Sustaining a community computing infrastructure for online teacher professional development: A case study of designing Tapped In

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Abstract

Community computing has recently grown to become a major research area in human-computer interaction. One of the objectives of community computing is to support computer supported cooperative work among distributed collaborators working toward shared professional goals in online communities of practice. A core issue in designing and developing community computing infrastructures—the underlying socio-technical layer that supports communitarian activities—is sustainability. Many community computing initiatives fail because the underlying infrastructure does not meet end user requirements; the community is unable to maintain a critical mass of users consistently over time; it generates insufficient social capital to support significant contributions by members of the community; or, as typically happens with funded initiatives, financial and human capital resource become unavailable to further maintain the infrastructure. Based on more than nine years of design experience with Tapped In—an online community of practice for education professionals—we present a case study that discusses four design interventions that have sustained the Tapped In infrastructure and its community to date. These interventions represent broader design strategies for developing online environments for professional communities of practice.

Keywords

Sustainability, community of practice, participatory design, social capital, human-computer interaction.

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1. Introduction

Community computing refers to socio-technical interventions and infrastructures that support community interactions and civic activities among people sharing common resources (Carroll 2001). For example, the Blacksburg Electronic Village (BEV) community computing infrastructure supports a web-based network that hosts local, online community information and activity (Carroll 2005). Community computing, in general, supports human computer interaction (HCI) and computer supported cooperative work (CSCW) among community members, both local and distributed, working toward shared goals.

A core issue in developing and maintaining community computing infrastructures is sustainability. Many community computing projects fail because the underlying infrastructure does not meet end user requirements; the community is unable to maintain a critical mass of users consistently over time; there is insufficient social capital to support significant contributions by community members; or, as it typically happens with funded community computing initiatives, financial and human resources become constrained or even unavailable to adequately maintain the infrastructure. When community activities and practices are supplied hierarchically, such as by formal institutions, instead of developing organically and being maintained by the community, they are often construed as belonging to others and are typically underutilized (Rheingold 1993; Schuler 1996). As a result, the community fades away and its infrastructure fails.

In this paper, we present a case study of successfully and iteratively designing and sustaining a community computing infrastructure. Our case study is an online environment called Tapped In® (http://tappedin.org/) that supports activities of a large and diverse community of distributed education professionals. Drawing on more than nine years of participatory design experience with Tapped In users, we present design interventions that were introduced in the Tapped In community to sustain its computing infrastructure. Our participatory design interactions with the Tapped In community have enabled end users to articulate problems and propose high-value improvements to the infrastructure. These recommendations, in turn, have enabled Tapped In designers to continually improve the infrastructure over time.

Our contribution in this paper is a case study analysis of developing Tapped In. Specifically, we present four design interventions that have helped sustain the Tapped In community computing infrastructure. These interventions represent broader design strategies for developing online environments to support professional communities of practice. These design interventions and strategies would be of interest to software designers and community computing developers.

In the following section, we present our conceptual framework with respect to prior literature. We explain our participatory design methodology and research methods in Section 3. Section 4 provides background of Tapped In that sets a historical context for our case study. In Section 5, we present four design interventions that have been successful in sustaining the Tapped In infrastructure and its community of users. Section 6 discusses three broader strategies for technology design to support online communities of practice.

2. Related work

Over the past several years, we have been developing and refining the Tapped In infrastructure, which is intended to support the online activities of a large and diverse community of education professionals. The community of practice framework (Lave and Wenger 1991; Brown and Duguid 1991; Wenger 1998; Orr

1996; Cothrel and Williams 1999) has guided us over the years to develop online teacher support activities and the community computing infrastructure to support such activities. Communities of practice are described as emergent, self-reproducing, and evolving entities that are distinct from, and frequently extend beyond, formal organizational structures, with their own organizing structures, norms of behavior, communication channels, and histories. Members often come from larger professional networks spanning multiple organizations, drawn to one another for both social and professional reasons.

The community of practice framework suggests that a teaching professional's community of practice can have a direct (positive or negative) impact on professional growth through various forms of informal collegial interactions (Barab and Duffy 2000; Brown and Duguid 2000). The recognition that communities of practice can play an important role in professional learning has spurred a great deal of interest in how to harness the power of such communities in the context of systemic school reform and professional development projects. Researchers (Garet et al. 2001; Smylie et al. 2001; Loucks-Horsley et al. 1998; Little 1990; Stein et al. 1998), practitioners (Wilson and Berne 1999; Rényi, 1996), and policy-makers (President's Committee of Advisors on Science and Technology 1997; National Commission on Mathematics and Science Teaching for the 21st Century 2000) are converging on a shared vision of effective teacher professional development as more than a series of training workshops, institutes, meetings, and in-service days. It is a process of learning how to put knowledge into practice through engagement within a community of practitioners.

