7

The Centrality of Culture and Community to Participant Learning at and with The Math Forum

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In this chapter, the terms *culture* and *community* are problematized, and their centrality to participant learning at and with The Math Forum (math-forum.org) is discussed.[2] Culture, as it is used here, refers to the rituals and norms that come to be associated with a site and its functioning. Community describes recognition of connections to and identification with other participants.

The Math Forum is an interactive and inquiry-informed digital library, or virtual resource center, for mathematics education. Previous chapters have addressed the ways in which The Math Forum has leveraged the concept of community in order to become a dynamic and resource-rich educational site (Renninger & Shumar, 2002; Shumar & Renninger, 2002). In the present chapter, this analysis is taken a step further. The culture of The Math Forum is described as providing its participants with a unique set of opportunities for learning and for making the relationship between the individual and the community one in which individual and community

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[1] Order of authorship is alphabetical.

[2] The present discussion is informed by in-depth structured interviews with teacher partici-pants over three years of work with The Math Forum (Renninger & Shumar, 2002), study of student responses to the Problems of the Week (Renninger, Farra, & Feldman-Riordan, 2000), study of participant-mentor exchanges in the Ask Dr. Math service (Renninger & Farra, 2003), study of collaboration in the context of site projects (Shumar, 2003), study of site participation using Internet questionnaires (Renninger & Shumar, in press), participant observation in workshops and projects, and focus group discussions with staff (Renninger & Shumar, 2000).

needs can both be met. Site culture enables contributions from individuals that by definition help to build out and sustain this community.

Math Forum participants include Math Forum staff members and a mix of teachers, students, and other individuals such as parents, software developers, mathematicians, math educators, professionals, and tradespeople, many of whom also volunteer their time as mentors for the site. Participants differ not only in terms of their roles, but in their experience, level of expertise, and interest for mathematics (Renninger & Shumar, 2002). Thus, partnerships and mentoring on the site typically take the form of cross-age tutoring, in that participants with different strengths work to scaffold each other's understanding of mathematics.

Two prepositions (*at* and *with*) can be used to describe the kinds of connections that Math Forum participants make between what they know and what they learn in working with site resources. This is because The Math Forum is both (a) a content site that has extensive archives and links to information and (b) an interactive site that promotes information exchange, discussion, and community-building. The Math Forum resources are rich, deep, and interactive. It is the site's interactivity, however, that distinguishes its resources from those provided by an encyclopedia or a compendium of tables. The design of the site leads participants to try out and select different ways of working with its content. Participants are not told what they need to do or learn on the site. The learning that takes place is driven by the questions and interests of participants and is facilitated by the design of the site.

The Math Forum presently consists of over a million and a half pages. It offers a number of services: five problems of the week, or *PoWs*, which are weekly, interactive, nonroutine, challenge problems that are archived along with explanations and answers; the interactive *Ask Dr. Math* service and its archives of frequently asked questions; and *Teacher2Teacher*, a question-and-answer discussion forum that is also archived. In addition, the site includes lessons, projects, games, discussions, and a newsletter.

The learning that characterizes participant engagement at and with The Math Forum appears to have its roots in both the site's culture and community (Holland et al., 1998; Lave, 1993; Smolka, DeGoes, & Pino, 1995), as well as in the staff members' goals to facilitate the development of mathematical thinking (DeCorte, Verschaffel, & Op T'Eynde, 2000; Ginsberg, Klein, & Starkey, 1998; Schoenfeld, 1987; 1992). Prior studies of Math Forum participation (see Renninger & Farra, in press; Renninger, Farra, & Feldman-Riordan, 2000; Renninger & Shumar, 2002; Renninger, Weimar, & Klotz, 1998; Shumar, in press) suggest that it is the interactive resources that (a) enable participants to make connections to serious mathematics content; (b) lead participants to engage their own questions and persevere in finding solutions or answers to them; and (c) provide models for working with challenging problems and topics

(Pea, 1993). These studies further suggest that interactive resources can provide a basis for interested engagement if interest for mathematics (pedagogy or technology) is less-developed initially. They also indicate that interactive resources can also lead to deepened interest(s) if participants bring a well-developed interest for mathematics (pedagogy or technology) to their work with the site (Renninger & Shumar, 2003).

In exploring the new social spaces opened up by the Internet, the staff appears to be enabling Math Forum participants to engage in forms of interaction that differ from those with which they are familiar. Thus, for example, elementary children may work on answering a question with a world famous mathematician (e.g., Renninger, Weimar, & Klotz, 1998); teachers may work with programmers to more effectively gauge the type of support students need (e.g., Shumar, 2003), and mathematicians may end up in a conversation with a pipe fitter or other tradesperson. Opportunities to work with people who are not part of one's everyday world lead participants to new senses of identity and identification. These new options for working and sharing together also promote the development of renewable resources for a site like The Math Forum that has archives.

The site provides individuals and groups of individuals with opportunities and support to experience optimal levels of autonomy. Also, it provides opportunities and support to engage in interactions that cause them to stretch what they know about mathematics, math pedagogy, and/or technologies that enhance mathematics teaching and learning (e.g., Renninger & Farra, 2003; Renninger, Farra, & Feldman-Riordan, 2000; Renninger & Shumar, 2002). Importantly, staff members' decision-making about the design and refinement of Math Forum services is informed by both their goals for the service and formal and informal sources of data, including research on service usage (e.g., Renninger & Farra, in press; Renninger, Farra, & Feldman-Riordan, 2000; Renninger & Shumar, 2002; Renninger, Weimar, & Klotz, 1998), feedback to the webmaster and the staff, and Internet questionnaires distributed to all participants.

Interviews with its participants suggest that the culture of The Math Forum typically contrasts with participants' other experiences as learners because it is a community to which they are welcomed and with which they feel comfortable working, regardless of how strong or weak their skills are (see discussion in Renninger & Shumar, 2002). Participants report that in their work with the site they are led to create opportunities and support for themselves that, in turn, lead to change in their participation over time. Resources that are used at The Math Forum lead to continued work with The Math Forum, which in turn leads to the development of new resources. Moreover, the tracks of these interactions are the raw materials out of which the different archives are developed. As such, work at and with The Math Forum is dialectical.

THE MATH FORUM

The Math Forum is a situated context for learning (Barab & Duffy, 2000; Chaiklin & Lave, 1993; Cole, Engestrom, & Vasquez, 1997; Kirshner & Whitson, 1997; Lave & Wenger, 1991) in which participants can be involved whenever, wherever, and however they choose as long as they have a connection to the Internet. The combination of site interactivity and substantial content appears to enable the site to be responsive to all types of learners. Across services, the culture or norms for interacting with others include (a) assuming that participants are using the site to learn or figure something out, (b) accepting at face value what a person says about both their interest and understanding, and (c) using an inquiry approach of questioning, exploring, and modeling in order to enable the participant to understand (c.f., Bruner, 1966). Participants using the Ask Dr. Math service, for example, typically do not receive answers to questions. Rather, if a participant asks how to solve a problem, the mentor is likely to ask what the participant needs to know in order to be able to solve the given problem, or others like it, on his or her own (see discussion in Renninger & Farra, 2003).

