., Oracle InterOffice and Lotus Domino). At one time, GroupWare operated exclusively on local area networks for confidentiality reasons. However, GroupWare systems are becoming increasingly available via the Web. Recently, FirstClass (http://www.softarc.com/) released a version of its GroupWare targeted specifically at the K–12 education environment. Called FirstClass Collaborative Classroom Gold (FCCC Gold), it creates an intranet that integrates communication tools with learning and scheduling tools.

While neither chat rooms nor GroupWare systems were designed with the needs of teacher professional development in mind, there have been some efforts to use GroupWare environments as a basis for systems oriented toward teacher professional development. In contrast, the synchronous conferencing system, TAPPED IN (http://www.tappedin.org/) was designed specifically with professional development needs in mind (Schlager & Schank, 1997; Schlager, Fusco, & Schank, 1998).

TAPPED IN uses a conference center metaphor to create a virtual space accessible over the Web in which teachers can engage in synchronous, text–based conversations. TAPPED IN allows users to leave messages and other artifacts in various conference center locations for subsequent reference. Thus, while the system is designed for simultaneous participation by multiple teachers, information can be accessed at later points in time. A file of the actual online conversation can also be created, saved, and later accessed. The ability to locate artifacts in places within the conference center means that a variety of resources can be made

available as objects of discussion by the participants. The compatibility of the TAPPED IN environment with characteristics of effective professional development is evident from some of the design principles that guide its structure and functionalities (Schlager, et al., 1998). In particular, teacher "professional development is (viewed as) a life long process that occurs in the context of daily practice" (pg. 7). Accordingly, the online environment "supports the same ebb and flow of communication and information sharing that face–to–face work teams engage in over time" (pg. 4).

TAPPED IN was designed to provide conversational spaces in which teachers could exchange information informally. Over time, it has been used in conjunction with formally organized online courses. For example, After School OnLine is a series of teacher–hosted discussions among small, focused interest groups.

Uses of Conferencing Systems in Teacher Professional Development

Conferencing systems are used in conjunction with various forms of professional development ranging from highly formalized and structured experiences to those that are more loosely organized and informal. On the more formal end of the continuum are structured "netcourses," in which participants officially register for a course, usually pay tuition, and are expected to participate "for credit." [Other labels for these kinds of experiences are telecourses (Vogeli, 1995, as cited in Tinker & Haavind, 1997), online classrooms (Berge & Collins, 1995, as cited in Tinker & Haavind, 1997), and online education (Harasim, 1990). Netseminars are netcourses that include online discussion groups, the rule rather than the exception at this point in time (Tinker & Haavind, 1997)]. Frequently, netseminars are courses offered by institutions of higher education for work on advanced degrees or to fulfill various district or state requirements for continuing education. Netseminars permit "any time, any place" participation by teachers. Course activities take place through the digital medium with face–to–face interactions optional. Course materials to read, listen to, or view might be sent out in advance or posted on the Web site for the course (Riel & Harasim, 1994; Tinker, 1992).

Until approximately the mid–1990s, the typical netcourse was structured by faculty and delivered over digital networks. "In class" discussion tended to occur via the more primitive forms of conferencing systems, including email, mailing lists, and bulletin boards. Because the communications were typed text, participants were also able to review discussions (Goldman, 1996). The schedule flexibility of many of these netcourses also had a downside: participants procrastinated on the assignments and in making contributions to the discussions. Much of the communication perpetuated a two–way faculty–student pattern rather than students interacting with each other. A typical attrition rate was one–third (Tinker & Haavind, 1997).

More recently, netseminars are being offered by a wider range of professional development providers, are available over the Web, and are frequently supported by federal funds. Increasingly, state, regional, and local districts are exploring ways to move their face–to–face professional development efforts online (Mather, 2000). To provide course credit, providers partner with institutions of higher education if they are not themselves able to offer credit. Netseminars typically use scheduled asynchronous formats wherein there is a syllabus and structured set of "requirements" that participants are to complete within specified time periods. Some are also providing for synchronous real–time discussions. Various forms of conferencing systems (e.g., Lotus Notes, First Class, HyperNews, TAPPED IN) serve as the platforms for discussions. Typically, the discussions are directly accessible by virtue of being linked to appropriate netseminar webpages.

