

TAPPED IN: A New On-line Teacher Community Concept for the Next Generation of Internet Technology

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Abstract

K-12 education reform research suggests that new models of teacher professional development (TPD) are needed to establish and support communities of teachers engaged in school reform. We are working with several TPD organizations to develop a new on-line TPD community concept called TAPPED IN. Together, we are forging what we believe will be a self-sustaining TPD community in an on-line environment that enables us to employ existing Internet technology to study modes of collaboration embodied by next-generation commercial Internet technologies. In this paper, we present the theoretical foundations of our concept, the rationale behind the design of the TAPPED IN virtual environment, and our community-building approach.

Keywords—Internet learning community, teacher professional development, MUD/MUVE, WWW

1. Introduction

Informed by a growing body of research, education reform leaders are acknowledging the central role that teacher professional development (TPD) must play in systemic reform efforts. However, in practice, even exemplary TPD efforts (Ruskus & Luczak, 1995) find it difficult to maintain support for teachers after an institute or workshop (Carey & Frechtling, 1997), to encourage sustained discourse among participating teachers, and to scale up (Corcoran, 1995). Back at school, teachers have little time to develop and test new ideas, assess the effects, and adjust their strategies and approaches (Cook & Fine, 1996).

TPD research (Loucks-Horsley, Stiles, & Hewson, 1996; Lieberman & McLaughlin, 1995; Little, 1993) suggests that new models are needed to provide teachers with greater opportunity to access and discuss exemplary reform-based materials, co-construct and publish resources that reflect new teaching practices, and jointly create locally relevant solutions. Teaching professionals must be able to form their own community to change teaching practices and sustain school reform efforts (Corcoran, 1995; Lieberman, 1996).

Some education technology advocates (Guzdial & Weingarten, 1996) suggest that *virtual* communities for TPD and socialization could help teachers learn new skills and adopt new approaches that will facilitate their

transition to reform-based practices. Unfortunately, research has offered practitioners little help in understanding and implementing sustainable virtual TPD communities. Efforts by state and local school reform projects to establish on-line venues for teachers too often result in a disappointing mismatch between technological capabilities that are expedient to implement and the requirements of collaborative TPD activities.

The goal of the Teacher Professional Development Institute (TAPPED IN) project is to help the education practitioner community understand the affordances of emerging Internet technologies and rethink their current TPD approaches to include innovative on-line community services and activities. To achieve these goals, we have been working with staff and teachers from several nationally recognized K-12 TPD organizations to develop a new concept of virtual TPD community.

The TAPPED IN concept is based on a vision of a shared virtual *place* (Fitzpatrick, Mansfield, & Kaplan, 1996; Harrison & Dourish, 1996) where teachers with diverse interests, skills, and backgrounds can (a) meet and learn from one another at any time, (b) be exposed to a variety of education reform concepts and approaches, and (c) find high-quality resources and contribute those that they find useful. By sharing a single environment, organizations enable teachers to gain access to expertise, ideas, and resources that no single organization could provide by itself. The teachers, in turn, can participate in and take ownership of a familiar and supportive place with their professional colleagues. SRI's multiple role as environment architect, community organizer, and support provider enables us to embed our research within a rich mosaic of authentic, ongoing teacher professional development efforts with the full participation of the practitioner community.

In this paper, we describe how we are weaving theoretical considerations and practical design constraints into an approach to realizing our goal of a self-sustaining on-line TPD community. We describe the TAPPED IN multi-user virtual environment that we are developing to support the community and some of the ways that teachers use it. We emphasize that the environment and community are young and evolving—not unlike a reef community, where the coral heads are just growing large enough to support a variety of

polyps, crustaceans, and fish enclaves. Although we see many encouraging signs, it is too early to provide data to support many of our conjectures and design choices.

2. Teachers as a Community of Practice

Many K-12 research and TPD projects help teachers incorporate the Internet into their *teaching* in innovative ways, but most do little to help teachers incorporate the Internet into their own *learning*. Notable exceptions are projects such as the Math Learning Forums (www.edc.org/CCT/ccthome/projects/mathle.html), which offers TPD courses via electronic bulletin boards, and Math Forum (forum.swarthmore.edu), which combines a rich set of Web resources with email communication.

