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# The Challenging Experiences of the Graduate Mathematics Teaching Assistant

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The Challenging Experiences of the Graduate Mathematics Teaching Assistant

Zoe Cramer

B.A., Central Connecticut State University, 2017

A Thesis

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The Challenging Experiences of the Graduate Mathematics Teaching Assistant

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CHAPTER 1  
INTRODUCTION

**Background**

The crucial role that graduate mathematics teaching assistants (MTAs) play in undergraduate education is well documented (Belnap & Allred, 2009; Ellis, 2014; Ellis, Deshler, & Speer, 2016). The specific duties of an MTA vary, but may include grading, tutoring, leading discussion (recitation) sections, or teaching as the primary instructor. All of these essential teaching responsibilities bestowed on the MTA are supplementary to the main reason they are attending graduate school, which is to further their own learning of mathematics. This means that, in addition to preparing to teach, creating and grading assignments, holding office hours, and attending course meetings, the MTA will also be taking core graduate mathematics courses as a student, which require staying on top of homework and preparing for exams (Belnap, 2005).

Research universities place the largest teaching responsibilities on their MTAs, with MTAs staffing up to 50% of their lower level undergraduate mathematics courses (Chae, Lim, & Fisher, 2009). In a survey involving 23 PhD-granting institutions, 35% of TAs were the sole instructor for one or two courses, 39% were discussion or recitation leaders, while 25% had other responsibilities such as grading or tutoring (Belnap & Allred, 2009). Investigating the experiences of graduate students in this dual position may be an ideal opportunity to integrate the two perspectives of student and instructor (Belnap & Withers, 2009).

Due to their roles as educators, MTAs have a significant impact on undergraduate students' experiences with mathematics (Speer, Gutmann, & Murphy,

2005). Yet, as they often have little to no prior teaching experience, many MTAs have a difficult time in this role. The specific nature of the challenges that may arise varies depending on the individual MTA. Although it is known that the beginning years of teaching mathematics can be challenging, there is limited empirical evidence regarding the specific types of challenges that many MTAs must overcome in their first couple of years teaching. This is particularly poignant since these early years are the time that MTAs need the most support.

The challenges faced by beginning teachers and the effects on students has been widely studied in the K-12 level, but this phenomenon is seldom found in research on college mathematics. According to the existing K-12 research, student achievement tends to be significantly worse in the classrooms of first-year teachers than teachers in their second and third years (Rivkin, Hanushek, & Kain, 2005). The steep learning curve is hard not only on the students, but also on the teachers themselves, with 15% leaving the profession after their first year, usually due to feeling overwhelmed, ineffective, and unsupported (Ingersoll & Smith, 2003). Some of these experiences at the K-12 level are likely similar at the college level and the challenges that beginning MTAs face may align with aspects of these previous findings, while it is also possible that others are undetected and unique to higher education.

### **Statement of the Problem**

The main motivator to undertake the research study presented here was the currently limited empirical data regarding the specific challenges that beginning MTAs face. Researchers have highlighted the need for further investigation in this domain, outlining a possible parallel between challenges beginning MTAs face with those that

new faculty members face. One such study was conducted by Bonaparte and colleagues (2015), which found that beginning faculty members have difficulty balancing publications, teaching excellence, and administrative assignments. While the publishing and administrative demands on beginning MTAs are lower, their teaching expectations can be nearly equivalent to new faculty, even though beginning MTAs typically have significantly less teaching experience.

In an article by Kung and Speer (2009), which investigates MTAs and their understanding of student thinking, the researchers noted that beginning college mathematics instructors have a significant amount of mathematical content knowledge but very little pedagogical knowledge. In part, this is due to the fact that MTAs spend their time studying graduate level mathematics but often have little background in mathematical pedagogy and may not have opportunities to take courses dedicated to it. Moreover, it is possible that beginning MTAs may be asked to teach a class that they themselves do not fully understand because they have either not been exposed to such undergraduate curriculum, or they had not seen it for a significant amount of time. This brings awareness to an additional problem, where the MTAs' limited mathematical background might be the source of their teaching challenges.

Some of the difficulties mentioned in the scant literature about beginning MTAs are that they often have a limited experience in teaching when they enter graduate school, find it difficult to receive and interpret feedback about their teaching, and are unsure of how to effectively communicate mathematics (Hauk et al., 2009). This can lead to uncertainty in the classroom and may negatively impact the undergraduates they teach. In addition, there is a significant amount of research that suggests that many

MTAs do not possess a sufficiently deep understanding of student thinking (Speer, Strickland, & Johnson, 2005; Speer, Strickland, Johnson, & Gucler, 2006). In summary, the main problem is that the overall development of MTAs as educators remains largely unexamined, even though MTAs play a significant role in educating students, especially for entry-level mathematics courses.

### **Purpose of the Study**

This research study will help further the understanding of the mathematics education community about MTAs' teaching experiences. In particular, the focus is on MTAs' challenges at the beginning of their development as educators and potential solutions to help address these. If we can determine what challenges beginning MTAs are facing and suggest solutions, then perhaps this would also have an effect on the learning experiences of their students. Furthermore, MTAs may be able to adapt the learned solutions throughout various phases in their teaching careers. Having the necessary skills to overcome existing challenges could potentially help raise the beginning MTAs' own self-awareness and assist them in developing additional skills to overcome new challenges they may face throughout their careers as college mathematics educators. In fact, early teaching experiences have been shown to largely influence long term teaching practices (Boice, 1996; VanZoest et al., 2012). Thus emphasizing the importance of this study, which brings awareness to the early teaching experiences of beginning MTAs and areas where they may need support.

In addition, this study has the potential for practical implications, helping current and future beginning MTAs acclimate to their new roles. The study's findings can be used to support the professional development (PD) provided to beginning MTAs.

Providers of PD programs can use this study, as well as others mentioned here, to create additional opportunities to improve the teaching experiences of beginning MTAs. The type of implementation of the suggested solutions found in this study can vary, ranging from the formal use of PD and pedagogical training, to informal conversations between faculty (or experienced MTAs) and beginning MTAs.

### **Research Questions**

Our study is focused on beginning MTAs, who have up to two years of teaching experience in college mathematics, as they can offer firsthand accounts of the current state of early mathematics teaching life. In addition, for a study of this nature, it is also important to explore the perspectives of experienced MTAs, who have more than two years of teaching experience in college mathematics. The experienced MTAs have recently gone through the vulnerable years of beginning teaching, making them a reliable source to help us better understand the realities of beginning MTAs and strategies that have been successful for them. The study's main goal is to understand the challenges beginning MTAs struggle with and uncover potential solutions from both beginning and experienced MTAs' perspectives to advance scholarship in this area and inform improved practices. Specifically, our study seeks to address the following research questions:

- 1. What are the specific teaching challenges of beginning mathematics teaching assistants at a large public research university?*
- 2. What are potential solutions for addressing the teaching challenges that mathematics teaching assistants face at the beginning of their careers?*

## Definitions

The following terms are used in the literature in different ways. They are defined below to bring clarity with respect to how they will be used throughout this thesis, as well as the alignment with the literature that will be used, compared, and cited in different chapters.

*Mathematics teaching assistants (MTAs)*- Graduate students in the mathematics department that are assigned a teaching assistantship where they either grade, tutor, lead discussion sections, or teach mathematics courses.

*Beginning MTAs*- Graduate students who are MTAs that have up to two years of college mathematics teaching experience.

*Experienced MTAs*- Graduate students who are MTAs that have more than two years of college mathematics teaching experience.

*Coordinated courses*- Mathematics classes, often introductory level ones, which have a designated faculty member in charge of coordinating all sections. All coordinated courses follow a common schedule and topical outline, with some also having common homework assignments, quizzes, and exams.

*Discussion section*- In the mathematics courses taught as large lectures (over 100 students), the students also meet in a significantly smaller setting (about 20 students) called a discussion section. Attendance is typically mandatory for the discussion section, which is referred to as a recitation section in some institutions.

*Discussion leader*- The MTAs who are assigned to lead the discussion sections. They are often in their first or second year in the graduate program.

*Pedagogy course-* A course that MTAs take to learn about pedagogical strategies and hone their pedagogical skills. At some institutions, this is a required course that all beginning MTAs must take during their first semester teaching, while at other institutions it may be an elective course or not be offered at all.

*Primary/lead instructor-* The title used for MTAs that are assigned to teach their own mathematics course, rather than being a discussion leader or tutor. In this context, the MTA is the main instructor teaching the content to their students and has the academic freedom to teach as they see fit, following the requirements specified by the department.

*Research universities-* Institutions that grant at least 20 doctoral degrees annually and have high to very high research activity (Carnegie Classifications, 2018).

## CHAPTER TWO

### LITERATURE REVIEW

This study's goal is to better understand beginning MTAs. Specifically, we aim to uncover what challenges they face and how those can be alleviated now and for future MTAs. The current literature pertaining to challenges and perspectives of MTAs is very sparse. Research in college level mathematics education is fairly new compared to other fields, and studies regarding MTAs are extremely limited. Further, scholarly articles typically focused on the identities and development of MTAs (Beisiegel, 2017; Ellis, Deshler, & Speer, 2016; Gibbons, 2019; Nepal, 2014), but we have been unable to find any that specifically addressed the challenges they face in the beginning stages of their roles as MTAs. For this reason, this chapter will discuss literature that mentions challenges and possible solutions for beginning MTAs, even though that may not be the primary research focus of the studies.

#### **Challenges**

Beginning MTAs are typically full-time graduate students, which means they take between six and nine credits of graduate-level mathematics courses, complete homework assignments, prepare for exams, and study for their preliminary examinations (Belnap, 2005). They are expected to do all of this in addition to fulfilling the responsibilities that come with a teaching assistantship. Most MTAs begin graduate school with little to no prior teaching experience, which can make this dual-role even more challenging (Speer, Gutmann, & Murphy, 2005). Some challenges for MTAs mentioned in the literature include maintaining authority in the classroom, balancing responsibilities, having confidence in themselves as educators, and being able to

effectively communicate mathematics (Beisiegel, 2017; Belnap, 2005; Gallagher, 2016; Nyquist, Manning, Wulff, Austin, Sprague, Fraser, Calcagno, & Woodford, 1999; Speer, Gutmann, & Murphy, 2005; Raychaudhuri & Hsu, 2012). Each of these are elaborated in turn below.

### **Maintaining Authority**

Beginning MTAs, similar to new faculty members, need to make the transition from one self-image as a student to a new self-image as an instructor (Magnuson, 2002). Belnap's (2005) study examined the development of MTAs through interviews and observations. The stories of three participants were shared in detail. Belnap found that it can be challenging for beginning MTAs to maintain authority in the classroom because some students will view the MTA as a peer, rather than as an instructor. This is partly because MTAs are often around the same age as their students.

In Nepal's (2014) study, he follows the development of the teaching philosophies of four beginning MTAs through a semester long preparation program. Three written teaching statements and three one-on-one interviews were conducted with each participant. Although Nepal's study did not focus specifically on challenges that beginning MTAs face, the study participants, at times, voluntarily reflected on these during interviews. Nepal's interviews confirmed Belnap's (2005) findings, asserting that some MTAs faced the challenge of students treating them like peers, instead of as an authority figure.

### **Coordinated Courses**

In many institutions, the multi-section courses where MTAs serve as primary instructors use a coordination model, under the oversight of a faculty member who

provides common material for all sections. Within coordinated courses, MTAs are typically expected to follow a common course syllabus, which results in MTAs viewing teaching as “covering the material,” rather than promoting student understanding, according to the findings from DeFranco and McGivney-Burelle (2001, p. 8). This was also observed in Belnap’s (2005) study, where he found that one MTA resorted to strictly lecturing because she worried about not being able to get through all the coordinated curriculum. This is particularly alarming given the evidence from research that has shown that lecture-based teaching is a contributing factor to students leaving STEM fields (PCAST, 2012; Saxe & Braddy, 2015; Seymour & Hewitt, 1997).

Aside from covering the coordinated content in a sufficient and timely manner, the literature points to other challenges that MTAs face when teaching for a coordinated course. For instance, another MTA in Belnap’s (2005) study lamented that the coordinator for her course made the exams easier than she would have liked them to be. She explains that her class had a very high overall average because the common exams were too easy for them. Gallagher (2016) had similar findings in her study, which looked at how first year MTAs develop their own teaching identity. She found that the MTAs experienced frustration due to a mix of valuing the opinions of the coordinators and questioning the MTAs’ own competence for teaching. This shows a divide in the expectations of coordinators with that of the MTAs, as well as perhaps a lack of communication among the two parties.

### **Balancing Responsibilities**

MTAs need to simultaneously juggle their academic and research responsibilities as a student with their teaching responsibilities as an instructor or recitation leader. This

places them in a unique position where they need to navigate across intersecting identities of student, instructor, employee, mathematician, and apprentice (Park, 2004), posing a potential dilemma for them. Indeed, in Nepal's study (2014), one challenge mentioned in an MTA's interview was learning how to effectively manage his time between preparing to teach, grading, completing graduate course work, and conducting research. This problem is further exacerbated by the fact that the research-universities that MTAs attend typically carry a heavier emphasis on research than they do on teaching excellence. In a study by Luft, Kurdziel, Roehrig, and Turner (2004), the researchers found that even MTAs who arrive with strong motivation to teach and substantial concern for undergraduate education may find that holding on to these ideals is incompatible with success as defined by their department.

These results hold at a large scale as demonstrated in a study conducted by Nyquist and colleagues (1999). The study took place over the course of four years with 99 graduate teaching assistant participants from various departments at three different universities. The teaching assistants were interviewed twice annually over the period of the study, focus groups were conducted with the students in the TAs' classes, and the TAs' supervisors were also interviewed. They found that many of the TAs believed that teaching would not further their career and was, in fact, looked down upon at their current research institutions. This is in stark contrast to the reality that historically, the vast majority of MTAs will join a career in a "teaching" institution after graduation, rather than one similar to where they earn their doctorates. Even though this is the case, academic positions that are not at major research institutions are still belittled by many

graduate faculty (Adams, 2002) which might be the source of some of the confusion for MTAs when it comes to deciding how to balance their responsibilities.

