1 Introduction

This book is an ethnography of the Math Forum (mathforum.org), an online math education resource center that is part of the National Council of the Teachers of Mathematics (NCTM). I began doing research with the Math Forum in 1997 when it was at Swarthmore College. The Math Forum began as a project of a faculty member at Swarthmore and an undergraduate math major. Originally the project was called the "geometry forum" and it was a discussion list on the Usenet. The geometry forum began before the web and so all interactions were text-based. These early pioneers thought that the internet could be leveraged to allow individuals who were interested in problem solving and talking about math to have more conversations with each other and to share resources. As part of this work, the team worked with the developer of geometer's sketchpad. This was a software tool that allowed people to visualize geometry in this text-based environment. Sketchpad is still an active product today sold through McGraw-Hill Education.

In 1996, the group received a one-year "proof of concept" grant to create the Math Forum from the National Science Foundation (NSF). Following that funding, the Math Forum then received its first three-year NSF grant to build out the internet's first online math education resource center and community. Of course by this point, the web was born, and the visualization of that virtual space was greatly enhanced. The Math Forum then came into being in the early heady days of thinking about "online communities" and the utopian excitement about web 1.0, as it were. From these early days at Swarthmore College, the Math Forum then has gone on a long adventure of development moving from the College to WebCT to Drexel University and now to NCTM. In the process it has built one of the most long-lasting education communities (or cluster of communities) and a robust set of resources on the web for math education. The Math

Forum began as an online education community during web 1.0 and has persisted and evolved to be a node of interaction among math educators in web 2.0. As such it is one of the longest lasting online educational communities. Its members have also been pioneers of the kinds of interactions and communications that the internet makes possible and how these new forms of interaction can be leveraged to help teachers and students of mathematics improve the work that they do and the knowledge they produce.

I originally began working with the Math Forum as an ethnographic evaluator and was on their original three-year NSF grant as an evaluator. I moved to many different roles with the Math Forum. I eventually became principle investigator on several projects, as well as continuing to work as a researcher and evaluator on others. I used to jokingly suggest that the Math Forum had become my main field site and that math was the language of my tribe, but of course this was an ironic illusion, as the metaphor had many difficulties. Many anthropologists have discussed the dilemmas of ethnography in the contemporary world, and ethnography with an online math education community has its own particular complications. Gupta and Ferguson (1997) suggested, at the same moment that I began working with the Math Forum, that the "field" was a concept used by ethnographers and that it needed to be deconstructed. Fieldwork, according to them, implies two spaces, the field and home, and, more important, two kinds of writing, fieldnotes and finished ethnographies, each done in their respective places. Likewise George Marcus has done a significant amount of work recently focusing on ways that globalization has impacted the practice of ethnography, as groups are no longer spatially contiguous and what binds them is very different from the traditional notions for community (Faubion & Marcus, 2009; Marcus, 2010; Marcus, 2012). These are all issues I faced with the Math Forum, where it was difficult to tell what were fieldnotes and what were writings for other purposes. All of these ideas I'll explore in more detail in Chapter 2 of this text.

One of the first activities I engaged in at the Math Forum with the staff members was an activity we called "mapping the Forum." I will talk about mapping the Forum in more detail in Chapter 2, but for here, it's important to point out that this activity was about making visible the more invisible elements of a social structure that was organized through digital media technologies. I quickly came to trust that the Math Forum was a dynamic community of teachers, students, researchers, hobbyists, and parents. And this community had a number of dynamic projects going on, interesting

collaborations, deep discussions, and "capital" in the form of math and teaching resources. But, for the most part, these things were not observable, and even when they were observable it was on a computer screen, through which one had to know how to browse or search. An important task for me as an anthropologist, but also valuable to the staff themselves, was to "objectify" these practices, to make visible the barely visible so that people could reflect on them more productively.

While originally a project, over time the Math Forum (mathforum.org) began to think of itself as a virtual math education resource center. It was, until recently, housed at Drexel University where I currently work. And it was at Drexel for a long time. We each came to Drexel at different moments, I in the academic year of 1996, and the Math Forum in 2001. The Math Forum left Swarthmore College and was bought by WebCT in April 2000 during the tail end of the dot-com boom. It was then "spun off" by WebCT during the dot-com bust. Drexel University picked up the Math Forum shortly before they would have been force to close down operations – that was in June 2001. This co-location was fortunate for me, as it allowed me to have a much deeper and more intimate relationship with the staff at the Math Forum than I might otherwise have had. During their time at Drexel, the staff of the Math Forum occupied one room at the university. It is a largish space with staff people who run the services, software developers who produce and maintain the site, and a back room with a bank of servers that house the virtual world of the Math Forum. The physical location of the Math Forum and the onsite staff are an important part of what the Math Forum is. A core of people met in this office every day. But around this core group revolved a set of telecommuting staff and a large set of virtual arrangements that could really be thought to constitute a nested set of communities or subcommunities. I will discuss these organizational elements more in Chapters 3 and 4.

