

Havelock, B. (2004). Online Community and Professional Learning in Education: Research-Based Keys to Sustainability. *Association for the Advancement of Computing In Education*, 12(1), 56-84.

Online Community and Professional Learning in Education: Research-Based Keys to Sustainability

BRUCE HAVELOCK

Research Corporation (RMC)

Denver, CO, USA

havelock@u.washington.edu

Though the concept of online community has been heralded as a promising tool to support teacher professional development, a robust and meaningful definition remains elusive. This review draws together research on community, teaching, and learning in traditional and online settings. Examples of current efforts in the field of online learning communities for teachers are described, and guidelines for their success and utility are synthesized from this diverse body of research.

A growing body of research in education and professional development for educators indicates the importance of social relationships in the developing professional lives of educators. Teachers who regularly engage in social and professional ways with other educators beyond their classrooms are much more likely to display the professional hallmarks of continuous inquiry and effective teaching than their colleagues who operate in isolation behind their classroom doors (Riel & Becker, 2000; Darling-Hammond, 1999; Wilson & Berne, 1999). While teachers' immediate milieu for professional learning beyond their classrooms is that of their school and district setting (Fullan, 1991; Elmore, Peterson & McCarthy, 1996; Westheimer, 1998), this review explores the challenges and potentials of learning communities for geographically dispersed groups of educators through online, or Internet-based environments.

Research highlights the difficulty of creating a sense of community among teachers (Grossman, Wineburg, & Woolworth, 2000). Fostering community in online settings may be even harder, given the characteristics of the medium; however, it may also carry with it a unique set of affordances and capacities that can contribute to participants' professional growth in novel ways. Online community shows potential for overcoming traditional issues of isolation for some teachers, but how will we know this kind of online community when we see it? How can we be sure that online communities are performing the functions that we value? Might successful online communities for teachers detract from participants' ability to forge local community in their school settings? In short, are they worth our continued attention and investment of resources? This review consolidates some ideas about community in traditional and online settings as applicable to teacher learning. Where appropriate, specific examples focus on science education; the disciplinary boundaries and requirements of that domain of focus may dictate that this definition is not widely applicable to educators outside of science. Nonetheless, by focusing on those ideas about community that resonate with current research in teacher professional development (Putnam & Borko, 2000; Hawley & Valli, 1999; Wilson & Berne, 1999; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Lieberman, 1995), I hope to provide a discussion that will be useful in the consideration of online community for teacher learning in other disciplines as well.

Researchers from the entire range of fields comprising the social sciences continue to disagree over a baseline definition of community. In the field of education, significant grant monies and numerous projects have been devoted to supporting educational community in traditional and online settings (Hoadley & Pea, in press; Grossman et. al., 2000; Scardamelia & Bereiter, 1994), but to date, though consensus may be forthcoming, there are still almost as many visions of educational community as there are researchers. This confusion is further compounded by the emergence of Internet-based or online social spaces, and efforts to define community as it may apply to these new social spheres. Even if we accept a vision of community not bound to place, as researchers concerned with social interactions in virtual settings must do, we are still left with competing visions of what exactly a community is and how we can recognize it when it emerges.

Acknowledging that community is a complex phenomenon with shifting boundaries, the author will follow Beck's (1999) caveat that constraining a definition of community with prescribed notions about its nature and

composition may be misleading. While acknowledging this complexity, the primary focus is on community as a social system comprised of meetings and interactions, exploring how principles derived from this perspective may help us design and sustain communities in service of teacher professional learning. Other perspectives on community's nature and composition, ranging from structural to critical-theoretical, are not explored in depth in this model; readers may look elsewhere for more technical (Stahl, 2000; Turoff, Hiltz, Bieber, Fjermestad & Rana, 1999; Garton, Haythornthwaite, & Wellman, 1997) or more postmodern (Stone, 1996; Turkle, 1995) explorations of online community.

To explore how online formations of community might best inform the professional practice of science educators, the author will first elaborate upon a general definition of community in a more traditional sense, followed by a discussion of how the idea of learning community has been applied to efforts to develop and update educators in general, and science educators in particular. Next the author pursues the community concept into virtual or online relations; by first exploring generalized notions of online community before applying the concept to online communities of educators and current research in this area. Finally, the article concludes with a set of methodological and design challenges and criteria for supporting the emergence of an online community and determining its impact on professional practice for science educators, a goal that is being explored in the SCOPE: Science Controversies Online: Partnerships in Education project at the University of Washington.¹

COMMUNITY IN THE PHYSICAL WORLD

Foundations for Understanding Community

Some of the earliest attempts to understand community go back to the emergence of industrial society and the concern that something of value in the traditional, tightly knit local community was being lost as the new formulation of the urban city came to define the lives of ever-larger segments of the world's population (Fernback, 1999). As community came to be understood as not strictly dependent on a physical location, but rather on the types of interactions and meanings found within the community, a new sense of the nature of community emerged. This is well captured in the oft-cited definition of Williams (1976), which describes the quality of holding something in common and a sense of common identity and characteristics

(Williams, 1976). Wallace (1999) describes the new sense of community prior to the ascendance of the Internet as being defined by belonging, loyalty, and commitment—attributes supported by a place-bound vision of community, but not inherently limited to the same.

Bellah, Madsen, Sullivan, Swidler, and Tipton (1985) elaborated on this concept, stating that a community is a group of people who are socially interdependent, who participate together in discussion and decision making, and who share certain practices that both define the community and are nurtured by it. Seen in this way, meaning-making is a central process to any community. These types of definitions contribute to a sense of community less as a place than as an interweaving of interactions and their significance (Jones, 1999). A static community ceases to be a community; we can only understand its temporal existence in a given moment. Fernback (1999) reminded us of this when she describes community as “both an object of study (an entity, a manifestation) and the communicative process of negotiation and production of a commonality of meaning, structure, and culture” (p. 205). Interpersonal dynamics, inter- and intra-group dynamics, and the ideologies underlying each, all contribute to the public sphere of shared experience that this type of community describes. This discussion embraces the notion of community as process, and will attempt to describe the mechanisms by which community takes on meaning for its participants and expresses meaning through them.

Learning Communities

Researchers in education have in the last decade turned hopefully to the community metaphor as a means for understanding and improving the nature of education and the interactions that surround it. From these discussions, the idea of learning community has emerged to signify a group of people who share a common interest in a topic or area, a particular form of discourse about their phenomena, tools and sense-making approaches for building collaborative knowledge, and valued activities that combine the three (Riel & Becker, 2000). The concept of a community of practice (Lave & Wenger, 1991) emphasized the social structures of community that allow novices access to roles that allow them to grow in their understanding and become members of the community. Lave and Wenger (1991) described this experience as legitimate peripheral participation, that is, engagement in

valued activities that build expertise and develop personal engagement as a novice progresses from the periphery toward the shared vision of expertise residing in the community's center. Though these definitions highlight the development of proficiency within the activities and processes that the community values, they do not describe a particular vision of practice or its meaning to individual participants. The process of meaning-making through practices previously described is bound to be highly idiosyncratic for any given community, as the practices are inextricably rooted in a given community's disciplinary focus and goals.

