Exploring the Pedagogical Empathy of Mathematics Graduate Teaching Assistants

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Mathematics graduate teaching assistants (GTAs) are an important part of the mathematics education community. Recently, there has been a concentrated effort to better understand GTAs' pedagogical beliefs and teaching practices. The purpose of this study is to explore how GTAs would respond to student feelings and if their feedback to student questions can be characterized as attending to emotion. Data was collected through interviews of current GTAs in which participants were shown samples of student work and asked to respond to questions about that work. Preliminary analysis has revealed varying abilities of GTAs to express student feelings.

Keywords: Graduate teaching assistants, students, empathy, emotion

Learning mathematics is an emotional experience for students (Hannula, 2002). Many studies have focused on the role of student affect in learning mathematics. However, little attention has been given to the relationship between teachers and student affect (Philipp, 2007). At the collegiate level, both emotional reactions and interpersonal relationships between teachers and students have been shown to influence what is learned in the classroom (Lowman, 1994).

Often, graduate teaching assistants (GTAs) play a large role in the instruction of lower level undergraduate mathematics courses (Speer, Gutmann, & Murphy, 2005). As a result, GTAs have opportunities to interact with a variety of students on a day-to-day basis and develop interpersonal relationships with them. These interactions likely influence GTAs' identities as teachers and shape their teaching philosophies (Kung, 2010). However, little is known about GTAs' teaching experiences and only recently has the mathematics education community begun to study their development as teachers and potential future faculty members (Kung, 2010; Speer et al., 2005).

This study seeks to add to the growing body of information about mathematics GTAs' pedagogical beliefs and teaching practices by investigating the awareness of GTAs to student feelings using a qualitative research design. The purpose of this study is to explore how GTAs would respond to student feelings and if their responses to questions can be characterized as attending to student emotions. With this in mind, our central research question is: *What are the characteristics of the responses that GTAs have to student questions on a typical pre-calculus problem?* To help refine our focus, we also pose the following two sub-questions:

1. Given sample written work on a typical pre-calculus problem, what feelings might GTAs attribute to students?
2. How might GTAs take student feelings into account when answering student questions?

After providing a brief summary of relevant literature, we give a detailed description of the methods that were used for this study and the data that was collected. Findings from preliminary analysis are also included, followed by some discussion and areas of future work.

Literature

The basis for this study is found in three key areas of literature: the role of emotions in learning, the relationship between teacher affect and student affect in mathematics education, and the importance of empathy and caring in undergraduate mathematics education.

The process of learning is complex and involves both cognitive and affective factors. In particular, emotions have an effect on student learning and "the teacher has a significant role to play in shaping those emotions" (Mortiboys, 2012, p. 2). Many educational studies have discussed the role of two different types of knowledge needed for teaching: content knowledge and pedagogical knowledge (Grossman, Wilson, & Shulman, 1989; Ball, Thames, & Phelps, 2008; Shulman, 1987). However, Mortiboys (2012) contends that teachers should develop and employ a third type of knowledge, which he terms "emotional intelligence," in order to enhance teaching and address the needs of their learners. Thinking of learning as only a cognitive process deemphasizes the central role of emotions in decision making and learning. Teachers must be able to use emotional intelligence to acknowledge and address the emotions that their students feel while learning (Mortiboys, 2012).

In recent years, neuroscience researchers have found that interconnected neural processes support both emotion and cognition. In fact, it is "impossible to build memories, engage complex thoughts, or make meaningful decisions without emotion" (Immordino-Yang, 2015, p. 18). To better understand the relationship between emotions and learning, Hannula (2002) developed a framework to analyze a student's attitude towards mathematics using the psychology of emotions as a foundation. This framework separates attitudes into four evaluative processes:

> 1) the emotions the student experiences during mathematics related activities;
> 2) the emotions that the student automatically associates with the concept 'mathematics';
> 3) evaluations of situations that the student expects to follow as a consequence of doing mathematics; and 4) the value of mathematics-related goals in the student's global goal structure (Hannula, 2002, p. 26).

