Research Statement

Prior to graduate school, I worked on two formal research projects in graph theory. The first was a Research Experience for Undergraduates (REU) at SUNY Potsdam and Clarkson University studying diameter-*n*-critical graphs, and the second was a collaboration with three peers at Morningside College, my undergraduate institution, investigating the game of Cops and Robbers on directed graphs. Both of these projects resulted in publications, and I planned to continue pure mathematics research in graduate school. However, my intention in getting a PhD was always to become a college teacher, and so I quickly found my research interests shifting when I was introduced to research in undergraduate mathematics education.

Oregon State University (OSU) has a group of professors studying the teaching and learning of undergraduate mathematics, and I started pursuing research in mathematics education after hearing one of the professors talk about her work in my first year. An asset of the graduate program in Mathematics at OSU is that students conducting research in mathematics education also complete the standard graduate coursework in mathematics expected for all doctoral students in the department. Thus, as a PhD student in Mathematics at OSU, I was able to study mathematics at the graduate level while also focusing my research in education.

Broadly, my academic interests can be described by two categories:

- Improving instruction of lower-division mathematics courses
- Providing training and support for novice teachers

My research interests align with these categories: for my Masters thesis, I studied College Algebra instruction with a focus on the variations in how different teachers present the same content; for my Doctoral research, I studied Mathematics Graduate Teaching Assistants and their growth as teachers through the lens of complexity science.

College Algebra Instruction

College Algebra, a pre-calculus course, is one of the most failed undergraduate classes in the United States: in 2007, over 50 percent of students enrolled in College Algebra did not pass on to the next course (MAA, 2007). Prompted by these low pass-rates and concerns about the effect of mathematics courses on the leaky STEM pipeline, the Mathematics community has made several calls for the improvement of undergraduate mathematics instruction. Notably, the *Common Vision Project* is a collaboration of five professional mathematics organizations – AMATYC, AMS, MAA, ASA and SIAM – that challenges the community to change the status quo in the teaching and learning of college-level mathematics. They write,

> "We believe that a central task for mathematics faculty at institutions of higher education, and more broadly, the mathematical sciences community as a whole, is to create a coherent, intriguing introduction to collegiate mathematics for all students." (Saxe & Braddy, 2015, p. 2)

At Oregon State University, a group of mathematics educators redesigned College Algebra in an attempt to improve student success in the course. The primary goal of the updated design was to increase student engagement during class sessions. Thus, class sizes were reduced to 60 students, and two of the four class periods each week were dedicated to active learning through student group work. The instructors attended weekly course coordination meetings to create a community of practice (Wenger, 1999), and they taught using the same course schedule, worksheet activities, online homework, and exams. A group of researchers hoped to capture the changes in instruction and student engagement in the new course, and so they video-recorded the class sessions of four teachers (two instructors, a senior instructor, and a professor).

In 2014, I started studying the College Algebra video data with two other researchers. Because the instructors were using the same course materials, we expected that there would be little variation in their teaching. However, during our initial analysis, we observed that instructors often gave widely different presentations of the mathematical content (Beisiegel, Gibbons, & Paul, 2016a; Beisiegel, Gibbons, & Paul, 2016b). This was concerning because student learning is impacted by the content of instruction; as Porter (2002) puts it, "No one would be surprised by the statement that students are more likely to learn the content that they are taught" (p. 3).

My Masters research was dedicated to further investigating the variation in the mathematical content presented by the College Algebra instructors. I chose three observation protocols to use in my study, the Mathematical Quality of Instruction (MQI) (LMTP, 2011), the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002), and the Teaching for Robust Understanding of Mathematics (TRU Math) protocol (Schoenfeld, 2013), to provide vocabulary about the instruction I was observing and a way to characterize and compare the videos. To focus my analysis, I looked at video clips of the instructors presenting similar problems about solving quadratic inequalities and finding the end behavior of rational functions. I scored each video clip using the MQI, RTOP, and TRU Math and then compared the results of the coding from each instrument. I found that while most instructors presented procedural, step-by-step processes for solving the problems, variation occurred in which method was chosen, if multiple methods were discussed or if multiple representations were provided, and the amount of explanation that was given for describing how the solution method worked.

Instructors choose how to present content to their students, but this is not always a conscious or intentional decision. I believe that to improve College Algebra instruction, we need to talk about the mathematics that we are teaching. For example, in settings where there are multiple instructors teaching the course, regular coordination meetings could include a short discussion of the mathematics that is being covered that week. For departments with a smaller number of mathematics faculty, instructors could form teaching trios and engage in pre- and post-lesson planning and reflection to focus on how they deliver content during class. It is important to design courses to include evidence-based teaching practices, but we cannot ignore the mathematical content we are teaching.