As Beck (1999) noted, seeking linear, directional relationships between constructions of community and valued educational outcomes is a reductionist misframing that ignores the multifaceted nature of community and its multiple possible meanings for its participants. Such linear relationships might also assume that one size, flavor, or metaphor of community can fit all educational needs. This is obviously not the case (Grossman et al., 2000). Grossman and colleagues' learning community involved the intersection of language arts and history, and as such exhibited disciplinary features specific to such a pairing. As they note, the humanities lack common axioms for knowledge production and analysis, and are intimately tied to the relationship between the self and one's sense of humanity and identity (Grossman et al., 2000).

Science-based learning communities, in contrast, must recognize the somewhat more algorithmic nature of knowledge production in science, as well as the relationship of that knowledge to human social practices. By reflecting the disciplinary features of the community's organizing focus, a discipline-based learning community can assist its participants in legitimate peripheral participation leading to enhanced disciplinary knowledge and thinking practices. Gordin, Gomez, Pea, and Fishman (1996) suggested a taxonomy of the features that support active participation in learning communities based in science, listing access to published scientific work, access to tools and raw data of scientists, engagement in dialogue with various community members, participation in joint coordinated activities, and incorporation of the work of community members into the community's archives.

Highlighting the importance of a solid disciplinary grounding for professional learning, Darling-Hammond (1999) found in a policy analysis of all 50 states that an advanced degree in the field where teaching occurred was the

most powerful predictor of student achievement. Teacher learning communities are uniquely positioned to engage teachers in active construction both of content knowledge, and the pedagogical content knowledge that described both how to teach and how to understand student thinking around that disciplinary content (Shulman, 2000; Wilson, Shulman, & Richert, 1987). Understanding community in its many contexts will require varying and perhaps discipline-specific means of analysis as we struggle to make sense of how a community organized around a particular kind of pedagogical content knowledge is perceived by those who live within its processes and meanings.

Beck (1999) offered four types of metaphors often used to explain and define learning community in educational research literature: community as structure, community as activities, community as values, and community as politics. In the analysis that follows the author mainly examines community as activities and values, touching lightly on issues of structure as the discussion enters the realm of online community. As mentioned, structural and political treatments of community are of less concern. It is also suggested that the primary consideration for politics within a community is that politically based distinctions among participants should be surfaced and acknowledged rather than marginalized or minimized. Roles in communities are discussed in more detail in the conclusion; first the values and activities underlying conceptions of the learning community are explored.

Characteristic Activities of Learning Communities

In their analysis of reform networks in American education, Lieberman and Grolnick (1996) described features of successful networks. Each of these comprises a conceptual foundation for a learning community. They described a sense of shared purpose and a commitment to the innovation around which the community is focused (corresponding to the community's values), and information sharing, psychological support, voluntary participation, and equal treatment (corresponding to the community's activities). They also suggested that structure should emerge from activities of the community rather than vice-versa, a position that gave further emphasis to the idea of activities as central to a learning community's purpose and function. In general, they suggested that activities lean away from the

prescriptive and toward engaged problem solving. This corresponds with a theory of professional development as grounded, shared inquiry into professional practice, a vision supported by several researchers (Ball & Cohen, 1999; Wilson & Berne, 1999; Putnam & Borko, 2000). It is also consistent with a perspective of distributed cognition in which the collective capacity for learning and intelligent action cannot be said to reside in any single individual member (Salomon, 1993).

Grossman and colleagues (2000), drawing on their work with 22 high school teachers over a period of thirty months, built on this definition to explore the particular social conditions that encourage this kind of distributed cognition. They suggested that communities must have a group memory and “constitutive narrative” that provide continuity and meaning to the community’s existence. They emphasized an active role for all members of a community in constructing and sharing knowledge relevant to the community’s purpose, recommending that the activities of the community enable participants to label, articulate, and share the tacit knowledge that they have developed through their work (Lieberman & Grolnick, 1996). This approach fosters a sense of respect for the professional knowledge of each community member, and is a critical feature of what they refer to as “navigating the essential tension” of a learning community—the tension between the two equally important goals of supporting student learning and of supporting each community member’s personal intellectual growth and renewal.

Other features that Grossman et al. observed during the development of their learning community include the formation of group identity, norms of interaction, and identification, shared participation in leadership roles, the acceptance of communal responsibility for individual growth, and the public marking of individual identity in relation to the overall identity of the group. Each of these features applies equally well to community in online settings, as will be explored in more detail. They highlight the importance of learning through social interactions with people rather than learning from information alone (Hoadley & Pea, in press; Lave & Wenger, 1991). While these types of norms should emerge in any healthy functioning community, explicit attention to their role can augment any community’s growth and vitality.

Grossman and colleagues (2000) argued against an uncritically inclusive notion of community, describing “pseudocommunities” as groups that lack an authentic sense of shared space and that “behave as if we all agree” by suppressing conflict. In avoiding the coalescence of a pseudocommunity,

they note that status differences, divisions and conflict, and hurt feelings must be acknowledged throughout the community's developmental trajectory. Understanding and navigating differences in values and opinions, they note, is essential to promote wider consensus about the overarching purpose of the community. Groups that ignore or pretend the non-existence of power differentials, or varying levels of influence and authority (Wallace, 1999; Kendall, 1999), might also be labeled pseudocommunities in this way. The term invites consideration of how political metaphors can enter into the discourse and norms of a community (Beck, 1999). It reminds us that an active process of meaning negotiation, give-and-take, and disagreement are normal features of a healthy functioning community. Squelching this authentic meaning-making disrupts the core authenticity of the community as a whole. The reciprocal influence between a community and its component individuals, norms, and practices, are an essential hallmark of community growth. Their documentation and exploration constitute one of several methodological challenges to the study of community.

Advocates claim that learning communities for educators, organized with the proper enabling structures for disciplinary thinking, can contribute to the elusive sense of shared purpose and overcome the traditional isolation experienced by most teachers in their professional work settings (Gordin et al., 1996). They argued that by sharing a way of knowing and a set of practices, and by experiencing the shared value of the knowledge that comes from these procedures, learning communities can have a powerful impact on the beliefs and practices of individuals (Riel & Becker, 2000). By modeling lifelong learning and engagement, learning communities can provide for intellectual renewal, the learning of new content and new ways of thinking about content, and multiple opportunities to cultivate and practice leadership among their members. As further support to this idea, Grossman et al. (2000) suggested that by developing, an understanding of the different intellectual roles played by their peers, community participants come to understand the proto-forms of these types of thought demonstrated by their students. Improved professional practice regarding student learning and enhanced intellectual development of teachers can both be supported through membership in an authentic learning community (Grossman et al., 2000).

