

**ONLINE MATHEMATICS CONTENT COURSE
CREATING COMMUNITY:
METRO'S MATHEMATICS FOR RURAL SCHOOLS
PROGRAM***

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Abstract

The Mathematics Teaching and Learning (MTL) group at the Metropolitan State College of Denver (Metro) has developed an online course to enhance the mathematics content knowledge of rural K-12 teachers in Colorado. Due to the isolated location of the rural schools, web-based technology was a necessity; in fact, the teacher participants are often separated by more than a hundred miles. Although the courses were content driven, the delivery of the courses modeled teaching practices which were directly transferable to the K-12 mathematics classroom, supported development of mathematical proficiency, and fostered a mathematical community among teacher learners. This paper will summarize the course and speak to the teachers' self-reported changes in teaching as a result of the course.

Guiding Principles

The goal in creating Metro's Math for Rural Schools program (Metro's Program) was to see if it would be possible to replicate a successful problem-solving course online. The online course was designed to deepen the mathematical knowledge teachers need to teach mathematics through participating within a community of problem-solvers. Teachers are responsible for solving novel problems, justifying strategies, generalizing results, and unpacking complex mathematical ideas (Ball & Bass, 2003) and that knowledge is created through social interactions as learners participate in a community of practice (Greeno, 2003). The relationship between individual learners and the community is reflexive; what individuals learn is inseparable from the context in which it is learned, and the learners influence the context through their negotiation of meaning (Peressini, Borko, Romagnano, Knuth & Willis, 2004). A primary goal of Metro's Program is to have participants "contribute to mutual understanding by appreciating and explaining assumptions involved in their thinking and that of other participants" (Greeno, 2003, p. 316). The online course was designed with these principles in mind and the retention of two essential components of Metro's campus-based courses: a problem-driven curriculum; and a collaborative instructional approach that emphasizes reasoning, communication, and creation of a learning community. The challenge is to maintain the integrity of these course components while moving to an online environment that reaches Colorado's rural teachers.

The key component of this project is the small group teacher interactions. These small group teacher interactions serve, not only as an example of research-proven pedagogical approaches, but as a way to foster collaboration and communication within the mathematics education community. Metro's Program attempts to facilitate a collaborative environment for doing mathematics through the use of web-conferencing software that allowed participants to interact in a variety of ways in real time.

Course Description

Each course begins with a kick-off, face-to-face meeting where all of the teacher groups come together to discuss the course and begin problem-solving in order to establish classroom norms and become familiar with the technology. These face-to-face interactions are essential components of the course. After lunch, we take the problem

solving process online. This gives the teachers a chance to get to know the technology and how the problem solving process will work online.