Our research reaches beyond these models by conceptualizing TPD as a situated learning process. Our TAPPED IN concept combines formal and informal learning opportunities within an environment that supports rich collaborative discourse, surrounded by a diverse *community of practice* (Lave & Wenger, 1991) engaged in the work of education reform. Extending Levin's Teaching Teleapprenticeship concept (Levin & Waugh, 1997) to in-service teachers, we view real-time collaboration and social interaction as central characteristics of professional development that serve as mechanisms for facilitating learning of new teaching strategies and adapting to new practices.

This perspective leads to design considerations that are fundamentally different from those embodied by many current teaching-support technologies. For example, with the exception of the occasional satellite video link-up, chat, or CUSeeMe session, few on-line teacher support projects have begun to employ real-time collaboration through the Internet; most rely on listservs and/or *teachers' lounge* Websites (Harvey & Purnell, 1995) to implement *community*. The result too often looks something like the following sequence excerpted from an actual listserv discussion on teacher professional development. Bill is responding to Mary, and Terry (all pseudonyms) posts a related question.

6/19 Mary, I think....the Bay Area Writing Project model is one of the best examples. First, it is explicitly structured for learning about the design of quality professional development for others--not about the discipline per se or leadership out of schooling context... Bill

6/19 I just tried to find the Bay Area Writing Project on the [group's] database of teacher enhancement projects, on their www page. But it isn't there. How frustrating. The project sounds very interesting. How can I learn about your project in detail, Bill? Do you have a useful www page, for example? Terry

7/3 Terry, Sorry that nothing about the Writing Project is on the [group's] server....Nevertheless, there is tons of stuff on the Writing Project Model--given

its 25 year history and reputation, it has been well documented and scrutinized. A place to start might be ERIC.... I don't have a web address off hand, but I am sure if you list Bay Area Writing Project or the National Writing Project with any search engine, lots will come up.... Bill

Although Terry might have used a search engine right away to find links to the Writing Project, she instead chose to ask Bill; perhaps she expected to open a discussion or was unfamiliar with Web searches. Instead of replying the next day, Bill is unable to respond for 2 weeks, and Terry does not respond to him. Given the technology at their disposal, little more could have been done. However, a technology designed to support more tightly coupled collaboration could have enabled Bill and Terry to jointly search the Web for the appropriate site and add the results to the group's library in little more than the time it took Bill to post his response.

Teachers must be able to *collaborate* effectively before they can collaboratively *learn* effectively. Although traditional implementations of Internet technology for TPD (e.g., email, listservs, Web browsing) offer access to educationally relevant resources and some support for communication (see Ruopp, Gal, Drayton, & Pfister, 1993; Honey & Henriquez, 1993), they provide few of the tools and communication channels needed to support the cycles of tightly and loosely coupled collaborative activities that occur over extended periods of time in successful workgroups (Kuutti, 1991; Sproull & Kiesler, 1991) and communities of practice. Consequently, little is known about the kinds of professional activities teachers might engage in with the aid of emerging Internet tools or the effects that such activities could have on the sustainability and scalability of TPD efforts (Hardin & Ziebarth, 1996).

To illustrate the problem, we contrast lessons learned from studies of communication in asynchronous and synchronous on-line community environments. Riel and Levin (1990) identified three factors that contribute to successful email-based teacher communities and concluded that at least two of the following must be present: group rather than one-to-one structure, well-specified goals or tasks with a timeline and end product, and a coordinator to facilitate group activities. We argue that these success factors are based more on the limitations of the technology than on the characteristics of teacher communities. Although the lessons of Riel and Levin are useful for establishing email-based communication within a homogeneous, task-oriented group, the lessons may not transfer to the design of on-line environments for larger, more naturally occurring communities supported by a real-time environment.

Recent studies (Ackerman & Palen, 1996; Kollock & Smith, 1996) point to characteristics of self-sustaining, *real-time*, on-line communities in which

one-to-one interaction is common, goals are ill specified, and there is no coordinator:

- Shared purpose, social norms, and multiple roles
- Ongoing activity, critical mass of users with persistent identities
- Public venue and recognition for performance
- Archive of prior interactions and contributions
- Support for peripheral participation or lurking.