The concept of a learning community also resonates with the situated perspective on teacher learning, supporting an approach that provides teachers with learning experiences that are grounded in the reality of their daily practice. Effectively situated teacher professional development draws

on the overlapping contexts of school, classroom, and student thinking and learning. By meaningfully anchoring teachers' own educational experiences in the processes of their daily work, it makes those learning experiences a natural part of their work lives. (Goldman, 2001; Putnam & Borko, 2000). A learning community can be a powerful context to support teachers' ongoing practical inquiry, providing a basis for their self-sustained lifelong professional growth and learning (Ball & Cohen, 1999; Franke, Carpenter, Fennema, Ansell, & Behrend, 1998). Knowledge networking among teachers can provide them with compelling examples of effective practice that are situated in familiar classroom practices and come from socially accessible sources of their colleagues. As discussed next, trust among the members of a community is one necessary though probably insufficient condition for these relationships to emerge. Grounding professional learning in experiences relevant to the actual professional practice desired by researchers can help insure that learning borne of those experiences is transferred into practice (Borko et. al., 2000). The collaborative stances of inquiry into grounded artifacts of practice that characterize the Japanese school system has been credited by researchers with the effectiveness of teacher professional learning in Japan (Linn, Lewis, Tsuchida, & Songer, 2000; Stigler & Hiebert, 1999).

Online Communities

Having explored some general features of learning community, Internet-based or online environments are now explored. Here focus is on the activities and interactions that participants in online social settings experience as those settings begin to develop into what might be called communities. Wellman and Gulia (1999) described online communities as "glocalized:" simultaneously more global, given the potential world-wide reach of the Internet, and more local, allowing participants to focus on very particular and personal interests without leaving their homes. This epithet captures the essential tension of involvement in internet-based communities, between the vast network of planet-spanning computer connections that is the Internet, and the ability of the individual to find a place for his or herself therein. While the basic theoretical grounds for understanding communities in traditional settings apply equally well to communities online, we will see that issues of time, size or scale, identity, take on a different shape and tone in online practice. It is hoped that awareness of the constraints and affordances that impede and enable community formation in online settings will

provide useful waypoints to researchers attempting to foster online learning communities to support professional practice.

Rheingold's (1993) definition of virtual communities as "social aggregations that emerge from the net when enough people carry on those public discussions long enough with sufficient human feeling, to form webs of personal relationships" (p. 6) has been used by many to herald online communities, as if declarations of community alone confirmed their existence. But how long is long enough? What comprises sufficient human feeling? At what point can this "web of personal relationships" be said to exist? In addressing these questions in the online setting, some myths are explored and caveats about online communities are offered. Next online interactions, their relationship to offline interactions, and the implications for meaning-making in online community for individuals and groups are characterized.

Given the hyperbolic nature of many promises and claims regarding online communities, it may be useful as a starting point to describe what online communities are not. A primary feature in public discussion about online community is the polarity of discourse: virtual communities are presented as either ideal utopias or embittered and fragmented dystopias, with measured accounts and modest claims receiving little if any public attention (Kollock & Smith, 1999). In considering social formations online, it is important to recall that any online formulation involving two or more people is not by necessity a community: as Jones (1999) reminds us, connection does not inherently make for community, nor does it lead to any necessary exchanges of information, meaning, and sense-making at all. Over-application of the term may be partially responsible for the disillusionment endemic to dystopian accounts of online community. And while advocates such as Doheny-Farrina (1996) herald the potential of online communities for revitalizing democracy, it is important to recall that online interaction does not occur within a single, homogenous, cultural context: in truth power differentials exist, people come to net with different positions of power within society (Kendall, 1999). As Jones (1999) put it, the exclusivity, inflexibility, isolation, rigidity, and homogeneity that can characterize the darker sides of offline communities can also take root in computer-mediated communities. As previously discussed, marginalization of these political realities undermines authenticity in a community.

Second, though the predominance of the view is waning, many accounts have positioned interaction and identity online as phenomena that are

fundamentally different and distinct from their offline counterparts (Turkle, 1995). Research would suggest that this is not the case. Though differences exist, as I will examine in the next section, the nature of personal interaction and the formation of relationships is fundamentally similar between online and offline environments, albeit influenced by the structural differences described below. Cody and colleagues (1997), exploring online activities of senior citizens, found that identity online is not wholly different than offline: those who are lonely offline tend to remain so online, whereas those who plunge into online interactions also are highly sociable offline. This finding might tentatively assuage those who fear that online community might detract from “real life” community, a wider social concern highlighted by Kraut and colleagues widely publicized study linking Internet use to social withdrawal and depression (Kraut et. al., 1998). In fact, follow-up research by Kraut and colleagues found the initial negative effects dissipated among their original 208 study participants (Kraut et. al., in press), and reinforces the notion that those with more offline social supports and extroverted tendencies will indeed tend to benefit more from online interactions than introverts and socially isolated individuals.

According to Kendall (1999), researchers need to consider participants’ local offline environments, as well as to explore how participants blend their online and offline social contacts. In her view, researchers must recognize that individuals exist and participate in offline social contexts both sequentially and simultaneously with their online participation. Wellman and Gulia (1999) also highlighted the need to acknowledge connections to real life behind any online projection of identity and interaction with others. For the purposes of building an online learning community, the persistence and continuity of personal identity are critical factors, for without an integrated whole behind the facets of identity presented online, the individual lacks an enduring context for the type of growth and development to which learning communities aspire. Research exploring the shape and influence of online community suffers from a lack of attention to its integration with participants’ offline worlds.

Structures and Interactions in Online Community

The bulk of research to date regarding online communities has emerged from sociological studies of organizations sponsored by the business world,

and as such may be in some ways inappropriate for analysis of the more elusive tasks and purposes of online learning communities. However, the sheer number of such studies demands their inclusion in any discussion of identity, interaction, and community online. Not surprisingly given the structured task orientation of most online group interactions in the business world, the majority of these studies have focused on structural elements of computer-mediated communication (CMC) and the implications of communicative structures for organizational objectives such as consensus formation and decision making. These studies have tended to follow a more classic controlled experimental design, trying to decipher the influence of synchronicity/asynchronicity, structural relations among nodes and links (Jackson, 1997; Garton, Haythornthwaite, & Wellman, 1997), and various aspects of CMC systems infrastructure as independent variables.