Discussions occur in conferencing spaces that vary in their degree of informality. On the more informal end are chat rooms, bulletin boards, or threaded discussion forums where goals are often more social than learning oriented. Participation is largely internally or interpersonally motivated and there are no particular requirements for joining the conversation. Opportunities to participate in discussions are often available

through websites that provide various kinds of resources, including curriculum materials, lesson plans, reference materials, and information on standards. Teachers, or anyone who accesses the site, can post messages to the discussion areas. For example, National Geographic hosts teacher discussion forums on their education page (http://magma.nationalgeographic.com/education/index.cfm) [If this URL fails to access the site, use www.nationalgeographic.com. From there, use the site index to access education. The Teachers Forum is located on the education page]. Another site, Teachers.net (http://www.teachers.net) hosts a variety of chatboards in their Mentor Support Center. These boards create a peer support environment. The majority of these informal discussion forums are not moderated or facilitated. Thus, while these sites provide opportunities to interact with a community, it would be difficult to determine what the benefits are in terms of teachers' learning.

A less informal discussion venue is illustrated by the Math Forum, hosted by Swarthmore College (http://forum.swarthmore.edu/). It provides online discussions on a variety of specific mathematics topics. Teachers can also ask questions of other teachers who have been named as Presidential Awardees for Excellence in Mathematics Teaching. The conferencing system TAPPED IN, hosts a variety of scheduled, synchronous online conferences, the most informal of which are After school discussions. TAPPED IN can also be used to host more formally organized workshops and courses. For example, the Education Development Corporation (EDC) hosted a 6–week workshop for school and district leaders on the use of MUVEs in classrooms.

Facilitation of Learning

Whether asynchronous or synchronous, focused on classroom activities or content learning, and for all but the most informal discussions, the role of the discussion moderator, or facilitator, is critical to the quality of the discussion, the effectiveness of the communication, and the depth of learning. In online discussions, facilitators have four specific roles and responsibilities (see Berge, 1996; Collison, Elbaum, Haavind, & Tinker, 2000; Milken Family Foundation, 1997; Zorfass, Remz, & Ethier, 1998). These are summarized in Table 4.

Table 4. Roles for Facilitators of Online Conversations	
Motivational	Motivate participation, model norms for effective learning community
Conceptual	Guide meaning–making Provide feedback Stimulate questioning of assumptions
Encourage reflection on learning processes	Guide formulation of new learning questions Guide self–assessment
Provide procedural support	Manage tasks Navigate the environment

The first concerns the Social/Affective/Motivational aspects of the interactions. Facilitators need to create interactive learning environments that motivate participation, model norms for online interaction, and communicate the value of participants' contributions and multiple perspectives. For an effective learning community, teachers need to learn and articulate new ways to talk about content, student thinking, and their own knowledge of content and pedagogy (Franke, Carpenter, Levi, Fennema, 1998; Rosebery & Warren, 1998a,b; Wilson, Lubienski, & Mattson, 1996). Facilitators need to help shift the discourse from participants (and themselves) giving definitive answers, activities, and scripts for behaviors to questioning and discussing assumptions, possibilities, and conjectures (Ball & Cohen, in press; Zech, et al., 2000).

A second role is conceptual. The facilitator guides meaning–making and provides feedback on the thoughts, work samples, and interpretations teachers share in the discussions. This guidance and feedback process requires that facilitators engage in an ongoing assessment process: What are the participants understanding and what does this mean for pushing learning forward? This assessment process is necessary for facilitators to be able to deepen dialogue and focus learning. Facilitators need to provide feedback in ways that help teachers question their assumptions, re–examine their understandings, and confront conflicts in their thinking. This sometimes requires juxtaposing the views of members of the community in ways that make salient the differences in perspectives that might otherwise go unnoticed. Related to the conceptual role is that of encouraging reflection on learning processes, especially in the online environment. Finally, the facilitator often must provide procedural support in terms of helping participants manage tasks and navigate the environment.