These characteristics reflect the social nature of large, self-sustaining communities and suggest guidelines for designing virtual learning communities that are consistent with the situated-learning literature. They also fit many of the professional development and community-support needs expressed by teachers in national studies of systemic reform (Lieberman & McLaughlin, 1995; Corcoran, 1995) and our own teacher focus groups:

- Overcoming isolation from and sharing experiences/resources with peers
- Equal access to TPD opportunities and ongoing support for the change process
- Recognition and rewards for achievements
- Safe environment and shared tools for professional discourse.

These considerations have led us to make several choices regarding both the design of the environment and the nature of the community. For example, the on-line TPD environment must seamlessly support a natural flow of communication (e.g., from real-time to time-shifted) in a persistent space that enables the creation and manipulation of discourse artifacts. Further, we reject the common assumption that one TPD program alone can effectively provide a sufficient number and variety of on-line activities to sustain the professional development of large numbers of teachers. High-quality activities offered by multiple organizations and general-interest activities through which individual members can contribute to the community are both necessary to sustain teacher participation.

3. Designing the Community Environment

The TAPPED IN concept described above is not tied to a particular technology platform, but rather is a set of capabilities and their affordances that are both theoretically motivated (e.g., synchronous and asynchronous interaction, shared artifacts, high traffic, awareness of others) and necessary for practical reasons

(e.g., platform-independence, Web-awareness, low bandwidth, low learning threshold). We implemented TAPPED IN as a multi-user virtual environment (MUVE) because it was the most appropriate technology available to satisfy this large set of design constraints.

MUVEs effectively support many collaborative activities that are central to professional development (Sproull & Kiesler, 1991; Bruckman & Resnick, 1993; Haynes & Holmevik, 1997), and they embody many next-generation Internet collaboration concepts (Harrison & Dourish, 1996; Orfali, Harkey, & Edwards, 1996; Roseman & Greenberg, 1996). For example, Orfali et al. describe the place-based metaphor as the next evolutionary step beyond the desktop and meeting metaphors. Roseman and Greenberg conceptualize their shared authoring user interface as *TeamRooms*. MUVEs also embody established criteria for effective groupware design: transparency, malleability, persistence, personal benefit, and awareness (Buxton, Bly, Frohlich, & Whittaker, 1996). We are confident that we can learn much about how emerging Internet technologies could support future distributed learning communities by conducting research in a MUVE today.

We designed the TAPPED IN environment to resemble a conference center (rather than a cafe or fantasy world) to evoke the kind of professional atmosphere (and thereby encourage the kinds of discourse) one would find at a conference facility or institute. Four floors of virtual meeting rooms, offices, and public areas (arrayed in North, South, East, and West wings) contain familiar discourse-support artifacts such as shared whiteboards and bulletin boards. Members can name and furnish their rooms, create and share text documents and WebViews (TAPPED IN objects that hyperlink to specified Websites), and post items in their workroom. Unlike a static Website that is updated occasionally (if at all) by one Webmaster, TAPPED IN rooms are updated continuously and collaboratively by participants in the community.

Using our TAPestry Java client applet and Web interface (shown in Figure 1), most actions can be performed by clicking on objects in the Web window (top left). Communication is entered and viewed in the text window (bottom left). The windows on the right of Figure 1 show shared Web browsing and sketchpad features that users can open on demand. Those who do not have enough memory to run a Web browser or do not want the inconvenience of waiting for Web pages to load can use a set of simple text commands (refined by training over 400 members) via one of several telnet-based text clients.

