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## **Developing a Mathematical Community Using an Electronic Discussion Forum in an Elementary Mathematics Methods Course**

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This study was designed to inspect the impact of using online discussion forum (a password-protected asynchronous web-based discussion forum) in an elementary methods course. The results of this study were that students felt that they were part of a community of learners and became more aware of current research in the field of mathematics education. Furthermore, some had begun to evidence signs of becoming a “teacher as researcher.” Students who were often reticent about participating in class contributed to discussions on the forum, became more thoughtful about their responses, and increased their use of technology to facilitate their learning.

To support the development of a mathematical community in an elementary methods course, an electronic discussion forum was developed as a teaching experiment for one semester. To design the activities, requirements, and protocols for participation, the author had to explore the notion of “mathematical community.” What are its characteristics? Why might it be appropriate for elementary school mathematics education students?

This article explores the role and characteristics of a mathematics community, speculates about its relevance in elementary school mathematics education instruction, and reports the results of using a semester-long electronic discussion forum in an elementary methods course.

## **Mathematical Communities for Learning**

Participants in a mathematical community are engaged in doing mathematics together. They are encouraged to engage in mathematical work—construction, collaboration, reflection, and presentation and defense of conjectures. They can share their work in a comfortable atmosphere where discourse and collaboration are valued (Brown & Campione, 1994; Bruner, 1996). At the heart of such a community is mathematical communication (Mendez, 1997).

To develop such a community, students must be given real opportunities to develop and share their conjectures, defend their solutions, and develop their “critical thinking” skills. There must be time to talk about the mathematics, to develop models, to analyze and synthesize ideas, and to develop an atmosphere in which they can think for themselves. Because active processing and discovery are important contributors to understanding (Perkins, Schwartz, West, Wiske, 1997), there must be adequate resources in an environment in which exploration and discovery are supported and ideas are valued and can be freely stated.

## **Importance of Mathematical Community**

As mathematics instruction shifts from teacher-centered practice to focus more on students and their ideas, one of the major goals of instruction becomes the ability to communicate mathematically. Students must learn worthwhile mathematical tasks situated in a discourse community (National Council of Teachers of Mathematics [NCTM], 1989, 1991). This kind of environment allows students to develop and test their own ideas rather than adopt others’ explanations, models, and ideas (Piaget, 1974).

In a supportive mathematical community, students can construct their own ideas, find their own representations, and connect mathematical ideas in their own ways. Moreover, they are working in many of the ways mathematicians do, by making and testing conjectures, collecting and analyzing data, and developing explanations, models, and images to explain their approaches and ideas. Thus, they shift from static conventional notions of mathematics to dynamic, active conceptions.

## Rational for Study

In response to an increasingly complex society and a rapidly changing, technology-based economy, schools are being asked to educate the most diverse student body in our history with higher academic standards than ever before. Accomplishing this task requires skillful teaching and schools that are organized to support teachers' needs. Results from the Third International Mathematics and Science Study (TIMSS) found that American teachers lack structured support to improve their pedagogical practice. Further this data suggested, unlike teachers in either Japan or Germany, that our teachers do not have much time or structured opportunity for interaction with colleagues about instructional issues. United States teachers are also more likely to work in isolation than in other countries (Silver, 1998). In addition, statistics have shown that as many as 30% of our secondary mathematics teachers do not even have a minor in their field, and in schools with the highest minority enrollments, students have less than a 50% chance of getting a science or mathematics teacher with a license and a degree in the field in which they teach (Darling-Hammond, 1998). Thus, finding alternative methods to educate our mathematics teachers is essential. We know that teachers learn best by studying, doing, and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see (Darling-Hammond, 1998). A discussion forum is an alternative method that can help facilitate teachers' learning.

In a traditional semester-length elementary mathematics methods course, there is generally time for preservice teachers to learn only a small portion of what they need to know to teach mathematics. Students must learn about both mathematical content and pedagogical content, as well as issues related to mathematics reform, NCTM Curriculum and Evaluation Standards, assessment/testing issues, and gender equity. Often, time limits an in-depth look at issues and, thus, only a cursory treatment is allowed. Since there is such a wide array of materials to learn, addressing all of these topics in depth is a challenge. Students generally meet only once a week and thus rarely get time to discuss their learning and teaching. It seems important to develop ways of extending community and reaching beyond course boundaries; therefore, an electronic discussion forum was implemented to facilitate this process.