There are several goals I have in this monograph. On the one hand, I want to situate the Math Forum within the broader structural context of changes going on in the US economy, and especially the internet economy. The optimism about internet organization when the Math Forum began influenced the plans for how the Math Forum would develop. And the dot-com bust had a big impact on the Math Forum and where it was able to go. Like many anthropologists, I want to use this macrostructural contextualization in order to frame the activities that have gone on within the Math Forum. My second goal is to look at the contributions the Math Forum has made to math education. Its focus on math as a practice that all can engage in and that all can talk about is an extremely important model. A third goal

is to look at the contribution the Math Forum has made to thinking about how to use internet and digital technology for learning. The Math Forum has kept its sights on interaction and problem solving, and this has helped it to think about the things technology can contribute to people who are learning math. While I will look at some of the things students do at the Math Forum, my main focus in the volume will be on teachers. Teachers are the people who spend the longest periods of time with the Math Forum, and they form most of what I would call the online community that is the Math Forum.

This volume exists within a small set of similar case studies. There are very few ethnographies of online educational communities. In education there are a number of edited volumes that have chapters discussing various aspects of digital media and online educational communities or groups (Barab et al., 2004; Ching & Foley, 2012; Falk & Drayton, 2009; Renninger & Shumar, 2002). Each of these edited volumes has some important case studies on different online educational groups. Further, they also explore some important methodological issues as well as important conceptual issues. Ching and Foley's (2012) volume, which is the most recent, has different chapters that engage with the important idea of identity and the ways identities are constructed and transformed online.

One of the few existing case studies is Slotta and Linn's (2009) book on the WISE project in science education. WISE is a collection of curriculum projects that individuals in different locations might use and so the book is really about the sharing of resources and the kind of distributed community that forms around these resources. As such, the WISE shares a good bit with the Math Forum, which is also a resource site for sharing assets. The WISE book is more a report on the use of the WISE curriculum and the ways people have connected with it. It never had the intention of being an ethnography. This volume, I hope, will fill a significant gap in the literature.

My research is influenced by learning sciences researchers and math education researchers who have taken a more social learning theory approach (Boaler, 2000; Cobb et al., 2000; Sfard, 2008). Some of these researchers have discovered ethnography and have been using ethnographic theory and techniques to enhance their work (Barab et al., 2004; Bell, 2012; Gee, 2007). This work has been very important in that ethnography has informed curricular design as well as giving researchers in education a good sense of the importance of looking at learning practices within larger social context. This research using ethnography probably goes back to the work of bringing Vygotsky to psychology and the general work in cultural

psychology (Cole, 1998; Rogoff, 2005). In a related way practice theory in education and the notion of community of practice has been important to thinking about online education groups (Bourdieu, 1990; Lave & Wenger, 1991; Wenger, 1998). Similarly, Gee's (2007) research on sociolinguistics and learning has been critical to the learning sciences and education research in general. Gee's theoretical ideas, like affinity spaces, are critical to the development of an ethnographic perspective in this area. Further I would argue that *What Video Games Have to Teach Us about Learning* is primarily an ethnographic text, although Gee frames it more as a kind of semiotic analysis.

Likewise in anthropology there have not been a large number of ethnographies of online communities. Boellstorff's (2008) *Coming of Age in Second Life* is probably the main text that one could point to as an ethnography that stays within a bounded virtual world and makes an interesting argument for doing so. He also briefly discusses some of the "ethnographically informed" case studies in this area, but again there are not a large number of them and many of them were written in the 1990s. Boellstorff also takes on a number of the interesting questions about virtual/actual/real, the questions of place in ethnographic research, the fluidity of otherness, and so on. It is an important work in this area. But in some ways virtual worlds like Second Life or online gaming worlds makes this a simpler matter because one can talk about the experience of natives and how the ethnographer shares that by remaining focused on the virtual space and the life in that space.

Miller and Slater (2000) attack the issue of virtual community in a different way by suggesting that a case study of the internet could in fact be the case study of any group of people and the ways they are able to reimagine themselves with new communication technology. In some ways Miller and Slater's book is about how Trinidad is a different place and Trinidadians are different people thanks to the internet. The internet has allowed for a warping of the social fabric that was previously not possible. Not only can Trinidadians on Trinidad think about their relationships with each other differently, but Trinidadians who have emigrated to other countries can maintain a homeland identity in a way that was previously not possible. Trinidad is not only a nation, but it can become a space of affinity (Gee, 2005). This study of the Math Forum shares some important perspectives with Miller and Slater's work. The Math Forum has woven together a complex social space within which bonds of affinity can take place, and this has created multiple and overlapping groups. While the Math Forum is not a country and its people do not share a nation, there are

similar ways to the ways Miller and Slater discuss that the Math Forum has helped to warp the social fabric. If Anderson (1991) has taught us that communication technologies are often at the core of a group's imagination, new communication technologies have allowed us to understand spaces and groupings and even temporality in heretofore unimaginable ways.

