Exploring Undergraduate Student Survey Responses About Engaging and Inclusive Experiences With ELITE PD MGTAs in Their Mathematics Courses

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We focus on equitable and inclusive teaching practices in a professional development program (PD) for mathematics graduate teaching assistants (MGTAs). In doing so, we hope that MGTAs will grow to improve the experiences of their students. We analyzed over 1200 undergraduate surveys corresponding to nine MGTAs in our PD program. We completed statistical analyses by comparing means in two ways: (1) the aggregate data for each term and (2) for the individual MGTAs for each term. In the first analysis, we found a statistically significant improvement in scores from the first term to the last term of an academic year. However, for the second analysis, when we analyzed the means of each MGTA's survey responses, we found that two of nine MGTAs had decreased scores over the course of the academic year. Ongoing research is investigating the extent to which experiences improved for different subpopulations of students within MGTAs' classrooms.

Keywords: Graduate Teaching Assistants, Professional Development, Student Experiences, Survey

Introduction

There is a growing body of research documenting undergraduate students' experiences of marginalization and exclusionary systems in mathematics classrooms (Battey et al., 2022; Leyva et al., 2021; Nieminen et al., 2024). Combating such inequities is desirable, but complicated. In recent years, scholars have recognized active learning instructional practices as capable of disrupting inequities in the mathematics classroom (Theobald et al., 2020), but also capable of perpetuating inequities without careful attention to equity and inclusion within those practices (Ernest et al., 2019; Johnson et al., 2020). As such, engaging learners through equitable and inclusive teaching practices is an important skill for instructors to develop.

Given the number of mathematics graduate teaching assistants (MGTAs) teaching undergraduate mathematics and their impact on undergraduate learners (Selinski & Milbourne, 2015), it has become increasingly common for mathematics departments to offer professional development (PD) for teaching to MGTAs (Braley et al., 2023; Ellis et al., 2016), with 'active learning' and 'equity and diversity in the classroom' becoming more frequent topics (Braley et al., 2023). As such, there is much to learn about the extent to which undergraduate students' experiences are shifting in more equitable directions when their instructors are engaged in PD with a focus on engaged learning, equity, and inclusion.

Our research team implemented a PD program for MGTAs that focuses on engaging learners through equitable and inclusive teaching practices. The goal of this preliminary report is to analyze undergraduate student survey responses from the mathematics classes of MGTAs enrolled in the PD program. Our research question is: *Do MGTAs receive improved student survey responses over time in a PD program?*

Literature Review

Many scholars and professional organizations have expressed the need for teaching practices that actively engage students in post-secondary mathematics classrooms (AMS, 2019; Freeman et al., 2014; MAA, 2019; Saxe & Braddy, 2015). This increased attention to and creation of policies on active and engaged learning are due to years of research that have consistently illustrated that undergraduate learners experience improved outcomes when teachers engage them in mathematical thinking via open-ended questions, problem-solving activities, and opportunities to reflect on their own knowledge (Harper & Quaye, 2009; Laursen, 2013; Laursen et al., 2014; Laursen & Rasmussen, 2019; PCAST, 2012; Wieman, 2017). Active learning has "large and consistent" impacts on undergraduate learning outcomes (Freeman et al., 2014; Wieman, 2014, p. 8319). For example, Rasmussen and Ellis (2013) found that STEM-intending students who experienced more engaging pedagogy in calculus courses were more likely to continue to the next mathematics course than students in lecture based calculus courses. Freeman and colleagues (2014) posited that students in the 50th percentile of a course would improve to the 68th percentile if their instructors implemented active learning.

More recent literature has called for more attention to diversity, equity, inclusion, and access (DEIA) in post-secondary mathematics education (Adiredja & Andrews-Larson, 2017; Gutiérrez, 2018; Voigt et al., 2023). Mathematics classrooms that support DEIA are often those that are active and engage learners in meaningful mathematical activity. However, Brown's (2018) investigation of undergraduates' experiences in mathematics classrooms found that not all active-learning classrooms are equitable. Other studies have confirmed that a focus on active learning alone may be insufficient to address inequities at the classroom level and beyond (Ernest et al., 2019; Johnson et al., 2020).