### **Confidence**

Every MTA likely has multiple supervisors, such as the department head, the coordinator for the course they're teaching, their research advisor, and perhaps others. Due to this fact, many MTAs self-organize and develop their own understanding of how things should be done (Gibbons, 2019). During their first couple of years, this can cause the MTA to be unsure of themselves and lack confidence in themselves as educators.

Beisiegel (2017) investigated the development of MTAs to better understand their transition into teaching. The study involved eleven MTAs, including three first year graduate students, two in their second year, and the remaining in years three through five. She found that many of the beginning MTAs did not know whether or not they were doing a good job, but focused on simply getting through the year, whereas the experienced MTAs stated they felt comfortable in their role. The literature suggests that the beginning MTAs' confidence may be negatively affected partly due to the fact that they are close in age to their students. This makes it difficult for them to confidently embody the position as the educator (Belnap, 2005).

### **Pedagogical Challenges**

Many beginning MTAs have always been good at mathematics but have never taught it before. This means that most MTAs have little to no experience pacing a course correctly, explaining concepts to students, or creating and grading homework assignments and exams (Belnap, 2005). Research has shown that firsthand experiences in teaching and learning shape teachers' practices, views, and beliefs

(Lortie, 1975; Thompson, 1992). Therefore, the first few years as an MTA are the most challenging because the MTA has minimal prior teaching experience to help with developing their teaching practices.

The weak knowledge that beginning MTAs hold regarding teaching has been well documented in the literature (Kung, 2010; Kung & Speer, 2009; Speer, Gutmann, & Murphy, 2005). Due to this fact, it is not surprising that Beisiegel (2017) found that the first year MTAs described their experience as “surviving” because of their limited pedagogical knowledge. One MTA explained his feelings of drowning during his first time teaching: “I [had] never taught a day in my life” (p. 4). The literature shows that these feelings and overall lack of experience are typically not clear to most undergraduate students, and although MTAs are paid less than full time professors, the students instructed by MTAs still pay the same price for tuition, which may put extra pressure on MTAs to perform equally as well as experienced faculty (Hauk et al., 2009).

### **Communicating Mathematics**

As students, MTAs enjoy the abstract and rigorous nature of mathematics, but often assume that the undergraduate students in their courses do not feel the same way, which was reported by Raychaudhuri and Hsu (2012). The study consisted of five beginning MTAs who were interviewed four times during one semester. The researchers looked at how these MTAs communicated mathematics to their students and what their pedagogical approaches consisted of. They found that the MTAs typically avoided teaching the theory and conceptual understanding because they didn’t think the students cared about it anyway. Rather than explaining the details of concepts, MTAs often provided students with a user’s manual, which many undergraduates simply

memorized without really understanding what they were doing. This reveals the challenge that beginning MTAs have in balancing a conceptual and computational focus when teaching.

Another aspect of this is exposed by Belnap (2005) through his experience as the supervisor of first year MTAs, where he found that most student-teacher interaction was low in MTA-led classrooms. Belnap also discussed the challenge of communicating mathematics to students in a way that effectively conveys the material, without focusing too much on computation. One of the MTAs, without realizing it, was removing the conceptual understanding by creating steps or algorithms for her students whenever possible. The literature suggests that this may be related to beginning MTAs' beliefs that their students simply want to get things done, but don't necessarily want to understand the mathematical concepts being presented (Nepal, 2014).

### **Solutions**

Nyquist and colleagues (1999) found that graduate students report that they would like additional forms of support for their professional development as teachers. Although a strong influence on teachers' development is firsthand experience in teaching and learning settings (Lortie, 1975), the literature offers several approaches that math departments can take to try to help beginning MTAs overcome the challenges they face. These approaches include providing pedagogical support, implementing coordinated courses, facilitating classroom observations, and providing feedback on teaching. In what follows, each of these is expanded on based on the extant literature.

## **Support**

Having peers and experienced instructors to discuss pedagogical ideas and challenges can be very helpful for beginning MTAs who may gain a sense of comfort in knowing they are not alone. It has been confirmed through work performed by Gallagher (2016) and Gibbons (2019) that MTAs frequently talk to other graduate students and use them as a resource for making decisions about their teaching practices. To help beginning MTAs develop this network of support, Belnap (2005) suggests incorporating interactive activities and discussions, as well as connecting experienced instructors with beginning MTAs who can turn to them for support. Many beginning MTAs want mentoring to become better teachers, but some are unsure of how to go about getting it and who they should ask (Hauk et al., 2009).

There is significant mention in the literature of the importance of professional development (PD) and training programs for MTAs. Findings by DeFranco and McGivney-Burelle (2001) endorse the use of mathematical pedagogy courses as a means of ongoing PD for MTAs. In addition to PD in a formal setting, the literature suggests that MTAs may also benefit from receiving support through other means, such as having a teaching mentor. Ellis (2014) found that between 60% and 70% of the institutions with programs pairing beginning MTAs with faculty members, or using another form of MTA mentoring, identified it as effective in supporting the MTAs.

## **Coordinated Courses**

Many lower level mathematics classes have a faculty member in charge of coordinating all sections. The coordination of these classes ensures that students have similar experiences across different instructors, through the use of a common schedule,

syllabus, exams, quizzes, and/or homework assignments. This can help beginning MTAs have more time to spend on preparing lessons to teach because they do not have to worry about creating all of the course material on their own. For this reason, coordinated courses can have a positive impact on student learning. In fact, Gallagher (2016) found that student performance in coordinated courses taught by MTAs exceeded student performance in the same courses taught by MTAs in non-coordinated courses with the same level of teaching experience and, in one case, matched that of experienced full-time lecturers teaching the same course. Moreover, when MTAs have questions pertaining to the specifics of their course or their students, they have the coordinator available to turn to for assistance (Nepal, 2014).

### **Observations**

Existing literature provides evidence that beginning MTAs can learn a significant amount about teaching by observing peers, experienced MTAs, and faculty members teach (Miller, Brickman, & Oliver, 2014; Reinholz, 2017). Different tasks can be achieved by observing the classes of these various types of instructors. For instance, in Belnap's (2005) study, one of the first year MTAs observed faculty members teaching mathematics courses similar to her own and discovered there were many areas she could improve on. She reflected on the pacing of the courses being much slower and more in-depth than her own. The limited examples the faculty members provided in class gave students enough of an understanding, without overdoing the same idea too many times.

## **Feedback**

As discussed by DeFranco and McGivney-Burelle (2001), graduate courses can be designed to help beginning MTAs develop their teaching. One strategy sometimes used in these courses is receiving feedback on lessons that are presented in front of students, peers, and/or faculty members, sometimes called “microteaching” (Roehrig et al., 2003; Schussler et al., 2008). Belnap (2005) suggests that beginning MTAs should get the chance to discuss their teaching with others after the initial presentation and then do a follow-up lesson, implementing the feedback given from the first try. The benefit of receiving feedback from others has been acknowledged by MTAs themselves, who believe it is an important component to identifying an instructor’s weaknesses (Nepal, 2014).

Additionally, the study that Reinholz (2017) conducted on graduate student instructors learning from peer observations, provides evidence that MTAs may learn as much from *giving* feedback to peers as they would from *receiving* it. This emphasizes the growth that beginning MTAs can have through both providing and receiving feedback because they have the chance to reflect on their own teaching in either scenario. Specifically, when providing feedback to peers, they can observe what works and does not work in someone else's class to get a sense of what to implement or avoid in their own classroom.

## **Literature Summary**

These studies provide an initial backdrop of the realities that MTAs go through at the beginning of their teaching experiences. However, the number of studies is scant, with very few having been replicated, confirmed, or scaled up, and some of the current

challenges experienced by beginning MTAs having not been brought to light yet. Clearly there is a need for continued investigation to better understand the experiences of beginning MTAs and support their transition into teaching. The study in this thesis provides a first step towards achieving this goal.

## CHAPTER THREE

### METHODS

#### **Study Design**

To help address the research questions in this study, a mixed methods design was deemed most appropriate. It followed a sequential exploratory design that was based primarily on a qualitative approach, which was succeeded by a phase of quantitative data collection and analysis that built on the qualitative results (Creswell, 2013). The primary goal was to understand challenges that beginning MTAs face and explore MTAs' views on potential solutions to alleviate their transition into teaching. Triangulation was used to validate our qualitative findings, defined by Campbell and Fiske (1959) as a process in which more than one method is used to ensure that the explained variance is the result of the underlying phenomenon and not of the method (e.g., quantitative or qualitative). Furthermore, the convergence of findings stemming from two or more methods enhances the validity of the results (Bouchard, 1976). Using a mixed methods approach, even one that is qualitative dominant, such as the case in this study, can provide richer data and allow researchers to be more confident of their results (Jick, 1979).

#### **Overview of procedures and timeline**

The data collected for this study consisted of classroom observations, interviews (qualitative data), and an online survey (quantitative data). Classroom observations were conducted to guide and inform the interview protocol and survey design. The study began with a review of the literature the year before the collection of data, which was followed by classroom observations at the beginning of the fall semester. Interviews

were conducted midway through the fall semester, and finally the online survey was administered at the close of the semester. Each component of the study design will be described in detail in the subsequent sections.

### **Participants**

The study participants were graduate mathematics teaching assistants at a large northeastern public university. There were two groups of participants in this study: (1) beginning MTAs (two or fewer years teaching college mathematics) and (2) experienced MTAs (more than two years teaching college mathematics). Although the research questions focus on beginning MTAs, having experienced MTAs participate as well provided an additional perspective. Being able to explore the challenges that experienced MTAs recall facing in their first two years of teaching helped focus the study on challenges that may have been more significant long term. Additionally, the perspectives of experienced MTAs provide a source for potential solutions, which may not be possible to uncover by relying solely on beginning MTA participants. In this section we discuss how the participants were recruited for the study and the demographics of the participants within each group.

### **Recruitment**

The participants were purposely selected for this study and recruited in-person for the interviews. 10 MTAs that were recruited for the interviews, which included six beginning MTAs and four experienced MTAs. All 10 interview participants also completed the online survey. Additionally, a recruitment email was sent out to all graduate students in the mathematics department to complete the survey portion of the study. 13 additional participants were recruited for the survey, thus yielding a total of 23

survey responses. Typically, this would not be a large enough sample size for a purely quantitative study. However, as stated above, by design, the qualitative data was the primary source of this study. The quantitative data was used during the analysis stage to facilitate the assessment of comprehensiveness in the qualitative data and shed new light on qualitative findings (Johnson et al., 2007).

## **Demographics**

The 10 interview participants were all domestic students with paid teaching assistantship positions at the institution. The MTAs were at varying levels in the graduate program, ranging from first to sixth year students. The majority (80%) of the interview participants were male. The additional 13 survey-only participants were also at different levels in their studies and consisted of 38% female and 62% male. The specific demographics within each group of beginning and experienced MTAs will be discussed without revealing any identifiable information.

**Beginning MTAs.** All six beginning MTAs were in either their first or second year of the graduate mathematics program. They did not have any prior teaching experience before starting their graduate studies. Some had experience tutoring students one-on-one or serving as an MTA in a lab where the primary role was to assist students with homework. Neither of these experiences were considered sufficiently close to the full responsibilities taken on by MTAs and were therefore considered at the same level as their peer MTAs who had no prior experience of any type.

The pseudonyms for the beginning MTAs are Ashton, Greg, Miranda, Pat, Skylar, and Terry. To protect the identities of the participants, we will not reveal the specific courses that each has taught at this institution. However, collectively, these

MTAs have been discussion leaders for Calculus I and Calculus II, both traditional and online versions. Further, one has been the primary instructor for an introductory level mathematics course.

**Experienced MTAs.** The four experienced MTAs ranged in teaching background and year in graduate school. Table 3.1 below provides information about each experienced MTA. To protect the identities of the experienced MTAs, their exact year in the program and the specific courses they have taught are not revealed. However, collectively, these MTAs have been discussion leaders and the main instructors for College Algebra, Discrete Mathematics, Problem Solving, Pre-Calculus, Business Calculus, Calculus I, Calculus II, Calculus III, Linear Algebra, and Differential Equations.

Table 3.1

*Demographics of Experienced MTAs*

<b>Pseudonym</b>	<b>Current year in this graduate program</b>	<b>Number of different courses taught as discussion TA</b>	<b>Number of different courses taught as lead instructor</b>
Adam	5-6	3	2
Jamie	5-6	2	3
Rob	3-4	2	3
Mac	3-4	2	4

**Data Collection**

Data was collected through interviews and an online survey involving beginning and experienced MTAs. The interview and survey questions were informed by a review of the literature and observations of the MTAs teaching. Observing the teaching of these

two groups of MTAs allowed the researchers to witness potential challenges that may or may not have already been addressed in the existing literature. The interview and survey data were collected over the course of one semester and throughout the month-long winter break.

## **Interviews**

The interviews were conducted in a semi-structured format, where there was a prepared set of main questions for the researcher to ask, while the follow-up questions were based on the responses of each individual participant. There was a slight variation to the set questions for the group of beginning MTAs versus the experienced ones. The interview conducted with the beginning MTAs primarily focused on trying to identify current challenges they face, while the secondary goal was to identify possible solutions, whereas, the reverse was true for the interviews conducted with the experienced MTAs. The interview protocols for beginning and experienced MTAs can be found in Appendix A and B respectively.

Each interview was audio recorded on two devices belonging to the researchers, which were password protected. Two devices were used to ensure the safety of the data in the event that one of the devices malfunctioned or could no longer be accessed. The interviews were transcribed shortly after being conducted, with all identifiable information replaced and pseudonyms used. Participant confidentiality was a top priority and is frequently a concern in studies of this nature because qualitative research requires confirmability, that is, documentation of all activities included in the study (Orb et al., 2001). For this reason, the main document containing the key of the

corresponding participants' names for each pseudonym was stored on a password protected computer available only to the research team.