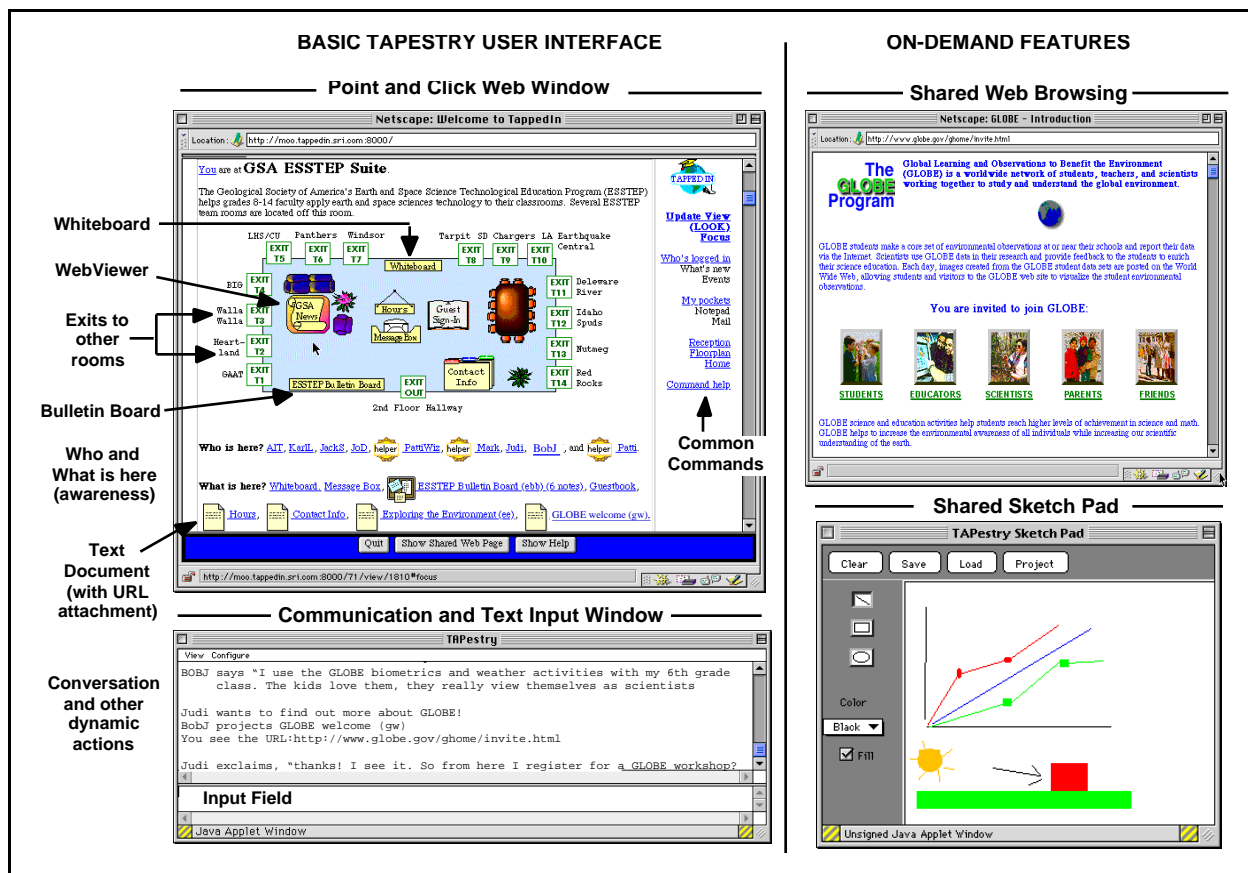


Figure 1. Basic TAPestry user interface with point and click Web window (upper left) and communication and text input window (lower left). As illustrated by the conversation, users can project Web pages to others in the room (upper right); they can also open a shared sketchpad (lower right) on demand.

In much the same way that teachers we have observed at summer institutes transform a generic classroom space (e.g., with flip-chart pages taped to walls and tables piled with sample resources), groups can create their own *place* out of generic rooms. Figure 1 shows a typical organization's *main* room (the Geological Society of America's ESSTEP Suite), where the organization's teacher affiliates can congregate and any member of the community can come to find out about the organization. Off of the main room are exits to 14 team rooms, where teachers from different schools and regions of the country meet, post their work, and exchange information.

User survey data indicate that the conference center user interface metaphor is a familiar and effective way to help users understand the environment and conceptualize how the user interface can be customized to fit their needs (our partner organizations have little difficulty designing their TAPPED IN suites). The place-based metaphor and object construction, manipulation, and persistence are also consistent with theoretical models of social cognition that emphasize the role of environment in supporting activities

(Fitzpatrick, Mansfield, & Kaplan, 1996; McClamrock, 1995; Pea, 1993).