With respect to this study, we will focus on the first part of this framework, which attends to the emotions that students experience while working on math problems. Whereas the framework was analyzed from the perspective of a student, we aim to explore how the framework might be viewed from a GTA's perspective and how the responses of a GTA might take into account the initial process of the framework when interacting with students. In addition, we also explicate the relationship between feelings and emotion. Hansen (2005) defines feelings as conscious perceptions used to describe emotions. Because feelings are perceivable and can be articulated by the individuals who experience them, we use this term for discussing student displays of emotion. We also define pedagogical empathy as "the ability to express concern and take the perspective of a student" in accordance with the definition of teacher empathy given by Tettegah and Anderson (2007, p. 50).

In the math education literature, few studies have specifically addressed the intersection between teachers and affect (Philipp, 2007). However, it has been noted that, "all research in mathematics education can be strengthened if researchers will integrate affective issues into studies of cognition and instruction" (McLeod, 1992, p. 575). With respect to math education, the affective domain has been described as encompassing the beliefs, attitudes, and emotions of both students and teachers (McLeod, 1992; Philipps, 2007). In a summary of studies focusing on teacher affect and student affect in mathematics education, Philipp (2007) acknowledges that he knows of no research linking teachers' affect to their instructional decisions. Furthermore, he does not mention any research that connects teachers' responses to student affect.

Although there is limited research connecting teachers' responses to student emotions, previous studies have been conducted which highlight the importance of caring and empathy in higher mathematics education. Weston and McAlpine (1998) present a study where six math professors' characterized as outstanding teachers were interviewed to explore their views on

teaching and learning. The most prominent teaching theme that emerged from the interviews was the importance that the professors placed on caring and concern for students. In their paper, the authors include suggestions of how to help teachers become more aware of having an "intentional caring perspective" which in turn, relates to developing pedagogical empathy. One recommendation they provide is to have professors engage in reflection upon their own experiences as learners in order to "recognize the importance of caring as part of the learning process" (Weston & McAlpine, 1998, p. 154).

In another study, Duffin and Simpson (2005) examine the link between cognitive styles and higher levels of cognitive empathy in graduate teaching assistants. As part of their study, the authors interviewed thirteen mathematics PhD students to explore their cognitive style of responding to learning new mathematics. During the interviews, many of the participants unexpectedly brought up experiences with teaching undergraduate students, which prompted the authors to consider the relationship between cognitive style and cognitive empathy. From the data, three levels of cognitive empathy emerged showing increasing levels of understanding how students might struggle with mathematics. These levels of cognitive empathy were then compared with the cognitive styles of the graduate students (Duffin & Simpson, 2005).

While it is apparent from the literature that there is a natural connection between student and teacher affect and that addressing emotions and feelings in the classroom is essential to student learning, this area has been understudied. Our study aims to help fill this gap and provide a qualitative way to capture pedagogical empathy.

Data and Methods

The participants in this study were 14 mathematics GTAs at a large Midwestern university. Each GTA had at least one semester of experience as an instructor of record for a pre-calculus class. Data was collected during the 2016-2017 school year through structured interviews with the GTAs. Participants selected their own pseudonyms and are used below. During the interview, participants were asked to solve a typical pre-calculus problem in order to familiarize them with the problem. They were then shown five different samples of student work for the problem and asked to respond to questions about the work. The samples of student work were fictitious examples of actual student work based on the author's experiences as a pre-calculus instructor. Student questions about the work were presented through audio recordings intended to simulate an actual student asking the question. At the end of the interview the participants were asked to reflect on how they thought each student might have felt when working on the problem. Participants were also provided with a list of feeling words to use a reference during this part of the interview. After data was collected, select interviews were transcribed and analyzed using open coding.

Preliminary Findings

By conducting this study, we aimed to find overarching themes related to the nature of responses that GTAs have while helping students in a pre-calculus class. Many of the responses to interview questions focused on helping students develop either procedural or conceptual math knowledge. However, several comments about student feelings surfaced during the interviews, even before being prompted by the interviewer to think about what feelings students might be experiencing in certain situations. In a few notable cases, GTAs were unable to articulate possible student feelings using descriptive feeling words. These responses were categorized under the code "Non-feeling" and were common among only a few participants. Table 1 shows

the primary codes that have emerged from the interviews along with representative excerpts from the interviews. These codes help to categorize the characteristics of GTA responses.

