The Role of Online Discussion in Building a Community of Practice for Beginning Teachers of Secondary Mathematics

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This paper reports on our research with beginning teachers of secondary mathematics in building a community of practice featuring face to face and online interaction. We analyse bulletin board discussions of our 2003 pre-service cohort in terms of Wenger's (1998) three defining features of a community of practice: mutual engagement, joint enterprise, and a shared repertoire of resources. The sustainability of the community is related to how it was expanded, transformed, and maintained during and after the pre-service program.

Research in mathematics teacher education is a complex and growing field that draws on a range of theoretical perspectives on the process of teacher learning and development. While much of this research has analysed professional learning in terms of teachers' beliefs and relations between beliefs and teaching practices, Lerman (2001) argues that sociocultural theories offer more useful conceptual tools for understanding teachers' learning as increasing participation in the practices of a professional community. The study described here develops the concept of a *community of practice* in the context of pre-service teacher education and its interface with beginning teaching. The aim of the study is to analyse processes through which such a community is established and maintained when interaction is online as well as face to face. Previously we identified features of an emerging community by analysing bulletin board discussions amongst our 2003 cohort of pre-service secondary mathematics teachers (Goos & Bennison, 2004). In this paper we investigate how the community was sustained after these students finished the mathematics curriculum course and moved into their first year of teaching.

Communities of Practice and Online Discussion in Teacher Education

Wenger (1998) describes three defining characteristics of communities of practice as mutual engagement of participants, negotiation of a joint enterprise, and development of a shared repertoire of resources for creating meaning. Engagement need not require homogeneity, since productive relationships arise from diversity and may involve tensions, disagreements and conflicts. Yet participants are connected by their negotiation of an enterprise linked to the larger social system in which their community is nested. Such communities have a common cultural and historical heritage, and it is through the sharing and re-construction of this repertoire of resources that individuals come to define their identities in relationship to the community. Because communities of practice evolve over time they also have mechanisms for maintenance and inclusion of new members.

While communities of practice are generally constituted through face to face interaction, technologies such as the Internet have opened up new possibilities for participation. Use of the Internet to foster online discussion via email, bulletin boards, or web-based conferencing has become common in pre-service and in-service teacher education. These discussion forums claim a variety of purposes (and with varying degrees of success): to challenge prospective teachers' beliefs (Schuck & Foley, 1999); to enable pre-service teachers to maintain contact with each other and course lecturers during the practicum (Brett, Woodruff & Nason, 1997); to promote reflective dialogue and critical

thinking about pre-service field experiences (Hough, Smithey & Evertson, 2004); to enable ongoing discussion following professional development workshops (Stephens & Hartmann, 2004); and to share knowledge, experience and good practice (Selwyn, 2000).

Not all research studies in this area invoke the notion of *community of practice*, but those that do so highlight some of the difficulties in building communities involving online interaction. When participants share few common interests or have little commitment to each other or the discussion forum, interaction consists mainly of information or empathetic exchanges or dwindles over time. Selwyn (2000) concluded that in these circumstances no virtual community is formed because participants are "disparate professionals whose sense of community lies elsewhere" (p. 774). A clear task focus and a sense of obligation to the task have also been identified as critical factors in building a professional community through online discussion. As Stephens and Hartmann (2004) discovered, this is difficult to achieve in professional development projects that also involve face to face interaction because teachers often prefer to collaborate in person rather than in a virtual environment. However other research has found that initial face to face contact is important in building virtual communities, and that providing structured tasks involving mandatory contributions does not appear to sustain participants' interest or improve the quality of reflection and critical thinking (Hough et al, 2004).

