

# **DEVELOPING A COMPLEX MATHEMATICAL LEARNING COMMUNITY: (RE)CONSIDERATIONS OF LEARNING/TEACHING EXPERIENCES**

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## **INTRODUCTION**

In my experiences as a student and as a high school teacher of mathematics I understood mathematics as infallible knowledge (an object) that was best transferred from teacher to student through lecture, practice, memorization, and regurgitation – a learning/teaching process that could be verified by testing. I learned mathematics using such positivistic (‘traditional’) perspectives and practices and I thought I had to teach mathematics in this very way because “one’s teaching methods tend to reflect one’s own history as a student” (Davis, Sumara & Luce-Kaplar, 2000, p. 94). However, through graduate courses and teaching experiences as a Masters student at the University of Regina, I am developing situated social constructivist perspectives and practices for learning/teaching mathematics. In considering a self-study research methodology it is necessary to explore and publicize teaching perspectives and practices with the goal of reframing beliefs and/or practice through collaboration (Samaras & Freese, 2006). I will share my recent experiences in focussing on counting emergent mathematics, while working with preservice middle years teachers, and my (re)considerations of learning/teaching as a result of this focus. I invite your feedback and hope you join me in this session by contributing personal teaching stories about challenges in developing mathematical learning communities. Through sharing and discussing such stories I hope we can collaboratively explore how teaching/learning communities might be developed.

## **COUNTING EMERGENT MATHEMATICS**

I was first drawn to the idea of counting emergent mathematics while reading “Who Counts What as Math? Emergent and Assigned Mathematics Problems in a Project-based Classroom” by Stevens (2000). In this chapter, Stevens describes his observations and experiences as a researcher within a seventh grade project-based mathematics classroom. He warns of “the institutional invisibility of emergent mathematics” (p. 134) by suggesting that when students work in small groups, most of the mathematical questions/ideas that emerge stay within the confines of the group. As a result, teachable moments related to such situated questions/ideas are often missed by the teacher. Questions/ideas remain ignored, hidden, or forgotten - they never make it from the group to the public arena for whole-class discussion because

only infrequently are teachers at the right time and the right place to participate pedagogically in emergent problems. In light of this, students themselves should have a

greater role in identifying and circulating those problems that emerge in projects as prospectively mathematically relevant. (Stevens, 2000, p. 137)

Stevens recommends that students be encouraged to share emergent mathematics questions/ideas with the whole class and that teachers need organizational and assessment devices for keeping emergent mathematics in the foreground. He argues that the students he observed already had “a relatively well developed notion of what counted as mathematics around traditional forms and social functions – as what appeared on tests, on work sheets, in textbooks, or in standard mathematical orthography” (p. 135). Therefore, students did not bother to publicize emergent mathematical questions/ideas that might lead to deeper understandings/interpretations because they did not realize their value.

As a high school mathematics teacher it was similarly my experience that only the mathematics I graded was perceived by my students as valuable so Stevens’ recommendations resonated within me. I began to (re)consider how learning/teaching experiences within my classroom might improve by bringing emergent mathematics to the foreground and making it worthy/count. My desire to focus on emergent mathematics continued to strengthen in the fall semester of 2006 when I volunteered as a teaching assistant in an experimental mathematics course (EMTH 290AA) designed for teaching preservice middle years teachers in non-authoritarian ways. Students were provided with mathematical experiences which differed from most of their previous school experiences. They participated in collaborative and independent activities including a problem-based geometry construction project and an investigative statistics computer project (which I co-authored with Dr. Kathleen Nolan). While observing and interacting with students and reflecting on their journal entries, I learned that many students were frustrated during these experiences, partially because they had unresolved difficulties with mathematical concepts and connections they would be responsible for teaching. I perceived that project related activities stimulated small group conversations and provided opportunities for students’ mathematical (mis)interpretations and (mis)understandings to surface. However, rarely did students’ questions/concerns about mathematical understandings and interpretations ever proceed to the public domain for whole class discussion. Davis and Simmt (2003) suggest “concepts and understandings must be made to stumble across one another. Without these neighboring interactions, the mathematics classroom cannot become a mathematics community” (p. 12). These words resonated within me too since sometimes I felt *the blind were leading the blind* during EMTH 290AA small group activities; group members did not seem capable of expanding and enriching emergent mathematical ideas for their peers and I could not be with groups simultaneously to facilitate/guide/coach deeper discussions of mathematical ideas. Through this experience I also began to (re)consider how students and teachers, as a whole/community, might enhance learning.