## **Survey**

The online survey allowed supporting data to be collected from a larger sample size than the one interviewed. The survey questions were created after the interviews were transcribed and the coding process had begun. Codes that arose frequently in the transcripts for challenges and solutions were incorporated into the survey questions. There were multiple portions to the survey, with the first main part focusing on challenges during the first two years as an MTA. The MTAs were prompted with a statement and asked to identify their level of agreement, as well as the level of importance it held to them. After they had responded to each statement, they were asked to rank items in order of what they believe was most challenging to least challenging for them in their first two years of teaching. The next portion of the survey followed a similar format but focused on possible solutions, rather than the challenges.

## **Data Analysis**

The data collected from the interviews and survey responses was analyzed according to standard qualitative and quantitative techniques respectively. The process for analyzing each of these types of data will be outlined in detail in the subsequent subsections.

## **Interviews**

Analyzing the qualitative data began with an open coding process. This refers to first impression phrases derived from an open-ended process that Saldana (2008) refers to as Initial Coding. During this early process, three to four transcripts were coded

simultaneously for challenges and solutions, which is a technique that the researcher established to aid in seeing patterns and commonalities among the transcripts.

Simultaneously reading the same responses from several MTAs at once enabled the researcher to clearly identify codes. Once the first batch was completed, an initial codebook was created to organize the codes that had arose up to that point.

During the next batch of three transcripts, new codes were found, and the original four transcripts were re-visited to account for the new codes. It is well-known that qualitative data analysis is nonlinear (Lichtman, 2012) and the analysis on this study was no exception. It was a cyclic process, where new codes were created, and old ones deleted. Some codes that were initially thought to be important were deemed unnecessary and either rephrased or deleted altogether. Once this cycle had continued three times per transcript, the true codes became clear and categories began forming. Definitions of codes and categories were created and fine-tuned by the research team following several iterations and negotiated discussions (Campbell, Quincy, Osserman, & Pedersen, 2013) to resolve all coding disagreements and to avoid potential misinterpretations. The finalized versions of the codebooks for the challenges and solutions can be found in Appendix C and D respectively.

Eleven main challenge categories were created, which encompassed all of the codes related to beginning MTAs' challenges. Further, these categories were separated into four major themes: extrinsic, intrinsic, pedagogical, and mathematics content challenges. This differs from the codes related to potential solutions, which were all independent of each other and therefore not separated into categories or themes. Even

though solutions emerging from the analysis were initially coded individually, four of them were found to be closely related and were subsumed into two different codes.

## **Surveys**

Responses from the survey were analyzed using standard statistical techniques. For the items where participants stated their level of agreement with a particular statement (challenge or solution), we used frequency analysis and the corresponding percentages were calculated. On the other hand, items requiring rankings were analyzed to determine the order that best fit the choice of the entire sample. This allowed us to identify the challenges and solutions that fell into the top-rankings. This analysis helped support the interpretation of the interview findings.

## **Subjectivity Statement**

In qualitative research studies, it is important to be aware of potential biases that the researcher may have. The original idea for this study was inspired in part from my own experience, as I am currently a second year MTA who has had to overcome certain obstacles associated with beginning teaching. Furthermore, I have witnessed my peers struggle with many aspects of teaching. Due to my position as a beginning MTA myself, I went into the research study with certain expectations of potential findings. Some of these conjectures were indeed confirmed through analysis of the data, while others did not hold true for all of the study participants. Even for participants whose challenges aligned with my initial conjectures, this study provided new insights I had not previously thought about.

Ramos (1989) described three types of problems that may affect qualitative studies: the researcher/participant relationship, the researcher's subjective

interpretations of data, and the design itself. The relationship I had with the participants and my own personal experiences may have influenced the way I interpreted the data. There were certain challenges that I or my peers faced that I expected others had faced too. For instance, one of my biggest challenges was how to effectively incorporate active learning in my classroom. To my surprise, this was primarily mentioned by only the experienced MTAs as a current challenge they are facing. In the first two years of teaching, most MTAs did not worry about how to incorporate active learning tools in their classes.

Although I tried to remain objective through the duration of this study, all of the participants were friends or acquaintances of mine. This may have also made them less willing to confess to challenges they have experienced out of fear of being thought of differently by me. It may have also led them to believe that I would quickly understand what they were saying without much explication. The knowledge and opinions I have formed about the participants prior to the start of this study could have made me biased towards them when analyzing the data. To prevent this bias, I tried to disassociate their pseudonyms to their true identities. I conducted this study, from design to interpretation of findings and results, in close collaboration with my thesis advisor, providing yet another way to prevent my own potential biases.

## CHAPTER FOUR

### FINDINGS

In this section, we present our findings addressing the research questions regarding the challenges that beginning MTAs face and potential solutions to alleviate these challenges. The primary data source used was transcribed interviews with participants which included both beginning and experienced MTAs. We also report on the findings from a survey administered to a larger sample of beginning and experienced MTAs, which was informed by the qualitative findings and served as secondary data for the study. The survey can be found in Appendix E.

The analysis of transcribed interviews with participants rendered many challenges that were organized into categories, which were then separated into four major themes. The themes for the challenges are: extrinsic, intrinsic, pedagogical, and math specific. The codebook for the challenges can be found in Appendix C. The findings are presented according to the four themes and the distinctive categories within them. Each category is further reinforced using illustrative excerpts from the interviews. Survey results corresponding to each category are also presented.

Next, we present the findings for possible solutions. Potential solutions were primarily found in transcribed interviews with experienced MTAs, but some suggestions came from the beginning MTAs as well. Analysis of the interviews rendered eight major potential solutions. The codebook for solutions can be found in Appendix D. Each theme is described in detail and illustrated with representative excerpts from the transcriptions. Finally, corresponding results from the surveys are presented for each theme.

## Challenges

The following table presents the themes, categories, and subcategories of the challenges found. The themes are expressed in a bolded font, with up to four categories listed in each corresponding column. If there were subcategories, they are listed in italics underneath the corresponding main category.

Table 4.1

### *Themes and Categories for Challenges*

<b>Theme</b>	<b>Extrinsic</b>	<b>Intrinsic</b>	<b>Pedagogical</b>	<b>Mathematics specific</b>
Category Subcategory	Engaging students <i>Participation</i> <i>Attention</i>	Balancing responsibilities <i>Student vs teacher</i> <i>Life outside of school</i>	Outside of class <i>Lesson planning</i> <i>Grading</i>	Communicating mathematics <i>Concepts vs computations</i> <i>Diverse students</i>
	Student incidents <i>Cheating</i> <i>Respect</i>	Confidence	In-class <i>Managing class time</i> <i>Discussion leader</i>	Content knowledge
	Authority vs rapport	Sympathy		
	Coordinated courses <i>Content</i> <i>Communication</i> <i>Common tests</i>			

### **Extrinsic Challenges**

This theme encompasses challenges related to interactions between the beginning MTAs with others, including students, peers, experienced MTAs, and faculty. The four categories that surfaced through interviews with the beginning MTAs in this theme are engaging students in the classroom, handling student incidents, balancing rapport with authority, and being part of a coordinated course. Several of the categories in this theme contain subcategories to further address the specific nature of those challenges.

**Engaging students.** This subcategory refers to keeping students engaged with the material. It was found to be one of the most commonly occurring challenges among beginning and experienced MTAs, with every MTA mentioning it at least once during their interview. The results of the survey indicate that over half, 52%, of all MTAs surveyed identify this as being within the top five challenges they face. Further analysis of transcripts exposed two related but distinct subcategories: participation and attention. The challenge of getting students to participate in class was brought up by nine MTAs, while the challenge of keeping students' attention was brought up by only seven. Each of these are described in detail below.

**Participation.** The subcategory of participation refers to motivating students to be actively involved in the class discussion. To some MTAs this meant asking students a question and getting responses from them, to others it meant putting them in small groups to discuss with each other or getting volunteers to come up to the whiteboard. Experienced MTA, Jamie, reflects back on her first two years of teaching and recalls engaging students as a big challenge. She explains how uncomfortable she felt when trying to get an interactive discussion started in class, "I would say it's like, it was just weird at first... When you're standing in front of the class and you ask a question and no one answers" (Jamie, p. 14). Not getting a response from students was a recurring challenge brought up by the MTAs interviewed. Greg, a beginning MTA, recalls with dismay, "when I was getting observed last week by another TA, the students weren't talking, they weren't interacting..." (Greg, p. 2). It can be very discouraging to beginning MTAs when they are unable to engage students in a class discussion. Mac, an

experienced MTA, describes one of his beginning teaching experiences where he actually left the class early out of frustration:

I've had a class or two that was just like abysmal and intransigent, dead silent, cold, and just did not want to engage at all. I had one that was so brutal, I got upset one time and it ended class, cause it was 40 minutes of no one saying any words. I was doing a problem and I said, "so guys, what do we do next?" No one said a thing. So I said, "ok, you guys can finish it." (Mac, p. 19)

Another issue within this subcategory that surfaced from this analysis was the challenge of getting *different* students to participate in class. In some classes, there are a handful of students who may be more willing to respond to questions asked during class, while others sit silently. Beginning MTAs Pat and Ashton expressed concern about the number of students who participated in their class discussions. Regarding this issue, Pat explained,

Just trying to get them to participate, you know, you'll write something and then you'll ask "okay guys, can you answer this x, y, z question?" And there's always like one or two students that'll answer. And it's hard, for me at least, to try to get more students to participate or to even just care about what's happening in the class at the moment. (Pat, p. 2)

Ashton also found it challenging to increase the number of students responding to him in class, but said he wasn't completely aware it was an issue until a student brought it up to him in their mid-semester evaluation of teaching.

I wasn't really giving all students opportunities to ask questions and I was kind of singling out only a couple of students, which I think is probably common because

it's easier to get questions or answers from students who you know are good and will usually give you the right answer and it's tempting to not receive any kind of question or answer from a student who may not always have the right answer.

(Ashton, p. 2)

**Attention.** This subcategory refers to keeping students focused and interested during the class period. While getting and keeping students' attention was not as prevalent of a concern as participation, a large number, seven out of 10, MTAs still alluded to this challenge. Several MTAs brought up the issue of students being on their cell phones or laptops during class, rather than focusing on the material being taught. Ashton was one of the beginning MTAs that raised this concern, explaining that technological devices makes keeping students' attention especially difficult.

I mean it's very easy to see when students are not paying attention. They could be on their phone or looking out the window or just, they just may not have their focus on what I'm doing. I think it's more obvious now with all the fancy technology that we have too. (Ashton, p. 9)

Pat had a similar perspective on the impact of these devices on students' focus on the material; "Yeah I mean they're not paying attention in class cause they're on their phone, on their laptop, just doing other work... As to why they do it, I don't know. I guess they just don't want to be there" (Pat, p. 8).

In addition to the distractions of technological devices, MTAs also seemed to feel that many students do not pay attention because they do not appear to care about the material. Reflecting back on his challenges as a beginning MTA, Mac says, "I think it's hard with the engagement thing, when you walk into a room and no one wants to be

there and none of them are hearing you. That's hard to address" (Mac, p. 24). Further, when experienced MTA, Adam, was discussing his biggest beginning teaching challenges, he said "[students having] a general lack of interest in what you're talking about... Like I had students falling asleep and I took really a lot of offense to that in the beginning (Adam, p. 18). He goes on to say that with time he has learned not to take it personally but still admits that the students' lack of interest he perceives is very discouraging to him at times.

**Student incidents.** This category refers to handling incidents involving students when it comes to the two subcategories of cheating and respect. Every MTA interviewed stated that they faced challenges dealing with at least one of these subcategories. Knowing how to handle these types of student incidents was ranked within the top five challenges by over half, 57%, of the MTAs surveyed. Detailed explanations of each of the subcategories is provided below.

**Cheating.** A large number, nine out of 10, MTAs interviewed have struggled with this subcategory of dealing with cases of cheating. If they strongly suspected students cheated on exams, quizzes, or homework assignments, some MTAs admitted that they did not fully understand the proper protocol to address it. While others, who knew what they should do, said the process was difficult for them. This was not only an issue for beginning MTAs, even three of the four experienced MTAs reported not knowing what to do in the case of a cheating incident. For instance, Adam stated,

I will say that cheating is very scary... So the Pedagogy instructor asked "What do you do when a student cheats?" None of us had read the bylaws or anything, so we just said, "You take the exam away. Give them a zero." And she was like

“Nope, you can get fired for that”... I was terrified, like what do I do about cheating? I don't even know. I guess you can write something on their paper, you can move them, but then what? I have no power in this situation. (Adam, p. 12)

The challenges regarding cheating incidents that were brought up by the beginning MTAs revolved around getting students to stop glancing at nearby quizzes or exams, as well as the actual process of reporting the incidents. Ashton recalls “during the final exam, I had a student who was looking at another student's paper and I didn't really know what was the best thing to do. I said multiple times to keep their eyes on their own paper and they still wouldn't” (Ashton, p. 11). Every single beginning MTA interviewed made some mention of witnessing students try to peak at their neighbor's work. Some felt they were able to handle the situation, while others, such as Ashton, felt unsuccessful in their attempts.

It is worth emphasizing again that experienced MTAs were not aware of the proper protocol, while beginning MTAs were aware, they just felt the process was challenging. Beginning MTA, Terry, said that he had a student who was clearly copying off his friend sitting nearby, and Terry could not get the student to stop in the moment. When he later looked at the two quizzes and saw they had done the exact same work, it confirmed his suspicion. Although he did not know what to do in the moment, after the fact, he decided to separate those two students on future exams.

**Respect.** This subcategory refers to beginning MTAs struggles with getting and maintaining student respect. Even though the beginning MTAs made no explicit statements about this challenge, it was clear through some of the stories they discussed during the interview that the main issue they were wrestling with was rooted in a lack of

respect. During Greg's interview, he explained that in his first semester, he graded one of the quizzes harsher than he should have. He goes on to say that he had a student complain to him about a point unfairly being taken off, to which Greg responded that he took that point off for everyone who made that same mistake. The conversation then escalated quickly, "[the student] just yelled at me, 'I don't care what you did for everyone else! I want my point back'" (Greg, p. 2). This shows that the student did not respect Greg as an authority figure in this moment.