Underlying the difficulties reported by these studies are two issues identified in research into online communities: the tension between designed and emergent communities and the question of sustainability. Derry, Lee, Kim and Seymour (2001) recommended that any attempt to design an online community for teacher education students should respect the context and follow from a careful analysis of local conditions and the needs of members. Similarly, Barab (2001) maintains that it is preferable to create a framework and then facilitate the growth of a community by adopting an emergent design so that participants build the space, rather than imposing a design completely formulated in advance. The sustainability of a community of practice is related to the designed/emergent duality in that an emergent community is more likely to meet the needs of its members because they have played a part in its development and thus identify with its goals and values. Our investigation of these issues was guided by the following research questions:

1. What evidence is there in bulletin board discussions of the emergence of a community of practice of pre-service and beginning mathematics teachers?
2. How was the community expanded, transformed, and maintained during the pre-service course and the transition to teaching?

Research Design and Methods

Participants

This paper follows the progress of the 2003 cohort of prospective secondary mathematics teachers enrolled in a pre-service Bachelor of Education program. The BEd is available to undergraduates as a four year dual degree or to graduates as a single degree taken in four semesters over eighteen months. Students take our mathematics curriculum studies course as a single class group during the Professional Year, corresponding to the fourth year of the Dual Degree and the first two semesters of the Graduate Entry program. The course aims to create a learning environment consistent with socioculturally oriented research in mathematics education in emphasising mathematical thinking and collaborative inquiry. Twice during the Professional Year all students complete a seven week block of

practice teaching. The class meets twice weekly for three hour workshops during the remaining 17 weeks of the year. Dual Degree students graduate at the end of the Professional Year while Graduate Entry students complete additional courses (not related to mathematics education) over Summer Semester and the first semester of the following year. This final Graduate Entry semester begins with a ten week internship in schools.

Data Sources and Analysis Methods

We used Yahoo Groups to establish a mathematics community website that offers a bulletin board, file sharing, and links to other educational websites. The advantage of such a community over Web-based course tools used in university programs lies in its continued accessibility to members after graduation. This website also allows members to use email for sending messages to the entire group as an alternative to posting messages to the bulletin board. (In this paper we refer to "bulletin board use" even though all members found it more convenient to use email for sending messages.) Messages are automatically archived on the website and thus available for analysis. In the light of previous research on designed versus emergent online communities, we decided to impose minimal structure on bulletin board communication. We told students the bulletin board would be an important form of communication for the course and we reinforced this from the start by providing information about forthcoming classes and events and inviting students to continue discussions about mathematics teaching begun during class. Students were free to use the bulletin board for any other purposes they chose.

Although mathematics curriculum classes in 2003 ended on 31 October, members of this cohort continued to post messages to the course bulletin board (UQEdMaths) throughout the remainder of their BEd program and after graduation – a move that brought them into contact with members of the incoming 2004 cohort. In January 2004, students in the 2003 cohort independently established a separate Yahoo Group (uqbedmaths04) to carry on their discussions in a different space so as not to overwhelm members of the new cohort with a large volume of messages from people who were strangers to them. The students also invited us to join this new Yahoo Group and gave permission to include discussions occurring here in our research study. Our analysis examines messages posted to both bulletin boards. For the UQEdMaths group this covers the entire duration of the Bachelor of Education Graduate Entry program, from the beginning of the 2003 Professional Year until the middle of 2004. We were also interested in the messages posted by the 2003 cohort to their own Yahoo Group in the twelve month period from the time it was established until the end of 2004. This overlapping analysis thus spans the transition from pre-service to beginning teaching for the 2003 cohort.

A frequency count of messages was conducted to determine the distribution of messages over time and who had posted them. Messages were then categorised in a two way analysis according to the phase of the BEd program during which they were posted and the message content. The following program phases were identified from the perspective of the 2003 Graduate Entry students, who comprised the majority of this cohort: *Professional Year Coursework* (17 weeks); *Practicum* (14 weeks); *Summer Semester* (8 weeks); *Internship* (10 weeks); and *Post-internship Coursework* (8 weeks). We also analysed *Post-graduation* messages sent in the second half of 2004. Five categories were used to describe message content: *administrative, professional, advice, information,* and *social*. Administrative messages were related to the organisation of the course, while professional messages were concerned with theoretical or practical issues arising from

readings, class discussions or school experiences. Participants sought or offered advice on a range of topics, such as handling teaching situations or preparing for employment interviews, and they exchanged information about teaching resources and job vacancies. The purposes of social messages included organising class social gatherings and celebrating personal achievements.