## **(RE)CONSIDERATIONS OF LEARNING/TEACHING EXPERIENCES**

By June 2007, through completion of thesis and ethics proposals, I expressed my (re)considerations. As a sessional lecturer for EMTH 290AA in the 2007 fall semester, I intended to focus on students' emergent mathematical *thoughts* (questions, concerns, ideas, understandings, interpretations, and connections) that arose within the classroom community as a result of statistics and geometry project-based mathematical experiences. I suggested I would encourage students to bring private (individual or small group) mathematical thoughts into the public domain by writing their thoughts on displayed chart paper, as per Steven's recommendation. I hoped seeing a peer generated list of mathematical thoughts would compel students to contribute to the list. I wanted students to then select from a variety of ways to participate in the development of mathematical interpretations and understandings by utilizing personal strengths/abilities in researching and presenting mathematical thoughts they perceived interesting. For example, I proposed students might inquire into the history of a mathematical concept, or depict (draw, sculpt, and etcetera) a concept or connections between concepts, or develop an activity to show how manipulatives can be used to enhance understanding of a concept, or find and explain useful concept related computer activities. I suggested students might even build on initial presentations so as to expand and deepen understandings/interpretations of mathematical concepts and connections – possibly critiquing presentations and providing alternative perspectives (histories, depictions, activities, and computer demonstrations).

In August 2007, after granted approval to collect data for my thesis through teaching EMTH 290AA, it was as though I had forgotten the breadth of my proposed ideas. Rather than (re)reading my thesis and ethics proposals, and fully pursuing my intentions, I looked at the past syllabus and prepared to teach EMTH 290AA as I previously observed while volunteering. I would begin with the statistics project and develop/adapt some proscriptive activities/assignments to introduce/review statistical concepts necessary for successful completion of the project. I would mark the assignments, project, and related journal entries[1] - then I would follow the same learning/teaching process for the geometry project. I neglected to consider how students might participate in the various ways described above and how I might count such participation but I did remember to focus on emergent mathematics.

In the first class I explained to students that my research entailed logging/writing, on displayed chart paper, *their* mathematical thoughts that would likely emerge through participation in class activities/assignments. I hung the paper on the wall. As the first month passed it became obvious, from lack of logging, that students had difficulty identifying emergent mathematical thoughts. One student even wrote in her journal that she was unable to recognize relevant thoughts and I agreed with her – for the time being. Sometimes, during group presentations, I noticed students struggle to clearly express understandings and interpretations of mathematical concepts so I was

able to identify and write a few thoughts on the chart. For instance, while returning to her desk from a group presentation one student remarked, “I think the mode is just a different type of average.” In response to hearing her I wrote on the chart ‘What is an average? Is the mode just a different type of average?’ In focussing on emergent mathematical thoughts I was learning to better listen to students and to identify situated mathematical thoughts. However, students were not (re)visiting the displayed thoughts; exploration of thoughts was unnecessary for it wasn’t connected to grading.

Inadvertently an emergent mathematical problem, that could not be ignored, arose from students having to collect data and find measures of central tendency for their project. Many students could not use their data for the set task because it was qualitative, nominal, or prematurely grouped. Questions had to be revised and data recollected for successful completion of the project. It occurred to me that I could purposely plan such difficulties in future projects so students would have to investigate particular problems. For part of the geometry project I decided to have students complete a 3-dimensional model of a geometrically architectural building using only paper and adhesives. I surmised the difficulty of making curved surfaces from flat paper might link some students’ projects to calculus and the idea of limits.

While sharing my insights with a colleague it was suggested that preservice teachers, in evolving from student to teacher, might also benefit from perusing the middle years curriculum, preparing lessons/activities, and teaching geometry project related concepts to class peers. This idea coincided with my understanding that students’ presentations provided me opportunities to identify mathematical thoughts. Thus, I planned for students to teach the remaining classes and in the introductory class for the geometry project students were divided into grade level groups to search the curriculum and present major geometry and measurement concepts. This exercise seemed successful as I was able to easily identify more thoughts during this class than in the past. That night I decided it might be interesting to see if students would (re)visit thoughts by counting related discussions. I posted the identified thoughts on WebCT (an electronic university discussion forum only accessible to EMTH 290AA students) and asked students to participate weekly, for the few remaining weeks, in at least one discussion a week for an unconditional 10%. To my surprise, not only did some students begin to investigate questions and share ideas, they began to ask their own questions. Consequently, I offered [on Tuesday November 6] students the choice to opt out of the geometry project and into a WebCT project.

I will share this project and student responses with you and I invite you to bring, for discussion, stories of other ways you have tried to build mathematical communities within your classrooms.

## **NOTE**

1. Journal entries involved reflections on: class activities; participation of peers or self; and mathematical concepts.

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