Adam also recalls a similar instance that occurred to him when he first started teaching. He explained that when he was a discussion leader for Calculus II, there was a WebAssign homework question that involved a trigonometric substitution, but the students had not learned it in lecture because it was cut from the coordinated curriculum that semester. Adam took it upon himself to go over it with the students during discussion but was surprised to find that they did not show him the proper level of respect while he was teaching it. "I said 'okay, we need trig sub for this one.' And one of the girls behind me said 'oh Jesus Christ' and I was really really flustered by this... the way it was said, and in the moment, it was incredibly inappropriate" (Adam, p. 7).

**Authority vs rapport.** This category has to do with the need of MTAs to balance the desire to be liked by students while simultaneously maintaining authority over the class. The struggle to find this balance was especially prevalent in the beginning MTAs, who had not experienced being in this type of situation before. For instance, Greg expressed extreme care for his students, but also had trouble maintaining boundaries. The following is an excerpt illustrating Greg trying to develop a good rapport with his students, but perhaps taking it too far and appearing as their peer, rather than the

authority figure. “Some of them tell me what's going on in their lives and I'm like yeah, I've been there... I am a grad student, but it's only like a few years difference” (Greg, p. 2). Greg discloses personal information to the students to try to make them feel comfortable with him, without necessarily keeping in mind the privacy line that needs to be drawn between students and teachers.

Another beginning MTA, Miranda, talks about how she uses language relatable to the students as a tool to build rapport. However, the phrases and words she describes using are often not thought of as professional and are typically avoided by people in positions of authority. Miranda admits she should not use this as a tactic, saying “I try not to do it a lot cause that's not great I guess, but it draws them in” (Miranda, p. 2). She continues to explain that it makes students relax and have fun in class, which is why she does it. She expresses clear concern for wanting to be liked by students and seen as a “cool” MTA, to the extent that they may no longer think of her as the authority in the classroom.

**Coordinated courses.** This category came from the fact that the institution where this study took place uses a coordination model for the lower level math courses. This means there is a faculty member who oversees all sections of a particular course and ensures that each instructor follows the same schedule and topical outline. The beginning MTAs in this study were all part of coordinated courses which used common exams, quizzes, and homework assignments. This category was actually perceived as both a challenge *and* solution by the MTAs. For now, we will focus on the challenging aspects of coordinated courses, which have been split into three subcategories: coordinated content, communication, and common tests.

**Coordinated content.** This subcategory is considered a challenge because in coordinated courses, MTAs have no control over the selection of course content. Both beginning and experienced MTAs expressed difficulty overcoming this lack of freedom when teaching a coordinated course. For instance, Pat comments, “in Calc 1 when they do the epsilon delta, I don't think it's necessary... they never come back to it. All it does is just confuse the students for that one week and one exam” (Pat, p. 9). Pat was a discussion leader for a coordinated Calculus I class where this section was part of the common curriculum, so he had to teach this material in his class.

When Terry was the lead instructor, he experienced topics that were challenging for him to teach but he had to follow the required coordinated content. He recalls, the stuff I don't think is that important and I know won't come up again in any other future math classes, that I think would make sense to throw out, I can't. Let's say I do skip something or not teach it so well, if it wasn't a coordinated class, I just don't have to put it on the exam. But since now if I don't teach something well, the coordinator could still put it on the exam, that kind of stresses me out a bit. (Terry, p. 5)

Although about half of the MTAs interviewed said that teaching coordinated content was a challenge for them, their overall opinion of this teaching format was still positive.

**Communication.** This subcategory refers to the challenge MTAs face to maintain clear communication between themselves, other MTAs, the instructor (in cases where the MTA was a discussion leader), and the coordinator. This became apparent in recounts when they felt that information was miscommunicated to them or when they did not feel comfortable sharing their opposing opinions with the people that were higher

up. For example, Greg and Skylar had very strong opinions about the use of multiple-choice exams in the calculus classes but did not feel comfortable communicating their feelings to the instructor or coordinator. Greg also mentioned that he did not like the way the grades were computed or the fact that they were required to use WebAssign for the homework (Greg, pp. 5-6).

Adam describes a challenging moment that occurred the first semester he ever taught, “the instructor with whom I was teaching didn't always tell us what he covered. So there was one day that I found out, about 15 minutes before my class, that we were covering polar coordinates” (p. 6). Adam explains that this caused him a lot of stress and he had to frantically try to put together a lesson plan right before the class started, on a topic that he needed more time to prepare well for.

**Common tests.** This subcategory reflects the challenges beginning MTAs face regarding the common quizzes and exams given in coordinated classes. For example, Miranda brings up cheating issues that can arise due to the nature of the common testing materials.

The quizzes are the same between sections. I think a few numbers are switched but the general question is the same. So a student who took the quiz on Wednesday could very well tell the students on Thursday what the quiz is like. (Miranda, p. 6)

In addition, there is the challenge of grading fairly within the given rubric. Terry explains his conflict regarding grading fairness,

because everyone's teaching a little differently, different sections will have slightly different answers and I feel like they don't always fit the rubric well for

quizzes and tests. But then I feel guilty if I stray from the rubric because that seems almost not fair to the other sections, but then I still need to be fair to my own sections as well. (Terry, p. 6)

Lastly, some MTAs revealed the challenges that arise when mistakes sometimes appear on the questions in common exams, including the solution options for the multiple-choice sections, where the MTA is unable to address it with the students in the moment. The decision regarding what to do about such mistakes are determined at a later time by the coordinator and all instructors.

### **Intrinsic Challenges**

This theme captures the types of challenges involving only the MTA with themselves. This differs from extrinsic challenges because there are no other people involved. These challenges range from internal conflicts to time management. The main issues involved balancing responsibilities, having confidence, and having sympathy for what the students are experiencing.

**Balancing responsibilities.** This category pertains to beginning MTAs needing to balance multiple aspects of their life, school, and teaching. Beginning MTAs need to take dense graduate level mathematics courses, while teaching with limited to no prior experience, and trying to maintain their own life outside of school. This is split into two subcategories: balancing student and teacher responsibilities and maintaining a life of their own apart from school.

***Student vs teacher.*** This subcategory addresses the challenge of being a graduate student in mathematics while simultaneously teaching undergraduate math courses. Nine out of 10 MTAs identified balancing their student and teacher

responsibilities as being a challenge, with 57% ranking this within their top five challenges, in fact, 39% ranked it as the number one most challenging. Greg confesses “it’s hard to know how much stuff I need to do in order to be ready for my own classes versus how much I have to spend on preparing for actually teaching” (Greg, p. 16). Greg’s natural tendency was to spend more time on his teaching duties and not enough on his own school work.

Of the nine MTAs who identified this as a challenge, eight admitted they spent more time than was prudent on their teaching. Terry was the only one who said his challenge was that he felt he did not spend *enough* time on his teaching (Terry, p. 4). Even the experienced MTAs said that although they have gotten better at balancing their teaching and student responsibilities, they still felt that the scale was tipped towards teaching. Adam openly admits this, saying “I still spend way too much time on teaching. My first semester I spent all my time on teaching and not enough time at all on studies” (Adam, p. 12).

***Life outside of school.*** The subcategory of having a life outside of school means seeing people and participating in activities that are not school related. This is difficult for beginning MTAs because they are still adjusting to graduate school and trying to stay on top of all of their work, which means that maintaining a life outside of school can sometimes take the backseat. Although every beginning MTA said taking a break from school was something they valued, they also noted that it is not always possible. Greg related to this challenge, stating “I know I’m going to be working constantly probably for most days of the week. Maybe I get a day off here and there... That’s great. I try my best to take off Sundays. We’re here today...” (Greg, p. 12).

Ironically, Greg's interview took place on a Sunday because he had to be at school that day to prepare for an upcoming exam.

Beginning MTA, Ashton, explains how important he thinks taking a break from school is: "You can't just do school stuff all the time because otherwise you'll go crazy and burn out really fast. I think it's important to not only see other people, but also have hobbies, like things that are not math related" (Ashton, p. 13). However, when asked how often he sees people and gets involved in non-math hobbies, he responded that "it's hard to do but [he tries] to go home by 5 or 6 o'clock at least on the weekends". He did not feel he would be able to reorganize his schedule to change this anytime soon. Similarly, Miranda, Terry, and Pat also expressed the fear of burning out from working too much but did not feel they could do anything about it at this point in their graduate school career.

**Confidence.** This category has to do with MTAs struggling to feel confident in themselves as educators. Every MTA's interview transcript was coded for confidence being a challenge for them at some point in their teaching career. Although the transcripts were coded in this way, none of the beginning MTAs *openly* admitted that a lack of confidence had ever been an issue for them, while the experienced MTAs all explicitly stated that they struggled with that when they first started teaching. Up to this point, the challenges that were mentioned by every MTA during the interviews also appeared as one of their top five in the survey ranking. However, this challenge certainly did not, with only 17% of MTAs surveyed identifying it within their top five.

The beginning MTAs showed they are currently struggling with confidence, though they did not openly volunteer that information, from the way that they described

themselves during the interview. For instance, when Skylar described the midterm teaching evaluations his students completed, he stated “I think honestly I was, by the few I've looked at so far, I was expecting them to dislike me more. I don't know. Just cause I don't know what I'm doing” (Skylar, p. 2). Similarly, Pat also displayed a lack of confidence in himself when he said “I feel bad for the students because they're stuck with me. I don't know what I'm doing. I'm trying my best but on some level I don't think it's fair to them, they're just stuck with someone who has never done any teaching” (Pat, p. 16).

Although the beginning MTAs were not very open about their confidence issues, the experienced MTAs were not shy about sharing what they went through. The most extreme was Jamie, who confessed “I was very very nervous every time I went to teach. Sometimes I would cry before I went to teach cause I was so nervous” (Jamie, p. 3). She said that her nerves settled a little after her first year, but the first semester was especially hard on her. Relating to Jamie, Adam says on his first day teaching, he had a challenging time being confident in himself in the classroom. He explains, “I was really really nervous, like getting sick type of nervous, about what was going to happen when I taught. I was really really not okay” (Adam, p. 8).

**Sympathy.** This category pertains to beginning and experienced MTAs feeling the struggles that their students are going through as if they are their own. Rob says most of his students do reasonably well in his class, but “then when I see a student who I know is working very hard and is struggling and it doesn't come out well, it hurts. I feel I want them to do better” (Rob, p. 10). Another way the MTAs sympathize with their students is regarding class structure or policies that are out of their control. Greg brings

up a conflict he has within himself regarding the coordinated course mandated multiple choice (MC) exams for all the calculus classes, saying “I don't like the multiple-choice exams. I don't. But at the same time, they say it makes TAs jobs easier... It does. I have to agree, it's just... I don't feel it's helping [the students]” (Greg, p. 6). The challenge is an inner one; Greg is partly against the MC exams because he sympathizes with students, but simultaneously acknowledges that the MC exams do make his job easier.

### **Pedagogical Challenges**

This theme revolves around challenges that beginning MTAs have regarding basic pedagogical skills. Unlike K-12 teachers, beginning MTAs often have little to no pedagogical training before they begin their teaching careers. This can lead to two types of pedagogical challenges: inside and outside of the classroom. Specifically, MTAs noted that when they first began teaching, they struggled understanding their role as a discussion leader, managing class time, lesson planning, and grading.

**In-class.** This category is regarding pedagogical challenges that beginning MTAs face while teaching in their classes. At this institution, MTAs in their first year are typically assigned positions as discussion leaders. There is a one-week orientation for new MTAs in the department the week before classes start to help prepare them for their discussion leader role. Overall, MTAs are given the freedom to run their discussion sections as they see fit, which leads to the two subcategories of what to do as a discussion leader and how to effectively manage class time.

**Discussion leader role.** This subcategory pertains to the challenges of knowing what to do as a discussion leader, which is very different from being the primary instructor of a course. An overwhelming majority of about 83% of survey participants

believed that it is very important for beginning MTAs to know what to do in their role as a discussion leader. However, some of the beginning MTAs come from undergraduate institutions with small class sizes where there was not a need for discussion sections, therefore, they were unsure of what to expect during discussions. Experienced MTA Jamie admits that she experienced this, “when I started, I wasn't really sure what my class should look like... Like what I was supposed to be doing” (Jamie, p. 5). The university and department try to give MTAs the academic freedom to run their discussion sections in the manner they choose. Some beginning MTAs felt this system was challenging for them, including Ashton,

I really wish that the university had some kind of common guide set up because I asked multiple instructors during orientation week, “What are TAs in Calc 1 supposed to do in the classroom?” and none of them could give you a direct answer. And that's really frustrating for someone who's starting out or doesn't even have really any experience. You're looking for like at least some direction. (Ashton, p. 4)

Experienced MTA Rob reflects on a similar beginning teaching experience, where he was not sure exactly what to do in his role, noting:

Obviously you're not teaching the lecture, and on some level, I almost thought it was babysitting, you go in, you give them a worksheet and you make sure they do it. But I wanted to do more and I came to find that I could do a lot more in trying to help re-explain ideas and get the students engaged in trying to discuss the questions in the worksheet and just questions in the class in general. But yeah, when I first started I didn't feel like that was very clear. (Rob, p. 12)

Rob states that he eventually was able to develop what this role meant to him and took it on in a more confident manner, although it was unclear initially.

***Managing class time.*** In this subcategory, MTAs discuss challenges they have had with covering the required content within the given class period. The majority of these issues were experienced by MTAs who were the lead instructor, but some who had only been a discussion leader also raised concerns. Discussion leader Miranda recalls a class period where she was covering concavity and a student asked her if they should be plugging test values into the original function, the first derivative, or the second derivative. Miranda explains that she knew it was the second derivative, but she directed the question to the rest of the class. She then began to second guess herself because students' opinions were "almost evenly split into thirds, for like which function to plug things into. This is something that you never want to happen, but the class ended in total confusion cause that happened in the last couple of minutes" (Miranda, p. 2). Unfortunately, she ran out of time to clarify what the correct answer should have been.