Emergence and Sustainability of the Community of Practice

Drawing on Wenger's (1998) framework, we analyse evidence that a community of practice emerged amongst the 2003 pre-service cohort in terms of the degree of mutual engagement between participants, the manner in which students negotiated the joint enterprise of learning to teach mathematics, and the shared repertoire of resources they developed for maintaining their community during and after completing the course. As part of this analysis we consider how the community was expanded, transformed, and maintained over time.

Mutual Engagement

Table 1 shows the number of messages posted to both bulletin boards by all participants. Altogether 955 messages were posted to the course bulletin board from 17 February 2003 to 2 July 2004. These included 207 messages sent by ourselves and 534 by students in the 2003 cohort. Of the nineteen students who finished the course, twelve posted between 1 and 20 messages, three between 21 and 40 messages, and two between 41 and 60 messages. The highest users were two students who sent 94 and 139 messages respectively. Although contributions were clearly unequal, all students insisted they checked their email regularly and read all messages, even if they did not always respond.

Table 1
Messages Posted to Both Bulletin Boards by Lecturers and Students during and after BEd

Participants	Program Phase					
	Prof. Year Coursework	Practicum	Summer Semester	Internship[a]	Post-internship Coursework[b]	Post-graduation
Lecturers						
• course bbd	45	36	42	24	60	--
• student bbd	--	--	--	9	41	30
2003 students						
• course bbd	52	87	188	101	106	--
• student bbd	--	--	--	80	228	258
2002 students	14	6	0	0	0	--
2004 students	--	--	--	33	161	--
Total	111	129	230	247	596	288

[a]Corresponds to the first period of Professional Year coursework for the 2004 cohort.

[b]Corresponds to the first practicum for the 2004 cohort.

During 2004 a further 646 messages were posted to the students' independently established bulletin board: 80 by us, and 566 by the 2003 cohort. Fourteen of the nineteen students who finished the 2003 mathematics curriculum course joined this Yahoo Group. Six posted between 1 and 20 messages, one between 21 and 40 messages, four between 41 and 60 messages, and three posted more than 60 messages (including one who sent 136).

Table 1 shows that online engagement of the 2003 cohort increased throughout the BEd program and continued after graduation. In particular, the onset of Summer Semester and post-internship coursework triggered intense discussion amongst the students. That this discussion lasted well beyond the conclusion of the mathematics curriculum course and the BEd, on both bulletin boards, implies that students found value in maintaining the sense of community engendered by their engagement.

Mutual engagement was observed not only within the 2003 cohort, but also in "generational encounters" (Wenger, 1998, p. 99) between the 2003 students and newcomers entering the mathematics curriculum course in 2004. Many of these encounters were prompted by newcomers seeking advice on teaching strategies:

> ***From:*** "Steve" <student email address>
>
> ***Date:*** Wed Apr 7, 2004 4:23 pm
>
> ***Subject:*** Logarithms
>
> Hi all,
>
> For those of you who don't know me, I am one of the 2004 batch of maths students. I was wondering if anyone could help me. I am currently tutoring a yr 11 Maths B student and last week we started to cover logarithms. He didn't get it. He couldn't understand them and I will admit I wasn't too flash at explaining them. Does anyone have any strategies for this particular abstract concept or know where I could look.

Members of the 2003 cohort, who were at that time completing their internship in schools, responded with strategies that had worked for them, such as checking the boy's understanding of exponents, explaining why we use logarithms, and approaching the concept via graphing inverse functions. Later exchanges between newcomers and "old timers" related to dilemmas arising during the 2004 cohort's first practicum session:

> ***From:*** "Bill" <student email address>
>
> ***Date:*** Mon May 10, 2004 7:17 pm
>
> ***Subject:*** Grade 10
>
> Hi all,
>
> I taught my first complete lesson today. (…) The (first) 65 minutes went great, as I managed to get fragmenting quadratic equations through to all but 2 of the students (…) until with 5 minutes to go I stopped them for a quick summary and conclusion which ended up only lasting a minute. It's true what they say about having a few minutes with students and nothing left to do, it lasts for hours.