Interactive services that enable the asking of questions, searching for answers with partial information or misspelled words, and reviewing of past questions or problems and solutions encourage participant engagement. They also provide reinforcement for participation. The process of working with services such as these positions participants to work on their own questions. They are assisted with clarifying their questions so that they can answer them by themselves and/or realize related or alternative solution paths. Because the services help participants to clarify their questions, they also make it possible for the mentors to better adjust their responses to address the questions that the participants are posing and increase the likelihood of their responses meeting the participants' interests and needs (Pea, 1993).

One reason that The Math Forum can begin to meet the needs of its participants is that it has a large corps of participants who serve as volunteer mentors. Volunteer mentors are not simply ceded the responsibility of working with others on the site, however. They are trained and supported as they assume these roles. Volunteers are considered to be in training with a particular service until each of them has demonstrated the ability to listen and provide questions or pointers to the questions as posed. Student mentors for the cross-age tutoring, which is a component of the Elementary Problem of the Week service, are also given instruction about how to write constructive responses to submissions, and the responses that are sent to other student participants are reviewed by their teachers and/or Math Forum staff members.

The design of the site also includes a set of Ask Dr. Math offices, PoW offices, and other service offices that are accessible by staff members and

volunteer mentors. Math Forum staff and volunteer mentors use these offices for training and for facilitating discussions among volunteers who have already been trained and tenured. These discussions often address staff members' and volunteers' concerns about particular problems that reoccur and dilemmas that arise. They work together and with Math Forum staff to generate alternate answers to questions, check that their intuitions are correct, and so forth. Also, they can request more information about answers to questions for which they do not know the answers (Renninger & Farra, 2003).

Importantly, the interactivity of Math Forum services is complemented by mathematics content that has depth and breadth. It is unlikely that the design of services alone would support participant learning or the willingness to be a volunteer mentor without the site's content (see related discussion in Shulman, 1986). Math Forum resources include a range of formats for topics in mathematics that typically span the K–12, undergraduate, and postgraduate levels. Just as participants who come to the site typically find and work with topics in the forms that work best for them given their dispositions, abilities, and levels of math, volunteers on the site can choose which problems/questions to mentor based on the topic being addressed because of the setup of the office for each service. This enables mentors to continue to develop their own thinking about particular topics, in addition to helping others to understand or think about them.

The fact that the same protocol for working with participants on the site characterizes (a) each of the services, (b) the webmaster's responses, and (c) staff members' interactions with each other and other participants means that newer participants feel welcome and realize that they too can ask questions and offer answers. Participants' ease in identifying the interactivity of the site has also been found to lead them to explore the site and identify other services and resources with which they then typically begin to work over time (see Renninger & Shumar, 2002). The design of the site includes many paths and many opportunities through which participants can anchor their knowledge (CTGV, 1990, 1991). Participants are encouraged to ask questions and learn using formats that make sense to them. If participants do best pursuing questions in the archives, the search function is set up to help them. If they do better talking with others about their questions, services and discussion groups are available.

Participants who continue to return to the site also report that their site involvement expands over time (Renninger & Shumar, 2002). Even if they initially sought only to support their students, teacher participants typically find themselves learning, teaching, and doing math themselves as they work with the site. In the process of designing a lesson on understanding how to find the volume of three-dimensional figures, for example, a

middle-school mathematics teacher might look for:

- Sample lessons to help students understand the difference between two-dimensional and three-dimensional figures (e.g., mathforum.org/alejandre/workshops/recprism.html; mathforum.org/alejandre/workshops/net.html; mathforum.org/brap/wrap/midlesson.html);
- Questions and answers in the Dr. Math archives that provide explanations of the characteristics of two- and three-dimensional figures (e.g., mathforum.org/dr.math/faq/faq.formulas.html);
- Problems of the Week at different levels of difficulty (e.g., mathforum.org/midpow/solutions/solution.ehtml?puzzle=64; mathforum.org/calcpow/solutions/solution.ehtml?puzzle=15; mathforum.org/calcpow/solutions/solution.ehtml?puzzle=16); and/or
- Discussions comparing students' responses to and questions about the volume of two cylinders made from the same size paper, one turned vertically and the other horizontally, in the Bridging Research and Practice videopaper (mathforum.org/wrap/brap).[3]

Teacher participants typically describe their use of Math Forum resources in terms of discrete resource-related goals such as finding answers to questions or providing students with nonroutine challenge problems. They talk about The Math Forum as different from their everyday experience of mathematics, and they return to use the site again and again, citing the availability of resources, the way in which people respond to their students or to them, and all of the things that they still want to check out (Renninger & Shumar, 2002). In contrast to discussions that suggest that culture is invisible to its participants (e.g., Rogoff, 1998), Math Forum participants talk about their own work with The Math Forum site as distinct from experiences they have had with other sites or mathematics resources, and/or with mathematics as a discipline (Renninger & Shumar, 2002). It appears that the site adds value to their experiences (CTGV, 1996). Participants

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[3] Similarly, students have a range of resources that involve different types of learning on the site. Elementary-aged students who are assigned to work with the Elementary Problem of the Week (ElemPoWs), for example, may use other site resources to help them explain their solution path (part of the ElemPoW task). They can search the PoW, Frequently Asked Questions (FAQs), or Dr. Math archives. Also, if they have not been able to answer their question based on their own searching, they can write to Dr. Math. While they cannot get a Dr. Math mentor to do problems for them, they can get help that will allow them to proceed in their work if they explain what their questions are, resources with which they have worked, and what they still do not understand. Through their teachers, elementary-aged students may also get involved in developing challenge problems that will later be posted for other students as ElemPoWs. Once problems they help to write are live (posted), they can work to mentor solutions that are submitted to the problems they helped develop, be led to think through the range of solution types submitted, and rethink the framing of the problems developed.

may be attuned to the culture of the site because they work with the site as an extension of individual culture. The site is not a replacement for the classroom and the school curriculum, but the culture of the site encourages individuals to extend their own interests and enrich their experience of their school curriculum. As such, the culture serves to enhance their experience with mathematics.

