

Scholarship and Professional Activity Plan

Dissertation and Future Research

A driving question behind my past and current research activity is, “Why do some students struggle to learn mathematics and what can teachers do to make more students successful in mathematics?” In order to research this question, I found it necessary to define more narrowly focused research objectives. The motivation for my dissertation research was to explore how variations in students’ cognitive habits influence their mathematical learning. Drawing upon my own teaching experience and the literature, I chose to study students’ intuition because it captures a set of factors I believe influence student learning: beliefs, the natural habits of the human brain, and personal experience. Although the concept of intuition is not well-defined in the literature, I was able to find indicators of intuition that were identifiable in the work of students in an elementary linear algebra class. To further focus my study, I chose to analyze how intuition affects students’ development of two concepts: span and linear independence. While the participants in my study are undergraduate students, I believe the findings of my research could have some generalizability to K-12 students.

I believe my dissertation research will serve as a basis for future research. The concept of intuition might be helpful in understanding student learning in mathematics, but a stronger theoretical foundation is needed. In addition, preliminary results from my dissertation indicate that students’ concept development of span and linear independence is a piecewise construction process. I am interested in exploring if there is a relationship between students’ construction paths and the quality of their understanding. If I find such relationships, I would be interested in extending this line of research to other content areas and grade levels. I would also want to study how teaching methods can influence the development of more productive construction paths.

A finding generated from one of my pilot studies indicates that the form of students’ written language may indicate gaps in students’ understanding. For example, students with weaker understandings tended to omit the names of objects in their answers to problems. That is, rather than explicitly stating the matrix, set of vectors, or solution set relevant to the answer, they omitted any reference to the object or referred to the object via a pronoun. I discovered some literature that may suggest a link between such language use and the development of mathematical ideas. Although this idea is speculative at this point, I want to explore it further. More generally, I would also like to study the validity and reliability of using students’ written and oral language as a means of assessing student understanding.

Other Research In Progress

I have three papers that are near completion. The first is a phenomenology study I conducted that explored students’ attitudes and beliefs about their experiences writing explanations of their work in an elementary linear algebra class. My research questions were 1) What is the nature of students’ attitudinal, belief, and behavioral responses to writing explanations of their work as a formative assessment in an undergraduate linear algebra class? and 2) What influences account for the students’ attitudinal, belief, and behavioral responses? I concluded from this study that less traditional formative assessment methods, such as written explanations, can support students’ learning when students are provided with adequate opportunities to learn how to respond successfully. While it is often assumed that writing helps support students’ understanding, it is not clear exactly how this works. In this study, I found that in order to produce quality writing students read the textbook more, spent more time discussing their thinking with classmates, and reflected more deeply on their problem solving strategies. An outstanding question is whether the cognitive processes of constructing written language also support learning.

The second paper describes a study directed by Dr. Nathaniel Miller. The research is based on task-based interviews with students who had participated in one or more inquiry-based geometry classes. In these classes, students explored the concept of straightness in multiple spaces, including the Euclidean plane and the sphere. The tasks for the study interview were designed to build on students' prior learning about straightness by asking students to think about what is a straight line on a flat 2-torus, a space with which most of the participants had not worked with extensively. The goal of the research was to understand students' cognition as they worked on problems designed to expand their understanding of straightness. The research questions were 1) How do students with inquiry-based learning experiences about straightness on the Euclidean plane and the sphere cognitively engage with tasks involving what is straight on a flat 2-torus? and 2) How is the nature of students' cognitive engagement with the tasks related to their overall understanding of straight lines on a flat 2-torus? We found a difference in the cognitive engagement patterns between those students who developed strong understandings as compared to those who did not. A possibility for future research is how to help students develop more productive cognitive engagement practices in an inquiry-based learning environment.

The third paper is a set of activities and lesson plans to teach upper elementary students the concept of closure. I collaborated with Dr. Cathleen Craviotto and Dr. Richard Grassl on this paper. The motivation for this project came from Dr. Craviotto and Grassl's experience that students in their abstract algebra classes were unfamiliar with closure. They believed that closure was a topic accessible to younger students and such early experiences could support the later learning of abstract algebra. See www.unco.edu/nhs/mathsci/facstaff/parker/closure for descriptions of the activities and lesson plans. We will be submitting this paper to *Teaching Children Mathematics*.

Professional Activity Goals

One of my career goals is to help improve K-12 mathematics education. I believe one of the best places to do that is to improve pre-service teacher education programs. Most pre-service teachers experience primarily traditional lecture-based instruction in their K-12 mathematics classes and then tend to use this teaching style in their own teaching, thus perpetuating the perception that mathematics is a rule-based activity free of creativity. Quality pre-service teacher education programs can provide the opportunity for pre-service teachers to experience and learn about other approaches to teaching mathematics that more accurately mirror the true nature of mathematical activity and make mathematics more accessible and inviting to all students. Therefore, I hope to have the opportunity to contribute to the development and implementation of quality pre-service teacher programs.

As a college faculty member, another activity I hope to pursue is creating collaborative relationships between the college and the public education system, including the local school districts and the state education department. These relationships can help to bridge the research-practice gap in education. I have had the opportunity to work closely with school district teachers and coaches during my professional development work, my work teaching middle school teachers, and my work on the Teacher Leadership Project. I know from these experiences that university staff can benefit from working within the real world of public education and public school personnel can benefit from the expertise and research knowledge of faculty.