As a discussion leader, there is a responsibility to help further the students' understanding, but as the lead instructor, there is the added pressure of knowing that the students are not receiving the information from anyone else. This means that managing class time effectively is extremely important as the primary instructor. Rob describes problems he ran into in his second year of teaching, where he tested innovative teaching methods but got discouraged with the time restriction during class.

I was trying to do the cooperative, almost flipped, classroom style. I think it would have been positive if there was more time. The difficulty would be that by the

time each group could solve the problem and they would go up to present, it wouldn't be enough time to explain the problems to each other and then effectively each student would have one problem done. (Rob, p. 6)

**Outside of class.** This category focuses on pedagogical challenges that arise when the MTA is performing teaching-related tasks outside of class, including the challenges of preparing lessons in advance and grading.

***Lesson planning.*** This subcategory had two opposite extremes: the beginning MTAs who put too much time and planning into their lessons, versus those who did not prepare enough for their class. Airing on the side of caution, Miranda explains

I used to write out pages worth of notes, almost like a script, of what I was going to say to them. But over the first couple weeks of the semester I realized that that was not only way too much, but it didn't leave much room for them to ask me questions. (Miranda, p. 14)

Similarly, when reflecting on his first semester teaching, beginning MTA Pat said “everything that I was doing, I spent a lot more time doing, like preparing lessons... I would always over-prepare and not really realize how much time I had in class” (Pat, p. 11).

On the other extreme was experienced MTA Rob in his first semester of teaching, where he explains that his challenge was trying to stay organized and making sure he knew the material in advance.

I remember getting sort of relaxed, I felt like, oh, “It's Calculus 1. I know this material inside and out,” which I mean, to an extent I did, but it got to the point where I wasn't really preparing ahead of time. I wouldn't spend much time

thinking about the material and it became a problem because I would go into class, and of course I knew how to do it, I could figure it out within a few seconds, but it became clear through a couple of mistakes I was making a couple of times, I hesitated for a little while, that I wasn't prepared. And I lost the trust of the students and I felt like I was wasting some of their time. (Rob, p. 5)

Adam, Ashton, and Jamie also mentioned instances where they did not spend enough time preparing the lessons they were going to teach.

**Grading.** The MTAs interviewed had different perspectives on this subcategory. Some issues mentioned were grading in a timely manner, knowing how much feedback to give, and grading fairly. Although there are grading rubrics provided for the MTAs teaching in coordinated courses, sometimes MTAs need to use their best judgement if a mistake is not explicitly addressed in the rubric. Greg struggled with fair grading during his first semester as a discussion leader, explaining

I took off a point on one of the quizzes that I wanted in a certain notation or just like I wanted you to show this step. So I took off a point there. At the time I thought "Okay this'll be fine." But then one student, she kind of was asking me about it and I said this is what I did and she was okay with it... She went actually later to the professor and he emailed me and was like "I don't think that was fair."  
(Greg, p. 2)

Greg admitted that he made a mistake and graded too harshly on that particular problem but said he had a tough time seeing that in the moment. He ended up giving the point back to all of the students who he graded unfairly.

Experienced MTA Rob had always struggled when it came to grading. When he first started teaching, he had a difficult time staying on top of his grading responsibilities. “My first two semesters, I got very, very far behind in grading. My first semester I had to spend three straight days grading because I was more than a month behind” (Rob, p. 10). He has since improved on turning graded material back in an appropriate amount of time, but still admits “grading is maybe the bane of my existence. I feel like it takes a long time because I don't want to just give check marks, just go through, yes, yes, yes, and move on. I want to spend time giving feedback” (Rob, p. 10).

The challenge of balancing grading in a timely manner with giving a sufficient amount of feedback was also seen in experienced MTA Jamie, who says,

I think getting written feedback is very important for the students. And actually I think that for Calc 1, I don't know if they still do this, but when I was doing Calc 1, they only graded one question from the worksheet and I really think that we should grade all the questions. Which would take a lot of time, but I think it's really important for students and I don't think it's good for them to be turning in work and getting 100 or 90 on it, when really half the work is wrong. (Jamie, p. 15)

In agreement with Jamie and Rob, 39% of the MTAs surveyed confessed they often find it difficult to know how much feedback to provide students on graded assignments.

### **Mathematics Specific Challenges**

This theme refers to the content related challenges that arise when teaching mathematics. The majority of the challenges presented thus far have been regarding beginning teaching in general, not specific to teaching mathematics. The categories

within this theme focus on the challenges revolving around communicating mathematics to undergraduate students and having the mathematical content knowledge to do so effectively. Additionally, the negative stigma associated around math makes it a particularly challenging subject to teach.

**Communicating mathematics.** In this category, we explore the challenges that beginning MTAs have with communicating mathematics to their students. This will primarily focus on communication within the classroom, although these types of challenges can also arise in other contexts such as office hours or via online platforms. Specifically, we will consider two subcategories of this; explaining the mathematical concepts versus simply the computations and communicating to a diverse group of students.

**Concepts vs computations.** This subcategory pertains to the challenge for MTAs to find the balance of explaining the concepts behind the mathematical ideas while still satisfying the students desire to simply learn the computations. Terry explains that when he went over the precise definition of a limit with his students, he only got excited about explaining this abstract idea if the students seemed interested in it. Otherwise, “when I just have a bunch of blank faces staring at me I’m kind of like, well... You don’t need to know this” (Terry, p. 7). In this instance, Terry does not emphasize a conceptual understanding because he believes the students would benefit more from focusing on the application of this idea in concrete examples and computations. Ashton shared a very similar view to Terry, stating,

if I believe that they don't need to know as much of the theory and they need to just be comfortable with working out examples then that's what I would tell them

because the truth is they just really won't care otherwise. I don't necessarily like that. But the truth is not everyone feels the same way about math. So you don't really have a choice. (Ashton, p. 8)

The feelings of the beginning MTAs interviewed was supported through the survey results, where 78% of the participants said they felt that undergraduate students do not want to hear about the theory behind the math being taught. Skylar and Miranda did not want to completely eliminate teaching for a conceptual understanding, but they expressed fear of putting excessive emphasis on it. Skylar states,

I try to balance [explaining concepts] with the fact that they, right now, kind of just want and need to know the mechanical way to do these things. I like that less... I want them to not just feel like they're pushing around symbols. (Skylar, p. 8)

Similarly, Miranda shares the challenges she too faced with accepting that her students want to know the computations more than they do the conceptual understanding.

We did midterm evaluations from our students and a lot of them were like "I want more examples." So I think most of them just want to do it and get through the class. So I have been doing more examples and slightly less concepts and I feel like they do like that more. But I'm not letting go of the concepts because again, I want to teach them why they're doing something or what is actually going on, not just how to solve a problem. (Miranda, p. 12)

These beginning MTAs are struggling to satisfy what the students think they want to get out of the course with what the MTA feels the students should be getting out of it.

***Diverse students.*** This subcategory has to do with the challenges associated with explaining content to students with diverse educational backgrounds who require

different levels of instruction. Determining the level of instruction necessary to benefit the majority of students in the class can be a difficult task for beginning MTAs.

Experienced MTA Mac recalls having to teach a Calculus I class where half of the students knew all of the material, a fourth knew most of it, and the last fourth knew none of it. He describes the challenges he faced with that particular class, saying

I had trouble because I had many students who were very very bored and basically falling asleep in class and kind of being grumpy with me because they felt like I was just explaining stuff they already knew, but I knew what I was saying was necessary for the other half of the class. (Mac, p. 3)

This was an instance where all of the students had varying educational backgrounds from one another, but it can also be challenging for the MTA when the students have different backgrounds from what is expected from them at a certain level. For instance, Jamie taught a summer math course and assumed everyone knew how to add fractions but found that many of them actually did not. “So one memorable thing I guess is during the summer I had to teach my students how to make common denominators. Which was strange for me because it's a college class, so you kind of assume everyone knows that” (Jamie, p. 1).

**Content knowledge.** This subcategory was not an overwhelming challenge for MTAs, however, eight out of the 10 MTAs interviewed made it clear that it had been a challenge for them at some point during their beginning teaching career. Skylar reflects on an experience he had as an undergraduate MTA at the previous institution he attended, where his duties were grading and holding tutoring sessions for an upper level undergraduate math course. He describes the difficult time he had understanding the

content of the course because the professor he was assisting used a graduate level textbook and “was covering all these theorems I had never seen before. I was mostly not helpful to the students in my TA sessions. I tried to follow along with the material but didn't do a very good job of understanding it” (Skylar, p. 10). Similarly, when Adam was a beginning MTA and first taught Calculus II, he says

I was uncomfortable in general with teaching calculus and when I found out it was Calc two I was terrified. I didn't remember how to take integrals, I didn't remember how to take limits, I didn't remember how to do a summation. So basically all of the material. (Adam, p. 9)

However, he proceeds to explain that he was able to refresh his memory and utilize resources to get himself caught up to where he needed to be to feel comfortable teaching the class.

In the previous instances, both Skylar and Adam had a difficult time with essentially all of the content in the courses they were MTAs for. Other findings showed that even when the MTA is only struggling with a few minor concepts, teaching those can still present many challenges. Jamie describes her first time as the lead instructor of an upper level undergraduate math course, where she didn't completely understand one of the topics she was supposed to cover. She felt she didn't teach that particular topic very well because the “textbook was just presented in a very different way than I had learned it... it felt very strange to me and I think I was having a hard time grasping what the book was trying to present to the students” (Jamie, p. 7). She goes on to say that she ended up only testing the students on very simple concepts from this section, to avoid needing to go into too much detail while teaching it.

Having a lack of content knowledge can also occur in the lower level math courses. Terry describes teaching a very specific concept that he was never entirely comfortable with in one of the introductory level math courses.

I learned it so long ago, and a lot of the stuff you don't even use in calculus, or ever again. So a lot of the stuff I actually had to re-teach myself in a way that I didn't have to when I was the discussion leader of Calc 1 or Calc 2, I mean that stuff I just know. This I had to relearn a bit. I know I never really liked the graphing so much and there's a whole big section we do on transformations. I'm not that good at it, I mean I can do it, but I don't really like it, and I've never had to do it in any later classes, so I have no practice with it in any way. So I teach it kind of poorly, I mean I know I did. Then they hate doing it and it's kind of challenging for me because I'm not so great at it, even though it's in a so-called 'lower' math class. Then they hate it too because they don't see it in a good way.  
(Terry p. 3)

In fact, almost half (43%) of the MTAs that responded in the survey admitted they often struggle when teaching topics they have not encountered before or have not seen in a while.

### **Solutions**

The solutions presented in this section to helping beginning MTAs overcome the challenges they face came mainly out of interviews conducted with experienced MTAs. The experienced MTAs were asked questions to elicit responses regarding these solutions. The beginning MTAs did not receive these same interview questions, however, some still offered suggestions on their own. The findings will be presented

according to each solution, which will be explained and tied back to the challenge(s) it addresses. There were eight main potential solutions identified through the analysis of transcripts: observations and demonstrations, schedule, feedback, positive attitude, relating to students, coordinated courses, online, and support and pedagogical training.

### **Observations & Demonstrations**

This solution involves beginning MTAs sitting in on experienced MTAs' and faculty members' classes (observations) and model lessons (demonstrations). Additionally, the classroom observations could be of a fellow beginning MTA's class because that can also provide a learning opportunity. Whereas, the model lessons would need to be performed by an experienced MTA or faculty where there are no students present, only other MTAs and faculty. This gives the beginning MTAs the opportunity to stop the presenter and ask questions as needed about the teaching methods being used. Setting up opportunities for beginning MTAs to participate in these types of demonstrations and classroom observations could potentially address the challenges identified earlier within the categories of communicating mathematics and in-class pedagogical challenges. In fact, eight out of the 10 MTAs interviewed said that they would have benefitted from having these observations and demonstrations available to them, with more than half (52%) of survey responses ranking this in their top three most important aspects of helping them perform their TA duties to the best of their abilities.

During Skylar's interview, he describes going into his discussion section on the first day and having no idea what to expect. Eventually he got into the rhythm of how he wanted the class to run. However, he explains "that was still the first discussion I'd ever

been in, was the one that I was teaching. So maybe seeing one beforehand would have been helpful, as an example” (Skylar, p. 5). This would help address the in-class pedagogical challenge of understanding the role of a discussion leader. Pat had similar struggles as Skylar, but he expressed wanting to see a teaching demonstration beforehand, rather than a standard classroom observation. “Because if we've never taught before then we have no idea what we're doing. I mean I would like to see something like that, you know, just sort of a mock presentation of how a class would run or something like that” (Pat, p. 4).

Further, seeing demonstrations or observing classes can also help beginning MTAs overcome the challenges associated with communicating mathematics. Greg addresses his concern of teaching to best suit the needs of diverse students, “I would've liked to see different types of teaching based on the group. Or attend an actual Calc lecture that the professor is doing” (Greg, p. 4). Rob also expressed the benefit he believed observations could have for communicating mathematics, but in a broader sense. He feels that observing peers teaching can be equally as beneficial as observing experienced MTAs and faculty. The following excerpt from his interview illustrates how he reflected on this point.

When you're observing a professor, well hopefully, they're doing very well, they've got a good idea of how to approach it and it's a positive experience. But also, when you're observing peers, you get a lot out of just saying, “oh, this person did this, that was really awkward, I should make a note not to do that.”