The site holds value for its participants, at least in part, because it has been designed and built out in collaboration with its participants (including the staff members). In fact, it could be argued that technology facilitates the tweaking, revision, and/or reorganization of norms or rituals, the culture that participants associate with the site. Moreover, as participants adjust their understanding of the site and contribute suggestions for its further development, they come to identify with the site in some way. Since the site uses participant input to refine its services, it could be said to be fine tuning its culture to its participants' strengths, needs, and interests.

Renninger and Shumar (2002), reporting on findings from in-depth structured interviews with site participants, suggest that it is possible to identify three types of Math Forum teacher participation: (a) those who find the site and are positioned to immediately make use of the resources it provides; (b) those who find the site and have a sense of what they might do to use its resources but need support to do so; and (c) those who find the site only because they have to and need a substantial amount of support both from the site and from others in their environment to persevere to make use of its resources. Importantly, over the three years of their study, those participants who were identified as needing particular levels of support when they were first interviewed were eventually positioned to help their colleagues or students to work with the site. The change typically meant that over time they needed less support from site staff members, and they were able and willing to help others. Changed participation was enabled by several forms of support: (a) the autonomy or space for participants to work with the site on their own questions whenever, however, and wherever they choose; (b) participant interaction with others and site resources to address their questions; and (c) opportunities for participants to extend or stretch what they know (Renninger & Shumar, 2002).

It seems that in their interactions with the site, Math Forum participants are led to new senses of possibility for themselves (Markus & Nurius, 1986; Renninger & Shumar, 2002), and they are positioned to explore and to shift their identities as learners (Barab & Duffy, 2000; Linehan & McCarthy, 2000). Take, for example, the case of the teacher who once thought she was neither mathematical nor able to work with technology. Forced to do something with technology because her school was becoming a model tech school, she found and decided to print out Math Forum problems of the week for her classes. Over the three years that she and her use of The Math Forum were studied, she became increasingly confident about mathematics

and teaching mathematics, and descriptions of her classroom instruction suggested shifts to reform practices. By the end of the second year, she had assumed a position in a different school as a lead teacher helping others to teach mathematics and use technology (see case description and discussion in Renninger & Shumar, 2002).[4]

Even though The Math Forum differs from most other sites because its participants are heterogeneous, it seems that the differences that exist between participants actually reinforce the participants' sense of the site as a community. On The Math Forum site many participants have strong mathematics backgrounds, and many do not. Some of these participants can also be identified as having a well-developed interest for mathematics; others cannot. There are participants who may have answers to one kind of question and others who can help think about other types of questions. Furthermore, some participants have been working with the site since The Math Forum's beginnings as a listserv discussion of the Visual Geometry Project (which produced The Geometer's Sketchpad), and some began working with the site when it evolved into The Geometry Forum. Other participants became involved with the site when the National Science Foundation (NSF) first encouraged the site to broaden its base to become The Math Forum, whereas others have only just located the site.

There are always possibilities for collaborating to figure something out on The Math Forum site. There are others with whom to check in and people for whom a person may have answers. Moreover, based on Internet questionnaires, it appears that approximately a third of the site's participants can be considered sticky traffic, a core group of participants who return to the site over time who are familiar with Math Forum culture. These participants can be assumed to have worked with site services, have had site practices modeled for them, and/or have received support that pushed them to think and work with mathematics. Thus, these participants can also be expected to support newer participants as they work with the site and learn how to participate in ways that lead them to stretch

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4 Similarly, weak and strong students who work with The Math Forum's PoWs over time have been found to make more connections to, generate more effective strategies for, and work more independently with PoW challenge problems than before working with problems that require them to explain how they arrived at the answer that they submit (Renninger, Farra, & Feldman-Riordan, 2000). Such findings suggest that at an individual level participants are not only seeking and using resources in their work with the site, but they are being supported in ways that deepen their understanding of the culture of mathematics (Schoenfeld, 1992). Because they can approach the problems in any of a number of ways, the approach they select is theirs, and any discussions they engage in with PoW mentors in build on their questions or work. Thus, the interactions that they have involve thinking about the solutions they have posed or on which they are trying to work. The process of these interactions leads them to a more developed understanding of mathematics, and it provides the foundation for asking the kind of curiosity questions that characterize interested engagement (Renninger, 2000) and deepen their connections to the community that they call The Math Forum.

themselves. Once archived, these interactions also make a contribution to the larger community.

CULTURE AND COMMUNITY PROBLEMATIZED

In previous work, The Math Forum has been described as a community and the role of community in virtual spaces has been addressed (Renninger & Shumar, 2002; Shumar & Renninger, 2002). As Kling and Courtright (this volume) argue, the term community may be overused in online environments; every discussion list does not necessarily constitute a community. In contrast to many sites, The Math Forum staff was invested in building community long before the term community became so widespread. The staff members use community to describe themselves and other participants who work together to build out The Math Forum site. In fact, it may be because of The Math Forum's success as an online community that others have chosen to emulate it.

Community

The usefulness of the term community has been questioned especially as it applies to virtual space. Rather than being focused on problems associated with the use of the term to refer to a group with whom others come to identify, per se, these questions claim that virtual communities (a) point to a loss of community in the modern world, (b) are distinct from physical communities, and (c) describe one-dimensional groups (e.g., a discussion listserv) (Nie & Erbring, 2000; Kraut et al., 1998; Putnam, 2000).

Building on the work of Barth (1981) and Cohen (1985), Shumar and Renninger (2002) suggest that modern society has not eliminated community. Traditional communities are typically presented as homogeneous, and modern society is presented as heterogeneous and, as such, not as community. Cohen (1985) points out that all communities – modern or traditional – are based on symbolic boundaries, which may actually be more complex in small, traditional fishing villages than they are in large, contemporary cities. If symbolic boundaries define communities, then attachment and belonging can be understood as socially produced and reinforced through rituals and other symbols. From an analytic point of view, community describes the way boundaries work and the forms of attachment and connection experienced by social actors. All communities are virtual in the sense that they are the product of social imagination and must be defined symbolically (Anderson, 1991). Thus, the distinction between virtual and physical to which some people point may more accurately represent a continuum of community types instead of two specific forms of community (see also Barab, MaKinster, & Scheckler, this volume; Hewitt, this volume).

Many people have suggested that Internet communities may be less deep and involve more superficial forms of attachment and belonging than physical communities (Nie & Erbring, 2000; Kraut et al., 2000). It also can be argued, however, that the Internet has made the experience of different forms of community more of a possibility than it ever has been in the past (Shumar & Renninger, 2002). The Internet allows for greater flexibility of forms of interaction and symbolic communication, and these, in turn, have stretched the realm of possibilities about community. There is a greater "virtualism" to Internet-based communities than there is to physical communities. Many online groups have thin connections, weak attachments, and not much of a sense of identity and belonging. These groups may or may not be communities. In contrast, The Math Forum site is an example of a very complex network of groups and individuals who work together virtually and face-to-face. They are not engaged in a simple, one-dimensional discussion group that self-identifies as a community. The Math Forum includes a multi-faceted and heterogeneous group of individuals who are positioned to learn, think, and do mathematics. For groups such as The Math Forum, the term community has proven to be a very useful and appropriate concept for thinking about the potential of social spaces.