McClamrock (1995) argues that humans have developed strategies/heuristics for dealing with complexity in the world that rely heavily on environmental structures. We often take advantage of prestructured parts of the environment and the fact that some more easily detected parts are good indicators of some less easily detected parts (e.g., seeing a file cabinet indicates the presence of files). Individuals also act on the environment, changing it in ways that help them better deal with complexity and relying on the persistence of those changes, as when we set up the local environment so as to remind us of things. According to McClamrock, these strategies help reduce computational load, increase efficiency, and increase the probability that the appropriate course of action will ultimately be taken.

An (edited) example of how users interact with the TAPPED IN environment to reduce complexity is illustrated in Figure 2 (a and b). Staff from the Bay Area School Reform Collaborative were holding a meeting to discuss the local implications of a speech delivered to their organization by leading school reform

Integrating new technology into an organization's old ways of doing business can be a recipe for failure. Trust, buy-in, cooperation, and change come slowly. In our role as support providers to authentic organizations, our researchers must learn to understand and help satisfy current needs, while helping the community to better understand, and effectively employ, innovative new concepts and technologies. The environment and our support alone will not cause innovative activities and appropriate behaviors to ensue; we must *co-envision* future practices. Organizations need examples to help them understand how they can modify their practices to best take advantage of TAPPED IN capabilities, provide adequate scaffolding for users, and conduct on-line activities that are cost-effective.

Our approach has been to invite exemplary TPD organizations representing divergent perspectives, approaches, and foci on technology to employ TAPPED IN to help accomplish their own TPD agendas.¹ SRI provides TAPPED IN training to staff and teachers, usually in the context of a workshop or summer institute, and provides follow-up support as needed. In

Figure 2a. BASRC staff discuss a 35-page text on school reform on the Web. They have difficulty scrolling to find relevant sections. SarahE suggests copying the sections to a shared bulletin board.