A major part of the challenge in designing and developing community computing infrastructures is *sustaining* the infrastructure and its critical mass of users over time. The theme of sustainability has long been addressed from different perspectives in the community informatics literature. Merkel and colleagues (2005) provide an overview of what sustainability means in community computing settings. Broadly, sustainability is centered on how people in community computing settings can best achieve their goals consistently over time. According to Merkel and colleagues (2005), this question has been asked in different ways, with researchers and practitioners focusing on: (a) the feasibility of various models and the physical, social, and technical requirements that must be in place to ensure technology access to citizens (Clement and Shade 2000; Benassi et al. 2004); (b) the role of the government in addressing issues that affect the public good, such as providing access to government information through web portals and to the Internet itself, especially for marginalized members of society who may lack the resources or training necessary to access such services (Doody 2004; Musgrave 2004; Malina and Ball 2004; Rideout and Reddick 2004; Schauder et al. 2004); (c) outcome-based approaches that study factors needed to encourage long-term changes in the lives of users (Gordon and Gordon 2004); and (d) socio-technical investigations of information technology adoption and features of one's social network (e.g., social capital) that tend to support or inhibit technology adoption (Day and Cupidi 2004; Prell et al. 2004).

For Tapped In, our concern with sustainability is related to developing design interventions to keep up with the changing needs of our community of users. Our mantra has been that design interventions that enhance end user participation and interaction with the designers of the community infrastructure can lead to sustainability. When end users have a greater stake in the community computing infrastructure, they feel empowered as they have the ability to guide design, and they are actively engaged in discussions with peers and designers, motivating subsequent community interaction and contribution.

Previous literature outside the domain of teacher professional development has looked at factors that motivate participation (Lampe and Johnston 2005; Lakhani and Hippel 2003; Ling et al. 2005) and enhance socio-technical capital (Resnick 2000) in online communities. Our interest lies in enhancing participation and social capital between end users and designers of the community in order to foster collective initiatives to improve the underlying community computing infrastructure.

The work most closely related to our investigation is the practitioner-oriented set of design lessons by Amy Jo Kim (2000). Kim proposes specific design principles that characterize successful, sustainable online communities. We reiterate five of Kim's design principles that we have used directly to design the four interventions for Tapped In that we present in this paper:

- *Build flexible, extensible gathering places.* Online gathering places provide a flexible medium for end users and designers to work together to evolve and continually define and articulate the purpose of the community.
- *Design for a range of roles.* As the community grows, it will become increasingly important to provide guidance to newcomers while offering leadership and ownership opportunities to more experienced members.
- *Develop a strong leadership program*. Develop a leadership program because community leaders are the fuel in the community: they greet visitors, encourage newbies, teach classes, and answer questions.
- *Facilitate member-run subgroups.* To grow a large-scale community, provide technologies to help community members create and run subgroups to drive member loyalty.
- *Create and maintain feedback loops.* Successful community building is a constant balancing act between the efforts of management (designers) to plan, organize, and run the space and the ideas, suggestions, and needs of community members.

Our integrated conceptual framework draws inspiration from the various pieces of literature mentioned above, especially Kim's design principles. Our framework has been developed over several years to support professional collaboration and peer support among teachers (Schlager and Schank 1997; Fusco et al. 2000; Schlager et al. 1998, 2002; Tatar et al. 2002; Derry et al. 2000). The major conceptual components of our framework that we directly leverage in this paper are:

- *Multiple interaction formats and technologies*. Our framework calls for a range of tools and workspaces that (a) support work practices of large numbers of different groups; (b) enable users to know with whom they are interacting and what is going on around them; (c) allow users to create, store, and share discourse objects (e.g., notes, overhead slides); (d) communicate in real time or asynchronously, as the need arises; and (e) engage in group activities hosted by designers as well as their own circle of colleagues.
- *Identity and trust*. User profiles and induction activities are aimed at building trust in the system and developing a strong sense of community and group identity.
- *Ownership and empowerment*. The framework facilitates a sense of ownership and empowerment in the community by encouraging members to contribute to community activities and resources, assist other members, and use the online environment to support their own collaboration with others.
- *Heterogeneity*. A key indicator of community health is the participation of a population with diverse interests and a range of expertise. The framework encourages the participation of teachers at all levels and from all disciplines, as well as district staff, researchers, university faculty and students, staff developers, and administrators.
- *Community management, leadership, and sustainability*. No professional community can be sustained without management and committed community leadership. Recognizing and rewarding informal leadership and centralizing community management can help coordinate activities across projects, increase efficiency, and create economies of scale.

One facet of our research deals with understanding the kinds of online activities and content that teacher professional development organizations can develop to achieve their goals and support teachers more effectively (Schlager et al. 1999). A second facet of our research, which is the focus of this paper, addresses the issue of sustainability with respect to the long-term and evolving design interventions that allow the online teacher professional development community to engage in participatory design with the designers of the infrastructure.