These structural analyses have provided insight into different psychosocial aspects of CMC. Kiesler and Sproull (1992) found that the reduced social cues of CMC create a willingness in participants to engage in more emotionally charged communication (known to Internet users as “flaming”) than is found in face-to-face communication. They also suggested that CMC reduces the influence of individuals’ hierarchical status and engenders more participation by peripheral members of an organization, a finding echoed in Jones’ (1999) assertion of increased social mobility in CMC environments. Wallace (1999) reports findings that both confirm and question this finding, reporting from one study that CMC structures reduce conformity among members (Smilowitz, Compton, & Flint, 1988), and from another that CMC fosters swifter and more radical group polarization: “as polarization gets underway the group members become more reluctant to bring up... information...that might contradict the emerging group consensus” (Wallace, 1999, p. 81). Finally, Walther (1996) found a similarly paradoxical finding that while many relationships developed through CMC are impersonal by nature, others are *hyperpersonal*, taking on an extremely personal tone more quickly than they do in face-to-face communications, such as online romance and the levels of self-disclosure found in online support groups. Each of these findings points to social context—notably the implicit and explicit purpose of given online interactions—as a highly influential factor affecting the tone of CMC.

These findings also fit Grossman and colleagues’ (2000) notion of pseudocommunity, suggesting that these types of controlled experiments in short-term settings do not demonstrate the type of sustained learning

community, with its acknowledgement of differences and sustained identity performances, that we would aim to support. Clearly CMC structures have an impact on the nature of interaction: as Kollok and Smith (1999) summarized, in cyberspace the economies of interaction, communication, and coordination are different than when people meet face-to-face. The findings previously noted do begin to provide a means for understanding online behaviors and interactions that can seem incongruous when compared to similar face-to-face relational dynamics. However, accepting structure as the critical defining feature of online community is a mistake. In Baym's (1998) exemplary work on community in text-based online newsgroups, she suggested that rather than seeing participants in CMC as operating in ways dictated by available resources or rules, we should understand that participants appropriate, or pick and choose from what is available, to create meanings in ways that researchers or system designers may not foresee. As one example, the lack of social cues in online environments that are normally available in face-to-face environments (Kiesler & Sproull, 1992) has not resulted in reduced expression so much as it has opened the doors for new forms of communication through abbreviation, "emoticons," and other devices that take over some of the functions that nonverbal communication exercises in a face-to-face environment.

Kiesler and Sproull (1992) offered that CMC is a medium in which participants can explore various facets of their identities at low risk to their existing social self-construction. One might hope that in online learning communities, a participant's existing social self-construction might be elaborated, explored, and strengthened through participation in activities that build and reinforce identity and community. Turkle's (1995) seminal work on internet-based identity explored aspects of anonymity and invention in the construction of identity; the author's interest here, however, lies in the connection, rather than the disjunction, between onscreen identity and lived experience. While it is certainly possible that educators might engage in identity performances online that they might not in real life, these performances are more likely to lead to meaningful personal and professional growth when they afford a presentation of self that is more integrated than fragmented. For this reason, continuity and persistence of identity are key factors in developing an online community that has the power to durably transform professional practice.

The conscious choices that individuals make regarding their self-presentation in CMC are in a sense "all-powerful," (Walther, 1996; Jones, 1999) in

that written (typed) language is the only means available for identity presentation and negotiation in a text-based environment: authors are inextricably tied to their words (Walther, 1996). The “distributed presence” inherent to presentation of the self through textual fragments directed at different audiences coexists with the need for continuity and permanence, accountability, and consequence in any authentic community (Kolko & Reid, 1998). Baym (1998) found an apparently natural trend to this effect, noting that frequent users of the CMC system she studied were “more likely to attend to interpersonal aspects, using names and explicitly acknowledging others’ perspectives.” This type of activity marked, in her view, a greater permanence, stability, and personal investment in participants’ online interactions. It contributed to a sense of social presence in which participants accept their online interactions as real and behave accordingly in their “real” lives, using their online experiences to inform their offline growth and development and vice-versa. Ultimately, as Baym (1998) noted, “most social users of CMC create online selves consistent with their offline identities.”

Where can a researcher look for clues to the meanings online community holds for its participants? One key element to the impact of online community on participants’ external contexts is those participants’ varying willingness to accept interactions that occur in cyberspace as real (Baym, 1998). In their ethnographic analysis of Trinidadians’ use of the Internet, for example, Miller and Slater (2000) argued convincingly that patterns of Internet use can best be understood by examining their connections to “core dimensions and contradictions” of Trinidadian history and society as a whole. It may be most productive, then, to examine how CMC both reproduces existing social modes and creates new ones (Jones, 1999). In the context of an online learning community, we will not only need to understand how educators can engage in new forms of interaction online, but also how they bring existing associations, expectations, and practices from their school-based professional lives into their online interactions. Can the core dimensions and contradictions of teaching find a home on the Internet?

Online Meaning-Making for Individuals and Groups

As is the case for individuals, the process of engagement in community on a group level is idiosyncratic and varies according to the purpose and compo-

sition of the group. The style or tone of an online community is fundamentally impacted by the prior history of its members. As with individuals, groups must successfully negotiate the tension between monolithic identity and schizophrenia to produce a group culture that is at once diverse and cohesive. This author agrees with Kolko and Reid (1998) that “it is our plurality, our multiple moods and changing opinions, that allows the creation of a vibrant and vital culture” (p. 227). However, the author does not mean for these ambiguities to trap this discussion in analytical paralysis. As an integrated personal identity leads to cohesive and meaningful identity performances for individuals in a community, so the development of integrated relationships within that community can lead to meaningful public expressions of shared identity that are manifested in the development of group trust.

Baym (1998) offered an operational definition of group trust for online communities, based in the frequency and content of messages exchanged within the community. Online communities with high levels of group trust, she argued, are marked by frequent message exchange. This criteria in itself certainly does not indicate genuine community, though the existence of broad participation in extended topical discussions has been used as a general measure of successful online discussion (Guzdial & Turns, 2000). From a meaning-making perspective, the content and context of those messages are of critical importance. In Baym’s (1998) view, message content in a group that has developed intra-community trust will be characterized by optimism, excitement, a clear task orientation, and shared leadership duties. A productive interplay between more “technologically astute” and more “socially astute” users will insure continued development of trust and higher levels of comfort among the participants, opening the door for more authentic dialogue and healthy mechanisms for describing and resolving conflict.

Group trust is also intuitively evident to newcomers, and plays a significant role in the ability of the community to socialize new members into its community-specific norms and practices (Schlager, Fusco, & Schank, in press). In a community of learners, we would expect this trust to be manifest in frequent, animated, and authentic dialogue among differing points of view, with various “experts” bringing their knowledge to the foreground as needed. Agre (1998) describes these “thought leaders” in a learning community as individuals who see an issue coming, gather positions and arguments about it, network with people who are relevant to it in various ways, and

articulate it in terms that supply useful raw material for individual community members' own thinking in their own situations. When the thought leader role is accessible (or at least potentially accessible) to multiple participants of the community, one form of trust can be said to exist within that community. These features should hold true for any construction of online community; and obviously resonate with the learning communities previously described by Grossman, and colleagues.