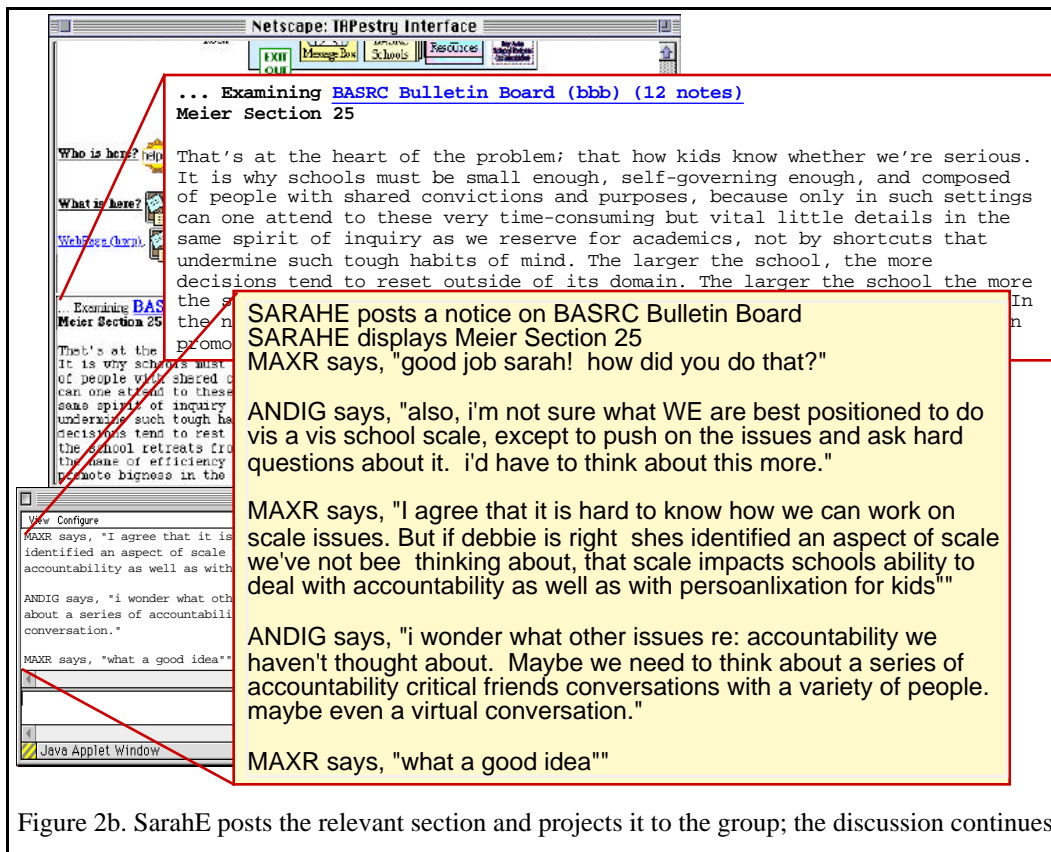


Figure 2b. SarahE posts the relevant section and projects it to the group; the discussion continues

The motivation for teachers to learn and use TAPPED IN must also come from their own desire to participate in a professional community. Over the last 9 weeks (July-August 1997), 127 TAPPED IN members logged in 910 times for a total of approximately 900 hours. Users issued over 7,000 communications and interacted with objects over 2,100 times. Most of the log-in time was for formal training. Our goal is to attract regular daily traffic during the school year (minimally 15-20 users simultaneously) so that someone is always *home* when someone logs in.

Research on virtual communities (Hagel & Armstrong, 1997) shows that content and member interaction are equally important in attracting and sustaining participation. TPD research (Harris, 1995) suggests that the community must offer teachers convenient access to high-quality experiences and resources, and teachers must derive personal value, reward, and efficiencies from their participation in the community. In a post-training questionnaire, we asked 89 teachers whether they felt that TAPPED IN would (a) require too much time to learn, (b) be worth the effort for their group to learn, (c) help them participate in their group more effectively, and (d) help the group stay in contact. On a 7-point rating scale from strongly disagree (1) to strongly agree (7), the median score for Question A was 3, and the others were 6, suggesting

that teachers perceive value in TAPPED IN for sustaining interaction.

We want to encourage high-quality, professionally relevant discourse in TAPPED IN and avoid the complaint-fests and social parties that teacher chat rooms can degrade into. Yet, we differ from many educational listservs, which exert control to keep discussions on topic. We do not want to discourage social, non-TPD-related conversation through either the technology or social taboos. But can we have it both ways?

In authentic professional communities, people engage in a range of activities at different times in different settings. A significant proportion of the interactions among community members is purely social, which serves relationship- and trust-building functions. One example is the social conversation that typically occurs at the beginning and end of face-to-face meetings. We seek to strike a healthy balance between professional and social discourse through the development of social norms/conventions and professionally valuable activities and reward systems. We fully expect that the bounds will be tested and broken and that those occasions will be opportunities for the community to develop and enforce its own rules.

5. Establishing Community Social Norms

Our approach to establishing community norms has been to gradually grow a core of members from a mix of education disciplines (teachers, administrators, researchers, staff developers) who work closely with us and our partner TPD organizations. The organizations incorporate in their face-to-face activities the professional norms, values, and practices that we hope will extend to teachers' on-line interactions. We also require users to enter professional descriptions of themselves to build reputation and trust (Kollock & Smith, 1996).

Our conjecture is that these core groups of teachers will serve as models to newcomers who join TAPPED IN as individuals. (That is why we have been slow to publicize TAPPED IN widely on the Internet, despite our need to encourage more daily traffic.) This conjecture is supported by the work of Lave and Wenger (1991), which suggests that newcomers to the community will actively seek to learn the community's social structures, rules, and norms through a gradual process of interaction with peers, veterans, and artifacts used by the community.

Kuutti (1991) also presents an activity theory framework that employs the kinds of social mediators that we want to establish. Members of the community may be engaged in a variety of activities with different objectives, but they share rules and norms that enable them to interact effectively. For example, feedback from users suggested that we develop guidelines for conducting on-line meetings. As in a physical room, meetings can take on many different characteristics. We have categorized four illustrative meeting styles:

- *Working Sessions* usually involve 2-5 people meeting to accomplish a well-specified task, provide specific assistance to one or more of the participants, or discuss a narrow topic in depth. Conversation is informal, focusing on the problem at hand, sometimes veering off to a tangential issue or a humorous interjection.
- *Lecture Sessions* can involve a handful of people each delivering a monologue (or position) or an auditorium full of people listening to one speaker. One person has the floor for a period of time, usually followed by questions and/or discussion. Examples are debriefings and report-out sessions.
- *Structured Sessions* can involve as few as 3 or as many as 20+ participants. A prescribed agenda is followed by an acknowledged leader, who maintains control over the conversation through a set of agreed-upon rules/norms (e.g., one thread of conversation, speakers must wait their turn, the leader determines when a topic is open and closed).
- *Expression Sessions* usually involve three or more people engaging in multiple threads of discussion at once. Leadership is loose, if attempted at all.