Graduate Teaching Assistants

At many universities, Graduate Teaching Assistants have a meaningful role in the instruction of undergraduate students. As part of the call to improve mathematics instruction, we need to attend to all of our teachers of college mathematics, and this includes Mathematics Graduate Teaching Assistants (MGTAs). MGTAs are both current and future teachers of mathematics: according to a 2016 report from the American Mathematical Society, over 60 percent of recent Mathematics PhDs are hired for academic positions (Golbeck, Barr, & Rose, 2016). Of course, not all of these academic positions include teaching duties, but this still means that many MGTAs continue to be teachers of undergraduate mathematics after they graduate.

Mathematics educators have implemented professional development (PD) about the teaching and learning of mathematics for MGTAs, and this PD is offered in most mathematics departments (Deshler, Hauk, & Speer, 2015; Speer, Murphy, & Gutmann, 2009). Further, education researchers have studied the effectiveness of PD in changing MGTAs' teaching practices. This research has found that MGTAs often change their beliefs about teaching as a result of participating in PD, but their teaching practices stay the same (Belnap, 2005; Defranco & McGivney-Burelle, 2001; Speer, 2001). There is currently no consensus among mathematics educators or researchers as to how to help MGTAs learn about teaching in a meaningful way that has a long-lasting impact on their teaching practices. If we want to provide PD that changes how MGTAs' teach, we first need to understand why MGTAs teach the way they do.

My doctoral work is situated within a larger study investigating MGTAs' growth as teachers. The project *Exploring Mathematics Graduate Teaching Assistants' Developmental Stages for Teaching* (NSF Award #1744139) is longitudinal and has participants from two institutions. For my dissertation, I examine a subset of this data, looking at one institution over an academic year, and my methodology is informed by the theory of complex systems. Researchers in mathematics education have previously used complexity science as a lens for investigating learning with groups of teachers (Davis & Simmt, 2006) and students in a classroom (Davis & Simmt, 2003). The data for my dissertation research was collected through individual interviews, group interviews, and entrance surveys from seven MGTAs at a research-focused university. I am currently in the process of analyzing the data, and I will be defending my dissertation in June 2019. I hope that the results of my research can provide insight into what impacts MGTAs' teaching and help inform future PD for MGTAs.

Outside of my doctoral research, I have been involved with creating and facilitating PD for incoming GTAs for the past three years through OSU's New GTA Orientation. The event is targeted to GTAs across all departments and has provided me with the opportunity to get hands-on experience with developing and presenting GTA PD. A more detailed summary of my involvement with New GTA Orientation can be found in the professional service section of my curriculum vitae.

Future Research

My research interests thus far have centered around instructors of undergraduate mathematics, investigating both how they teach and how they learn about teaching. Mathematics is a meaningful aspect of the college experience for a range of students, from those who are satisfying a liberal arts requirement to students pursuing a STEM degree. I believe mathematics instructors deserve specialized attention for improving their teaching. Moving forward, I hope to keep my research focused on how we support teachers, whether they be graduate students in mathematics or faculty across disciplines. I would like to work with instructors to observe and reflect on their own teaching and the teaching of their peers. I am particularly interested in creating PD for instructors and then disseminating research about the effects of that PD.

An asset of research in mathematics education is its accessibility to undergraduate students. By the time a student is in college, they have years of experience being in mathematics classrooms. This first-hand knowledge gives college students a preliminary foundation for conducting education research. Doing research in any discipline requires some understanding of the previous literature, but mathematics education research is more quickly accessible to undergraduate students in that it does not require a prerequisite background in a specific area of mathematics. Because of this, student researchers can tailor their projects in mathematics education to fit their interests. Although there are areas of education research I do not have experience in, my graduate background in both mathematics and adult education have prepared me to mentor students in any area of mathematics education research. I can recommend resources to students as a starting point, get myself up to date on some of the relevant literature, and reach out to colleagues who specialize in that area of education research for further support.

I intend for my next project to include implementing and studying PD for teachers. The design of this research will depend on the context of where I am employed, particularly in the type of teachers who are available to work with. Also, as a continuation of my doctoral study, I am currently conducting a second year of data collection with 11 MGTAs, five of whom participated in my original study. I will use results from my dissertation to inform the next phase of analysis with this new data. Overall, whether I am mentoring undergraduate students or collaborating with other teachers and researchers, I plan for my future projects to stay aligned with my scholarly interests of improving instruction in lower-division courses and providing training and support for novice teachers.

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