Analyzing Online Community

The author has attempted to show how online community exists primarily in the meaning that individual members and the community as a whole derive from their participation therein. It has been argued that individuals must develop online personae consonant with their offline identities, and that group trust must be evidenced for an online gathering to transform into a community that has the potential to influence the lives of its members. Other elements instrumental to individual and group meaning-making and patterns of relation that may signal the emergence of community in an online environment and distinguish any given online community from any other will now be considered.

Baym again provided insight into relevant features of vibrant and functional online communities that can be used to comparatively analyze their development. At the individual level, she noted the processes of experimentation with new forms of expressive communication and the exploration of possible public identities. These playful forms of tentative engagement correspond to earlier stages of community development, and mirror features of the previously described learning community. They highlight the need for multiple, explicit, and non-threatening opportunities for individuals to situate themselves within the context of the group's values. More active levels of community engagement, Baym argues, witness the formation of otherwise unlikely relationships—such as between the practicing scientist and the classroom science teacher, for example, or between geographically far-flung teachers who employ particular reform-based instructional practices—and the emergence of group-specific behavioral norms. Categorizing and taxonomizing these norms is challenging, as they may represent specific forms of expression and uses of language, specific activities, specific parameters for relationships, and other normative conventions

(Baym, 1998; Agre, 1998). According to Baym (1998), “when these emergent features develop into stable group-specific understandings, the group gains the potential to be imagined as a community” (p. 62).

The differences between group-normative conventions found in an online learning community versus any other type of online community, then, may be more of content and degree than of form. Organizers should carefully consider both the online and the learning aspects of community to successfully merge the two: the keys to success may be largely the same, but levels of participation, interaction, shared problem solving, identity formation, trust-building, shared leadership, and shared norms may need to be higher for the community to gel in a visible and productive way. As Pea and colleagues (1999) noted, “the interactions involved in shared learning are more extensive and subtle than the typical tools for sharing information among interest groups; support is needed for long-term, supportive, structured relationships, not just casual exchange of tidbits” (p. 33).

Researchers at WISE (UC Berkeley), HI-CE (University of Michigan), TappedIn (SRI International), and other projects have applied various aspects of the principles previously described to support online learning communities for teacher professional development. They have explored online community as a form of designed professional development, providing various concrete illustrations of the theoretical principles already described. In the concluding section, the grounds for design experimentation in professional development and how researchers in the field have applied the baseline principles for online community to their efforts are described.

ONLINE LEARNING COMMUNITIES FOR EDUCATION: EXAMPLES AND GUIDELINES

Online Community as Designed Professional Development

The Learning Technologies in Urban Schools (LeTUS) project has embraced a design experimentation methodology (Brown, 1992) for professional development, attempting to ground their practical efforts in theoretical knowledge and conduct empirical research on how their innovations fare in natural settings. They have argued that professional development should incorporate its traditional craft knowledge into a science of professional development, and as such have balanced theoretical and empirical knowledge in their formulation of innovative educational solutions. From this

premise they have explored different models of professional development, teacher learning and student learning, exploring how changes in one part of their theoretical framework influence conditions in the others. Empirical assessment of their results allow for constant refinement of both the models that guide their work and the practical enactment of those models in professional development strategies (Fishman, Best, Marx, & Tal, 2001).

Results from their work have provided further guidelines for design and enactment of systemic teacher professional development involving inquiry-oriented learning tools. They emphasized that cultural norms currently in place in schools and districts (including capabilities, policies, management, and culture) pose a considerable challenge to systemic enactment of the kinds of reform they champion (Fishman, Soloway, Krajcik, Marx, & Blumenfeld, 2001; Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000). Further, the bulk of research on professional development has used volunteers—a group with higher intrinsic motivation who tend to be more receptive to innovations and are already doing their job effectively anyway (Bobrowsky, Marx, & Fishman, 2001; Riel & Becker, 2000). How to bring professional learning to less capable and motivated teachers is an open question, partially addressed by the following criteria of accessibility. Though learning community is not the LeTUS group's explicit focus, these principles for designed professional development apply to professional development explored through online community. Applied in this way, the question for researchers is how to support online community as a valid and accessible site for meaning making?

The TappedIn online community was formed to support the ideal that, “by way of engagement with an online community of educators, teachers can reflect on practice with colleagues, share expertise in a distributed knowledge framework, and build a common understanding of new instructional approaches, standards, and curriculum” (Schlager, Fusco, & Schank, in press, p. 7). These processes of community occur in a virtual workplace where any educator can establish a free “virtual office,” share documents, post messages, conduct synchronous (chat-based) meetings, and interact with other members of the TappedIn community through various channels. Over 2,000 members and a steady rate of growth, combined with affective engagement of many members as evinced by their claims of enthusiasm, trust in the community, and development of their sense of professionalism as educators, allow the TappedIn community to claim some measure of success. The detailed structural affordances and designed activities of TappedIn will not be described here (Schlager et. al., in press; Schank,

Fenton, Schlager, & Fusco, 1999). However, the TappedIn experience does highlight some of the unique issues that technology surfaces for professional development in education.

The Role of Technology

The unique affordance of technology may be to overcome the time constraints that hinder so many professional development efforts, by bringing the diversity of thought about educational practice in a given discipline to a setting where all participants can negotiate its relevance to their learning and growth in a way that supports their individual meaning-making and growth as professionals. However, at the present time, this potential benefit is probably overshadowed by the high “entry cost” in terms of technological comfort and ability. Not surprisingly, TappedIn researchers found that teachers and professional developers of teachers must understand and be proficient with online technology before they can engage in productive activities. Documenting this trend, they noted that early utterances in the TappedIn environment focused heavily on technology and the management of online discussion but declined to five percent of discourse as community developed (Schlager et. al., in press). Given the growing presence of computing technologies in our lives, it seems fair to posit that general computing ability and connectivity will be relative givens in the teaching force of the next generation. The ability to effectively apply that technology for educational purposes, including for one’s own professional development, may be less forthcoming.