Strategies for facilitating have recently been documented in an excellent forthcoming volume by a group from the Concord Consortium(Collison, Elbaum, Haavind, & Tinker, forthcoming in 2000). Collison and colleagues discuss strategies for building community, supporting a culture of respect, and cultivating reasoned discourse. For example, one strategy for building community is to create a "water cooler" discussion area that becomes a place for informal social exchanges of the sort that go on face–to–face around physical water coolers or coffee pots. They also suggest drawing in participants in ways that respect their contributions while simultaneously moving the thinking of the group forward. For example, a moderator might respond to a participant's first post that praised the use of manipulatives by writing, "Your comment really made me think about why we do use manipulatives in mathematics. I realized I had often used them just because they were part of the tool kit. Now I'm beginning to think about why they might be useful." Many other forms of questions and probes deepen thinking and help navigate around roadblocks to continued, productive dialogue. Questions or comments such as "Can you help me think more clearly about these issues?" or "That's an interesting point but I'm not totally convinced that it's the right way to go." can help keep participants from becoming defensive about ideas they have posted.

In short, facilitators function to support participants in developing norms for interacting online as a learning community, and becoming critical inquirers into their own, their peers, and their students' content understanding and learning processes. This enables the participants to examine their teaching and instructional processes with respect to whether they are achieving standards–based goals and make necessary adaptations based on these assessments.

Challenges Embedded in the Use of Technology for Professional Development

There are a number of challenges and issues that must be considered to realize the potential of electronic technologies for supporting standards–based reform. Creating the possibility for ubiquitous access to teaching and learning resources does not insure that they will be used. And if used, how they will be used. Similarly, the existence of different learning configurations does not mean that teachers will take advantage of them. Nor do they insure that participating in such discussions will lead to hoped for changes in teaching and learning. In this section, discussion focuses on these issues and challenges, first with respect to access to resources, including materials and feedback, and second, with respect to conferencing systems, including comfort with the technology as well as the demands of facilitating learning in these environments.

Access to resources: Challenges and Issues

The myriad of curricular and instructional resources available on the web makes it look as if it would be an easy task for teachers to locate resources that could facilitate their teaching in "standards–based" ways. Many websites not only provide project ideas but they provide lesson plans and often the information resources that students need to complete the project. In addition, a number of websites provide teachers' commentaries on how they thought about, developed, and directed the project with their students. There may even be video of teachers and students over the course of the project. The best of these projects provide teachers with a vision of standards–based teaching and learning and models of how teachers teach and students work in these settings.

Access to materials, however, is not sufficient for teachers to be able to create these instructional environments in their own classrooms. There are several reasons for this, all of which are related to the nature of human thinking. [Piaget (1952, 1970) recognized the tendency for individuals to assimilate or take in new information in ways consistent with their current ways of organizing and processing the world. Balancing against this tendency is that of accommodating to discrepancies among current views and new information. Adaptation and learning involve dynamically balancing these two tendencies. See also Bransford et al., 1999; Greeno et al., 1996; Goldman, Petrosino, & CTGV, 1999; Black & Atkin, 1997. First, when people are faced with new information, what they notice, remember, and learn is heavily determined by what they already know. They interpret new information through the lenses of their prior experiences. The more complex and multifaceted the information, the more variation there will be in what different individuals "take" from the exposure and how they interpret what they do take away. In other words, there is a strong tendency to take new information and make it consistent with the way we already see the world.

Second, research on domain expertise indicates that people who know a lot about a particular topic or domain as compared to those who know little in that domain differ in terms of what they notice in a new, domain–related situation (Bransford, et al., 1999; Chi, Glaser, & Farr, 1989; cf. Goldman, et al., 1999). For example, when shown a video of a classroom lesson, novice teachers notice different things than experienced teachers (Sabers, Cushing, & Berliner, 1991). Furthermore, when domain knowledge is organized in terms of important principles, as it is for domain experts, it is these principles that serve as the basis for the relationships seen among new events or experiences in that domain. When such principles are absent, people tend to use surface characteristics–the way things look–as the basis for relationships among new events. Understanding domain principles is important because of their explanatory power for a host of what otherwise appear to be unrelated events and situations (see e.g., Bransford & Schwartz, 1999).

A third important reason relates to why people make changes in what they do and how they do it. The adage "If it isn't broken, don't fix it" is appropriate. If teachers are content with student learning processes and outcomes in their classrooms, there is little reason for them to rethink their practices. They may look at new materials and models of other forms of teaching and even see contrasts with their own classrooms. Yet there may be little impact on their approach to their own students. Realizing that current practices are not achieving desired educational goals is an important motivation to change. Seeing alternative models of teaching and student thinking plus noticing contrasts with current teaching and student thinking may contribute to this realization.