Table 1. Characteristics of GTA Responses

Code	Description	Interview Excerpt
Procedural Math Knowledge	Responses involving procedures, algorithms, rules, or formulas that do not directly attend to conceptual ideas	"If I plug in 25,000 students, do I get out the 13,000?"
Conceptual Math Knowledge	Responses connected to underlying concepts of math content including discussion of abstract ideas or relationships	"What sort of function are we trying to come up with here?...Think of the function as a machine."
Student-centered Reflection	Evidence of reflection centered around student thinking or past experiences with students, but not directly related to student feelings or emotions	"I think it's important to teach them how to identify their own mistakes."
Instructor-centered Reflection	Evidence of self-reflection that is centered around the participant, rather than students, including personal beliefs	"I would look through all of it…so that I'm prepared when something goes wrong."
Student feelings or emotions	Anything about what a student might be feeling or anything related to emotions that students might experience	"It's less that they don't know the math and more sort of fear or being uncomfortable with story problems."
Non-feelings	Use of words that are unrelated to emotions to describe what a student might be feeling when specifically prompted	"They probably feel medium."

Discussion and Future Work

The characteristics listed above help answer the central research question by classifying the types of responses that were common among GTAs. Both procedural and conceptual knowledge was a central focus for most GTAs. However, it is also important to note that GTAs also used both student-centered and instructor-centered reflection during their interviews when responding to student questions. In addition, the presence of potential student feelings or emotions was also brought up by many of the GTAs, although only some of them were able to express those feelings clearly.

Further analysis is ongoing to identify common feelings that GTAs might attribute to students. A few of the feelings that were mentioned in interviews included fear, confusion,

uncertainty, and confidence. From the preliminary analysis, it is evident that the GTAs who participated in this study were aware of the potential for student feelings to arise when working on a math problem, but varied in their ability to express those feelings. For example, one GTA, James, found it difficult to attribute emotions to students:

James: I guess I have a hard time ascribing emotion to people as they're working on math problems. That's not something I really consider too much.

However, there were other GTAs who were able to articulate student feelings. In addition, a couple of these GTAs mentioned how taking account of student feelings was something that they already did when answering student questions:

Nicole: I think that's something that I do think about when a student asks me a question, like where they are not only mathematically but also emotionally.

Aubrey: I try to think on the spot about how they're feeling and look at people's faces…I try to pay attention to how they're feeling.

This preliminary analysis of the data has revealed differences between the abilities of the GTAs to describe and account for possible student feelings. These differences provide a rich area for further analysis of the data that has already been gathered, the results of which we hope to present at the conference. In addition to presenting further analysis of the data, we also look to ask the audience a few central questions to help us better answer the research questions.

Questions for the Audience:

Within the field of GTA professional development (PD) there is a great deal of anecdotal experience. We wish to check our data to see if it is representative of the experience of others who provide GTA PD. To this end, we intend to ask the audience:

- In your experience, working with both instructors and students, are there characteristics of responses to student questions that are missing?

These interviews provide a rich set of data on GTA responses to students. However, the data did not provide an answer to our second research sub-question: How might GTAs take student feelings into account when answering student questions? To help direct future avenues of research, we also intend to ask the audience:

- What data, or analysis, would you recommend we collect in order to better answer research sub-question 2?

Finally, neither the research questions nor the data collected directly address the content of professional development programs for GTAs. Nevertheless, we are interested in how PD activities can better incorporate aspects of pedagogical empathy. To this end, we intend to ask the audience:

- How can the findings from this research study be incorporated into professional development activities for GTAs?

Existing literature shows the value of empathy in the classroom. However, the existing literature does not address how that empathy is developed or expressed in the collegiate mathematics classroom. This study has begun to outline some characteristics of empathetic interactions that might exist in the classroom. Further research should expand upon these characteristics and help connect experiencing pedagogical empathy with communicating that empathy to students.

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