While one conception of community holds that it is a homogeneous and simply bounded entity, most contemporary thinkers reject that model (Barth, 1981; Cohen, 1985, 1994; Goody, 1994). They suggest instead that community is a complex set of overlapping boundaries. These overlapping boundaries are subtle and are often only seen by insiders to the group whereas external boundaries are those seen by outsiders. For example, the very boundary that is more important to the outsider, such as, "Oh, you are from New York," is not often considered by those who live and work together within the city boundary. For a member of a community, the boundaries that matter are those that separate neighborhoods and groups from each other. These boundaries are the symbols of belonging and attachment. These boundaries also are manipulated by social actors and are often contested, resulting in a patchwork of connections and discourses about imagined connections. Social networks can be a useful tool for understanding the relationships between individuals and arrangements of connections (Barnes, 1972; Barth, 1981; Gulliver, 1971; Koku & Wellman, this volume; Wellman, 2001; Wellman & Gulia, 1999). From this perspective, community and culture are closely related and can be said to share the same complex structure.

Online, recognition that community is a symbolic construction is useful because it addresses the roles of participants' imaginations about attachment and belonging to others. The Math Forum community is comprised of groups that have distinct projects and resources. Participant observations and interviews with participants suggest that individuals imagine

The Math Forum community differently from each other. The boundaries they describe overlap and reflect varying visions of The Math Forum. As Renninger and Shumar (2002) suggest, participant imagination builds on participants' experiences, including the nature of exchanges participants have had, as well as the design of services and availability of resources that the site makes possible. Thus, Math Forum teacher participants, looking for lesson plans, find resources that are available when they have the time and space to work with them. Textual interactions such as student submissions to the Problem of the Week, online discussions, or archives of FAQs provide teachers with different formats and levels of materials that allow them to find the match for their interests and abilities. In this way, they can build on what they know. These interactions are not formulaic; they have been adjusted to meet the strengths, needs, interests, and experiences of participants. As such, they also provide models of how teachers might work with their students, or other participants (Collins, Brown, & Newman, 1989; Renninger & Shumar, 2002).

The culture of the site is explicit. There is an assumption that everyone working with the site (including staff members) is trying to learn and can, given support, appreciate the elegance of a well-worked problem and develop the perseverance and sense of humor necessary to continue working to understand. This context is one in which both imagination and sense of creative play are freed because both the culture and the community of The Math Forum acknowledge that there are always more questions to ask and to answer. Also, The Math Forum appreciates that one needs to start with what he or she does understand in order to learn. Given the assumption that participants want to learn, learning then appears to yield participation, even for those who are initially "required" to use the site (Renninger & Shumar, 2002).

Those who do not know The Math Forum site may equate it with other math education sites, discussion lists, or virtual communities. However, interviews with Math Forum participants who have used the site over time suggest that they focus on other boundaries, such as those of the site's services, partners, or projects. These are the type of symbolic boundaries that define the outsider (Cohen, 1985). On a site as large as The Math Forum, however, there are also projects to which even the staff may refer as though the projects were homogeneous entities. Thus, participants in such projects appreciate the nuanced subgroups that exist and the differences that emerge, for example, between participants and staff, staff and staff, those who are strong in math versus those who are strong in pedagogy, and those who are strong in both. Participation in or increased knowledge of a given project shifts the perception of homogeneity that initially existed for participants.

Importantly, the culture that is experienced and associated with The Math Forum by individuals, groups, or other communities when they begin

work with The Math Forum is recognizable and distinctive. The site culture facilitates participants moving from feeling like outsiders to becoming insiders in the community. Presumably, it is also this ease of participant movement that accounts for return visits to the site, continued work with and willingness to volunteer on the site, and identification of opportunities to learn.

Culture

Just as there have been questions about the applicability of the term community to virtual spaces, there have also been questions about the usefulness of the term culture. There are at least three reasons that this is the case. (a) Culture could imply homogeneity within a clearly demarcated border; (b) culture could imply an entity with boundaries that are static and nonoverlapping; and (c) culture, as entity, raises questions of whose power, voice, and vision are used to represent the social group described as a culture (Clifford, 1988; Ewing, 1990; Holland et al., 1998; Paul, 1990; Rosaldo, 1989; Stewart, 1996; Strauss & Quinn, 1997). While valid, these problems could also be argued to enhance understanding of the role of the social group in an online learning community if they were used to reconceptualize the meaning of the term.

On one level, the evolution of the concept of culture mirrors the experience of newcomers to a culture that is unfamiliar. Anthropologists, for example, began doing research as outsiders to different cultures. At first, their tendencies were to make a strength out of a weakness by arguing that outsiders could understand the contours of the culture better than insiders (Bourdieu, 1977). There is a parallel between the theories and concerns of anthropologists and the folk taxonomies of individuals. Newcomers to a culture see that it is bounded, homogeneous, and static. Over time, the newcomer gets to know the members of a community and develops a basic model on which to base an understanding of a group. With an increasingly complex understanding of the culture, the person who once was a newcomer becomes more dynamic and fluid. Thus, boundaries can be understood as overlapping, and struggles for power and the assertion of different values, knowledge, and concerns surface (Holland et al., 1998).

People may hold onto simpler visions of culture even when their understandings include more complexity because these provide them with an easy shorthand for representing a group. It may be because anthropologists traditionally study groups in which the language and ways of interacting are unfamiliar that they inadvertently saddled themselves with a simplistic model of culture. Bourdieu (1980) suggests something similar to this in his observation that the methodological objectivism of structuralism and functionalist anthropology really involves making strength out of a weakness. In fact, anthropologists have argued that it was an advantage to not

know a culture intimately because an outsider can objectively define the rules of the game and the structure of the system. By taking such a position, the traditional social scientist limits him- or herself to a newcomer's understanding of rules and structure. Official rules and structure often are not an accurate reflection of the complexity of a group's actual structure and process. Identifying rules does not necessarily allow for a more intimate (Herzfeld, 1997) appreciation of the strategies that are employed by social actors.