3. Methodological approach and research methods

Our methodological approach most closely resembles participatory design. Participatory design (PD) is a practice among design professionals that explores conditions for user participation in the design of technology (for detailed discussions, see Clement and van den Besselaar 1993; Greenbaum and Kyng 1991; Kensing and Blomberg 1998; Schuler and Namioka 1993). Participatory design, as it is referred to in HCI and CSCW, has its roots in socio-technical systems theory (Mumford 1983). Historically, Emery and Trist (Emery and Trist 1960; Emery 1993) were pioneering thinkers in understanding the importance of including the membership of a community in the design process.

Our approach to participatory design brings end users and designers together in mutual commitment, where users learn about what computer technology can do for them and designers learn about the application domain in order to build a flexible and efficient system to fit the users' needs (Bjerknes 1993). Most of our participatory design interactions occur online in an asynchronous manner.

Our participatory design approach also has a flavor of action research. We assume that the end users who are scrutinized in our research and are potentially affected by our research can be, or can be qualified to become, co-researchers. Overall, our methodological approach can be described as a design experiment, in which our investigation includes research to design professional activities and technical capabilities that we conjecture will help establish and sustain online teacher professional development communities.

Since the Tapped In project started in 1996, it has spawned many different smaller projects (e.g., theses and dissertations). It is difficult to briefly describe how data were collected, analyzed, and evaluated over such a long period of investigation. For the purposes of this paper, we refer to snapshots of our efforts with data collection, analysis, and evaluation that have occurred during multiple instances in the nine years of our research with Tapped In. These snapshots establish that we followed a rigorous and systematic research investigation.

3.1. Data collection

Field research began in 1997 when Tapped In went online. We have used a multitude of quantitative and qualitative instruments in collecting data. Because our methodological approach was guided by participatory design mostly through online interactions, the primary methods of data collection were online observations recorded through field notes, surveys, activity logs, and interviews. Secondary sources of data included documentation (e.g., newsletters), archival records (e.g., e-mails), and physical artifacts (e.g., design mockups and scenarios).

As reported in Schlager et al. (1999), we have collected data for online member activities (e.g., objects they access, rooms they visit, when they log in and out). All Tapped In members are informed of such research data collection efforts when they apply for membership. Strict confidentiality is maintained, and the content of conversations is never recorded without additional explicit permission from the participants. The only exception is our After School Online (ASO) sessions, which are recorded and posted in Tapped In's transcript archive for Tapped In members and guests to access in the future. Participants are informed that by participating in an ASO session, they agree to the publication of their transcript.

Our membership and list of partners have grown steadily over time. As of January 1999, we had more than 2,500 members and an average of more than 60 logins a day. In July 2006, we had about 20,000 members and approximately 1,200 to 1,500 member logins a day. As membership has grown, the monthly login rate has remained steady at approximately 10-20% of the membership. For example, in July 1998, 378 different members (out of 1,700+) logged in. In July 2006, 2,100 different members (out of about 20,000) logged in. Members log in every day of the week and almost around the clock. Logins are relatively equally distributed from Monday through Friday and shrink by about two-thirds on weekends. Currently, about 40% of our members describe themselves as K-12 teachers and 25% are composed of researchers, university faculty and graduate students, staff developers, school support and administration staff, and pre-service teachers. The remaining 35% describe themselves as "other".

Over the years, we have also held summer institutes, workshops, training sessions, and online seminars to expand our data collection efforts. One of our largest efforts started in summer 1997, when we were part of two 2-week summer institutes in July and August. We followed seven teams of two to four high school and/or community college teachers who attended each institute to gain hands-on experience with software and techniques used in earth and space science. Periodic follow-up online meetings with the 14 teams also occurred over the course of the school year. At least one representative from each of the 14 teams was asked to log in and report on their progress, obstacles, and lessons that they wanted to share with other teams. Transcripts of all the meetings were collected via Tapped In's automated transcript logging mechanism. We analyzed these meetings and learned a great deal in this research about how people learned to communicate, share information, and collaborate online. In the course of three meetings, we observed people being able to work and accomplish things online (Schlager et al. 2002).

We have also administered surveys with Tapped In users. For example, one such survey was developed to help us learn who our members are and how their experiences in Tapped In have affected their professional lives. We collected data on standard demographics and professional development activities, technology use, and Tapped In use, affordances, and barriers (Fusco et al. 2000).

3.2. Data analysis

The data collected were analyzed by using the general analytic strategy of developing case descriptions (Yin 2003). A descriptive approach was followed to help identify the complex stages of designing and sustaining a community computing infrastructure for Tapped In. Our perspective on participatory design guided our analysis of the data, reflecting important socio-technical elements of designing the Tapped In infrastructure. However, the data were also used to inform the participatory design approach itself, in that the design emerged as an iterative process taking place throughout the data collection and analysis phases. For example, the designers and researchers of Tapped In addressed many features and bugs in the order end users prioritized them.