As well as drawing a range of responses from fellow students, Bill's message was noticed by a newly graduated teacher from the 2003 cohort who posted a message explaining that she used spare time at the end of a lesson for quizzes and games that build mathematical language skills. This kind of mutual engagement between cohorts served to expand the pre-service community by integrating new members and sharing practices across generations.

Joint Enterprise

The way in which students negotiated the joint enterprise of learning to teach was investigated by examining how the content of bulletin messages changed over time. Figure 1 plots the number and type of messages posted by the 2003 cohort to both bulletin boards and demonstrates that the enterprise was defined differently as students moved through the different phases of the BEd program and into full-time teaching.

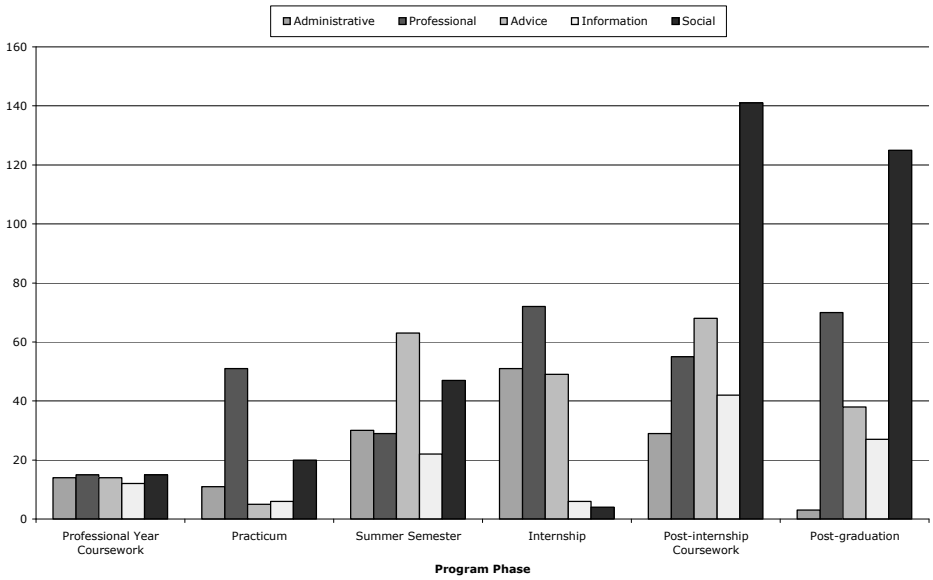

Figure 1. Content of 2003 student messages in different phases of the program (both bulletin boards).

While there was no distinctive focus for pre-service students' messages in Professional Year coursework, during the practicum sessions and internship the discussion was mainly about professional issues as they constructed their new identities as mathematics teachers in a school setting. This was also largely the case after graduation, although social messages became more important for maintaining community cohesion when members were no longer in the same geographical location. Professional exchanges included several heated debates about ethical or moral questions concerning treatment of particular students, demonstrating that a joint enterprise does not imply agreement. When the Professional Year ended students did not meet again for classes as a mathematics curriculum group. Instead they were scattered amongst cross-curricular tutorial groups during Summer Semester and after the internship while they completed courses on the sociology of education. During this time they struggled to reconcile their developing identities as mathematics teachers with new identities as learners in an unfamiliar discipline. This is reflected in the high proportion of messages where advice was sought and offered: for example, students used the bulletin boards to share their summaries of course readings and give each other feedback on assignment drafts.