Participation and expression of ideas/perspectives (brainstorming) are maximized at the cost of arriving at consensus, cohesion, or in-depth discussion of a topic.

Meetings can shift from one style to another and become unwieldy as group size increases. We have found that the first three can quickly and unintentionally degenerate into the fourth, especially if the participants are novices, through lack of visual cues and social constraints (e.g., on talking out of turn and side conversations). Agendas, roles, and outcome expectations must be set at the start; participants must actively assist the leader in regulating the pace; groups can be divided into smaller subgroups that report out to the larger group. We are collecting data to assess how these norms work and whether on-line meetings differ qualitatively from telephone and face-to-face meetings.

We have also chosen to impose some social constraints enforced by the technology, such as issuing user names (concatenated first name and last initial) rather than enabling users to create their own. We also have made design decisions that affect privacy and artifact control. For example, rooms are open to anyone by default; access can be restricted, as needed. Whiteboards can be written on and erased by anyone at any time; a print function enables anyone to make and post copies before erasing. Bulletin boards and documents can be set to read/write or read-only at the discretion of the owner. Objects in one's *pocket* are completely private. Finally, we determine which actions are *seen* by others. For example, room occupants are notified whenever someone enters or leaves, and when someone writes on or erases a whiteboard; however, reading a whiteboard or document is a private act.

6. Establishing TPD Activities

One of our most important objectives is to understand the kinds of on-line activities and content that TPD organizations can develop to achieve their goals and support teachers more effectively. For example, organizations that currently must plan their offerings to fit into a summer institute (and hope that teachers can implement months later what they learned) can now plan activities that begin at the institute and continue over the school year. Organizations that conduct site-based activities can conduct some of those activities on-line, saving time and travel costs, while, we conjecture, using face-to-face time more effectively. Our partner organizations are developing several kinds of on-line activities, including office hours, follow-up workshops to supplement face-to-face activities, facilitated discussions, teacher-led discussion groups, topic-based seminars, and exhibit rooms where teachers can post their work and review work published by others. We are also exploring opportunities to offer certification and continuing education credits for participation in TAPPED IN activities through local universities.

Our experience has suggested that the activities provided by each of the organizations will not be sufficient to encourage the kinds of daily traffic and interaction *across* groups that are central to our concept. We want to encourage teachers to treat TAPPED IN as the *water cooler*, and drop in whenever they have a few minutes to spare. TPD research (Harris, 1995; Loucks-Horsley, Stiles, & Hewson, 1996) and our own users suggest (at least) three ways that we might motivate teachers to participate on their own: by offering access to exemplary, reform-oriented TPD content and expertise, opportunities and professional recognition for contributing to the community, and regularly occurring, TPD-focused events.

The TAPPED IN environment enables us to offer popular forms of on-line activity that teachers can participate in whenever they have the time and to enhance them in ways that we believe will help encourage teacher participation. For example, searching Websites is a solitary, time-consuming, and often frustrating experience with no guarantee of quality because resources are not filtered and annotated by peer-recognized reviewers. Moreover, few of these offerings provide the kind of public feedback mechanisms that enable the community of users to learn from each other's experiences which of the offerings are really worth their time.

To add value to individuals' Web searches, we could marry the popular *Hot Website of the Week* concept with the *Reader Review* concept. Members would be able to browse a small collection of selected teaching-related Websites, leave their own ratings and comments about the sites, and read those left by others, on a virtual document that is hyperlinked to the site. Several of our organizations have also expressed the desire to hold a regular series of small, informal, real-time events open on a first-come, first-served basis to TAPPED IN members. Events might include Website tours, discussions with researchers in TPD and school reform, and presentations by community members.