(Rob, p. 15)

## Schedule

This solution presents the possibility of beginning MTAs creating a schedule to organize their time and responsibilities. Beginning MTAs interviewed admitted to often finding themselves setting aside their graduate studies because they got carried away with lesson planning and grading. The suggestion of creating a schedule came up in every interview at least once and was seen as very to extremely helpful by 65% of the MTAs surveyed. If beginning MTAs are exposed to this technique and choose to embrace it, that could help them address the challenge categories of balancing responsibilities and outside of class pedagogical challenges. Experienced MTA Mac can personally speak to the success this has had for him, “I think that actually keeping like legitimate stopwatch time of when you're working on what has helped to show me what that balance is and to make sure that I don't tip it too far” (Mac, p. 12).

Ashton and Greg also reference instances where they have benefitted from setting up a schedule because then they know there is a certain time put aside for teaching versus another time for being a student. Ashton says, “I found that setting certain days and times to grade or to prepare for discussion was helpful” (Ashton, p. 12). Similarly, Greg explains, “there's one day where I'm like ‘okay, I'm in study mode’ and the next day I'm in going-to-school mode” (Greg, p. 12). Further, Miranda discusses how keeping a schedule has helped her maintain breaks and have a life outside of school.

I do like a healthy balance because it can't be work all the time, it also can't be no work, so I like being here for a “workday”. So I get here at 8 AM every day, even

when I don't teach at 8 AM, I get here at 8 AM, and I stay until five-ish, but that's every day. (Miranda, p. 14)

This gives her time outside of the set schedule to relax and do things she enjoys that are not related to school, without feeling guilty about neglecting her responsibilities.

## **Feedback**

This suggested solution involves beginning MTAs receiving feedback on their teaching from peers, experienced MTAs, faculty, and students. Receiving feedback on teaching can help address a wide variety of challenges that beginning MTAs may be facing, including the categories of engaging students, balancing a good rapport with being an authority figure, having confidence in one's self, and communicating mathematics effectively. There are different forms in which feedback can be received, all of which can be helpful in different ways. A commonly practiced form is having beginning MTAs get feedback from experienced MTAs and faculty members, which was ranked as one of the top three most helpful solutions by 65% of the MTAs surveyed. However, sometimes it can be intimidating to get feedback from people in higher positions than one's self, which is why there is also a benefit to peer and student feedback.

**MTAs and faculty.** Here we will focus on the specifics of receiving feedback from other MTAs and faculty. Ashton recalls a time when he was teaching and had a faculty member observe his lesson. He thought everything was going great and had not taken the time before this to reflect on areas where he might have opportunity for growth and improvement. Through the feedback he received, he discovered "my board work was not as organized as I thought it was. When I had people observe it, I was able

to get better feedback about it” (Ashton, p. 4). If it were not for that moment of receiving feedback, Ashton quite possibly would have continued on for the rest of the semester with the same type of problematic board work. This shows that sometimes beginning MTAs aren’t fully aware that there is something that they can improve on. Further, Adam suggests that to help beginning MTAs build confidence and learn how to communicate better to students, the feedback should start at the very beginning of the semester. He suggests, “[the beginning MTAs] do one lecture at the beginning, the first day, and then [faculty and peers] give you suggestions, and then you do the lecture again” (Adam, p. 8).

**Students.** The other possibility for who to get feedback from is one’s own students. Ashton describes how lost he felt when he first began teaching his discussion sections and recalls having no idea of what he should be doing until about halfway through the semester. Beginning MTAs are advised to hand out midterm evaluations to their students, to get a sense of any changes they might need to make before the semester comes to an end. Ashton states this was a helpful tool for him, noting, “I gave midterm evaluations to the students and then I was able to get feedback from them. And so I just did things based on their responses” (Ashton, p. 2). This may address the challenge of engaging students also because if students see that the MTA put a good effort forward to teach to their needs, they may be more willing to participate and pay attention.

### **Positive Attitude**

This suggested solution pertains to beginning MTAs maintaining a positive attitude and energy while teaching their courses. Coming to class with a genuine

excitement to teach the course material may potentially help overcome the challenge of keeping students engaged and of maintaining a good rapport, while still being seen as an authority figure in the class. Students develop perceptions about their instructors, whether intentional or not. Terry describes experiencing this phenomenon himself as a student,

I've always been interested in classes more when the teacher has a little bit of a personality. It doesn't have to be funny, but when they've got a little personality, it kind of just makes it more pleasant to be there. As a student, you don't want to be in a class you hate being in. Even if you hate the material, you should at least not be miserable. (Terry, p. 12)

Terry displays an awareness for the fact that there are students that do have strong feelings against math, but still feels there is a way to make the class more enjoyable for them. Adam has similar opinions regarding this matter and always tries to keep a positive attitude while teaching to try to get students interested in the material.

That's something I always try to do. That's my teaching style. I'm excited and interested in the material and I know that not everyone in the classroom is, but I do know that my excitement and my interest is infectious because I have students that get excited about the things that I get excited about. (Adam, p. 21)

Rob and Ashton take this idea a step further and describe the positive impact this may have on students' learning. They express a desire to utilize this technique in order to further the students' conceptual understanding of the content. Rob states,

the goal has to be to engage the students, to get them excited about the material and get them interested in the material, which comes down to being likable,

being interesting. If I just walk up there, standing and talking at them, they're not going to get anything out of the class other than maybe a letter, you know, A, B, C, D. But if I can get up there and be excited, interesting, ask questions, get them involved, I feel like I can teach them a lot. Maybe get someone excited about math. (Rob, p. 11)

Similarly, Ashton believes it's important that the students know the instructor is interested in teaching the material. He says, "you just want to feel like your instructor cares about being there and isn't there just because they have to be. That makes you feel engaged and not want to stop paying attention" (Ashton, p. 14).

### **Relating to Students**

This proposed solution involves finding ways to relate the math content or one's own experiences to the students in some way. The MTAs interviewed gave examples of times when they were able to relate to their students, whether it was through confessing struggles they had themselves as undergraduates to their current students or finding innovative ways to present the content in a manner that piqued their interest. This could potentially address the challenge of having too much sympathy for students because it puts the sympathy to use, where the MTA can relate and make the students feel understood. Additionally, relating to students can help with the categories of student engagement, rapport, and communicating mathematics.

**Relating to their struggle.** Learning something for the first time can be difficult and frustrating for students, but it may help if the MTA is able to sympathize with the students and make them feel understood. Miranda believes it's important that MTAs are "being mindful and respectful of what [the students are] going through as well. Knowing

what it means to learn something for the first time and being able to support that” (Miranda, p. 17). Adam recalls an instance when he was teaching the chain rule and had students who were not able to solve the more challenging examples. He proceeds to say,

I also can remember what I had questions on and what I struggled with, so I also try to let the students know things that I've had problems with cause I think it humanizes me and also let's them know that they're not an idiot for not knowing. (Adam, p. 2)

**Relating to other academics.** Connecting the math curriculum to other courses that students are currently taking or have taken in the past may help promote interest in the subject. There will always be students who intend on pursuing future careers that will require them to use some of the mathematics that they learn in college, although this is often hard for them to see in the moment because what they are learning may feel theoretical and disconnected from real world applications. Pat admits that “sometimes it can be abstract so just try to, you know, tell them why it's important, where it would be useful, why they should care about it. We're not just doing it to make you suffer” (Pat, p. 14). Jamie takes this idea further and focuses specifically on the engineering students taking her math courses. She reveals that she is not entirely sure of the exact applications, but she knows there are many.

We teach a lot of engineers, for example, so it would be helpful if we could have some engineering professors or graduate students come in and say to us ‘you know, when you teach your students derivatives, this is how they're going to be using it in their engineering classes.’ So then maybe we can motivate students

who are engineers, this is important because you're going to be using it in this course. (Jamie, p. 15)

**Relating to the real world.** Some MTAs revealed creative tactics they have used to relate the math content to their students' interests outside of school. Experienced MTA Mac said when he made word problems for his class, he would utilize real world facts to try to get the students more motivated to engage with the content.

I had this thing going where every question had all these footnotes on it. So instead of saying you're climbing a mountain, it'd say you're climbing the tallest pyramid in Giza and then the footnotes would say things about the actual pyramid in Giza. So every time I made these problems, I'd look for ways to make them a little more fun or just put a little bit of extra stuff in them, so students would actually enjoy doing the problems. (Mac, p. 4)

Another innovative technique was mentioned by beginning MTA Ashton, who connects a calculus application to a popular movie that many students are familiar with.

Once I think that they're comfortable enough to be able to determine or play around with different types of limits, I like to show them the clip from Mean Girls and introduce that limit. Because the truth is they can actually, once they see what the graph of that function is, it's actually quite easy to determine that the limit does not exist. And when they actually make that connection with what they've probably seen in the past versus what they know now, I think that actually is pretty rewarding for them because otherwise they may have all heard, "oh yeah, the limit does not exist" from that movie, but now they can actually make

the connection and realize why it doesn't exist. And I told them they can impress their friends. (Ashton, p. 3).

### **Coordinated Courses**

Every MTA interviewed agreed that teaching in a coordinated course in their first two years provides much needed support and structure. The MTAs agreed that the positive aspects of coordinated courses outweighed the challenging ones that were mentioned previously, with about 70% surveyed stating that coordinated courses are very to extremely helpful. Having a coordinator oversee everything and create a common curriculum means that beginning MTAs get help with overcoming challenges relating to student incidents, balancing responsibilities, out of class pedagogical challenges, and lack of content knowledge. The coordinators are typically the ones responsible for addressing cheating incidents and preparing the bulk of the exams, quizzes, and homework assignments, which means that beginning MTAs do not need to take that on by themselves.

Pat feels very strongly that being an MTA for a coordinated course benefited him greatly. He says he appreciated “having someone, an overarching person, who you can just go to and ask any general question to about that class... It helps when someone’s just setting up the classroom, instead of me having to do everything on my own” (Pat, p. 5). Ashton felt similarly about being part of a coordinated course, although he also pointed out the negative, challenging aspects to it as well. However, overall, he was grateful for having the coordination because, as he describes it, “I don’t need to decide what material, what certain topics or ideas we need to cover. Those are laid out for us... So we could focus more on just what we’re doing in the classroom” (Ashton, p. 5).

Ashton's point shows that having coordinated courses could benefit beginning MTAs with the challenge of lesson planning because it allows them more time to focus on mainly that component of teaching.

Additionally, some coordinators will go above and beyond, providing information about what to focus on for each specific week and giving beginning MTAs a sense of what content students may have a particularly difficult time with. Terry had this experience with the coordinator he worked with during his first time as the lead instructor.

The nice thing, as a grad student, about coordinated courses is that it takes a big burden off you. Coordinated courses are nice because you don't have to do everything. In my coordinated class, [the coordinator] will tell us what needs to be covered that week, she'll give us tips because she's taught this class before.

(Terry, p. 5)

This can be extremely helpful for MTAs who have never taught before. If some of the challenges associated with coordinated courses can be worked out then having coordinated courses could be a great solution to help beginning MTAs.

## **Online**

Utilizing online platforms, such as the learning management system, email, and Piazza, can be invaluable tools for communicating with students outside of class.

Piazza is a relatively new online math discussion board, which allows students to write and respond to math related questions with their peers. Experienced MTAs noted they

felt using Piazza helped them manage the number of repeated student questions they received. Additionally, MTAs felt that being able to connect with students online, in general, took some of the pressure off in class because they knew if they did not have time to get to something or if they did not know the answer to a student's question, they could reach out to the whole class at a later point to address it. Online tools could potentially help beginning MTAs with communicating mathematics and with the challenge of managing class time.

**Email.** Contacting students through their university-assigned email addresses helps MTAs communicate effectively with their students whenever they need to do so. Greg explains that there are times when a student will ask a question and he is not immediately sure of the answer, or he may think he is sure but then when he demonstrates it, it does not work out exactly as planned. When either of these instances occur, Greg says

I'll work it out later and then send the students an email later and explain "this is where it went wrong." I've done that a few times, where we couldn't figure something out in discussion, and then I just take a few minutes by myself and I'm like "oh it's obviously this" and then I just send them an email. (Greg, p. 7)

This takes the stress out of feeling the need to figure out the problem in the moment during class time, where doing so might use up a significant portion of class and make it impossible to get through the remaining content that day.

**Piazza.** Email is one useful tool for managing class time, but there are some homework problems that a large percentage of the class will naturally struggle with, which is where the online math discussion board, Piazza can be utilized. To avoid

needing to email the same response to dozens of students, experienced MTA Jamie suggests using Piazza, where students can post their math related questions and other students can log in to view previous posts and respond to their peers. This means that if many students have the same question, it only needs to be posted once and when someone responds, the answer will be visible to everyone. Jamie explains the success she has had with it,

I made a Piazza page for my last few classes, just so that I'm not getting the repeated questions. So I'd make my students post their questions there.

Sometimes I read them but then I just wait to see if another student will answer the question so that I don't have to type up the answer. Then if it's been an hour or two, I'll go and I'll answer the question myself. (Jamie, p. 9)

She also brings up a point about Piazza not only saving time for the MTA, but also giving the students the opportunity to further their knowledge by being able to respond directly to peers.

### **Pedagogical Training & Support**

Beginning MTAs expressed their desire to have more formal training in overall teaching strategies and logistics, as well as additional pedagogical support within their department. The majority of MTAs surveyed (91%) stated that asking experienced MTAs and professors for teaching related advice when needed was very to extremely helpful for them as beginning MTAs. This solution can potentially address all challenges reported on in some way. It is worth noting that this institution currently has some aspects of this in place, with a one-week orientation before the start of the beginning

MTAs' first semester, a mandatory one semester course focused on mathematical pedagogy, and a mentor program specifically for teaching assistants.

**Pedagogical Training.** The logistics of teaching develop over time, but if beginning MTAs can be shown the way right from the start, it can help them become great educators sooner and save them from feeling lost. For instance, Ashton still currently wonders, "how do you organize your board work or how should you be positioned in the classroom? What should the level of your voice be?" (Ashton, p. 4). Experienced MTA Mac chimes in on this matter too, explaining it would have been helpful to him if he had known right from the beginning "how to write an exam, build a syllabus, schedule a course, write a lecture, use a textbook, all these kind of fundamentals of how to build the logistics of a course" (Mac, p. 5).