We have used discourse analysis on meeting transcripts to interpret our data (Schlager et al. 2002). As an example, one of our transcript analyses shows that even with a group that uses technology minimally over a period of several months, the structure of their meetings shifts from a focus on technology and group norms to a predominantly task-oriented focus, similar to dialogue captured in face-to-face meetings (Olson et al. 1992).

We have also coded our data to address specific research questions (Schlager et al. 2002). For example, with the data we collected from the summer institutes, a coding scheme was developed to quantify the structure and flow of the online meetings, based in part on studies of face-to-face dialogue in collaborative design group meetings (Olson et al. 1992). We coded each utterance and nonverbal action as an instance of one of several categories of discourse. As an example, the four most common categories of discourse that emerged were business focused, meeting management, technology related, and social.

3.3. Data evaluation

To achieve rigor in our data analysis and interpretation, we triangulated the multiple sources of data collection. To ensure reliability and plausibility of our results, the Tapped In research group attended biweekly meetings to discuss their field observations. The research group included developers and designers with considerable experience in online communication technology. All members of the group reflected on the collected data to generate collaborative interpretations. Discussions related to design and improvements of the Tapped In infrastructure were the primary focus of these meetings. This process of collectively reflecting on data interpretations helped to remove individual researchers' subjective biases, thus increasing the reliability of data analysis. During our coding efforts, the transcripts were read by two researchers, who coded independently and then came together to calibrate their findings. Differences between the two coders' ratings were resolved by a third reviewer.

Because many of our research group members were geographically dispersed, we often used Tapped In ourselves as a communication and collaboration mechanism for our research meetings. We analyzed our meeting transcripts as well. These analyses revealed many episodes of knowledge building, mentoring, argumentation, and resolution, all key characteristics of productive group work. A research issue we encountered in our multidisciplinary research group was learning each other's jargon and interpersonal styles (Schlager et al. 2002). We also had to develop our own norms for interacting as a dispersed group. We were all used to the social constructs of face-to-face meetings—rapid-fire dialogue, long monologues, whispered side comments, topic shifts—and the skills needed to break into the dialogue at just the right moment or guide a meeting through the items on an agenda. Online collaboration requires adjustments to these constructs and skills.

The data we present in the forthcoming sections has been anonymized. For screenshots, we have blocked out the last names of the participants. In some cases, staff members have given permission to leave their names unaltered.

4. Background of Tapped In

From 1996 to 2002, we developed and hosted the Tapped In Testbed, a MOO-based platform (Curtis 1992) in which we cultivated a diverse education community of more than 20,000 members with the aim of understanding the nature and affordances of online communities of practice in the service of teacher professional development. Two critical pillars of the infrastructure were the establishment of a live Help Desk and a discussion series called After School Online (ASO). We felt that greeting new members was an important first step in welcoming them into the Tapped In community. We established the Help Desk in the reception room for this purpose. Although the Help Desk was originally staffed by members of the research group, community members acknowledged its importance by adopting it to such a degree that it was eventually staffed primarily by volunteers. ASO was originally conceived of as a venue for our partner organizations and community leaders to reach out to teachers, but it grew over time into a way for members to meet others with similar interests, to gain comfort with the technology, and to develop online discourse and leadership skills in a low-pressure, motivating context.

To further support the key activities of an online community of practice and move forward with our research, we decided to abandon the MOO platform for a more modern, flexible, and extensible architecture. The MOO used an unsupported language, was single-threaded and hence scaled poorly, and was a text-based system at odds with the increasing use of multimedia to support online learning and collaboration.

Starting in mid-2001, we began working with our partners and community to incorporate new features and capabilities, including groups, discussion boards, and search, among others. We used a scenario-based, participatory design approach (Rosson and Carroll 2001), bringing together a design team representing researchers, teacher educators, technology developers, regional education support providers, national teacher professional development organizations, and our core constituency, the Tapped In members. After a rigorous needs assessment process and multiple design iterations, mockups, and user tests, the resulting feature set and interface design were reified in a web-based demonstration and a set of functional specification documents, including feature prioritization.

The development team chose open-source, scalable, Java-based solutions in which to implement a redesigned system that would be robust, versatile, and scalable. By building on open-source foundations, we benefited from and contributed back to existing development communities. We released a basic system for alpha testing ahead of schedule in September 2002. As a result of a second formal round of user testing, we made a major conceptual design change to the "place" metaphor employed in the user interface (Schank et al. 2002). We continue to develop features in the system based on suggestions by community members. Screenshots of the current system are shown in Figure 1.