While earlier discussions of culture identified a simple boundary and everyone within that boundary as homogeneous, more recent models have specified overlapping sets of boundaries and pointed to heterogeneity that is intertwined with homogeneity (Barth, 1981; Cohen, 1985, 1994; Goody, 1994). To borrow a botanical metaphor, if the older models identified culture as a plant bulb, more contemporary models describe culture as a rhizome (Deleuze & Guattari, 1987). A rhizome has structure and pattern. It also has diversity and a separation of parts. Within any specific community, there are many subgroups, alliances, overlapping boundaries, and differences that make up the whole. These groups have both an individual and a shared culture that informs their senses of community. The more dynamic structures may lead to a great deal of identity confusion and conflict, but they may also become very dynamic, active, and productive social groups. The question that surfaces is whether to consider these groups one culture, multiple cultures, or to drop the term culture altogether and refer to the social group in some other way. Here, the term culture is used to refer to the dynamic interplay of ideologies, values, practices, and so on that comprises rhizomatic social groups.

The classic problems of difference and identity, which characterize all cultures, are compounded by the hybrid collaborations of people and groups that are possible in virtual spaces. Poster (2001), reflecting on the possibilities of the Internet, suggests, "Culture has lost its boundary" (p. 1). He points out that debates about the determining role of technology in the development of culture miss a very significant point. The Internet constitutes a space, "which encourages practices and which, in turn, serves to construct new types of subjects" (p. 3). In a richly textured and interactive virtual space such as The Math Forum, the Internet appears to enable possibilities for learning that facilitate a changed sense of possibility for participants and for the organizations building sites on the Internet (Renninger & Shumar, 2002).

In fact, Math Forum data suggest an even more nuanced view of culture than Poster's. Interviews with participants who return to the site over time suggest that they simultaneously hold both a simplistic and a heterogeneous model of the site. They think of the site as amazing or rich. They also are aware of and appreciative of the site's complexity and that it is hard to have everything work perfectly. In the past, the layers suggested

by this kind of description have led many researchers to jettison the term culture in favor of the rubric of practice. Lumping all social interaction under practice, however, does not yield clarity about the role of culture in learning.

For present purposes, it seems appropriate to use the term culture to describe both a group's social imagination about the rules, models, strategies, and understanding of conflict and success, as well as the intersection of this group understanding with individual understanding (Holland et al., 1998; Shore, 1996; Strauss & Quinn, 1997). For example, some participants who submitted questions to Ask Dr. Math were told that the staff was receiving too many questions if the answer to their question already existed in the FAQ portion of the site. Their responses to questionnaires specifically asking about being pointed back to the FAQs indicated that they understood the problem of scaling, may have found the FAQs useful, and had not changed their sense of the service, or the site, as a resource that they wanted to continue to use. By providing information about their situation, the staff members involved participants in helping them to figure out how to make the site go forward. The staff took what could have been understood as individual rebuff and provided information that involved participants whose questions were not answered in the larger group issues of how to scale services.

In keeping with site culture, the staff members are inclusive. They seek and make use of feedback from all participants. They have been able to leverage the heterogeneity of the population and side-step possible complications that could be introduced by differences of cognition, power, and representation.[5] It was similar feedback to participants submitting answers to the Problems of the Week service that led to the development of a volunteer group who could help respond to the many solutions that service receives each week.

Presumably because of the way that they are received (heard, enlisted, etc.), participants of all types identify with the site. These participants also typically characterize Math Forum staff members as problem solvers, citing the fact that they can and do work along with the participants, so learning and working with mathematics (or new or different mathematics)

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[5] Divisions within a social group typically involve differences of power, including the subordination of one group to another. In such situations, the dominant group may speak for the subordinated group because of the privilege of its position. Feminists were among the first to call attention to the problems of voice and representation. They recognized that many traditional ethnographic accounts of cultures involved male informants talking with male anthropologists and constructed a version of male culture that may not fit the realities or imaginations of women within the social group they described. The silencing of women within the social group and within the ethnographic literature is one example of how difficult it is for the subaltern to speak (Spivak, 1988). There are also cases where the dominated group is not represented or able to speak for itself.

becomes possible. For example, when Math Forum staff members began running workshops for the Urban Systemic Initiative teachers, they neither assumed that workshops needed to be held in 90-degree classrooms with no air conditioning, nor that they should give up when assigned to these classrooms. The staff members began rounding up fans from their homes and neighbors and opening windows to make the air flow. Once conditions were tolerable, they moved on to talking about doing mathematics on the Internet. On feedback forms from the workshop, the teachers reported that they had never seen anything like The Math Forum staff in action. They said that other groups would have given up. They also said that they were glad The Math Forum had not.

Math Forum staff members respond similarly to developments on the site by involving others in helping them to describe the problem, its attributes, and its possibilities and using these data to problem solve. After The Math Forum began posting PoWs and facilitating teacher and student use of these problems, it also began receiving questions from teachers, students, and others working with mathematics. Instead of responding that it was not a question and answer service, the staff members responded to the questions, viewing them as an indicator of participant need. They resurrected a defunct question and answer service that another site had mounted, and they launched the service that is now known as Ask Dr. Math. Then, because Ask Dr. Math was quickly overwhelmed with submissions and publicity that yielded even more submissions, they decided to develop a tenuring process for volunteers who were willing to help mentor other participants. The tenuring process allowed them to enlist help from participants and maintain a focus on enabling participants to become resourceful problem solvers without needing to single-handedly do all of the support that this entails. Furthermore, by refining the way in which questions are submitted, the service also guaranteed that the mathematics with which volunteer mentor doctors worked was not routine. It also ensured that the problem was of interest and would increase the likelihood that the doctor would want to continue to mentor problems from the queue in the Dr. Math office (see related discussion in Renninger & Farra, 2003).[6]

On The Math Forum site, structural features of information technology are used to facilitate forms of interaction where participants can begin work from the position of their own strengths, and then move on to different challenges and/or types of questions about mathematics as they are ready to do so. The design of the site and the staff members' approaches to working with participants distinguish The Math Forum from the bureaucracy that

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[6] Presently, the Dr. Math service has one full-time staff member, who answers questions and facilitates the tenuring and mentoring of volunteers, and two part-time people assisting with programming and archiving. This service alone receives over 350 questions a day and could not exist if it were not for the support of volunteer mentor doctors.

characterizes most schools and many teacher professional development programs. The culture of The Math Forum provides its participants with a context for thinking and working with mathematics that is characterized by individual autonomy and opportunities for interaction and knowledge-building. In fact, it may be the staff's democratic focus on problem solving that accounts for the positive feelings for the site held by participants who do not have an interest for mathematics and/or technology.