Pushing past the basic logistics of how to teach, having a sufficient amount of pedagogical training can also help provide beginning MTAs with ideas on innovative teaching practices that they can try out in their own classrooms. Terry admits that he teaches the same way that he has always been taught, which is a very standard lecture style class with minimal student interaction. He recalls his math professors writing a theorem on the board, proceeding to prove the theorem, and then erasing the board to repeat the whole process. Terry states, "I think getting some instruction on how to do other things, kind of things that you could do outside of the box as an instructor, I think that would be very useful" (Terry, p. 4). Trying out new, creative teaching techniques may even help increase student engagement in the classroom.

**Support.** This pertains to providing pedagogical support within the department for beginning MTAs, where they have peers, experienced MTAs, and faculty members

that they can turn to if issues arise or simply to get new ideas on different teaching strategies. Specifically, having support from peers was identified by every beginning MTA interviewed as being an important component to their teaching success. They all stated they felt close to the other beginning MTAs in their cohort and often reached out to them with teaching concerns. Pat recalls, “in the beginning we were all more or less teaching the same courses. So in terms of having problems with our class, I guess we could talk to each other and that was helpful” (Pat, p. 12). Skylar also feels that having fellow beginning MTAs available to discuss teaching has been extremely useful for him.

I'll sometimes ask, especially [two other beginning MTAs who are discussion leaders], have the same instructor as me and they're in the office. So I'll ask them like “how are you planning to cover this?” or do such and such a thing. Yeah we work together on that kind of thing a fair amount.” (Skylar, p. 14).

Getting support from other MTAs certainly does not have to be limited to only within their cohort. If we could find a way to get beginning MTAs to feel comfortable reaching out to experienced MTAs or faculty members for advice too then we can help them build a strong foundation for their pedagogical skills. In fact, the survey results showed that 57% of MTAs rank getting advice from experienced MTAs and faculty in the top three solutions that would help them overcome the challenges of beginning teaching.

## CHAPTER FIVE

### DISCUSSION

#### **Challenges**

In the findings chapter, eleven categories of challenges were presented, some of which involved subcategories. The categories for all of the challenges coded through the interviews and confirmed in the surveys were: engaging students, managing student incidents, having confidence in one's self as an educator, balancing responsibilities, difficulty communicating mathematics to students, maintaining authority while keeping a good rapport, teaching for a coordinated course, having sympathy for students, pedagogical challenges in class, pedagogical challenges outside of class, and a lack of content knowledge. We will begin this chapter by taking an in-depth look at the top five challenges as described by MTAs. This section of the chapter concludes with a discussion of the remaining categories, which were not as prominently identified by the participants as one of their top challenges.

#### **Engaging Students**

One of the categories developed through coding was engaging students in the classroom. This came up because every MTA, beginning and experienced, mentioned this being a challenge for them. Some focused more on the side of keeping students paying attention during the class discussion, while others seemed to struggle more with getting students to actively participate during class time. Recent research has found that students in traditional lectures have higher failure rates than students in classrooms that support active learning and student engagement in mathematical work (Chen, 2013; Freeman et al., 2014; PCAST, 2012). However, it was mainly experienced MTAs that

expressed unsuccessful attempts of innovative teaching practices, while beginning MTAs appeared to be satisfied with their lecture style classes and had implemented little to no active learning techniques.

One of the experienced MTAs mentioned feeling discouraged by trying to incorporate active learning and thus chose to resort back to a traditional lecture format. The remaining experienced MTAs had similar feelings regarding the challenge of implementing active learning in the classroom but showed awareness of the benefit to using innovative teaching practices, such as group work, flipped classroom, and more. They all were in agreement that this was difficult to actually incorporate into their classes. Rob was the only one who stated he always tries to give students at least a little time to try out problems in groups during class.

On the other hand, beginning MTAs did not seem to have the thought of innovative teaching methods cross their minds during their interviews or in their survey responses. Additionally, the classroom observations showed that every beginning MTA stuck to a relatively traditional lecture style classroom. That being said, there were still a few beginning MTAs who regularly asked questions to their students to try to get them actively participating in the whole class discussion, making their class an interactive-lecture style. These findings support previous research done in this area, such as Gallagher's study (2016), where she found:

[The first year MTAs] wanted students to pay attention and valued the ability to explain clearly. While they valued having multiple instructional options and desired student engagement, they viewed that engagement taking the form of developing questioning techniques within a structured lesson plan revolving

around content delivery in the form of lecture. That is, they valued teacher-student interaction, but student-student interaction was not mentioned at any time by any of the participants. (p. 129)

The main challenges that beginning MTAs were concerned with regarding engaging students was getting a variety of students to respond to their questions during class (participation) and minimizing the distractions during the discussions (attention). The bigger issue here, that is within the control of the MTAs, is getting students to participate in class, since minimizing distractions (e.g. cellular phones, laptops) is only truly in the control of the students, not the MTA. There are times when the MTAs recalled asking a question to the class and not getting an answer from anyone. This could be due to two main reasons: (1) the students understand what is going on but are simply too shy to respond to the question in front of all of their classmates, or (2) the students might not be completely following along with the lesson and for that reason, they do not offer a response.

It is crucial to be able to differentiate between the two situations because if the latter is what is occurring then the MTA may need to find a different way to explain the concepts to help the students understand. Both cases involve being able to read the students' level of understanding, a skill that comes with experience, but proper training may help them develop this ability sooner. This result confirms what was seen in DeFranco and McGivney-Burelle's (2001) study, where MTAs' beliefs regarding teaching and learning mathematics changed through training, although interestingly, their overall teaching practices remained the same.

## **Student Incidents: Cheating**

Another major challenge that the analysis brought to light was regarding MTAs properly handling student cheating incidents. The beginning MTAs at the institution where this study took place were mainly discussion leaders for coordinated courses. This means there is a main instructor for the course, who the students meet with in a large lecture setting (one hundred or more students) and they separately meet the MTA in a smaller group (about twenty students) in discussion sessions that focus on the lecture content. For beginning MTAs, being a discussion leader for a coordinated course gives them multiple resources to go to in the event of a student incident such as cheating. Many beginning MTAs pointed out that they felt comfortable speaking with the main instructor or the coordinator in this type of situation. However, some stated that dealing with these situations in the moment made them uncomfortable and they found it difficult to know what to do right then and there.

At the institution where this study took place, there are very specific protocols that must be followed if a student is suspected of cheating. Further, MTAs are not permitted to take a quiz or exam from a student based only on suspicion. This can be scary to beginning MTAs, who are thereby unsure of what they are actually allowed to do in the moment of a suspected cheating incident occurring. Students attempting to cheat academically is a growing problem, with the International Center for Academic Integrity finding that 68% of college students admitted to cheating on a test or written assignment (International Center for Academic Integrity, 2015)

One interesting finding was that the experienced MTAs thought of this as more of a challenge than some of the beginning MTAs. Every experienced MTA stated they find

it difficult to know how to handle a student who is attempting to cheat, both in the moment and afterwards. All of the experienced MTAs admitted that they were unsure of the correct procedure for handling cheating incidents, while on the other hand, every beginning MTA said they *knew* what to do, but it still made them uncomfortable. Several beginning MTAs described witnessing a student glancing at someone else's exam or quiz at some point during their teaching career. Miranda described this phenomenon as “the glance” and explained that she saw it during exams but normally telling students to keep their eyes on their own papers did the trick for her. Unfortunately, this is not always the case, some students will be persistent in their cheating efforts and in those situations, MTAs expressed deep concern and uncertainty in how to address it.

This finding helps us better understand not only the challenges of beginning MTAs, but also of experienced ones. This extends the work done by Belnap (2005), where his findings revealed some challenges that MTAs face, although it was not the focus of his study. Specifically, he found that one participant had to deal with three major challenges, one of which was dealing with cheating and the relevant protocols, which he was unsure of (Belnap, 2005). This shows a need to address this with both groups of MTAs and thoroughly explain the proper cheating protocol to them for the specific institution they are at.

### **Confidence**

As presented in the findings chapter, many MTAs had a particularly difficult time during their first semester teaching with having confidence in themselves. Some of the experienced MTAs recalled their first day in their roles and the nerve-wracking experience of walking into a class with all eyes on them. All of the experienced MTAs

stated they had a challenging time staying calm and confident during their first semester teaching, with some stating it took them as long as their third year to build up confidence in themselves. These findings are in line with several other studies which have found that because beginning MTAs have little to no prior teaching experience, they begin their teaching career lacking confidence in their ability to teach mathematics well to undergraduate students (Beisiegler, 2017; Belnap, 2005; Gallagher, 2016; Nepal, 2014).

The beginning MTAs that participated in this study did not voluntarily express that confidence was a challenge for them, but this surfaced through the analysis of experiences they described during the interviews. For instance, Greg displayed a lack of confidence when describing his views on his position in the department and his ability to explain ideas to students. He revealed that if he is unable to explain something to the students or answer their questions then he directs them to the instructor because he is only a “small potato” in the department and he presumes the instructor knows more. Having this attitude and harboring this unhealthy relationship with oneself can translate to an overall lack of confidence in class, which may impact the way that the students perceive the MTA as well.

Unlike beginning MTAs, the experienced MTAs were extremely open and honest about learning to have confidence in themselves as educators. This could be due to the fact that the experienced MTAs felt they had grown since then and therefore they were not admitting a current weakness, but rather an old one that they overcame. Whereas, if the beginning MTAs had confessed struggling with confidence, it would be either something they are currently dealing with or only recently overcame. For this reason,

they may have feared being perceived as insufficient educators due to a lack of confidence. Additionally, the beginning MTAs' lack of confidence may have also contributed to the fact that they did not want to acknowledge their confidence issues head-on. This particular point has not been discussed in any of the existing literature reviewed, however, it is a prominent line of research at the K-12 level.

### **Balancing Responsibilities: Student vs. Teacher**

In this study, all beginning MTAs besides one, stated they thought they spent too much time on their teaching duties and perhaps not enough on their own studies. This could be due to the specific sample that participated in the study or the institution itself. A typical first year teaching load is three sections with twenty student each, meeting twice per week, as a discussion leader. Some second year MTAs are given their own class as the primary instructor, where they have two sections of about thirty students each, that meet for 150 minutes per week. MTAs expressed that this teaching load can take up a significant amount of their time if they are not careful and strategic in organizing their schedules.

The 10 MTAs that participated in this research study showed a particular interest in student learning and in teaching overall. The majority of beginning and experienced MTAs in this sample (70%) made it clear that they enjoyed teaching and for that reason, they often prioritized it over their own studies. This differs from the overall consensus in existing literature, which suggests that many MTAs in research institutions often do, or feel they should, prioritize their research over their teaching duties. Many MTAs often internalize the ambiguity surrounding the relative value of teaching and research and are subsequently pulled in opposite directions (Nyquist et al., 1999).

## **Communicating Mathematics: Concepts vs. Computations**

These findings pertain to the challenges MTAs face when trying to find a balance between explaining the mathematical concepts to the students while satisfying the students' desire to simply focus on the computations. Most mathematics teachers have an innate desire to help students reach a conceptual level of understanding of the content being taught. However, students often only memorize formulas, without a complete understanding of the underlying concepts, just knowing that a particular formula should be used to some type of problem (Gomes & Mendes, 2007). Due to this fact, students typically prefer the instructor to walk them through the step-by-step procedures and computations, rather than spending class time explaining the concepts.

As a beginning MTA, it can be difficult to know how much of a lesson should center around conceptual understanding, while also giving enough attention to the procedures that students seem to care more about. It can be easier to focus on the computations and satisfy the students than to talk about ideas when you feel like no one in the room cares about it anyway. In the findings section, a quote from Ashton regarding his avoidance of going into too much theory or conceptualization was presented. He believes that the students do not seem to care about the concepts and he stated that he prefers to spend time in class going over applications and not placing too much emphasis on the deeper meaning. At this point, Ashton has only taught as a discussion leader, so his views may or may not change as he gains more experience.

The findings in this study extend results of previous research done by Raychaudhuri and Hsu (2012). One of the study participants prefers theory and proofs to examples and applications for herself but offers students quite the opposite, because

she knows “they don’t care about [the theories and the proofs]” and she does not want to “make them feel confused about it” (p. 3). They proceed to explain that this MTA holds a rich and connected view of mathematics, admitting that challenging questions enriched her own understanding as a student, whereas she provides her students with a user’s manual approach to calculus and straightforward questions so that “they don’t feel the pressure” to understand (p. 3).

### **Remaining Challenge Categories**

The remaining challenge categories found in this study that did not fall into the top five were: maintaining authority while keeping a good rapport, teaching for a coordinated course, having sympathy for students, pedagogical challenges in class, pedagogical challenges outside of class, and a lack of content knowledge. Through a review of the literature, many of these challenges have not been closely examined at this point, although Belnap’s (2005) study revealed that MTAs faced challenges regarding maintaining authority, having sympathy for students, and pedagogical challenges both in and out of class. Additionally, Nepal (2014) found that MTAs have a difficult time dealing with certain aspects of teaching a course that is coordinated. Although these were not the main challenges found in this study, our findings still extend the existing literature in identifying additional points of difficulty for beginning MTAs.

### **Solutions**

In chapter 4, eight possible solutions were presented: observations and demonstrations, maintaining an organized schedule, receiving feedback on teaching, having a positive attitude while teaching, relating to students, having coordinated

courses, online communication with students, and having support within the department and pedagogical training. We will first focus on four of these, specifically the ones that the department and institution could help implement, which include observations and demonstrations, feedback, coordinated courses, and pedagogical training and support. The remaining solutions were ones that MTAs are in sole control over and should be encouraged to try to implement themselves.