Mathematics departments often rely heavily on MGTAs for teaching or supporting 100- and 200-level courses. MGTAs often lead multiple recitation or lab sections for large lecture courses or they might teach courses as a lead instructor. At some doctorate-granting institutions, MGTAs teach up to 68% of Calculus I courses (Selinski & Milbourne, 2015). This means that during their graduate programs, MGTAs likely contribute to the learning experiences of hundreds, and possibly thousands, of undergraduate students. Despite their contact with and impact on undergraduate students, there have been few studies that have investigated MGTAs' understanding of teaching practices (Miller et al., 2018; Speer et al., 2010). Thus, it is important to implement and study a PD program for MGTAs that focuses on engaging learners through equitable and inclusive teaching practices. We expect that such a program has the potential for significant impact on undergraduates' mathematics learning environments.

Data Collection and Analysis

In this report, we present initial results from one academic year during which we had four MGTA participants in their second year of the PD program and five MGTA participants in their first year of the PD program.

Context of the Study

Our PD program aims to educate and support MGTAs in enacting instructional practices that center equity and inclusion within active learning strategies. The ELITE PD program has five components that are offered to MGTAs over the course of three years. Each of the components is highly collaborative and fosters regular interactions among cohort members. These are intended to provide a model of effective teaching practices for MGTAs, highlighting facilitation practices, grouping students for active learning, group-worthy tasks, and questioning strategies. The MGTAs begin the PD program with an orientation, which takes place two to three days prior to the start of the term. The orientation includes information about the department and the graduate students' roles and expectations as MGTAs. Leaders of the orientation focus on community building within the new cohort, and support MGTAs in developing knowledge of teaching practices focused on active group learning and dynamics, classroom logistics, as well as expanding their awareness of the diversity of experiences and access needs of undergraduate mathematics students. Second, in the term subsequent to the orientation, MGTAs take the Graduate Teaching Seminar where they continue to learn about the department, the university's teaching support resources, classroom management, and how to implement small-scale instructional practices with attention to equity and inclusivity through active engagement. The third and fourth components of ELITE PD occur in the second year of their graduate program with the Introduction to Equity and Active Learning seminar during which MGTAs continue to build upon their understanding of and facility with active learning and equitable teaching practices, and the Advanced Active Learning and Equity Seminar, which has MGTAs engaging with specific research-based pedagogical approaches as well as equity research associated with teaching. Throughout the ELITE PD program, MGTAs are observed in their classroom and given feedback about their teaching. Once the first four components of ELITE PD are completed, the fifth component has MGTAs serving as peer mentors to new MGTAs who enter the program.

Survey Items & Responses

We collected survey data from nine MGTAs' classrooms. There were two MGTAs who were assigned to a research assistantship during the year, so we do not have data for those terms for those MGTAs. We administered student surveys toward the end of each of the three academic terms. The surveys had 15 Likert-scale questions (Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)) that addressed their experiences with their MGTA primarily focused on students' active engagement (e.g., My TA helped facilitate group discussions that promoted my participation), inclusivity (e.g., I felt welcomed and a sense of belonging in this course), and access (e.g., My TA helped me identify and/or access resources to be successful in the course). We collected 1285 surveys total across all participants as seen in Table 1.

Table 1. Number of surveys collected from ELITE PD participant's classes.

MGTA	Cohort	Fall	Winter	Spring	*Total*
1	1	80	69	26	175
2	1	–	–	37	37
3	1	97	80	32	209
4	1	52	15	39	106
5	2	75	38	–	113
6	2	50	28	52	130
7	2	76	60	46	182
8	2	54	51	73	178

9	2	56	56	43	155
Total		540	397	348	1285

The surveys noted in the table above were collected in the same academic year. During that year, Cohort 1 participants were second year mathematics graduate students in their second year of the ELITE PD program, and Cohort 2 participants were first year graduate students in the first year of the ELITE PD program.