Researchers and designers of technology-supported professional development need to apply their awareness of this fact to their efforts to design accessibility into their technology-supported programs. Goldman (2001) suggested dedicating time during a community project’s initial phases to developing and supporting technological competence; Hoadley and Pea (in press) of the Center for Innovative Learning Technologies (CILT), recommended tools with “very low threshold interfaces,” or VLTIs, that allow participants to access relevant knowledge without disrupting their workflow. The absence of VLTIs is a significant impediment to many technology-based innovations and partially explains the reluctance of non-volunteering practitioners to invest time and energy in their adoption. At the University of Michigan, the Project Based Science group’s casebook of project practices

(CaPPs), an artifact-grounded teacher development tool, and their project integration visualization tool (PIViT), designed to support teachers' planning activities, are both powerful tools for teacher work and improvement of practice, explicitly grounded in contemporary knowledge about teacher learning (Marx, Blumenfeld, Krajcik, & Soloway, 1998). However, the steep technology learning curve associated with their use keeps them mainly the province of early adapters and volunteers. Current professional development work in the University of Michigan's Center for Highly Interactive Computing in Education (HICE), centers around their Knowledge Networks on the Web approach to developing online communities for professional development (Fishman, Marx et. al., 2001). Math Forum (Renninger & Shumar, in press; Klotz & Weimar, 1999; Renninger, Weimar, & Klotz, 1998) is another successful example of teachers talking with teachers about teaching and collaboratively building knowledge about math learning.

Social Supports for Online Community Building

The vision of community-based learning described here suggests that the most powerful supports for teacher knowledge building may be less structural than social. Certainly structural considerations such as threadability of discussions, the nature of artifact representation for grounded discourse, community size, and the like are fair game for design research on professional development. More critical is the way that norms, roles, and identity are exercised in these environments. All successful communities are organized around their own norms; however, by virtue of being learning communities in online settings, it is reasonable to expect that some of the norms emerging over time would address issues of learning. Language, activities, and social interchanges within the community should reflect this commitment to learning through reflective engagement and knowledge of sharing. Not only technologically but socially as well, these communities should create contexts that encourage sharing knowledge among participants of differing abilities and expertise (Clift, Mullen, Levin, & Larson, 2001). Conversations benefit from being anchored in practice as previously described as well—Guzdial and Turns (2000) found that such anchoring led to significantly more productive and sustained discussions in online environments among students in university courses. Mayer-Smith, Pedretti, and Woodrow (1998) suggested that computer mediated communication that is

grounded in practice supports “a special kind of partnership, where participants establish a common vision, and view their roles and responsibilities as completely interwoven, interdependent, complimentary, and essential to the project” (p. 133).

Supporting authentic growth for all community members through legitimate peripheral participation (Lave & Wenger, 1991) requires awareness of what Nolan and Weiss (in press) referred to as the curricula of community: protocols and norms that describe issues of participation, membership, and control. In the expansive setting of the Internet, a community’s “valued activities” may be more likely to cross traditional group interest lines, bringing new human resources into learning such as retirees and practicing scientists and fostering the “unlikely relationships” that Baym cites as a happy by-product of a vital online community (Glaser, 2000; Baym, 1998; Pea et al., 1999). The SCOPE project has aimed to foster such relationships through online knowledge forums that draw together teachers, education researchers, scientists, and technologists for discussions and knowledge networking related to scientific and pedagogical knowledge (Bell, in press). Though ideally, learning communities are politically open, designers should remain aware of how perceived differences in status, power, and expertise may play themselves out in community interactions. Open acknowledgement of these differences should be welcomed and publicly acknowledged as a sign of community development and emerging trust.

Trust itself remains one of the most valuable goals for enabling authentic learning within a community, as well as perhaps the most elusive. It fosters the sense of belonging, commitment, and loyalty that marked the earliest formations of community among human beings. It engenders optimism, excitement, shared responsibility, and growth and learning of all community members. One vehicle for building trust, as mentioned, involves providing multiple, explicit, and non-threatening opportunities for individuals to establish their identity in the context of the community’s group values, to establish themselves in relation to the narrative that defines the community’s existence. Engaging in this activity across various roles, from initiate, to thought leader, facilitator, or devil’s advocate helps consolidate an identity performance and establish social ties with the other community members with whom their interaction is realized. As Levin and Cervantes (in press) note, awareness of the stages of development, growth, decline, and renewal that network-based communities experience can help accurately identify and support the dynamics at work in any given stage thereof.

Consistent with this theory, TappedIn researchers attributed a significant measure of their success to the “persistent place and identity” that they have encouraged visiting educators to build through their virtual offices. Other identity-based constructs that have enhanced the TappedIn community involve the diversity of the community: they report having successfully attracted a population with diverse interests and expertise within the profession (approximately 50% of members are teachers). Participatory leadership also plays a significant role in TappedIn; their research has shown that the primary catalyst for professional growth in their online community is teachers’ changing roles and contexts within the community, and that the multiple styles, modes, and paces of interaction available through TappedIn encourage participatory leadership among the community members. Developing professional identity is a primary goal of the TappedIn community, one they claim to accomplish through regular meaningful activities that, analyzed with their coding schemes, have given rise to consistent occurrences of knowledge building, mentoring, argumentation, and resolution.

Learning communities designed to support teacher learning around the Web-based Inquiry Science Environment (WISE) at UC Berkeley also highlight, among other factors, the need for persistence and growth of identity (Cuthbert, Clark, & Linn, in press). Evaluation methodologies are needed that allow us to understand the emergence of these conditions and the interactions and design factors that support them. This will require a continued focus on, and efforts to empirically operationalize, the reciprocal influence of online and offline ecologies of personal and professional identity, and their relation to classroom practice and teacher learning for educators. We need empirical study on the dynamics that influence how an individual makes sense of their own professional knowledge and comes to express their knowledge and their identity in a social arena. Structural, technology-based supports can provide effective scaffolding for this process only if we are able to understand it.

CONCLUSION

This discussion has focused on the reciprocal impact that online interactions express between individuals and the community that they form. It explores the qualities that internally define an online community and lend meaning to

its activities for the participants within its context. Though number and frequency of connections provide some sense of the activity of community, they say little about how these interactions influence the identity formation, meaning-making, and professional practice of participants. As Jones (1999) stated, the social construction of reality that exists online is not constituted *by* the networks CMC users use, it is constituted *in* those networks. It is far easier to understand the physical, hardwired connections than to understand the symbolic connections that emerge from interaction. As Jones puts it, “it is not the transmission of information, but the ritual sharing of information that binds communities in cyberspace” (p. 6). The author also agrees with Baym (1998) that an online community’s “style” is shaped by a range of preexisting structures, and is emergent rather than predictable. In her words, “it may not be possible to specify the specific factors that will combine to affect CMC outcomes in a particular group in advance of actual interaction, let alone what the impact of those factors will be” (p. 49). For these reasons, the author favors a participant-observation approach such as that employed by Kendall (1999) or Kolko and Reid (1998) in their online community research. As with traditional approaches to participant-observation research (Glesne, 1999), the online participant-observer should become a familiar part of the social setting of the online community, gaining an insider view while maintaining a critical and reflective stance toward their own participation and observation. As Kendall noted, participant observation allows researchers to gain a better understanding of participants’ ranges of identity performances and the meaning those performances have for them.