New Locations

As soon as groups of people began to congregate through new technologies they found themselves in a new land, cyberspace. And immediately spatial metaphors began to abound. The internet created the possibility for all kinds of communicative interactions, but it also did more: it created persistence. This is something that one can see developing even before the internet. Perhaps for consumers, some of the first social cyberspaces were the spaces created on one's phone answering machine. But this space indeed was limited. And as social cyberspace became more common, people began to talk about online community and virtual community. And there has been a long discussion about community, online communities, hybrid communities, and the transformation of all communities. I've found myself caught up in this discussion at a number of historical junctures (Renninger & Shumar, 2004; Shumar & Renninger, 2002). The debates in anthropology about spaces, locations, virtuality, and the digital and the hybrid have yielded some interesting review articles (Coleman 2010; Shumar & Madison, 2013; Wilson & Peterson, 2002). What is critical in these discussions is not specifically whether we are talking about a community or something more like new forms of affinity but rather that we have a way to theorize the social space and how social life and its practices are organized temporally and spatially, whether these spaces are completely digital, virtual, or actual (Boellstorff, 2008).

From the perspective of these debates about the virtual and the digital the Math Forum is a collection of resources (lesson plans, math problems, FAQs, etc.), a few services (Ask Dr. Math, the Problem of the Week), and a set of discussion lists. But because of the nature of internet communication technologies and the ways people use them, the Math Forum could be conceptualized as a community or a community of communities. And as such it involves people who interact in distributed ways as well as face to face. There are regular participants on the Math Forum site who participate across a number of different lists and services. But there are also regular participants who are just part of one area (e.g., Teacher to Teacher (T2T), a discussion group around issues of pedagogy). People who see

themselves as members of this discussion group might have little involvement in other parts of the Math Forum site. The core of what makes the Math Forum a live sociality is the persistence of resources and the persistence of the traces of earlier conversations. These archives make future participation possible and are what people are looking for in this organization.

Participation at the Math Forum is interesting precisely because it demonstrates the transformative potential of the internet for individuals and communities. Coleman (2010) suggests that anthropologists are skeptical about the life-transforming nature of the internet. That certainly makes sense. We know that the internet has changed things, but like other communication technologies, it has been integrated into the practices that already went before it. What is hard to value are the tectonic shifts that the internet has brought about. We tend not to see them because they unfold through time, and the past is always a foreign country (Lowenthal, 1999). There are several unique features of the Math Forum. First, it is one of the oldest, best-known, and most active online educational communities. It has been challenged, but not terminated, by changes in the forms of support and institutional locations it has experienced. Although at times it looked like things were going to end for the Math Forum, it always managed to bounce back. It has continued to inspire teachers and students to focus on the everydayness of math, the pleasure of problem solving, and the importance of talking and thinking about math. It is truly a remarkable organization.

Themes

In this section, I will talk about some of the key themes that will come up in the book and form important parts of future chapters. These themes are interlocking, but I lay them out with separate headings for analytical purposes. This will allow the reader to think about what is often implicit in a chapter in a more concrete way.

Math Forum Culture

In anthropology in recent years the concept of culture has been criticized. A number of anthropologists have suggested that we even discard the notion of culture. But I would maintain that the notion of culture is useful for thinking about the Math Forum (Renninger & Shumar, 2004). Following Holland et al. (1998), I would suggest that the Math Forum culture is a

process and one that is still unfolding. It is caught up in the practices of the Math Forum and the social imagination of the members of the Math Forum community. My understanding of culture is very similar to the notion of "figured world" in that it is a process, is made up of strands from other processes, is structured and is caught up in the material relations within it and surrounding it, and, importantly, involves the creative actions of the individuals involved (Holland et al., 1998: 60).

For simplicity's sake, we can think of the Math Forum culture as having three major influences: the small liberal arts college where it began, the utopian culture of the early internet, and the dynamic personalities of the founding members. These influences, of course, produced their own history, which built the culture and is constantly being reworked at each new juncture.

Swarthmore College is a thoughtful and well-resourced environment. Students are talented and they tend to share a progressive orientation toward education and the world. They also have a habitus that makes them resilient problem solvers. The early Math Forum staff was made up of a number of former graduates of the college or similar institutions. While the members of the staff did not come from the most elite family backgrounds, they shared a social class and educational privilege that shaped the early culture. They were and are thoughtful, engaged in the world, and problem-solving oriented, and they cared about improving educational opportunities for a wide range of students and teachers.