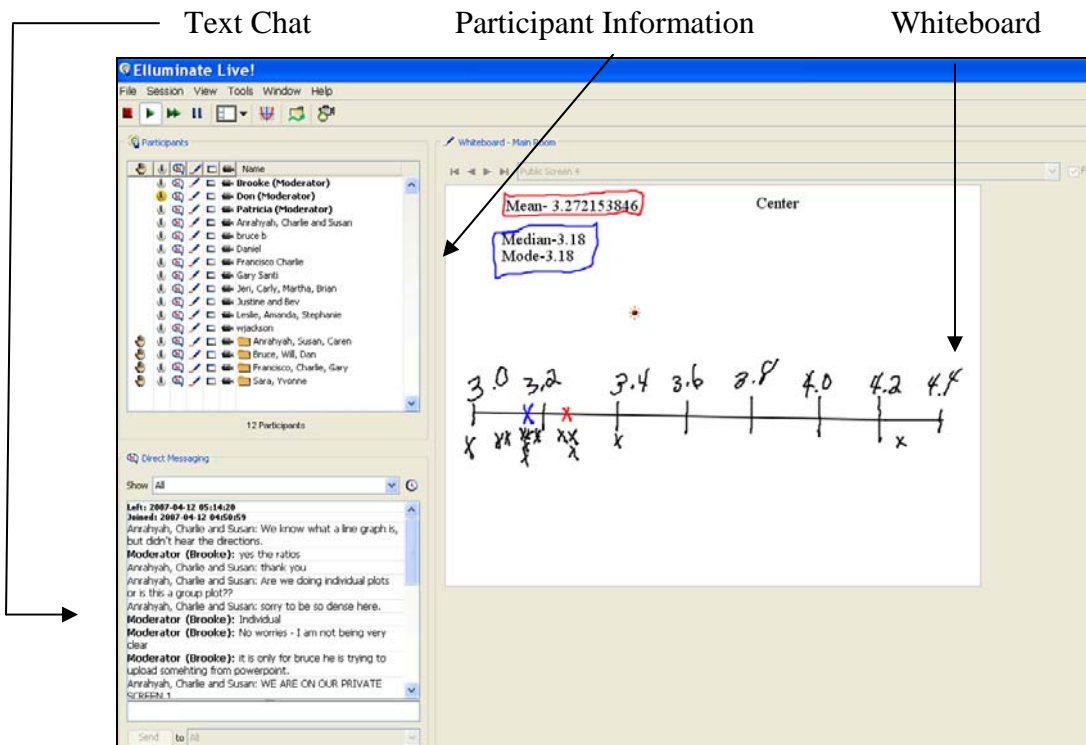
For the online portion of the course, the teachers meet in small self-selected groups of two to four people either from schools or homes spread throughout Southern Colorado and are connected online with the other groups and the instructors –situated in Denver, Colorado some 500 miles away- who facilitate the learning experiences. Most groups share one computer. In some cases, individuals in separate locations come together to work in a “virtual” group. The four Metro faculty take their laptop computers and microphone headsets and split into two pairs; one pair facilitate a session for elementary teachers, and the other pair facilitate a session for secondary teachers. The courses meet online twice a week at a set time for five weeks. The exact problems and proposed learning outcomes are slightly different for each group based on their needs, but both sessions incorporate the same basic mathematical content. Online sessions are sometimes conducted from one of the Metro faculty members’ homes in order to accommodate care of young children (this situation reinforces community ties with several course participants who also log on from home in order to care for their children). Once everyone is online, Metro faculty use the software tools to present interesting, complex problems for the groups to tackle.

In contrast to self-paced and text-based distance learning, *Elluminate*[®] software facilitates synchronous audio, video, text, and visual interaction among participants. Metro’s Program relies primarily on the software’s audio, text, and visual capabilities. Most participants deem the video feature unnecessary for successful interaction. The software allows Metro faculty to place groups of teachers in virtual “breakout rooms” where the teachers solve problems using the software’s interactive whiteboard tools. Metro faculty then engaged in electronic “eavesdropping” in order to listen to group interactions, observe “whiteboard” work, provide hints and encouragement. The audio is generally clear, with occasional feedback and distortion, and the whiteboard content is usually easy to manipulate.

After working independently, the groups are then brought together in one virtual “room” to present findings and interact using the whiteboard, audio, and occasionally video. Groups are responsible for restating and analyzing each other’s solutions and engaging the underlying mathematical concepts. Groups generally used synchronous voice and the “whiteboard” to communicate with each other. The *Elluminate*[®] interface also allows participants to text chat while other participants or instructors use the audio feature to communicate. The text chat feature provides an alternative communication channel that enables participants to hold public “conversations” that may or may not be directly related to the topic at hand. Text chat will often be praise or encouragement for the presenters, comments on the sound quality, or side comments directly to the instructors that may or may not relate to the presentation. We are currently researching the opportunities and challenges associated with this software feature in the context of online mathematics instruction and community building. In addition to the interactive whiteboard, text chat, and moderator tools, Metro faculty typically use the software’s math symbol library, application sharing, file transfer, and session recording features. A screenshot of the *Elluminate*[®] interface is proved in Figure 1.

Figure 1

Screenshot of Elluminate® Interface used During Metro's Program



The course ends with another in-person meeting. This meeting gives Metro faculty the chance to conduct research on the course via surveys and group interviews; allows us to wrap-up any mathematical questions left from the course; and gives the teachers another chance to connect with each other.

The primary objective of the courses are to provide mathematics content for teachers while simultaneously modeling a pedagogical approach designed to create a community of teacher-learners. Problems for the courses are chosen in order for teachers to expand their mathematical thinking concerning K-12 curricula and to communicate their mathematical ideas. During the in-person closing session interviews, participants recognized how the course had fostered collaboration and communication within the San Luis Valley mathematics teacher community. Working with colleagues can help teachers answer questions, learn new ideas, and reflect on their teaching practices (Romagnano, 1994). The course participants also formed bonds with Metro faculty, furthering communication, collaboration, and reflection. As Sowder (2005) notes, direct communication with a mathematics education specialist is important in pushing teachers' mathematical thinking.