Any sustained engagement in an environment where an educator negotiates their beliefs and values about teaching and learning, should allow that educator to reap some of the benefits of learning community. As Schlager et al. (in press) are learning through their efforts with TappedIn, we should view community as a context in which efforts can take root and propagate, rather than as an outcome in itself. A platform of community on which we can develop efforts at professional growth and development needs dedicated time and resources so that it may mature, develop social norms, grow leaders, and become part of the dominant culture.

Learning communities both online and offline are about sharing meaning, identity, and growth. The impact that community participation has on the professional work of individuals is inherently idiosyncratic, informed by the participant’s prior knowledge and experiences, their learning experiences and meaningful interactions in the online environment, and their ability to

use that learning and experience to thoughtfully and reflectively form their practice. As Grossman et al. (2000) found in their work, transformative events in the professional lives of teachers occur when they take on new roles within the educational community, engage in sustained essential dialogue about teaching and learning, and test and reshape the boundaries of their professional knowledge. This definition highlights Jones' (1999) point that to be considered a learning community, engagement therein must lead to some kind of change in action or practice. Our shared knowledge about building learning communities offers many insights into the dimensions that will support their effective coalescence; the time has come to establish the link between these innovative forms of professional development, a robust vision of educational community, and student learning outcomes. Understanding this dynamic, for online communities as well as other forms of professional development, is a research imperative.

References

- Agre, P. (1998). Designing genres for new media: Social, economic, and political contexts. In S. Jones (Ed.), *Cybersociety 2.0: Revisiting computer-mediated communication and community*. Thousand Oaks, CA: Sage.
- Ball, D., & Cohen, D. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession*. San Francisco: Jossey-Bass.
- Beck, L. (1999). Metaphors of educational community: An analysis of the images that reflect and influence scholarship and practice. *Educational Administration Quarterly*, 35(1), 13-45.
- Bellah, R.N., Madsen, N., Sullivan, W.M., Swidler, A., & Tipton, S.M. (1985). *Habits of the heart: Individualism and commitment in American life*. Berkeley, CA: University of California Press.
- Baym, N. (1998). The emergence of online community. In S. Jones (Ed.), *Cybersociety 2.0: Revisiting computer-mediated communication and community*. Thousand Oaks, CA: Sage.
- Bell, P. (in press). Studying the educational opportunities of current controversies in science. In M.C. Linn, E.A. Davis, & P. Bell (Eds.) *Internet environments for science education*. Mahwah, NJ: Lawrence Erlbaum.
- Blumenfeld, P., Fishman, B., Krajcik, J., Marx, R., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project based science in urban schools. *Educational Psychologist*, 35(3).

- Bobrowsky, W., Marx, R., & Fishman, B. (2001). *The empirical base for professional development in science education: Moving beyond volunteers*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis, MO.
- Borko, H., Peressini, D., Romagano, L., Knuth, E., Willis-Yorker, C., Wooley, C., Hovermill, J., & Masarik, K. (2000). Teacher education does matter: A situative view of learning to teach secondary mathematics. *Educational Psychologist*, 35(3), 193-206.
- Brown, A.L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2 (2), 141-178.
- Clift, R., Mullen, L., Levin, J., & Larson, A. (2001). Technologies in contexts: Implications for teacher education. *Teaching and Teacher Education*, 17, 33-50.
- Cody, M.J., Wendt, P., Dunn, D., Pierson, J., Ott, J., & Pratt, L. (1997, May). *Friendship formation and creating communities on the Internet: Reaching out to the senior population*. Paper presented and the Annual Meeting of the International Communication Association, Montreal, Canada.
- Cuthbert, A., Clark, D.B., & Linn, M. (2002). WISE learning communities: Design considerations. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Darling-Hammond, L. (1999). *Teacher quality and student achievement: A review of state policy evidence*. Seattle, WA: Center for Teaching and Policy.
- Doheny-Farrina, S. (1996). *The wired neighborhood*. New Haven : Yale University Press.
- Elmore, R., Peterson, P., & McCarthy, S. (1996). *Restructuring in the classroom: Teaching, learning, & school organization*. San Francisco: Jossey-Bass.
- Fernback, J. (1999). There is a there there: Notes toward a definition of cybercommunity. In S. Jones (Ed.), *Doing Internet research: Critical methods and issues for examining the Net*. Thousand Oaks, CA: Sage.
- Fishman, B., Best, S., Marx, R., & Tal, R. (2001). *Fostering teacher learning in systemic reform: Linking professional development to teacher and student learning*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis, MO.
- Fishman, B., Marx, R., Bobrowsky, W., Merrill, W., Warren, D., & Ball, A. (2001, April). *Knowledge networks on the web: An online professional development resource to support the scaling up of curriculum enactment*. Demonstration presented at the annual meeting of the American Educational Research Association, Seattle, WA.

- Fishman, B.J., Soloway, E., Krajcik, J., Marx, R., & Blumenfeld, P. (2001, April). *Creating scalable and systemic technology innovations for urban science education*. Paper presented at the Annual Meeting of the American Educational Research Association. Seattle, WA.
- Franke, M., Carpenter, T., Fennema, E., Ansell, E., & Behrend, J. (1998). Understanding teachers' self-sustaining, generative change in the context of professional development. *Teaching and Teacher Education*, 14(1), 67-80.
- Fullan, M. (1991) *The new meaning of educational change*. New York: Teachers College Press.
- Garton, L., Haythornthwaite, C., & Wellman, B. (1997). Studying online social networks. *Journal of Computer-Mediated Communication*, 3(1).
- Glaser, R. (2000). Cognition and instruction: Mind, development, and community. *Journal of Applied Developmental Psychology*, 21(1), 123-127.
- Glesne, C. (1999). *Becoming qualitative researchers*. New York: Addison-Wesley.
- Goldman, S. (2001). Professional development in a digital age: Issues and challenges for standards-based reform. *Interactive Educational Multimedia*, 2, 19-46.
- Gordin, D., Gomez, L., Pea, R., & Fishman, B. (1996). Using the world wide web to build learning communities in K-12. *Journal of Computer-Mediated Communication*, 2(3).
- Grossman, P., Wineburg, S., & Woolworth, S. (2000). *What makes a teacher community different from a gathering of teachers?* Seattle, WA: Center for Teaching and Policy.
- Guzdial, M., & Turns, J. (2000). Effective discussion through a computer-mediated anchored forum. *Journal of the Learning Sciences*, 9(4), 437-469.
- Hawley, W., & Valli, L. (1999). The essentials of effective professional development: A new consensus. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession*. San Francisco: Jossey-Bass.
- Hoadley, C., & Pea, R. (2002). Finding the ties that bind: Tools in support of a knowledge building community. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Jackson, M. (1997). Assessing the structure of communication on the world wide web. *Journal of Computer-Mediated Communication*, 3(1).
- Jones, S. (1999). Studying the net: Intricacies and issues. In S. Jones (Ed.), *Doing internet research: Critical methods and issues for examining the Net*. Thousand Oaks, CA: Sage.
- Kendall, L. (1999). Recontextualizing "Cyberspace": Methodological considerations for online research. In S. Jones (Ed.), *Doing Internet research: Critical methods and issues for examining the Net*. Thousand Oaks, CA: Sage.