Discussion forums lend themselves to facilitating and promoting discourse as they enable students to share their views by way of the Internet and respond to other students' opinions and pose interesting questions. In addition, forums provide interesting modalities for students and instructors

to share information and challenge each other's suppositions in a nonthreatening manner. All participants can take the time needed to research, think about, and compose their response before making it public, in contrast to discussions in a classroom that require immediate responses.

## **Study Design and Purpose**

An online discussion forum (a password-protected asynchronous web-based discussion forum) was established as a component of an elementary methods course. The 20 preservice elementary teacher candidates were required to use the forum to respond twice to each of five central topics: the NCTM Standards, equity, technology in the mathematics classroom, brain research, and the Massachusetts Comprehensive Assessment System (MCAS—the high-stakes test administered in the fourth, eighth, and twelfth grades). First they were asked to comment about what they knew initially about the topic, and after researching each topic they were again asked to respond, summarizing the knowledge they researched and commenting on it. They were encouraged to respond to each other and to extend the conversations. Small groups were formed to facilitate the online discussion and to summarize their research in a class presentation or facilitated discussion.

Topics chosen for this discussion were directly relevant to elementary preservice teachers. These topics were chosen not only for their relevance, but because they represent many of the “big ideas” in mathematics education. Topics discussed on the forum were also discussed during class time. As an alternative to traditional assessment, the forum was used to demonstrate a variety of approaches to assess learning. It was interesting to “view” the changes from initial response to researched response, in which students summarized their findings, stated their opinion, and read others responses and assimilated that information into their opinions.

The first day of the semester students were provided with instruction about how to use the forum and access help; they were also informed that this was a research project developed so that students would have more “class time” to discuss issues. The extent of the instructors' participation changed over the semester from reading all responses and posting regularly to eventually just reading all responses. At first, the instructor was frequently posting to the discussion forum to model use of this communication tool and begin the dialogue; however, as the semester progressed students appeared to be more comfortable serving as facilitators for the topics and posting to the forum. After students posted to the discussion forum about

each topic, it was discussed in class. The Instructor often began the discussion; subsequently, the small groups that were formed to facilitate the online discussion did so in class. As the semester progressed, the students often began the discussion without prompting from the instructor.

### **Designing the Online Forum**

This course was designed to provide students with the experience of participating in a “mathematical community.” Many of the components of constructivist learning support the development of a mathematical community; therefore, components of a constructivist learning experience were used. These included seeking and valuing students’ point of view, challenging students suppositions, posing relevant problems, teaching to the big ideas, and offering opportunities for students to demonstrate knowledge in a variety of ways (see Brooks & Brooks, 1996).

### **Data Collection and Analysis**

To study these changes, two different types of data were collected. Data from the discussion forum and data from a survey collected at the end of the course. Discussion forum data were analyzed by inspecting for trends and computing means and ranges. In addition, survey data were also analyzed for trends.

### **Results**

Analysis of the data resulted in a range of responses from 4 to 20, including the postings from one student who withdrew from the course and a mean of 13.2 responses per student. The total number of postings for this group was 264. Table 1 represents the frequency of responses per topic for each student. It does not include the responses posted by the instructor.

**Table 1**  
Frequency of Responses by Topic

Student	Topic #1	Topic # 2	Topic # 3	Topic # 4	Topic # 5	Total
#1	1	1	2	3	3	10
#2	2	2	5	4	7	20
#3	2	1	4	3	4	14
#4	2	4	3	4	4	17
#5	3	3	3	5	5	19
#6	2	2	3	2	5	14
#7	2	2	4	6	5	19
#8	1	1	3	3	2	10
#9	3	2	3	0	5	13
#10	2	3	3	1	2	11
#11	2	2	3	2	4	13
#12	2	3	4	5	5	19
#13	2	3	3	3	0	11
#14	2	3	3	4	4	16
#15	2	3	2	3	5	15
#16	2	2	3	4	6	17
#17	1	1	2	2	4	10
#18	1	1	1	1	0	4
#19	2	1	2	2	1	8
#20(withdrew)	2	2	0	0	0	4
						264