Research Question and Methods

Although Metro faculty hoped that the course would serve as a model for how to implement community of practice pedagogical techniques in K-12 classrooms, pedagogy was not directly emphasized in the course. Metro faculty expected that teachers would, ideally, perceive the value of building community and seek to transfer such knowledge to their classrooms. Also, teachers are often told that a problem-solving approach creates meaningful experiences for students, but many teachers have not had experience with the approach as learners themselves. As previously noted, we argue that an essential component of learning mathematics for teaching is to engage teachers in mathematics problem solving in ways that they can use with their own students. Experiencing a new approach firsthand is critical if teachers are to see its value and become comfortable using it. Based on this premise, we developed a research question, namely: *are teachers building community and changing their teaching practices as a result of Metro's Program?* A preliminary assessment of the program, using a combination of observations, questionnaires, and focus group interviews, suggests that Metro's Program has substantively influenced teachers' thinking about their work in their classrooms.

Preliminary Results

Preliminary results here are based on pre- and post-course questionnaires and the interviews conducted on the participants in the third course offered in the spring of 2007. Pre-course questionnaires focused on teachers' reasons for enrolling in the course and what they hoped to gain from it. Post-course questionnaires were used to assess whether as a result of the course, teachers: 1) felt more comfortable teaching mathematics; 2) spent more time preparing mathematics lessons; 3) perceived that they engaged more successfully with students around mathematics issues; 4) believed that they were able to prepare mathematics lessons more effectively, and 5) had attitudes toward teaching mathematics that had become more positive. Mean values (N=19) for these elements are provided in Table 1. These preliminary data from self-reports suggest to us that teachers found the course beneficial.

Table 1: *Post-Course Assessment*

Assessment Category	Mean Score (1-7 scale)
I am more comfortable teaching mathematics as a result of this course.	5.6
I devote more time to teaching math as a result of this course.	5.2
I find ways to engage my students more successfully as result of this course.	5.6
I prepare my math lessons more effectively as a result of this course.	5.4
I have a more positive attitude toward teaching math.	6.0

In addition to questionnaires, focus group interviews provided data indicating that the course encouraged teachers to revisit basic assumptions about mathematics instruction and spurred adjustments to teaching practices in three interrelated ways: 1) teachers are

attempting to utilize the problem-based approach modeled during the course; 2) teachers are emphasizing the importance of the learning process itself, rather than simply disseminating content to students; and 3) teachers are networking with course participants to strengthen community bonds and to share ideas and resources.

Teachers' Use of the Problem-Centered Approach

Teachers found the online problem-centered approach stimulating, and several indicated that they would use it in their own classes. One teacher commented: "What is most useful is how well [the problem-centered approach] transfers to my classroom." Key to the success of the approach is the "fun" teachers had in trying to solve the problems: "[Problems] were stimulating and exciting to find the answers to. I just felt really great when I could solve it, or even when someone else solved it. It was like, 'Wow, look at that!'" Another teacher stated: "There was one problem I even lost sleep over trying to figure it out....When a problem gets into you like that and really makes you think, that's really positive. I like a challenge." Teachers recognized the value of the problem-centered approach in motivating and engaging their students. One teacher commented, "I enjoy learning better ways to teach from watching you all teach us. I even try to use your techniques in my chemistry class."

Teachers also recognized the value of asking students to rephrase their own and others' approaches to solving a given problem: "Some problems weren't really challenging until [Metro faculty] made us rephrase them...They'd put a twist on it and then it became engaging again." Small group interaction enhanced the problem-centered approach. One teacher stated, "I loved looking at how other people solved problems." Another added, "I liked being able to see how others approached the problems. That really helped me grow as a teacher. I feel I have a wider range of approaches to teach." Comments such as these affirm the value of collaboration.

Teachers' Focus on Process

The course underscored the importance of process for many teachers. As one teacher observed: "I liked how the moderators guided us in our learning instead of just telling us the answer." Another teacher added: "It wasn't getting the answer that was important; it was the process of doing it." This teacher began experimenting with the process-centered approach in his classroom by "allowing children to explain the process by which they're doing things and allowing them to see that there are different ways of getting the same answer." The process-centered approach appears to have also affected change in other teachers' classrooms. As one teacher stated: "A light would go on [for someone] when the rest of us were stumbling in the dark. It made me aware of how important it is to reach children on lots of different levels, to reach all the children." Another added: "I find it's more important to teach the 'why.' They [Metro faculty] kept saying: 'We want to know the why.'" Another teacher summed up the value of the process-centered approach when she stated, "If you can teach [students] that inquiry, they're going to be much better learners overall....Experience like that is like a branding iron to the brain."