The early culture of the internet nicely dovetailed with the progressive orientation of the College. Markoff (2006) discusses some of the ways that the personal computer industry grew out of the 1960s counterculture in the San Francisco Bay area. That culture, he suggested, carried with it progressive ideas about the freedom of knowledge and information and the ways that could make a democratic and more egalitarian society. The culture of the internet was very much connected to this utopian '60s counterculture. The internet would not only allow for free and unfettered communication between individuals, it would also bring digital goods that could be distributed freely and begin to demonstrate that a society based on plentitude, not scarcity, was possible. Poster (2001) continued to take up these ideas in his book *What's the Matter with the Internet?*, suggesting that this utopian potential of the digital was very much at odds with our economy based on scarcity. In certain arenas we continue to see this tension around the possibility of plentitude. In a real way the Math Forum took advantage of the utopian notion of open and free discussion and the sharing of educational resources. Because they were dealing with math, and

not something like popular music, the pushback on their views was different. They were pressured to commodify their resources so that they could be self-sustaining, and this had a limiting effect on the vision. But we will discuss that more in Chapters 3 and 4.

The third element of the culture is the founding members of the culture, as well as the individuals who join the Math Forum later. The Math Forum is made up of a group of people who as participants of the small liberal arts college culture and/or the early utopian internet culture shared the optimism of how the internet can benefit education. But more specifically, the members of this culture, each in their own way, had an interest in people and an ability to take people for who they are and for where they are located. They were all genuinely interested in the well-being of others, and they had and still have an ability to see past a person's social status when working with them. The Math Forum staff took advantage of the internet's capacity to suppress a person's status. When talking with teachers and students, the Math Forum staff are interested in who that person is and in having a conversation with them, regardless of where that person came from. One of the early mentors in the Problem of the Week (PoW) system was a teenage student who just happened to be very good at math. And the student not only worked as a mentor for math fundamentals, this student was a mentor at every level of mathematics. The Math Forum staff members did not see this person as a category (teenage student) but, rather, as a person who was not only very good at math but very good at talking about math. They cultivated that person because they are interested in people and good conversations. They were, of course, interested in helping that student move even further in their own thinking.

Math Forum Dialectic

I came to see the way the Math Forum approached mathematics as a dialectic. The focus at the Math Forum starts in practice and is very much about problem solving and doing math. Math Forum staff think constantly about doing math because they see math as rooted in the everyday. And while some people may need to do more math and more complex math than others, math is part of everyone's life. In order to get better at doing math not only does one need to engage in the doing, but one needs to talk with others about the math that is being done. Finally, doing and talking leads to ways of thinking, which then lead back to practices. This process is ongoing. It may involve short-term reifications, like writing things down

and taking notes, but there is never really a final reification – the answer. Answers lead to new thought and new questions.

When I began to see how central communication was to the Math Forum and the process of doing math, it made me think of Peirce's statement that all thought is dialogic (Peirce, 1931; Shumar & Madison, 2013). I have been using Peirce's point for a long time to make the link between thought and communication. Later I discovered the work of Anna Sfard (2008), who addresses this connection between thought and communication brilliantly. The Math Forum's original interest in the internet was that it created more and different opportunities for talking about math. And because it allowed these opportunities, one could get to know the other person better and have a much better sense of how they thought about mathematics. This sense of how others think is invaluable. Understanding how learners think gives one ideas for how to mentor that person and help them move their thinking about math forward (Pea, 2004). But, of course, the mentor might learn new things him- or herself in that process and become better at mathematics. The Math Forum has always seen math education in this dialogic way. It is not a matter of teaching kids things; rather, it is a matter of having a conversation where each participant in the conversation might move his or her thinking. The Forum approaches students, teachers, and other colleagues in the same dialogic fashion.

The fact that these conversations can be technologically mediated allows for more and different conversations and opportunities for doing math, as well as allowing for former bits of dialogue to be incorporated into new interactions. In a very real and practical way the Math Forum has always seen "utterances" in a Bakhtinian way: discussions are built around new speech acts, but they might potentially incorporate the text of former utterances as well. Interestingly, these technologically mediated conversations opened up new technologically mediated spaces. The Director of the Math Forum always said to me that community was not something the Math Forum was seeking. Rather, it was an effect of the effort to improve opportunities to do math and to have conversations around mathematics.

If we think of the notion of reification – turning activities into things – and the central role that reifications play in human thought (Sfard, 2008), the Math Forum produces different kinds of reifications and interacts with them differently from what we might expect given more traditional ideas about math education. If the traditional math classroom was once focused on correct answers and on the procedures and mechanics of doing mathematics, the Math Forum is not particularly interested in reifying those parts of the process. It is interested in learning to think mathematically, and so good