Amy Westbrook
Mercer University
GERA Proposal
August 14, 2014
Paper Presentation

Completed Dissertation Title: A Case Study of How Ninth Grade Mathematics Students Construct Knowledge During a Productive Failure Model
1. Title:

A Case Study of How Ninth Grade Mathematics Students Construct Knowledge During A Productive Failure Model

2. Purposes:

The purpose of this case study was to understand how ninth grade mathematics students at a rural high school in Georgia constructed knowledge through student talk when problem solving using Kapur’s (2009) productive failure (PF) design.

3. Research Questions:

Central Question: How do ninth grade mathematics students construct their own knowledge while problem solving using the productive failure model?
Subquestions:
1. What role does student talk have in making learning gains during the problem-solving task?
2. What role does student choice have in making learning gains during the problem-solving task?
3. How do ninth grade mathematics students utilize prior knowledge to make gains in solving the problem-solving task?
4. How do the ninth grade mathematics students persist during the problem-solving task?

4. Theoretical Framework and Conceptual Framework:

The conceptual framework is a problem-solving model called productive failure (Kapur, 2012). The productive failure model (PFM) for problem solving is a learning design based on the belief that students have a greater capacity to understand novel mathematical concepts when students are initially afforded opportunities to problem solve, even though the problem-solving activity may not produce correct answers (Kapur & Bielaczyc, 2011). A productive failure task must (a) provide context (b) cultivate critical analysis and (c) allow for connections between failed and successful attempts (Kapur & Bielaczyc, 2011).

My theoretical framework draws upon three constructivist perspectives. A Vygskian (1934/1962) perspective on verbal thought and concept formation informed this study by explaining how student talk is a necessary component for learning and initiating prior knowledge. Secondly, a Freirean (1970/2012) perspective informed this study by providing insight into the importance on the freedom of the learner to critically think and generate multiple representations of their work. Lastly, a Piagetian (1971, 1980) perspective on reflective
abstraction and disequilibrium allowed a better understanding of how the productive failure model served as a process of persistence through failure.

5. Methods:

I chose to study a representative case study group to determine how a typical group of ninth grade students would construct knowledge during a productive failure modeled task. I collected multiple sources of data in to determine how students construct knowledge during a productive failure task. Students took a pretest, utilized learning logs to record their work, answered questionnaires, and completed a final assessment. Videotaping of the students occurred while they worked on the task in groups, during a student confessional, and during the last interview. I coded the major themes by using constant comparative analysis according to my research questions, review of literature, and clusters of emerging themes.

6. Results:

The group processes (making a plan, working the plan, reporting results, and evaluating the plan) showed how the group utilized components of the PF model when trying to solve tasks. When the group made a plan, they activated their prior knowledge. When the group worked a plan and reported results, they created multiple representations for solving the task. The group cultivated critical analysis of their work when they sought to understand a concept and when they evaluated their work. The group freely shared their ideas, understandings, written work, and explanations for solving with one another. Student discourse fostered a communal learning environment where their individual knowledge was a valuable commodity for the entire group.

The four roles for communicating verbal thought were the responder, the explainer, the questioner, and the hypothesizer. The group members also spoke aloud using the explainer role more than the responder role, which showed that the group used more than a few words to respond to the group when talking aloud. A group member played the hypothesizer role when he or she showed new thinking about the task.

Allowing the students to choose the method they thought would work best to solve each task provided the group choices in their learning. The students chose to solve the tasks by generating new ideas, writing their ideas, using different tools, reading for understanding, defining variables, using a guess-and-check method, using graphs, admitting when they were stuck, using algebraic methods, and using statistical analysis. The group-chosen approaches of writing their ideas, taking time to read the task and the work of other group members, and admitting when they were stuck during the task that promoted reflective thinking.

The Model of Persistency served to show how my findings on group processes, student roles, and student problem-solving approaches were interrelated to one another. The group persisted by continually assimilating new mathematical concepts with their prior knowledge as “one brain.” When the group evaluated the plan, they deeply analyzed the concepts and
experienced a greater sense of disequilibrium. The students initially attempted to assimilate new concepts with their prior knowledge, but sometimes needed to make accommodations in their learning. The group made learning accommodations only after the group evaluated the plan.

7. Implications:

The three main implications of formatively assessing students through their group talk, celebrating errors as a means for accommodations through persistence, and allowing student voice to facilitate critical thinking are relevant to teaching. Teachers need to be able to assess students by listening to them talk, allow students to make mistake for the good of student learning, and empower students to become critical thinkers by using their voice. Knowledge construction is not about being efficient. Knowledge construction is about being effective.

8. Recommendations:

Suggestions for future research include study of a non-representative population, focus on the role of gender, writing, group size, and academic conversations; implementation of Kapur’s (2012) productive failure design in a different content area; the role of group processes and student roles forwarded their conceptual knowledge; and the determination of the zone of proximal development during the model supports learning.