The culture of The Math Forum is not embodied in either its participants or in the resources or text of the site, however. The culture is dynamic, and, as such, it is in an ongoing process of being recreated as participants work with the site, their exchanges are archived, and their understanding of their own sense of possibility shifts. As successive refinements to the Ask Dr. Math service suggest, the culture is one of both creative and substantial problem solving. The staff members developed a tenuring process because of the unevenness in the responses being provided by volunteer mentors to participants posing questions. Although they had a huge need for the kind of support that a volunteer corps of mentors could provide, their vision for the service was that mentors would help participants to use their own resources to think through the question and not simply answer them. The process of tenuring was designed to help mentors "hear" the questions posed so that they can support participants to think mathematically. The process of tenuring takes as much or as little time as the mentor in training needs. All levels of mentors, including Ph.D.s, high school students, and former teachers, have to be tenured before they are permitted to respond directly to participant questions.

The staff works to help participants engage mathematics by focusing on what is understood and providing a context that enables participants to stretch their understanding. The staff members communicate an appreciation of the field of mathematics as broad and deep and a playful approach to the process of problem solving (Winnicott, 1971). At times, this means that the environment needs to be altered (e.g., volunteers need to be trained) so mathematics can be taken up. At other times, it means that, in order to address a problem, participants are encouraged to either identify the complications that they experience and revise what they are doing or work on identifying the problem to be answered (cf., Sternberg, 1985). This type of interaction about mathematics reinforces the perception of the site as distinctive, and it enables the individuals who find and become participants on the site to think of it as a place as well as a community.

MATH FORUM CULTURE AND COMMUNITY

Like a rhizome, Math Forum culture and community have emerged from and within a diverse set of forces. The Math Forum is a product of existing educational institutions, the individuals who first came together to

create The Math Forum, and technology that has facilitated the collection of resources that both support and reflect inquiry-based approaches to instruction (Renninger, Weimar, & Klotz, 1998). The culture and the community are a dialectical interplay of (a) the people and institutions that are and have been a part of site and its development and (b) the technological possibilities brought into being by personal computers and the Internet.

In fact, the community that formed The Math Forum in 1992 can be likened to a foraging band in that it was (and continues to be) a highly egalitarian structure where the norms of reciprocity fuel its development. The staff was a small group. Everyone worked alongside of and knew everyone else. Its beginnings were a response to the desire of geometers working with The Geometer's Sketchpad[7] to exchange figures. Some teachers and students found The Geometry Forum, The Math Forum's predecessor, and these "lone rangers," as the staff referred to them, were welcomed to think about and discuss geometry along with the geometers and developers. The staff members thought of those people with whom they worked as collaborators and referred to themselves as a community; they did not think of the participant list as something to protect, but instead they worked to pool a range of perspectives from this diverse population.

Without realizing that they were doing so, the staff members had begun to establish a utopia, infused by the values of the early Internet and the privileges of being housed in the liberal arts college environment of Swarthmore College and funded by the NSF. Like other pioneers of Internet use, the staff members shared a problem-solving orientation toward the world and the beliefs that (a) individuals have great things to contribute and the Internet can make it possible for these contributions to be understood by others, (b) learning is essential and the Internet can be a medium for communicating about ideas, and (c) everyone can learn and the Internet can bring people together so that they can work on their understanding(s) with others. Like other Internet groups at the time, a lot of the everyday social niceties from official titles and positions down to style of dress were also considered to have little to do with real value. Consistent with these values, The Math Forum was designed and built out to model democratic education (e.g., Dewey, 1938).

The habitus (Bourdieu, 1977, 1980) of the early days of the site included various forms of privilege. It combined the excitement of the new "digerati," the technologically elite who understand and can use the new technologies, with the intellectual surety of mathematicians. Furthermore, it was nurtured in the intellectual and pedagogical milieu of a small liberal arts college. This context was powerful for fueling a group that felt it could

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[7] The Visual Geometry Project, which produced software for visualizing geometric figures, including *The Geometer's Sketchpad,* was the first of a series of National Science Foundation-funded projects that evolved into what is currently known as The Math Forum.

use technology to make a real contribution to mathematics education – a field that concurrently was undergoing self-examination about exactly what reform practices in mathematics involved and needed to look like.

Having established itself in geometry, the staff was encouraged by the NSF to build out their offerings in mathematics topics in 1997 as The Math Forum. As a condition of this funding, however, staff members were also asked to train teachers in two large, urban school districts that were part of the NSF's Urban Systemic Initiative (USI). These were school districts in which the technology and math skills of the teaching staff were largely undeveloped. The NSF was interested in harnessing the capacity of projects such as The Math Forum to help meet the needs of students and teachers in underprivileged settings. Not all of the teachers for whom The Math Forum was to be responsible as part of this plan were mathematics teachers, however. Unlike The Math Forum's work with teachers prior to this, USI teachers had not sought to be supported by The Math Forum staff.

The Math Forum staff members worked to figure out what would be useful to USI teachers. In the course of face-to-face and, eventually, virtual work, they were able to adjust their services and begin to develop forms of social interaction that a number of these teachers found to be beneficial.[8] Teachers in these districts voted to allot their in-service funding to continued support by The Math Forum staff following its support by federal funding. The experience of working with the USI teachers helped the staff to build out the site in ways that made it more accessible to people who were uncomfortable with mathematics and technology. Work with USI teachers also led the staff to realize that they could not be all things for all people. The staff members knew that in face-to-face workshops they could support teachers in ways that made them want to work with the site. They also recognized that they needed to focus their efforts. Either they could focus on building out site services with participants who had their own questions about mathematics, technology, and the use of technology in classrooms, or they could focus on staffing workshops to encourage teachers to consider working with technology. They could not continue to do both things well. Because of the rate at which the site was growing in terms of both pages and participant numbers, it rapidly became clear to the staff that its choice had to be providing and refining site services if theirs was to be a site that others would want to learn to use.

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[8] Because the teachers for whom The Math Forum was responsible were not all mathematics teachers, staff time on this project involved helping the teachers to learn and work with technology. Thus, they were thinking through the issues that learning to work with technology required and ways in which the site might be better developed to help those who needed this type of support to work with the site.

Even though its beginnings were rich in social and cultural capital, like all small Internet organizations, The Math Forum has been shaped by limitations on support and problems of scaling and sustainability. Ironically, rapid success with services like the PoWs and Ask Dr. Math meant that there were many people using the services and few staff members to manage the needs of participants. Furthermore, there were limited financial resources to address issues of additional staff, space, and equipment.[9] The staff recruited help, streamlined the need for participants to ask questions, and developed tools and procedures to enable mentors to more easily assess the strengths and needs of participants.

Over time, the culture of The Math Forum has become more complex and polyvocal (Turner, 1969, 1974). Following work with USI teachers and publicity in the mass media, the site has grown to include an increasingly diverse group of participants and these participants have become integral to the site's expansion and existence. Participants bring their questions and concerns to the site or work with site problems and content. They help to provide the interactivity of the site's resources. Some participants contribute web pages, answer students' questions about math, have their students submitting problems, and work with their colleagues to build site resources into their classes. Many participants retain contact with The Math Forum through workshops, professional meetings, projects, and their collaborations with others on the site – which in other parlance might have been identified as rituals of belonging.