Figure 1 does not include our own contributions to discussion with the 2003 cohort because these are difficult to disentangle from our interactions with the new students joining in 2004. One example of our role in these discussions centres on a course assessment task completed at the end of 2003. This task asked students to make a contribution to the profession in a form negotiated with us, and most chose to work in groups to create Maths Trails around the university campus. We then produced an edited

collection of their activities and ran a Maths Trail professional development day attended by forty local teachers in May 2004; however, it was the students themselves who presented their work and led participants around the Trails they had created. Because we were no longer teaching this group of students we used their bulletin board to organise the program for the day and later to distribute a summary of the teachers' written feedback. The bulletin board was thus a medium that helped us connect the enterprise of learning to teach mathematics with the practices of the wider professional community in ways that transformed the students' identities and oriented them towards possible futures.

Shared Repertoire

In the course of its existence a community of practice develops a shared repertoire of resources by "producing or adopting tools, artefacts, representations; recording and recalling events … telling and retelling stories; creating and breaking routines" (Wenger, 1998, p. 95). The two Yahoo websites were themselves important tools in the repertoire of resources this community used to make sense of learning to teach mathematics. Two examples illustrate how the 2003 cohort employed both bulletin boards to maintain the community and its shared history. After the internship, Graduate Entry students used the course bulletin board to organise their own mathematics-specific debriefing session, and they invited newcomers in the class of 2004 to attend. A date during the Easter vacation was suggested to enable Dual Degree graduates who had started teaching to participate also:

> ***From:*** "Chinh" <student email address>
>
> ***Date:*** Tue Mar 16, 2004 7:40 pm
>
> ***Subject:*** Re: debrief
>
> Hi everyone!
>
> We will have two beginning teachers and a dozen or so half cooked teachers to share our experience and hopefully many interesting stories. For all the half-cooked teachers out there please come along, I am sure that your stories would be interesting as any others because we all have different schools, different classes, different in many ways. Class of 2004 please come along because some of your questions might help us to think about our teaching approaches again. As well we may give you a bit of insight of what your prac would be like according to our limited but very real experience.

At the debriefing session members of the 2003 group identified challenges they had experienced and sources of assistance, shared strategies for building positive relationships with students, and related anecdotes about their best and worst lessons. Interns of the 2004 cohort who participated in this session as newcomers are currently organising a similar debriefing, which suggests that this practice may become a routine and part of the shared history of the community.

The second example is related to the function of social gatherings as a means of expressing community membership. Figure 1 shows that social interactions accounted for a large proportion of messages at the end of the Graduate Entry BEd program and in the first six months of teaching post-graduation. At these times members were congratulating each other on securing teaching appointments, maintaining social relationships when separated by distance, and organising graduation or reunion dinners. The dinner held in December 2004 (fittingly dubbed the "XMaths" dinner) was attended by ten of the fourteen members

of the students' Yahoo Group. Yet this was more than a social event, as it provided an occasion for quite detailed analysis and comparison of teaching experiences in different schools similar to that undertaken in the internship debriefing session.

Implications and Future Directions

We attempted to manage the tension between design and emergence in establishing communities of practice (Barab, 2001) by creating a community framework in the form of the mathematics education course website and bulletin board, and allowing our pre-service students to build the space that would meet their needs. We regard their appropriation of the course bulletin board to their own purposes and their establishment of an alternative Yahoo Group as convincing evidence of the sustainability of this community of practice. Our analysis indicated that members of the 2003 BEd cohort increasingly took the initiative in engaging with each other and expanding the community through generational encounters with newcomers, defining their own academic and professional goals and values in ways that transformed their identities as novice teachers, and constructing a repertoire of resources for maintaining their community beyond graduation. Previously we have reported on factors contributing to the emergence of this community (Goos & Bennison, 2004), such as the voluntary and non-assessable nature of participation, and the critical importance of initial face to face interaction in creating familiarity and trust. Yet many questions remain to be investigated, especially regarding our own role in influencing the learning trajectories of the pre-service and beginning teachers, and the roles of other key members of the community – the small group of students and graduates who posted the highest number of messages. Such an investigation may yield new insights into pre-service communities of practice that span the transition to beginning teaching of secondary mathematics.

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