Although the teachers valued the process-centered approach, interviews revealed teachers' concerns about "helping" students versus "casting them adrift." Teachers

generally praised the course for allowing them “to do [their] own thinking” and letting them “explore and find the answers,” yet others stated, “I have students who’ll say, ‘Just give me the formula’” or “Could my students stand going through the process, when in actuality, half of them are just going to want the formula?” In other words, teachers stressed the importance of the process-centered approach for their own learning, but some were reluctant to try such an approach in their classrooms. It is not unreasonable for teachers to want to package mathematics for their students in a way that will increase the probability that they will get the “right answers,” but according to Ball and Cohen (1999), the risk is that “what they have accomplished is perhaps less major in terms of learning” (p. 11). Metro’s Program creates this tension, or at least increases it, because it puts teachers in the position of having to reconcile what they see as a valuable community of practice for their own learning while resisting creating such a community for their students. However, several of the teachers have, as a result of the course, expressed more willingness to move toward process-centered approaches.

Influence on Community

Participants acknowledged the benefits of working with other teachers in their community. One teacher stated: “The camaraderie is one whole piece [of the course’s success]. Being able to work with my colleagues who are in some other room all day and I never see, and to learn how their minds work, is just wonderful. We worked with three different schools.” The course format allowed teachers to sit “elbow-to-elbow.” One teacher commented that “it was really juicy to sit at the same table with other people.” Another teacher added: “There’s a big learning process in the interaction.... You get a lot more out of it if you can interact more.” One teacher commented that Metro’s Program had brought rival schools closer together: these teachers even agreed to travel to one location in order to work together as a single online group. Another teacher acknowledged the benefits of collaboration, but stated: “When you throw it into the real schedule—in reality, we’re all on our own islands.” Another teacher, however, pointed out that as a result of Metro’s Program “you increase your comfort level with being able to contact somebody [in a different school.]” As mentioned above, the teachers saw real benefit from sharing ideas and taking on the thinking of others. One teacher mentioned that as a result of the course, their school administration recognized the importance of teacher communication and collaboration and is looking for new ways to foster it.

Research Results and Next Steps

Metro’s Program has demonstrated that it is possible to capture, online, two of the essential components of Metro’s campus-based courses: the creation of a learning community, and a collaborative, problem-based, process-centered instructional approach. Participants praised the technology for facilitating interpersonal relations—especially when the technology was transparent—and criticized the technology when it degraded contextual cues or became a barrier to communication. Teachers felt that technological hurdles including variable online connection speed, microphone feedback and distortion, absence of certain mathematical symbols in the software tools, and software functionality

issues occasionally hampered interaction. As one teacher stated, “I could spend my time focusing on the whiteboard and getting it to work right, or focus on the math.”

The small group interactions are an essential component of the course. Metro faculty would like to conduct further research on the ideal make up of the groupings. We believe that most of the elementary teachers tend to be more successful in the course when their group is physically together in a common location. However, it appears that the secondary teachers who are grouped virtually are just as successful as the secondary teachers who are physically grouped. It would be interesting to see what factors make a virtual grouping successful.

Metro faculty believe the in-person opening and closing meetings to be essential to the success of the courses and are planning further research on their necessity. These face-to-face interactions give the teachers a chance to build community and see other participants as actual people instead of names on a screen. It also gives the instructors a chance to set the class norms. The teachers learn quickly that the processes they and others used to get to solve mathematical problems is the focus of the course and just getting the correct answer is not. They learn that the course is designed to make them take on the thinking of others and to share their own.

Online courses, sometimes criticized as being merely electronic bulletin boards, have gained currency in recent years, especially for rural students and teachers who are geographically isolated. At the same time, the mathematics education community has increased its understanding of how participation in a community of practice can support the learning of mathematics. The preliminary results reported here suggest that online professional development environments can capture elements of a community of practice and engage mathematics teachers in learning experiences that raise important questions about mathematics and mathematics teaching.

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