The Math Forum as an organization has always put individuals first in the sense that it is individual strengths and needs that have informed the building out and tweaking of its services. The staff has constantly asked itself, "what do participants want and how can resources be made more useful?" To this end, for example, the staff takes feedback on the questionnaire that might to some be considered eccentric and an indication of not knowing how to use a particular set of problems, and it proceeds to develop pages to address this understanding. The presumption is that if one teacher had a misunderstanding or need, this perspective is likely to be shared by others. In this way, the staff has broadened the site's base of services, the nature of the explanations, and the resources available to participants. Importantly, although the response of the site has been to meet individuals' needs as learners, social interaction has consistently been

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[9] This chapter does not detail the contradictions that emerge in the process of scaling and the need for sites to be sustainable, even though these issues have had and continue to have an impact on the activity of The Math Forum. Such issues are the focus of a number of other papers (Shumar & Renninger, 2000; Renninger & Shumar, 2001). Briefly, these papers suggest that scaling and sustainability could be understood as the instigators of cultural change at The Math Forum because they necessitated that the staff grow quickly albeit with modest remuneration, and that the staff as a whole found ways to sell its services to potential buyers who could provide sustainability.

perceived as central to learning. Thus, site development has also focused on enhancing the possibilities of interaction.

In addition to work with the USI teachers and other teacher groups, Math Forum staff have also been partners on a number of NSF projects, which have brought participants to The Math Forum (physically and virtually) to work together in ways that benefit participants and further expand the resources of the site (e.g., www.mathforum.org/brap/wrap/; Shumar, 2003). The Math Forum staff does not reify social interaction by creating forms, lists, and rules (Wenger, 1999). Rather it interacts and facilitates interactions. Participants in these projects, like participants in site services, are typically given a wide range of choices about what they want to know and do – whether they are a staff member, workshop participant, or participant. Reification takes place only at the point of archiving what is useful and effective in these learning interactions for others.

Although critiques of progressive approaches to education typically suggest that focusing on pedagogy undermines attention to content, The Math Forum has been and continues to be both person-centered in its attention to learners' strengths and needs and strong in its mathematics content. Participants are attracted to and willing to help this staff that models creative problem solving – whether this is an alternative solution path to a challenging problem, the ability to figure out how to deal with hot weather so that a workshop can proceed, or refining a service to better meet the strengths and needs of participants. The Math Forum is a community of practice where newcomers apprentice with more senior and skilled participants (Lave & Wenger, 1991; Renninger et al., 1998; Renninger & Shumar, 2002), and learning on the site is considered a social activity, whether the learning is modeled, learned through apprenticeship, or scaffolded through interactions with or conversations about text (Collins, Brown, & Newman, 1989). Consistent with reform pedagogy, site design focuses the process of participants' engagement on thinking mathematically with others, and the content of this engagement is rigorous mathematics.

LEARNING, A POSSIBILITY BECAUSE OF CULTURE AND COMMUNITY

A central question for a site such as The Math Forum is how it can continue to effectively facilitate learning online, given rapidly increasing usage. Moreover, how can participants who require a lot of time be supported, given the needs to continue to scale services and become sustainable? The answer to these questions seems to be that once the culture and community of a site are articulated and sustained, in the sense that the site becomes an entity for participants, the culture and the community of the site lead participants to help. Participants facilitate interactions, help others to stretch mathematical thinking, and so forth, allowing staff attention to be directed

to figuring out how to scale services and address the need to be financially sustainable.

Based on in-depth structured interviews with participants, it appears that early in their work with technology, participants need to form a sense of social identity online (Renninger & Shumar, 2002). This identity provides them with a sense of with whom they are talking and working, and it allows them to feel a sense of belonging. The sense of belonging, like the ability to cross symbolic borders, is facilitated by interactive services that scaffold participants to feel welcomed, heard, and taken seriously as learners. Thus, as Renninger and Shumar (2002) point out, participants typically use one or only a few resources or services when they first find the site. Then, they expand their work with the site by exploring and finding other resources or services with which to work and learn. They also begin to assume some responsibility for aspects of those resources to which they previously had connected. Over time, participants who continue to work with the service continue to stretch and deepen their work with mathematics and become co-creators of the site. The developmental course of participation proceeds from processes involving identity formation to those associated with identification (Virilio, 1995).

Similarly, students' work with the Problems of the Week service over a ten-month period has been found to have an impact on their abilities to (a) make connections to the mathematics of the nonroutine word problems they were presented, (b) generate and revise strategies for working with these problems, and (c) become increasingly independent in their abilities to accurately work with this type of problem (Renninger, Farra, & Feldman-Riordan, 2000). Because student work in this service is highlighted in the archive, the students are at once learning and making contributions to the learning of others who will use their work as resource material.

The connection between changed participation and site functioning was further examined in the Math Forum's Bridging Research and Practice (BRAP) project[10] using microanalytic methods, including study of participant observation in workshops, videotapes of classroom practice, interviews, and email exchanges. The BRAP project was (and continues to be) a collaboration of teacher and staff participants who worked face-to-face and online over a three-year period to (a) read and think together about applications of the research on mathematics learning to their work with students and (b) write a live videopaper (mathforum.org/brap/wrap/) that describes their insights about the research they read and its application, provides detail about their study of their own students' work with the

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[10] The Math Forum's Bridging Research and Practice (BRAP) project was The Math Forum's contribution to a Math Forum, TERC, and Michigan State University collaboration sponsored by the NSF to study the value of video in online learning.

cylinder problem, a classic challenge problem,[11] and allows them to continue this conversation among themselves and with others over the web through links in the videopaper.

The learning of those involved with this project took two complementary forms. First, participants stretched their thinking and experience with mathematics, pedagogy, and technology. Second, participants also shifted some of the assumptions with which they began the project, including concerns about their abilities to do mathematics, research and write a paper, and collaborate in thinking about the content and direction of their work together. Findings from this study suggest that staff members' efforts both to share power and to learn through their own participation in the project supported collaboration and resulted in learning for all participants. Through collaboration, the teachers and the staff members came to identify (or reaffirm) The Math Forum as a community that they are helping to build (Harasim, 2002). Their participation in the project was not simply part of a received identity.