These three facets of human thinking make it important to provide experiences that cause teachers to begin to question their assumptions about content knowledge, goals for student understanding of that content, and what supports students' in developing those understandings (Van den Akker 1998; Black & Atkin, 1996). Otherwise, there is a high risk that teachers will not use the materials in ways consistent with standards–based reform. Rather, they will adapt the materials to fit their current instructional strategies. Discussion and reflection with peers are important components of the change process. The process of questioning one's assumptions however, involves a certain degree of risk. To take such risks, participants

need to feel a sense of trust and safety. Establishing and maintaining a safe, trusting context for and among the participants is one important responsibility of the professional development facilitator. Anchoring discussions around instructional ("teaching") cases may stimulate the process of questioning assumptions. Furthermore, if by design, the instructional cases feature important contrasts in ways of approaching subject matter and student thinking, this can stimulate the process of teachers critically examining practice (Lampert & Ball, 1998; Davies & Zech, 1999).

However, the results from such experiences are typically dependent on feedback, which has long been recognized as a critical component of learning processes (e.g, Thorndike & Woodworth, 1901). The challenge of providing feedback on classroom practices and student work, and doing so in a manner that goes beyond telling teachers what to do, is one for which a number of face–to–face solutions have been proposed. These include modeling, cognitive coaching on site, and analysis of classroom teaching–both one's own and that of other teachers. Several professional development efforts have used face–to–face, one–on–one or small group discussions to engage in these analyses and the efforts have produced desired changes in teaching practices (Ball, 1996; Ball & Cohen, in press; Franke, Carpenter, Levi, Fennema, 1998; Anders & Richardson, 1994; Rosebery & Warren, 1998a,b; Wilson, Lubienski, & Mattson, 1996). Such efforts extend over lengthy periods of time and often times are not available to teachers on an "as–needed" basis.

Electronic technologies could provide a means of more readily available feedback and reflection on classroom implementations. To do so, teachers would need ways to "share" their classrooms and the work of their students online. As yet, it is technically difficult and expensive to digitize, compress, and transmit streaming video over the Web so it is presently difficult to envision feedback on classroom implementation occurring through this medium. However, the existence of portable downloading devices for audio (e.g., MP3 players) suggests that we may soon see similar devices that permit downloads of videos. Furthermore, increases in infrastructure capabilities will make video streaming (playing) over the Web more ubiquitous. This is made more doable by digital video cameras and more teacher–accessible means of digitizing video locally.

However, hybrid approaches that rely on a combination of face–to–face, local study groups with electronic discussions, and offline and online activities may be a more promising approach to professional development. A hybrid approach takes into account the need to overcome feelings of isolation that sometimes develop in courses that occur only online. The local study group also provides participants with colleagues who are intimately familiar with the local situation and can be present in each other's classrooms. This helps keep the basis for the inquiry and reflection process in teachers' day to day classroom activities. As technologies for digitizing and compressing video files become more easily available, affordable, and usable by teachers it may be possible to share the classroom more directly with online participants. In the meantime the human contact and proximity at the local level play an important role in the success of classroom–based inquiry activities.

Online Discussions: Challenges and Issues

There are several important considerations regarding conferencing systems for communication in online professional development. Participants in discussions must feel comfortable in the conferencing environment before they can engage in substantive learning. A second set of issues concerns facilitating effective learning conversations.

Learning the conferencing environment. This is an issue that is often overlooked in planning for the use of online discussions in professional development. Time needs to be allocated to learning the conferencing tool. Both teachers and professional development providers need to understand, and be proficient with, online technology as a prerequisite to engaging in productive dialogue online. Failure to take the time and effort to learn to employ the technology appropriately and cost–effectively can sabotage its use, leading to

abandonment of the technology. The result reinforces a negative perception of technology as a teaching and learning tool. For example, "adding on" online discussions to existing professional development approaches often does not yield any benefits and can produce the negative effect.

A related issue concerns the need to allocate time and resources to training staff and teachers to use the online technology effectively. This often involves redesigning courses or learning experiences. Other industries have learned that the adoption of new and better approaches and technologies is often "accompanied by an initial decrease in productivity, with benefits accruing only after the technology in question has been effectively assimilated, a process that often involves the introduction of significant structural changes within the adopting organization" (Presidential Committee of Advisors on Science and Technology, 1997). Time and effort need to be devoted to redesigning teacher professional development to take advantage of the capabilities and work within the constraints of online communication technologies.

