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Down the Rabbit Hole: Explorations in Barn Quilts Using Emergent Curriculum and Problem-Based Learning

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Abstract: From a project-based, emergent curriculum paradigm, teachers must always consider the complexity of the teaching- learning process, including choosing available tools, listening for hermeneutic understanding, recognizing opportunities and questions to promote higher order thinking, and documenting learning. This session will describe the experiences of two colleagues, one a mathematics educator and one an early childhood educator, when doing a quilt project to integrate geometrical concepts with perspective elementary school teachers.

Issue: Many prospective teachers see learning mathematics as a series of acquired procedures/algorithms rather than as a way of organizing information into patterns and justifying those patterns. Our attempt is to fracture their perceptions of mathematics in order to see fully the complexity of relationships among mathematical ideas and within the process of learning – develop metacognition so they are aware of the intricacies of the thinking-learning process. This paper provides a glimpse into challenges two instructors faced while designing a project-based learning experience in geometry for prospective elementary school teachers.

Literature Review & Background Experiences
We frame our thoughts using ideas from ethnomathematics (D'Ambrosio, 2001), teaching via problem solving (Schroeder & Lester, 1989), constructivist perspectives (Cobb, Yackel, & Wood, 1992), hermeneutic listening (Davis, 1997), and aspects of the Reggio Emilia approach to education (Rinaldi, 2012, 2006).

Briefly stated, ethnomathematics is the study of how culture groups use mathematics. In this case, the culture group would be quilters. The ideas of teaching via problem solving require students to develop their mathematical knowledge from "…reasonable responses to reasonable problems" (Schroeder & Lester, 1989). In this case, the problem is how to transfer a quilt pattern to a 2-foot by 2-foot board. Constructivism (Cobb, Yackel, & Wood, 1992) posits that students organize and reorganize their mathematical understanding based on questions posed and attempts to organize within current frameworks. Because prospective teachers need more dynamic and fluid mathematical understandings than just the recall of basic terms and knowledge, this quilt project was aimed at causing cognitive dissonance and providing supports for the reorganization and creation of new knowledge. We viewed the teacher's hermeneutic listening (Davis, 1997) as integral to this process as a means both to rethink mathematical knowledge organization and to generate higher order questions that would spur students' rethinking and reorganization of the mathematics. Finally, we conceive the confluence of these ideas as a Reggio Emilia approach that incorporates emergent curriculum. In this curricular design, the teacher has long-term goals with no

detailed knowledge of the journey; the day-to-day work emerges because of listening carefully to students' thinking and questions (Wien, 2008). This lack of a road map, while welcomed and valued on one hand was a source of anxiety on the other. This lack of certainty creates complexity and cognitive knots in teaching. The teacher was forced to consider what tools to make available to students, when to make those tools available, and what questions to ask to spark movement from simple solutions to seeing details in the work. When students offered multiple and competing ideas in class, the teacher had to decide which ideas to pursue the next day and which to leave for another time. Additionally when considering mathematics to be the study of patterns, the formation of generalizations of those patterns, and the justification of those generalizations, the teacher had to choose forms of language and justification that will be acceptable in the class. All of these decisions and dilemmas resulted in cognitive knots (Edwards, 2012) for both students and teachers.

The students initially struggled with the easy, but insufficient, solution of using ratio and proportion to increase the size of each individual shape within the quilt. This did not account for central angle measurement constructed with straight-edge and compass. Once they had resolved that issue, they were faced with a new challenge of selecting a quilt pattern and recreating the process on the larger board.

The instructors also experienced cognitive knots in their decision making. We were aware of students' emotional reactions and dispositions; we worked to support the students' development of cognitive discipline, persistence, and processes to complete the work and to learn mathematics. While we wanted to challenge them to think in new and different ways, we realized that there is a fine line between stretching them and frustrating them. We recognized the need for the students' ideas to be honored and pursued in the classroom, while feeling the tension in choosing from among the multiple ideas presented to determine what to pursue the next class period. One additional tension we felt was determining when to introduce background information and when to let them struggle and recall concepts in their own time.

Swim felt tension between wanting to suggest emergent curriculum ideas of where to go and realizing her limitations due to lack of geometrical knowledge. She struggled with when to pose a question to Mau and when to wait for the question from Mau, when to offer concrete solutions and when to wait for invention. In effect, Swim struggled with letting the understanding of emergent curriculum actually emerge from Mau's thinking. In effect, this became an emergent project on two levels … between us and between Mau and students.

Learning Objectives: Our learning objectives were layered from the learning of mathematics itself to the learning about one's thinking to learning for teaching. The geometric content was imbedded in a project with the intent of students seeing geometric ideas as a part of life. From that point of view, our hope was to help students, through their observations and discussions, become aware of the complexity of the mathematics and of the thinking *they* were doing in order to make sense and to organize their thinking. Layering upon that, we hoped students would begin to think of ways to use this kind of activity (content imbedded in tangible work) as teachers. From there, we hoped they would begin to see the potential uses of the geometric content

in other situations and that they would become capable of designing meaningful, engaging, and complex situations to bring geometric ideas to the forefront in their future classrooms.

Outcomes: Each student chose a quilt block to recreate on a two-foot by two-foot board. Additionally, they wrote reports articulating the mathematics found in the quilt and their efforts at the mathematical analysis of the patterns. As students analyzed the patterns, some found that looking at the shapes and rotations made the recreation possible. Others found that looking at the points of intersections of lines made the recreation possible. Many students demonstrated beginning awareness of their thinking (metacognition) and many of the dispositions, especially persistence, that will serve them well as future teachers.

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