However, what was most interesting were the trends in the data and the student comments made about using the forum as a communication device. Several trends were identified early on and continued to be more prevalent as the semester continued:

- Students felt that they were part of a community of learners.
- Students became more aware of current research in the field of mathematics education; furthermore, some had begun to evidence signs of becoming a “teacher as researcher.”
- Students that were often reticent about participating in class contributed to discussions on the forum.
- Students became more thoughtful about their responses.
- Students increased their use of technology to facilitate their learning.

***Students felt they were part of a community of learners.*** Students stated that they felt they were part of a community of learners. One student commented, “ In most cases you never have contact with students between class sessions. The Net Thread was an open communication line that I could use on my own time and connect with my colleagues.”

Another stated,

I had a sense of classroom community. It was great to have discussions with everyone from the class, especially to hear from those people who do not always participate in classroom discussions. It was nice to be able to continue discussions on the Net Thread that we would not have had time to discuss in class. I felt that we all learned from each others' experience and that more voices were heard than in a classroom discussion.

Overwhelmingly, the students stated that this forum enabled them to feel part of a community.

***Students became more aware of current research in the field of mathematics education; furthermore, some had begun to evidence signs of becoming a “teacher as researcher.”*** As the semester progressed, some students became more aware of research in the field of mathematics education and some evidenced signs of deepening their interest in assessment issues. Evidence of this was exhibited in several situations. The average number of student responses varied as the semester advanced. Students chose to alter one of the prompts and create their own, which better served their learning needs. The Assessment prompt was tailored by the students to meet their learning needs after they had completed some investigation into the topic. In addition, students began investigating topics from a variety of angles, not just from the teacher perspective, to provide an accurate picture to help them form their opinions. Questions posed after reading the prompt inspired students to investigate the history of the exam resulting in learning about the history of reform in Massachusetts and to interview principals and parents for other points of view, test validity and reliability, as well as student points of view. According to the instructor, students were delving deeper than they typically had in prior semesters on the same topic.

***Students who were often reticent about participating in class contributed to discussions on the forum.*** Technology also has the potential to provide a supportive and non-threatening environment (Perkins, et al., 1997). The discussion forum provided an environment in which many students felt they could state their opinions in a nonthreatening atmosphere. Many students who were typically shy and afraid commented that using this type of communication enabled their voice to be heard for the first time in a class. For example, this forum enabled them to think about and compose what they wanted to say on their own time without “having forty pairs of eyes”

on them. One student said, "I was able to use the discussion forum to comfortably voice my research, thoughts, and opinions to respond to others. This forum really helped me to have my voice, to have a presence in class I might not have otherwise had."

***Students became more thoughtful about their responses.*** Throughout the semester the students' development of their ideas and opinions about the material was evident in both classroom discussions and the forum. Whereas it is more difficult to recall a student's thought process and development in the classroom, discussion forums provide the means for clarity and documentation of student progress.

When inspecting the data, students' responses became more reflective, collaborative, and critical as the topic and semester developed. For instance, many students started discussing a topic with responses such as the following:

First Response: I am sorry to say that I am completely ignorant as to what NCTM Standards are. I look forward to learning all about them. I am clueless.

Second Response: So, as of last week I had no clue as to what NCTM Standards were. I am very glad to say that now, after reading the standards; I am no longer completely clueless. I found it exciting to read about the changes that the standards are trying to make happen in the classroom. I wish these standards had been implemented back when I was in school. Even now I find math inaccessible and foreign. Would this be different if my teachers had understood the importance of teaching math with a holistic approach? If math concepts had been taught to me in a way that made sense in my world would I not now be so overwhelmed by it? I am not currently teaching so my opinions on the subject of NCTM standards are extremely idealistic. The standards coincide with my views and approach to teaching; so, I am very excited about them. I would be interested to know how teachers in our class feel on the subject and if the standards are unreasonable in a real classroom setting as opposed to what I envision from my non/teacher Pollyanna perspective. I look forward to researching an article on the subject.