Redesign involves considerations of the kinds of discussions that are best held face–to–face rather than online and whether different strategies are needed for facilitating teacher learning in online environments as compared to face–to–face situations. For example, it is important to allow time for participants in online discussions to get to know one another. While this may be of some importance in face–to–face professional development, it becomes a critical issue for online discussions where participants may be drawn from more diverse backgrounds. Providing explicit ways in which participants can get to know one another needs to be part of the design of the online professional development experience.

Facilitating Effective Learning Conversations. One of the important potential uses of informal asynchronous and synchronous discussions is to break the traditional isolation of teachers from their colleagues and from ongoing learning opportunities. Merely providing discussion spaces–electronic or otherwise–is insufficient to insure learning, especially when the goals of professional learning opportunities concern rethinking the nature of subject–matter learning and its assessment, as is required for standards–based instruction. The teacher preparation experiences of most teachers, and the school cultures in which they work, do not provide them with the ways of thinking and talking about learning needed to engage in classroom–based inquiry (for discussion see Cochran–Smith & Lytle, 1999; Darling–Hammond & Ball, 1997; Fullan, 1993, 1999; Wilson & Berne, 1999). Thus, just as teachers need to facilitate the knowledge building of their students, online professional development requires facilitation of teachers' learning [Similar kinds of facilitation are needed in face–to–face professional development discussions]

Facilitating teachers' learning includes the need for teachers to learn new ways to talk about content and student thinking and to articulate their knowledge of content and pedagogy in greater detail (Franke, Carpenter, Levi, Fennema, 1998; Rosebery & Warren, 1998a,b; Wilson, Lubienski, & Mattson, 1996; IC, 1992). To learn different ways of talking about learning content, discussions may build on teachers' experiences when learning the same content as their students, but at a level appropriate for them as adult learners. Another possibility is to focus on student thinking and ways to support student learning in the classroom (Carpenter, Fennema, & Franke, 1996; Featherstone, Smith, Beasley, Corbin, & Shank, 1995).

The kinds of knowledge needed for good facilitation, shown in Table 5, are similar to what classroom teachers need to know to create standards–based teaching and learning situations in their classrooms. The avenues by which facilitators can acquire this knowledge are by no means clear. This is a serious issue of capacity building for online professional development efforts. There is at least one online course that addresses the issue of pedagogical strategies (http://ccservices.concord.org/moom/) but there are scant opportunities to develop content and pedagogical content knowledge for purposes of mentoring adults. These issues are just as pertinent to face–to–face facilitation.

Table 5. Knowledge needed to conduct effective facilitation
Content or access to resources that provide it.
How to listen and monitor the conversation, assess what teachers' comments imply about their content and process understanding, and move the thinking forward.
Pedagogical strategies for establishing safe, trusting, motivating contexts in which discussion can occur.
Technology and how to troubleshoot problems participants have using it.

Related to the issue of content and pedagogical content knowledge is a tension that often arises in working with teachers, especially those who come to professional development with expectations framed by traditional instruction and inservice workshops. Standards–based reform requires standards–based professional development (see Zech, et al., 2000). The facilitator has the opportunity and responsibility to model teaching for understanding. Yet, many teachers expect to be told how to teach and how to use technology. They often do not expect to engage in an inquiry process, either in professional development or in their own classrooms. The difference between these expectations and the experiential, inquiry orientation of many online professional development activities creates a tension between the facilitators and the participants that may be difficult to overcome. Indeed, all participants may not ever be comfortable with the inquiry orientation and may drop out of the course. For facilitators, it is no easy task to decide what to say when, and how much information to provide. This is especially true when the discussions focus on content knowledge because it is tempting to short–circuit struggles to understand content. Knowing when to insert a question, reframe the issue, redirect the conversation toward more productive conjectures, or offer the "accepted" disciplinary view requires that facilitators have sensitivity, patience, faith in the group–learning process, and deep content knowledge. Furthermore, facilitators can model the inquiry process by sharing their own puzzlements and points of confusion with the group. This helps establish a collaborative learning community by softening the often held "infallible expert" view of facilitators and other professional development staff. Moving out of the "expert" role creates learning and leadership opportunities for other participants in the discussion (Cochran–Smith & Lytle, 1999; Gause–Vega, 1999; Zech, et al., 2000).