To help us understand the kinds of community-wide activities our 400+ members are interested in, we are in the process of conducting a survey asking members to rate their interest in 16 services and activities (see www.tappedin.sri.com/info/surveys/activity.html) on a 1-5 scale. After one week, we have received 21 responses (8 from teachers). The top four interests of the teachers are: Library of Websites organized by grade and subject (4.9), live librarian available (4.5), conducting an on-line project (4.1), and participating in Website tours (4.0). Three respondents indicated that they would be willing to review Websites. We will post a summary of the results on our Website.

7. Summary and Next Steps

In this paper, we described the goals and approach of a theory-based design experiment at the intersection of TPD, Internet technology, and education reform. Reform initiatives and TPD programs need mechanisms for extending their reach that computer networks can provide. Education technology research suggests that virtual communities can help teachers learn new skills and adopt new approaches that will facilitate their transition to reform-based practices. Each can substantially benefit from the experience and expertise of the other. The common ground on which the disciplines can come together is the opportunity to jointly develop effective, scalable on-line TPD models based on the social affordances of next-generation Internet technologies.

Our goal is to help education reform practitioners understand and use emerging Internet technology in ways that facilitate the growth of sustainable and scalable TPD communities and help accelerate teacher adoption of education reform efforts. Our approach is to understand the basic discourse-support needs of those whose business it is to conduct TPD activities, and to develop an appropriate shared venue, set of tools, and social infrastructure to enable them to go about their work efficiently and effectively. Our job as developers and support providers is to ensure that the design solutions we implement are grounded in design principles and are compatible with existing, as well as emerging, technology; otherwise, our efforts will not be useful outside the research context. Our job as researchers is to ground our work in applicable theories, investigate overarching issues that bear on the success or failure of the community, and turn the lessons back into design refinements and guidelines for others establishing their own TAPPED IN communities.

This fall (1997), we are beginning a 3-year series of studies to investigate the implementation process, TPD benefits and outcomes, community building, and other issues. Each category of research issues will require a combination of quantitative and qualitative data collection and analysis methods. We invite interested researchers and practitioners to join us in developing innovative on-line activities and equally innovative ways of assessing their value to teachers. For more information, see our Website, www.tappedin.sri.com, or visit TAPPED IN via our WebGateway or telnet address [moo.tappedin.sri.com](telnet://moo.tappedin.sri.com) port 7777.

Acknowledgments

The work reported in this paper has been a collaborative effort by people in several disciplines and organizations. We would like to thank our partners and acknowledge the contributions of Jorge Barrios, Marie Bienkowski, Barbara Chriss, Sharon Derry, Kimberly Ford, Chris DiGiano, Judi Fusco, Phil Gonsalves,

Wayne Grant, Denise Gurer, Mary Pat Horn, Peter Hewson, Eric Mercer, Steve Sanchez, Ken Schweller, Linda Shear, Thomas Schubert, David Weksler, and especially Richard Godard, TAPPED IN ArchWiz!

This material is based on research supported by SRI International, the Walter S. Johnson Foundation (Grant No. 96-24), and the National Science Foundation (Grants No. CDA-9616585 and MDR-9454729).

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ⁱ We are often asked whether we considered implementing TAPPED IN as a world with avatars. In social and gaming virtual environments, avatars' primary function is to establish social identity (e.g., through dress or gender). We implement this function with a simple description, icon, or photo. Other functions that make avatars attractive to designers of meeting-support and collaborative simulation systems include point of view, awareness of and proximity to others, and locus of attention. We believe that these functions are important; however, we feel that current implementations of avatars place too many cognitive and psycho-motor demands on users and require too much bandwidth/screen space. While avatars may be appropriate in other contexts, our less intrusive and lower cost awareness mechanisms are satisfactory to our users.

ⁱ From September 1996 through August 1997, the community has grown to over 420 educators and researchers worldwide. Partner organizations include Lawrence Hall of Science (GEMS & SEPUP Programs), Math Forum, Bay Area School Reform Collaborative, Geological Society of America, CoVis Project, Life Lab Science Program, Science Education Academy of the Bay Area, Joint Venture: Silicon Valley, and New Haven Unified School District (CA).