Importantly, community for the BRAP project participants appears to be an experience or process and not a product. It included the activity and work that went into creating the videopaper; the close friendships created in this process; the learning about mathematics, pedagogy, and technology that each individual continues to realize from the group's work, and the changed imagination of participants' individual identities and that of the group. This process of identifying with, contributing to, and growing through participation is critical for identifying the BRAP group as a community distinct from a collection of resources. Moreover, as mentioned above, participants not only established a group identity through association, but they took part in an active process of building identifications with the other community members as well as the site. Interestingly, this process of identification mirrored the characteristics of the larger site culture, suggesting that on The Math Forum site, community and culture are co-dependent.

While change in participants' work with and perception of the BRAP project might have been expected over the three-year period of the project, there was no reason to expect this particular group of teachers and staff members to cohere, especially given the precarious status of The Math Forum at the time. The BRAP project was launched in the midst of rapid scaling and a need for the site to find financial sustainability for its infrastructure since the infrastructure could no longer be covered by NSF grants. Furthermore, the BRAP project was undertaken with some staff who were being trained during the project. Unlike the way the site requires its

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[11] The cylinder problem: Form two cylinders from a rectangular piece of paper, one by joining the long sides, one by joining the short sides. Which of these cylinders will have greater volume, or will they hold the same amount?

volunteers to practice mentoring before they begin responding to others, the conditions at The Math Forum at that time necessitated that new staff leap into the project alongside experienced staff and work though the challenges of understanding site culture and its implications for collaborative process as the project evolved.

In spite of complications, participants in the BRAP project did cohere. It is likely that site culture and the community that this culture fosters account for participant learning in this project. The expectation that participants come to a site project to learn meant that the staff worked with the participants as learners. The expectation that participants should be welcomed and able to work at the level for which they are ready not only made teacher participants feel welcome but appears to have enabled them to maintain the esteem they felt for Math Forum staff coming into the project and to accept the strengths and needs of various staff members as the project unfolded. It also appears that connections made to participants' questions, or interests, in the design of the project meant that both teacher and staff participants focused on these in their discussions rather than site difficulties. This enabled all of the participants to deepen and/or develop their understanding of the BRAP project content, including discourse, mathematics, mathematical thinking, and the applications of research to practice.

There was no hidden curriculum (Jackson, 1968). The Math Forum staff did not hold a goal to reform or change participants (nor did the teachers who joined the project have a goal to change the staff, for that matter). Rather, the staff and teacher participants in the BRAP project came together to explore issues of research and practice in mathematics. In the process, they stretched what they knew not only about research and practice, but about mathematics, teachers doing research and writing, and collaboration. They also deepened their connections to each other and to the site.

Study of individual and group participation in The Math Forum's BRAP project suggests that as long as there is rich content in addition to multiple opportunities and support for engaging this content, there is no particular ratio of autonomy, interaction, or opportunity to think with others that needs to be in place for participants to be supported. Rather, like findings from studies of project-based learning (Blumenfeld et al., 1991; Brown & Campione, 1994), an open-ended project such as the BRAP project allows participants to (a) connect to content in the way that they can, (b) assume the autonomy that they need, and (c) take advantage of opportunities to think with others as they are ready. Motivation for participating in the project grew from participant and group questions and the interest that these questions held (Renninger, 2000). Staff members' support of participants' questions as the focus of the project meant that participants developed their understandings of mathematics, pedagogy, and technology at a pace and in a way that matched their strengths, needs, and interests. The process of participants addressing their own questions also led them to additional

questions and the need for resources to address them. The site held some of the resources they needed, and they brought additional resources that they identified to the site. In this way, participants addressed their own questions and shared them and the resources that they found with others through the site.

It might be argued that the combination of face-to-face and online communication of the project's design was important to the cohesion that the BRAP participants developed during the project. It is possible, however, that a well-facilitated online discussion could have been as compelling for participants. This is an open question.

CONCLUSIONS

Face-to-face workshops and projects have been important to developing the participant base that constitutes The Math Forum. In fact, participation in the BRAP project replicates and extends previous descriptions of learning at and with The Math Forum (Renninger et al., 1998; Renninger et al., 2000; Renninger & Shumar, 2002). The Math Forum has leveraged the concept of community by fostering interactions and contributions that increase opportunities for individuals to work together to think, do, and learn mathematics. The focus on interaction and provision of support for the strengths, needs, and interests of individuals working with the site are central to Math Forum culture.

The Math Forum has always worked virtually and through face-to-face meetings with participants. Participants' shared goals of creating a place where thinking about mathematics is supported has been more critical than a specific site design. Design decisions have been undertaken in response to and at the suggestion of participants. As site participation has changed, the design of the services has been adjusted. Because of its increased size, The Math Forum staff has had to leverage the concept of community in order to foster interactions on the site, to encourage people to volunteer to staff services, and to help create resources for the site. These recruiting efforts have been very successful. For example, teachers, who at one time may have seen their professional community as being made up of their local colleagues, have come to view online colleagues as part of their professional community. At times teachers blur the boundaries of these communities by drawing on Math Forum staff and resources during staff meetings and/or their school-based colleagues for online discussions. This blurring of boundaries has led to a much more complex sense of professional community. Parallel findings can be reported for student participants too. For them, based on site questionnaires, it appears that the site represents an expanded sense of mathematics. They point to opportunities to ask questions without fear of ridicule, do mathematics that challenges them, and extend the learning they do in school.

The Math Forum is a community rich in resources. These resources are not simply resources compiled for others; rather, they have been built out through participants and the mining of archived learning interactions. These resources are community resources and they contribute to participants' senses of ownership and belonging.

As study of BRAP participation suggests, the site appears to have evolved to a point where the culture and the community can be considered entities (albeit complex and heterogeneous), which while continuing to be supported by staff, are also sustained by the imagination and participation of participants. The relationships between staff participants and other participants on the site continue to be reciprocal (Pea, 1993). Participants who are experienced in their work with the site are able to make use of it and help support the work of others. Participants who are new to the site continue to need additional support in order to use the site well, but over time they are able to become more independent in their efforts – in fact, as evidenced by the BRAP project, helping others appears to heighten the likelihood of independence (Shumar, 2003).

Because the Math Forum culture is increasingly complex and polyvocal, it can and does enable the learning of all types of participants – those who are strong in mathematics and those who are weak, those who have interest for mathematics and those who do not, those who have lots of previous experience and those who do not, and those who come to the site in different roles (e.g., teachers, students, mathematicians). For each of these individuals or groups of individuals the culture and the community of the site provide support to continue to think with others about mathematics. The staff builds on participants' stated or evident needs and uses these to inform refinements of site options and services. It may be that because The Math Forum provides a contrast to the other experiences of its participants, that it is a site to which they tend to return over time. It does appear that The Math Forum provides its participants with a unique set of opportunities for learning, and that the relationship between the individual and the community on the site is one in which individual needs are met while the community benefits.

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