In addition, especially in structured course situations, facilitators need to balance the preset schedule with pursuing interesting directions that develop in the group discussions. Having to "move on" when participants want to continue with the same topic can be a source of frustration and tension so it is helpful to build in time to allow flexibility in topic coverage.

Another issue concerns sensitivity to participation patterns among participants. Facilitators need to monitor the involvement of all participants and develop ways to draw out those who are reluctant to enter the discussion. Often it is helpful to contact such participants privately via email. The tone the facilitator sets in responding to the contributions of those who are participating can encourage or discourage less frequent participants. In general, facilitators need to move the discussion into a critical inquiry mode where participants question each other's ideas at the same time as they invite and welcome all contributions. Effective ways to accomplish these goals are by no means obvious or straightforward to implement.

Finally, for sustained standards–based reform, facilitation needs to be taken over by the participants

themselves. When teachers can engage in inquiry together with little involvement of outside facilitators, life–long learning will become far more ubiquitous.

Online Professional Development: Directions for Development and Research

Several projects discussed in this paper indicate that it is possible to involve teachers and other educators in online courses, Web–based classroom projects, and discussions. There is also evidence from projects and websites such as the MathForum that teachers do access content resources and make use of available content "experts" to deepen their understanding of subject matter content. Other online forums (e.g., Math Learning Forum) illustrate the productive use of student work samples to stimulate discussions about mathematics understanding (Honey, et al., 1994). Furthermore, experiences in face–to–face professional development indicate that video cases of classroom teaching and student work samples are very powerful starting points for teacher discussions. The reflective analysis of both kinds of artifacts leads to examinations of assumptions about content knowledge, student understanding, assessment, and instructional strategies.

Nonetheless, based on extant experiences with online and face–to–face professional development activities, for teachers to truly engage in reflective analysis of content learning, two conditions need to be met: First, is the need for multiple perspectives. The existence of multiple perspectives on the same classroom artifact greatly enhances reflective analysis and leads teachers to reconsider their own perspectives. This reflection helps teachers make explicit their assumptions about students, learning processes, content, assessment, and their roles in the classroom. And, making assumptions explicit is a first step toward re–examining them, a process important to standards–based reform. Second are the norms and ways of engaging in critical discussions that facilitators create. Perhaps most critical to standards–based reform is in the role facilitators play in establishing dialogue patterns that enable teachers to critically analyze each other's artifacts, thereby conceptually deepening the dialogue and pushing learning forward. There is a tendency for teachers to regard all artifacts as equally valid or equally good. In other words, there is the danger of equating multiple perspectives with multiple "right" answers [The idea that any answer is okay is a misconception regarding constructivist views of learning] The facilitator must make sure that members of the group do not fall into this conceptual trap. There are important differences in student work and in classroom practices that teachers need to be able to confront and analyze with respect to differences in student understanding and how these differences relate to classroom practices, assessment of content learning, and standards for content learning (Gause–Vega, 1999; Zech, et al., 2000).

In sum, efforts to engage teachers in standards–based professional development in electronic learning environments indicate potential directions, constraints, and issues that must be considered in moving toward increased use of online learning opportunities. The final section of this paper discusses several of these, along with suggestions for development and research that would inform our understanding of these issues.

- Hybrid models of online and onsite professional development. Professional development needs to move beyond the delivery model to a dynamic, interactive model of teacher learning, whether onsite or online. People's natural tendency is to assimilate information into their existing frameworks. Without venues for reflective analysis, the availability of materials (videos, text, audio) will not substantially alter teachers' orientations toward curriculum content, instruction, assessment, or student understanding. In addition, teachers need opportunities to get feedback on their efforts to implement standards–based instruction in their classrooms. In the absence of feedback, especially initially, it is difficult to self–assess the results of one's efforts.
  Fruitful ways to approach this issue are to investigate hybrid models of online and onsite professional development. Several efforts are now underway to prepare videos of classroom "best practices." These videos might be used in small pilot projects that investigate different models for combining online and onsite professional development experiences. Such projects might engage in codesign of these models with existing providers of professional devleopment, including those within school districts as well as those outside (e.g., university, nonprofit, and forprofit providers).

Working with these groups would increase the fit of the models to the "local" circumstances of the teachers. Some projects might use local study teams to investigate different configurations of online and onsite interactions.