Third Response: Hi Quite a few of us "non-teachers" would love to hear from the teachers in our class about their own personal experiences with NCTM Standards in their classrooms. Is it wonderful in theory, but difficult in practice? Please fill us in.

Fourth Response: So, I went out searching for the viewpoint of the 'other side.' It certainly is out there. I found *A Critical View of NCTM Policies with Special Reference to the Standards Reports*, written by Frank Allen, who was a past president of NCTM in the 60's. I found it at <http://mathematicallycorrect.com/allen1.htm>. Another interesting site to check out is [www.intres.com/math/News.htm](http://www.intres.com/math/News.htm). Well, Frank Allen is... Anyway, it was interesting to hear the other side. In the other site I gave earlier there really are a lot of people that have a problem with the Standards. I wonder if we will eventually find some middle ground. It seems that with Language Arts we have swung from one end of the spectrum with phonetic learning to the other with the whole language movement. It seems that in most cases there is a happy medium to be found. I guess the best thing is to remember that overall, we must be concerned with what is best for the children. And to remember that each small step is as important as the big ones as long as we keep moving forward.

Please note: All of this development took place before the Standards were discussed in class. For additional examples, see Appendix A.

***Students increased their use of technology to facilitate their learning.***

Using technology in a classroom can facilitate learning because it can help to provide extended supportive environments (Perkins, et al, 1997). Technology can be used to provide individuals with access to a wide range of information resources and tools to facilitate their learning. Technology helped facilitate these students' learning by using the Internet to access information and research about teaching mathematics. Many students had limited exposure to technology and stated that this was a new resource for them. One student commented, "I have never used the Internet to do so much research before. I still feel like I am swimming around on the Internet, but I am less afraid of it and can find things more easily." As the semester progressed, the numbers of students referring their peers to resources on the Internet increased.

Using a discussion forum appears to have had a major influence on many of the students who participated in this study. The information gathered from online responses and survey data helped to craft how the instructor would use discussion forums in the future.

## **Advantages and Disadvantages**

The advantages to using such a medium to create a mathematical community have been mentioned extensively, the disadvantages to using

discussion forums have not. Access to and ease of using computers was initially a problem for many of the students. To address the ease of use issue, training on how to use the discussion forum was provided and faculty support was available. However, while all students had email accounts on the school system and had access to the Internet, some did not have computer access at home. The students participating the most had access at home, while those individuals participating the least did not have computers at home. One student commented, "I felt my limited access to computers was a major reason for my lack of participation." In addition, some students found that reading all of the responses was, at times, overwhelming.

If all students do not have equal access to such technology this medium, though effective, may not be appropriate because it does not include all students whom we are responsible for educating. In fact, it may create a large divide in access to appropriate education if we are to use this technology without equal access for all.

### **Further Implications for Mathematics Education**

Using an electronic discussion forum to develop a mathematical community appears to have been effective for this group of preservice teachers. However, while using this approach may be successful during the semester, it is often difficult for many new teachers to maintain the perspectives they have developed in preservice programs due to pressures to return to traditional teaching approaches when they begin teaching (Wilcox, Schram, Lappan, & Linier, 1991). Thus, an electronic community, developed during a preservice program and continuing after graduation is a potentially realistic and effective way to provide support. Many of the students in this class wanted to see this type of communication device implemented in other courses and especially in their student teaching semester. Mary, a student new to discussion forums, commented,

This would be great in other classes because you don't have to do all of the research yourself, there are lots of resources on the discussion forum from others [students]. I could start with those resources and go from there. This [the discussion forum] would be great to keep in touch with others during student teaching.

However, for those students who did not have easy access to a computer and Internet, this may further increase the gap technology can create between the "haves and have nots."

The instructor will definitely use discussion forums in the future. Topics may vary depending on the make-up of the class. One alteration to this study for the future might be to have students post initially before the topic is discussed in class, but after they have done research on the topic and then after the discussion in class. This could be done so students would have more time to reflect on each topic.