Analytic Methods

In our first approach to the data, we analyzed the entire data set, comparing the mean scores on the surveys Fall to Winter, Winter to Spring, and Fall to Spring. We first applied Levene's Test for Equality of Variances to the data. Then, based on the results of this test, we were able to conduct a t-test for equality of the means. In our second approach to the data, we analyzed each participant's data separately, still exploring whether their student survey responses increased over time. For this analysis, we calculated the average responses for the 15 survey items for each MGTA. Then we found the mean of these values to calculate a composite score for each term for each MGTA. Given the small sample size, we applied the Wilcoxon non-parametric statistic to compare the mean scores between Fall and Winter, Winter and Spring, Fall and Spring.

Results: Improvements in Survey Responses in MGTAs' Classes

Overall, student responses were skewed toward the positive end of the scale for all three terms, with their ratings being higher than 4 (Agree), for 14 out of 15 questions, and slightly below 4 for one question (My TA presented examples that resonated with me or related to my interests).

First Analysis

In our first analysis, where all the data across all participants were analyzed together, there was a slight improvement in means from Fall to Winter, but it was not significant (it could be just random). There was a slight improvement in means from Winter to Spring, which was marginally significant (at α =.05). From Fall to Spring, we found statistically significant improvement in means with a medium effect size (Cohen's d=.70). Table 2 shows the results of the test that compared the means from Fall to Spring. When we look for students' ratings as a whole, they gradually improve over time.

Table 2. Independent Samples Test

					95% Confidence Interval of the Difference	
t	df	Significance One-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
-2.975	924	.002	-.13989	.04702	-.23216	-.04761

Second Analysis

In our second analysis, where we analyzed each participant's data separately, we observed more cases of improvement than of decline from Fall to Spring and from Winter to Spring. The negative Z values in Table 3 indicate improvement of mean responses from one term to the next, but the differences were not statistically significant.

Table 3. Wilcoxon Signed Ranks Test

	Fall to Winter	Winter to Spring	Fall to Spring
Z	-.140	-1.352	-1.521
Asymp. Sig. (2-tailed)	0.889	0.176	0.128

We noticed that seven of the nine MGTAs received improved student responses over time, whereas two of the nine MGTAs received decreases in student responses. These two MGTAs were in Cohort 2, and thus in the first year of their graduate program and the ELITE PD program. The decreases in these cases seem significant and might be skewing the data in such a way that we cannot conclude that the increases across the seven other MGTAs are statistically significant.

Discussion and Directions for Future Work

Based on the results from both analyses, we are optimistic that MGTAs are improving their practices over the course of a year, and curious about MGTAs who experienced a decrease in overall student responses. Our preliminary exploration suggests that MGTAs who participate in ELITE PD with an intentional focus on active, engaging, equitable and inclusive teaching practices have the potential to provide positive classroom experiences for undergraduate students over time. Namely, it appears that the students of such MGTAs can experience an increased sense of participation and engagement, belonging, and clarity of expectations and feedback. These preliminary findings and interpretations are substantiated with another source of data from our larger research project - video recordings of the MGTAs' classes. In our preliminary analyses of these observations (Quaisley & Beisiegel, 2024; Quaisley, Beisiegel, & 2024b), we see, for example, MGTAs learning to set norms for group work discussions and improve in their efforts to facilitate conversations through questioning intended to moderate discussion among all group members.

We will continue to analyze the data from multiple perspectives. Specifically, we aim to answer the questions: Do we see a relationship between the MGTAs' average student survey responses and: (1) the course the MGTAs are assigned to, (2) the identities of the MGTAs, (3) the identities of the students (while it was not reported in this preliminary report, the surveys also collected information about the students, such as their gender, race, age, and more), and (4) the stage of ELITE PD, i.e., before, during, and after completing ELITE PD coursework?

Questions for Further Discussion

We propose these questions to start off the conversation with conference attendees:

- What are ways we can further study students' experiences in MGTAs' classrooms?
- What other analyses should we explore with these (and other) data?
- What purpose do these results serve for the RUME community?
- In what ways do you see this study and its results as beneficial to mathematics?

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