This might include a comparison of the quality and impact of feedback on classroom lessons viewed via video versus onsite. As well, there might be a focus on tracking the development of content understanding among teachers. One concern often voiced by those not familiar with online discussions is that "wrong" content information will get promulgated throughout the community. Data on this issue are scant but those that exist indicate that discussion by the community tends to steer preconceptions, misconceptions, and "wrong" information in the direction of more appropriate conceptions of the content. Also important is that participants in the conversation come to understand why these are more appropriate conceptions.

- Relevance and sustainability. Professional development needs to be relevant to day–to–day classroom realities of teachers and must be sustained over time. Given the realities of modern life–there is never enough time for everything–teachers need to be motivated to make professional development a priority so that they will make the time to pursue it. When teachers perceive professional development experiences as useful, it is more likely that they will make time for it. But, even when it is perceived as useful, it is important to avoid layering it on top of other work that is already part of teachers' jobs. Just because online is available "anytime" does not mean teachers will have any time to devote to it.

Investigations are needed that address the issue of bringing professional development into the classroom context so it becomes a regular part of what teachers do as their "job." With the exception of "planning" periods, the work day of teachers is largely occupied with student contact. Even "planning" periods are often taken up with things other than instructional planning, (e.g., parent contact through phone calls and conferences). Teachers are left with little time during their work day to collaborate with their peers, interact individually with students, and most especially reflect on their practice. Policy makers at national, state, and district levels, as well as those responsible for implementing policy, need to begin to consider plans for comprehensively examining multiple aspects of the educational system so that curriculum, instruction, assessment and professional development work in concert with one another rather than being separate compartmentalized aspects of teachers' work. Such efforts might develop underlying principles for restructuring the school day that would be helpful to many schools and districts facing the "time" dilemma.

- Capacity building. A key issue for professional development is building the core of people who have the necessary knowledge and skills, or who can acquire them relatively efficiently. One key to successful professional development for standards–based reform is staff developers who can facilitate the process of teacher learning. The knowledge base for facilitation is multifaceted, whether in online or onsite contexts. Facilitators need to have content knowledge that is at least sufficient to recognize when content expertise beyond the facilitator's needs to be brought into discussions. They also need to be effective listeners who can assess the learning process of the group and of individuals. They need pedagogical strategies specific to content so they can deepen understanding, as well as strategies that establish supportive and productive learning environments. Specific to online facilitation is knowledge of the technology and how to troubleshoot problems participants have. Furthermore, facilitators need to be able to cultivate leadership in members of the discussion group. This is an important step in building capacity among teachers to engage in reflective conversations that enhance their growth as professionals.

Multiple approaches to capacity building need to be investigated. One approach is for those responsible for leadership development to themselves engage in online conferencing on some topic or issue. This would provide them with an initial starting point for understanding what's involved in developing facilitator skills. The learning about the use of online conferencing systems would come from including an explicit reflection process whereby participants share their insights about use of such systems and begin to develop their own experiential knowledge base. This could serve as a basis for then beginning to collaborate with other stakeholders and interested parties (e.g., schools of education, local unions, etc.). Ultimately it would be important to develop "career paths" for teachers that reflect their expertise in facilitating learning conversations among their peers.

- Content knowledge resources related to standards. Standards–based reform requires in–depth understanding of content knowledge. This is necessary so that teachers can assess what students understand and what produces this understanding so they can figure out how to move students toward more developed content understanding. One way of enhancing teachers' content knowledge is through specific content–centered online courses. Enrolling in such courses may be possible for some teachers but for many it will add a layer of work to an already full schedule. Therefore, it would be useful to explore ways to enhance content understanding through mechanisms that are directly related to the classroom. Teachers would be learning content because of its direct relevance to their classroom situation.

  One approach to enhancing content knowledge might be modeled after the Japanese approach to model lesson development Stigler & Hiebert, 1999). Teacher–produced materials could be the focus of local study teams. Materials might be designed to satisfy a standard, or group of standards, in specific areas that have high relevance and salience to teachers. Such teams would make the pursuit of content understanding something done for a reason. The process of creating the product would involve teachers having content questions and seeking out content expertise to answer them. The products could be shared with others via the Web and would benefit the larger professional community.

In summary, the potential is great for electronic technologies to productively contribute to professional development in support of standards–based reform. Organizations concerned with the professional development of teachers need to begin to utilize their resources to understand the possibilities, constraints, and human needs associated with efforts to engage in online professional development. Such efforts will be invaluable in informing directions for enhancing teachers' lifelong learning opportunities.

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