## CONCLUSION

Online discussion forums have the potential to provide professional development and support in very different and interesting ways. They have been used to support a variety of educational efforts such as providing support to preservice teachers in their student teaching experiences (Dewert, Babinski, & Jones, in press), as a method for providing professional development (Harris, 1998), and facilitating discussions among students in a middle school science classroom (Winslow & Smith, 1998). Using online forums can help extend classroom time so that more important discussions about mathematics education can occur. It may provide an environment that supports collaboration among students and supports their learning and facilitate the development of a mathematics community of learners.

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## APPENDIX A

### First Response:

Having read a little of the textbook re: standards...on the one hand, I suppose I am a little suspicious of "standards" in any subject: how did they come about? who made them up? Where were they coming from? Was the

group diverse/representative of many perspectives (incl. race? class, gender, etc. issues). Making many conform to one set of standards can be dangerous if too rigidly adhered to, if misunderstood, etc.

On the other hand, so far, it all looks pretty positive to me—looks like the standards make math more interesting, relevant, fun, and non-threatening than when I was a kid in the 60's and 70's. I especially loved in the book where it said that using manipulatives was a more positive experience than using pen (or crayon) and paper, because the student is free to experiment, make mistakes, be a creative thinker, without fear of making an irreparable mistake.

Second Response:

Yes, I, too, like so far what I see of the standards, as far as teaching kids to think, and the idea that everyone can do math, etc. One thing, though, that I think we tend not to question is what we are preparing kids for (i.e. to live in the global economy, etc). In a science class I took last semester, we talked a little about this: i.e. being careful about seeing kids just as little worker bees for the global economy, and seeing school as the vehicle for churning these worker bees out, so that the U.S. can remain competitive. Is this what math/science education should be all about? This is just the chord that the words “global economy” struck in me today!

Third Response:

Very interesting info — thanks for the research! Just a question, re: your thoughts on the LD kid learning math...is the “real world” ONLY about reading bus schedules and fixing flat tires? If this (mythical) kid gets from school a sense that s/he has abilities, is able to solve problems and think things through (even if it takes more time and/or help — a calculator, a cheat sheet), isn't that in itself invaluable? And don't we all need help sometimes? I guess I need clarification about what you meant...I am not sure, and am reacting to something that may not be what you were actually saying!

Fourth Response:

Hi Suzanne (and others out there in net-thread land): Yes, it's funny and interesting that we both used the term “workerbees” without having read each other's messages! In general, it seems to me that this is not what the NCTM Standards are about, in their content (though maybe some of the motivation for creating them in the first place comes from that place of needing to compete in a technological global economy and blah blah blah).

Anyway, today I read one short article from a 1992 issue of Arithmetic

Teacher entitled “The Dangers of Implementing the Standards; or, When Bad Things Happen to Good Ideas” by David J. Whitin. This is not a guy who is “anti-standards,” but rather someone who is worried that the standards will be used as a rigid methodology for teaching math, rather than being seen and used as what they are, theories about how people learn, meant to be fluid, flexible, and always subject to question and adaptation, based on teachers’ experiences with their students. This is the humility of the standards, which you (I think) spoke of! In Whitin’s words, the document “calls us to reflect and question, not receive and accept.” I like this idea.

He goes on to say that the standards were based on the premise “that learners construct their own knowledge; that learners grow by sharing and generating ideas with others; and that learners gain new understandings by representing their ideas in different ways, such as drawings, written narrative, or oral discourse.” These seem to me like good premises, that reflect to a large degree how I, too, think about learning.

But he fears that what has happened with the “Whole Language” movement could happen with the NCTM Standards. He doesn’t go into this in detail, and I don’t know a ton about that controversy, either — but it does seem that Whole Language has come in for an unfair share of criticism of late, and perhaps it IS in part because some tried to implement it as if it were a “cookbook” rather than ideas about learning upon which to “reflect and question.” Then we end up being reactionary and ‘throwing out the baby with the bathwater.’