- Kiesler, S., & Sproull, L. (1992). Group decision making and communication technology. *Organizational Behavior and Human Decision Processes*, 52, 96-123.
- Klotz, E., & Weimar, S. (1999). Math forum annual National Science Foundation grant progress report. Published electronically at <http://mathforum.org/build/99.html>.
- Kolko, B., & Reid, E. (1998). Dissolution and fragmentation: Problems in online communities. In S. Jones (Ed.), *Cybersociety 2.0: revisiting computer-mediated communication and community*. Thousand Oaks, CA: Sage.
- Kollock, P., & Smith, M. (1999). Communities in cyberspace. In M. Smith & P. Kollock (Eds.), *Communities in cyberspace*. London: Routledge.
- Kraut, R., Kiesler, S., Boneva, B., Cummings, J., Helgeson, V., & Crawford, A. (2002). Internet paradox revisited. *Journal of Social Issues*, 58, 49-74.
- Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukopadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well being? *American Psychologist*, 53(9), 1017-1031.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
- Levin, J., & Cervantes, R. (2002). Understanding the lifecycles of network-based learning communities. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Lieberman, A. (1995). Practices that support teacher development. *Phi Delta Kappan*, 76(8), 591-598.
- Lieberman, A., & Grolnick, M. (1996). Networks and reform in American education. *Teachers College Record*, 98(1), 7-44.
- Linn, M.C., Lewis, C., Tsuchida, I., & Songer, N.B. (2000). Beyond fourth-grade science: Why do US and Japanese students diverge? *Educational Researcher*, 29(3), 4-14.
- Loucks-Horsley, S., Hewson, W., Love, N., & Stiles, K. (1998). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.
- Marx, R., Blumenfeld, P., Krajcik, J., & Soloway, E. (1998). New technologies for teacher professional development. *Teaching and Teacher Education*, 14, 33-52.
- Mayer-Smith, J., Pedretti, E., & Woodrow, J. (1998). An examination of how science teachers' experiences in a culture of collaboration inform technology implementation. *Journal of Science Education and Technology*, 7(2), 127-134.
- Miller, D., & Slater, D. (2000). *The Internet: An ethnographic approach*. New York: Berg.

- Nolan, J., & Weiss, J. (2002). Learning cyberspace: An educational view of online community. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Pea, R., Tinker, R., Linn, M., Means, B., Bransford, J., Roschelle, J., Hsi, S., Brophy, S., & Songer, N. (1999). Toward a learning technologies knowledge network. *Educational Technology Research & Development*, 47(2), 19-38.
- Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(1), 4-15.
- Renninger, K., & Shumar, W. (in press). Community building with and for teachers at the math forum. To appear in K. Renninger and W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Renninger, K. A., Weimar, S. A. & Klotz, E. A. (1998). Teachers and students investigating and communicating about geometry: The math forum. In R. Lehrer & D. Chazan (Eds.), *Designing learning environments for developing understanding of geometry and space*. Mahwah, NJ: Lawrence Erlbaum.
- Rheingold, H. (1993). *Virtual Communities*. Reading, MA: Addison-Wesley.
- Riel, M., & Becker, H. (2000, April). *The beliefs, practices, and computer use of teacher leaders*. Paper presented at the meeting of the American Educational Research Association, New Orleans, LA.
- Salomon, G. (Ed.) (1993). *Distributed cognitions: Psychological and educational considerations*. Cambridge, UK: Cambridge University Press.
- Scardamelia, M., & Bereiter, C. (1994). Computer support for knowledge building communities. *Journal of the Learning Sciences*, 1(1), 37-68.
- Schank, P., Fenton, J., Schlager, M., & Fusco, J. (1999). From MOO to MEOW: Domesticating technology for online communities. In *Proceedings of the Third International Conference on Computer Supported Collaborative Learning*, 518-526.
- Schlager, M., Fusco, J., & Schank, P. (2002) Evolution of an online education community of practice. To appear in K. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace*. New York: Cambridge University Press.
- Shulman, L. (2000). Teacher development: Roles of domain expertise and pedagogical knowledge. *Journal of Applied Developmental Psychology*, 21(1), 129-135.
- Smilowitz, M., Compton, D., & Flint, L. (1988). The effects of computer mediated communication on an individual's judgment: A study based on the methods of Asch's social influence experiment. *Computers in Human Behavior*, 4, 311-321.

- Stahl, G. (2000). Collaborative information environments to support knowledge construction by communities. *AI & Society*, 14, 71-97.
- Stigler J., & Hiebert, J. (1999) *The teaching gap*. New York: The Free Press.
- Stone, A.R. (1996). *The war of desire and technology at the close of the mechanical age*. Cambridge, MA: MIT Press.
- Turkle, S. (1995). *Life on the screen: Identity on the age of the Internet*. New York: Touchstone.
- Turoff, M., Hiltz, S.R., Bieber, M., Fjermestad, J., & Rana, A. (1999). Collaborative discourse structures in computer mediated group communications. *Journal of Computer Mediated Communications*, 4(4).
- Wallace, P. (1999). *The psychology of the Internet*. Cambridge, UK: Cambridge University Press.
- Walther, J. (1996). Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication Research*, 23(1), 3-43.
- Wellman, B., & Gulia, M. (1999). Virtual communities as communities: Net surfers don't ride alone. In M. Smith & P. Kollok (Eds.), *Communities in cyberspace*. London: Routledge.
- Westheimer, J. (1998). *Among schoolteachers: Community, autonomy, and ideology in teachers' work*. New York: Teachers College Press
- Williams, R. (1976) *Keywords: A vocabulary of culture and society*. New York: Oxford University Press.
- Wilson, S., & Berne, J. (1999). Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. *Review of Research in Education*, 24, 173-209.
- Wilson, S., Shulman, L., & Richert, A. (1987). 150 different ways of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.), *Exploring teacher thinking*. Sussex, England: Holt, Rinehart, & Winston.

Note

This material is based upon research supported by the National Science Foundation under grant REC 98-05420. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

1. SCOPE and the SCOPE Teacher Center can be viewed online at <http://scope.educ.washington.edu/>