I guess it is harder to teach without a recipe, so to speak. Maybe a lot of teachers don’t want to do it. Maybe some teachers feel standards (of different sorts) being forced upon them, without room for their own thoughts or ideas, and so implement them half-heartedly and without excitement — so doomed to failure! Perhaps these are the hazards inherent in ANY so called “standards.”

All that being said though, as a person naturally suspicious of such things, I am really quite impressed with these standards — which do, for the most part seem really open-ended and useful. They are helping me think differently about math, which I think can only be a good thing!

Whitin, D. (1992). The Dangers of Implementing the Standards; or, When Bad Things Happen to Good Ideas. *Arithmetic teacher*, 40,8-9.

Fifth Response:

An interesting book to take a look at...

I recently took a very interesting book out of the Lesley Library called *Talking Mathematics: Supporting Children's Voices* by Rebecca B. Corwin (with Judith Storeygard and Sabra L. Price), Heinemann, 1996. This book addresses the communication part of the Standards with a variety of articles, essays, and ideas. I've only read the intro and one essay so far, but have found it very inspiring, particularly in thinking about LISTENING to children, really hearing what they are saying, how they are thinking, and how their thinking Processes and even what's important to them in a given situation, may be very different than our adult agenda. Personally, I think learning how to listen to kids, and how to not immediately jump in there with my own agenda or "the answer," will be one of my biggest challenges.

In reading through all these postings, the thing that is jumping out at me most is that the NCTM Standards represent a particular philosophy of education (developmental, Rousseauian) which is not accepted by all. Many people are still coming from the place of "child as blank slate to be filled with appropriate knowledge." From what I have been learning in my development class, it seems like these arguments have been going on for centuries and there is no sign of an end, or of any universal agreement! And as usual, it seems that the issues have become divisive and some of the arguments very angry and disrespectful. It is sometimes scary to think about entering this fray! Does anyone else feel this?

Another student:

First Response: I do not know what the standards are for the state of Massachusetts? I am thinking that the standards for the state are on a national level and are probably similar to many other states. How are the standards determined? Does anyone have an idea?

Second Response: The following article can be found at this Internet address: <http://tcrecord.tc.columbia.edu/journalstuff/fulltextpdf/vol96/elmfuh.pdf> The article addresses the historical background of "Standards" and how their original intent differs dramatically from the current standards in place today. The author specifically centers on "the opportunity to learn" which they list among other standards relating to performance and content. Opportunity to Learn (OTL) standards "define a set of conditions that schools, districts and states must meet in order to ensure students an equal opportunity to meet expectations for their performance. These standards have long been a subject of debate but more so now than ever with the reauthorization of the Elementary and Secondary Education Act (ESEA) in 1994 and the Clinton administration's *Goals 2000* which attempts to establish a voluntary national set of standards and support for state and local

systemic reform. As with many issues surrounding education today, politics is deeply involved. This article addresses the roles state and federal government should play in this most recent standards debate. It is interesting to see the original conception of standards and their intent. As with many hot political topics, these ideas have been circulating for over a century, yet a new “spin” is put on them to create a source of political debate on local, state and federal levels. This article focuses mainly on the state participation in the creation of standards for education and to what extent they should be involved. The author quotes the original New Hampshire (1784) and Massachusetts (1780) constitutions “The educational provisions speak of “spreading the opportunities and advantages of education in the various parts of the country, and among the different orders of the people”. Despite this early recognition of state responsibility, states did not begin to exercise authority in any notable fashion until the last half of the 19th century. The article goes on through the history of state roles in education, which differ dramatically from the goals set forth in today’s social education. The authors review opposing and contrasting options for new standards. One theme is continuous throughout the article and that is the tendency to layer new ideas on top of old ones which ultimately creates such a thick stack of “rules” both new and old that it is almost impossible to start anew. “

I think drastic changes need to be made in terms of the state role in education. I feel it is important to have standards because our society does not seem to function well without them. Yet, it is essential to allow for flexibility. Every school system is different from the next just as children are unique in their own way. The standards should strive to provide teachers with the opportunity to incorporate their own instincts and resources in order to provide every child with the opportunity to learn. What are your thoughts?