### **Observations & Demonstrations**

This presented solution pertains to the mathematics department setting up opportunities for beginning MTAs to observe real classes or model classes of either other beginning MTAs, experienced MTAs, or faculty members. This could be implemented through a pedagogy course for beginning MTAs, to give them an outlet to discuss teaching related challenges and grow with their peers. However, if an institution is unable to provide a formal course dedicated to pedagogy, they can still implement required or recommended observations before the start of the beginning MTAs' first semester, as well as potentially throughout their entire first year. This is a tool that not only beginning MTAs can grow from, but it can also benefit experienced instructors because we can always learn more and continue developing our teaching.

Watching the class of a peer can be very useful for beginning MTAs because they can learn new teaching techniques, see what they maybe should avoid doing in their own class, and observe how students interact with the instructor and material. Reinholtz (2017) found that peer observations enabled MTAs to notice students' reactions during lessons, because they provided an opportunity for the MTA to focus only on the students, rather than all of the other responsibilities associated with

teaching. It has been noted that observations of teaching are most beneficial to those involved when using a common observation instrument accompanied by time for discussing the processes and reactions to observation (Hauk et al., 2009). Our study further reinforces this because the participants at the institution where this study took place mentioned that the observations conducted through their Pedagogy course helped them overcome challenges they faced in the classroom.

### **Feedback**

Our findings revealed that receiving feedback from their students, other beginning MTAs, experienced MTAs, and faculty, can potentially help beginning MTAs become more aware of areas where they can improve. This enables beginning MTAs to get another perspective on their teaching besides just their own. In fact, the Pedagogy course at the institution where this study took place, requires all beginning MTAs to conduct mid-semester teaching evaluations during their first semester as an MTA. Having this requirement enabled some of the beginning MTA participants to realize that there were areas they needed to improve on, as noted by their students.

Extending this idea past simply student evaluations of teaching, brings us to the idea of teaching evaluations conducted by experienced MTAs and faculty. For beginning MTAs, having an experienced MTA or faculty member observe their class might be intimidating at first, so it would need to be approached delicately. The observer should provide constructive criticism, but not in a way that comes across as harsh or attacking. Even if the observer believes that the MTA is doing a good job, there is always room for growth and improvement, thus the observer should complement the MTA while simultaneously suggesting possible improvement, even if only minor. This

supports findings from Belnap's (2005) study, where one of the MTAs expressed frustration when a faculty member observed her class and provided essentially no concrete feedback. The MTA wanted to develop her teaching and valued this faculty member's opinions, thus resulting in disappointment when very minimal feedback was received (Belnap, 2005).

Finally, the findings from this study showed that there is significant opportunity for growth through peer feedback, where beginning MTAs are observed by one another and provide their thoughts on what could be strengthened in the teaching. The beginning MTAs mentioned this was helpful to them and was the least intimidating form of receiving feedback because they are getting it from someone who is their equal. The beginning MTA receiving the feedback knows that this is their peer who is also just learning how to teach themselves, none of them are experts in the field yet. However, due to this fact, the beginning MTAs may need guidance in *how* to provide constructive criticism, because again, the goal is not to hurt anyone's feelings, but it also needs to serve a purpose and the beginning MTAs need to gain something from it. Getting feedback that doesn't highlight areas for potential growth is not a useful tool for either party involved. This area is addressed in the pedagogy course that some of our participants attended, thus it is worth noting that our findings indicate that constructive peer feedback is still an area that MTAs find valuable and necessary to ameliorate challenges in the beginning years.

### **Coordinated Courses**

Interestingly, the findings concluded that having coordinated courses was overall more of a solution than it was a challenge for beginning MTAs. There were certainly

challenging aspects to being an MTA for a coordinated course, but at the end of the day, beginning MTAs made it clear that they appreciated the support it provided for them. The coordination model at this institution was such that a faculty member whose sole responsibility was teaching (there is no research requirement associated with their position), oversees all sections of a particular mathematics course. This entails creating a schedule of which topics to cover on which days, designing or delegating instructors to design the common quizzes and exams, and oftentimes assigning common homework. This model is in place for all lower level mathematics classes through Differential Equations and Linear Algebra. Additionally, this institution assigns all first year MTAs as discussion leaders, to help ease their transition into teaching.

The study participants stated that they appreciated having an overarching person they could turn to if any issues arose in their class. Further, the MTAs who had taught as the lead instructor of a course said the coordinator was a useful asset to them because they alleviated their workload significantly. It can take a very long time to prepare homework assignments, quizzes, and exams, especially the first time around. Not having to worry about taking care of all of these logistical aspects of a course completely on their own was a big help for the beginning MTAs, who were then able to focus their time and energy on successfully explaining course content to students in class.

Through a review of the literature, there was not a significant amount of research found pertaining to the benefits or drawbacks to having coordinated courses from the perspective of MTAs. The limited research on this topic differed from our findings. For instance, Nepal's (2014) study came to the opposite conclusion that ours did, finding

that although MTAs appreciated the support, they would prefer having the freedom to teach in their own way without a coordinator. However, bringing a positive light to coordination, Gallagher (2017) found that student performance in coordinated courses exceeded performance in the same course taught by MTAs with a similar level of teaching experience. Based on her results and the findings from this study, coordination models seem to be an area that require further investigation to understand how they can benefit both the students and MTAs.

### **Pedagogical Training & Support**

The findings from this study showed that having pedagogical training and support in place for beginning MTAs can be an extremely useful tool, as it is well known that many beginning MTAs have limited to no teaching experience upon their arrival to graduate school. Kung (2010) found that it is possible for GTAs to develop rich knowledge of their students' mathematical understandings through professional development programs that emphasize student thinking. Establishing a training program that helps beginning MTAs teach in a way that promotes student learning may help them with communicating mathematics more effectively and gaining confidence in themselves as educators. There are several options for training programs that could be implemented, some of which have been described in existing literature (DeFranco & McGivney-Burrelle, 2001; Harris, Froman, & Surles, 2009; Speer, 2001).

Aside from a formal teaching preparation program, it is also helpful to provide pedagogical support to beginning MTAs in other ways. Research on K-12 professional development points to the important role that mentoring plays in increasing teacher effectiveness (Putnam & Borko, 2000; Sowder, 2007). In the college context, perhaps

assigning beginning MTAs a mentor they regularly meet with could have the same affect, or even just having experienced MTAs and faculty members go out of their way to check in with the beginning MTAs. The institution where this study took place has an MTA mentor program, which may have prompted participants to present this as a possible solution to challenges they have faced. This would be just as valuable in a non-formal context, where experienced MTAs and faculty reach out to the beginning MTAs since they may not know to ask for it or may think it is too much to ask. Beginning MTA, Terry, pointed out that he would have really appreciated having someone do this for him because he did not feel comfortable reaching out for help himself.

### **MTA-controlled Solutions**

The additional solutions discussed here are those found through the study but which are primarily within the control of the MTAs themselves and they include: maintaining an organized schedule, having a positive attitude while teaching, relating to students, and having online communication with students. It is our hope that those reading this thesis are either beginning MTAs who can try implementing these potential solutions or faculty members who can help guide the beginning MTAs to try these suggestions in their own teaching. These findings appear to be mostly new contributions because there was seldom mention of any of these solutions in the existing literature reviewed. The suggestion for beginning MTAs to have a positive attitude while teaching is the only solution that had been found in existing literature. As has been noted, what the students remember more than the content is the personality of the teacher (John, 1996), thus it is important for beginning MTAs to leave a positive impression on their students.

Balancing work life using organized schedules is discussed in the literature, however, the contexts are radically different from college teaching, thus this study opens an opportunity for researchers to look further into it. On the other hand, what was not seen in existing research findings was the suggestion for beginning MTAs to find ways to relate to students in order to increase interest in the content and communicate mathematics more effectively. Similarly, the suggestion for utilizing online methods of communication was not seen in current literature, perhaps because this is a fairly recent tool that is continuously advancing. These potential solutions are new contributions to the existing literature that we hope can be utilized to help current and future beginning MTAs.

### **Limitations**

This study had a few limitations that are worth taking note of. One of the limitations being that the study does not include student input, which would have been a valuable insight into the performance and challenges of beginning MTAs. Future study or others planning to do research in this area, should give this aspect consideration at the planning and design stages.

An additional limitation was the sample that participated in the study. All of the participants were domestic MTAs, only two were female, and almost all of them (70%) expressed a passion for teaching. If the study had included international MTAs the findings may have differed because international teachers often face challenges with the language as well, which was not the case for the domestic MTAs. The fact that the majority of the participants were male could have also skewed the results because perhaps female beginning MTAs have additional or simply different challenges. Finally,

the recruitment process for participation was in such a way that only MTAs who had an interest in teaching considered participating, which also may have limited the types of findings we got. Specifically, in regard to the challenge of balancing student and teacher responsibilities, many participants said they spent more time on teaching, which may not have been the case if the sample were different.

Although there were challenges that experienced and beginning MTAs clearly agreed upon having to overcome during their first two years of teaching, there were some that varied among the groups. This may have been due to the fact that the pedagogical training and support at this institution has evolved over the years, so the experienced MTAs did not have the same resources available to them during their first couple of years teaching as the current beginning MTAs have. If all components at this institution had stayed consistent over the past six years, then the findings among the two groups may have had more similarities.

Finally, the online survey had a limited sample size, with only 23 participants, which is relatively small for the collection of quantitative data. Additionally, there were no formal measures put in place to test the reliability of the survey itself. This was due in part to the fact that this particular study was mainly qualitative, as well as the time restraint placed on the investigators.

## CHAPTER SIX

### CONCLUSION

#### **Concluding Thoughts**

This study shows that beginning MTAs want additional support to help overcome challenges they face. The suggested solutions can be implemented at institutions with MTAs to attempt to help facilitate them in the difficult initial years transitioning to teaching college mathematics. Moreover, findings revealed that even experienced MTAs may benefit from having additional support models in place to guide them from the start to the end of their career as an MTA and set them up for long-term success in academia.

#### **Future Directions**

Due to the study's limited sample, possible future work includes conducting the same study with a focus on international beginning MTAs and/or female beginning MTAs. It would be interesting to compare the findings for the varying groups of beginning MTAs. Additionally, the experienced MTAs in this study brought up areas where they are still facing challenges, which shows there is perhaps a need to further investigate that group of MTAs as well. If this type of study is taken on with experienced MTAs, it can expand to include their struggles with preparing for the job market. A survey conducted by the College Board of Mathematical Sciences (CBMS) showed that while there was a steady increase in the number of students enrolled in introductory mathematics courses nationwide, there was a five percent decrease in the number of tenured and tenure-track mathematics faculty from 2005 to 2010 (Lutzer et al., 2007).

Another area that we did not incorporate in this study involved students' views of the teaching and quality of the beginning MTA they have as their discussion leader or primary instructor. Getting the students' perspectives could inform strengths or weaknesses that the beginning MTAs may not be completely aware of themselves, thus providing insight into additional challenges and/or solutions for beginning college math instruction. This could be accomplished through carefully designed surveys, perhaps aligned with traditional end-of-semester course evaluations.

The final suggestion for future work is to implement the suggested solutions in this thesis and report on the level of effectiveness each had in regard to addressing the associated challenges. This could be done by interviewing beginning MTAs at the start of their first semester to determine the initial challenges they believe they are facing, then proceed to introduce the suggested solutions, and follow up with an interview at the end of their first year. This would allow the researcher to gauge the beginning MTAs perceived level of improvement for each of their previously stated challenges and try to correlate it to which solution it was that helped address the issue.

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## APPENDIX A

### INTERVIEW PROTOCOL FOR BEGINNING MTAS

1. First, I would like to gather some background information.
  1. How old are you?
  2. Which classes have you taught as a discussion/recitation leader?
  3. Which classes have you taught as a lead instructor?
  4. Did you have any prior teaching experience before starting here?
2. Describe your overall teaching style and any strategies you use.
  1. Has this changed at all since starting out? If so, in what ways?  
(communicating with students, preparing for class, presentation of content)
  2. What does a typical lesson look like?
  3. How do you feel these teaching strategies make the classroom successful?
3. Describe a good/memorable teaching moment you had.
  1. When did this moment occur?
  2. Which class was this? How many students were there in the class? What was your rapport with them?
  3. What was the math topic being taught? Do you particularly like this topic?
  4. What was the teaching style you used during this event?
4. Describe a challenging/difficult teaching moment you had.
  1. When did this moment occur?
  2. Which class was this? How many students were there in the class? What was your rapport with them?
  3. What was the math topic being taught? Do you particularly like this topic?
  4. What was the teaching style you used during this event?
  5. How did you handle this?
  6. Which would you say was the most contributing factor to the challenge: the class, the topic, or your approach?
5. Have you had any formal teaching preparation?
  1. (Yes) What did it consist of?
    1. Do you think it helped? Why or why not?
  2. (No) Would you have liked to have some?
    1. What would it consist of?
    2. In what way would it have helped you?
6. Did you have anyone guiding you or mentoring you at certain points throughout your teaching journey?
  1. Did you feel comfortable reaching out to people for help if you needed it?
  2. If not, do you think this would have helped?

7. What are your favorite aspects of having coordinated courses in the department?  
Without necessarily thinking about any one coordinator in particular.
  1. What are your least favorite aspects? (Common syllabus, exams, grading, etc.)
  2. Overall, do you think you appreciate the coordination or would you prefer to have more freedom?

We will now move our conversation closer into specifics of your day-to-day teaching,

8. How do students contribute in your classroom?
  1. Are they quiet listeners?
  2. Do they ask questions?
  3. Do you prompt them with questions and they respond?
  4. Do they do group work together?
9. What would you do if you were in class and a student asked you a question you're unsure of the answer to?
  1. How do the students respond to this? Have they ever seemed frustrated you didn't have the answer?
  2. Does this situation make you uncomfortable?
10. Many undergraduate students have had bad experiences with mathematics in the past so they harbor negative feelings towards the subject. Does this impact the way you explain ideas to them?
  1. Do you enjoy explaining rigorous mathematical concepts to students? Why or why not? Do you think they appreciate learning these concepts?
  2. If a student confessed their negative feelings towards mathematics, what would your response be?
11. Have you ever felt you did not have your students' full attention?
  1. Why? (Technology, talking, sleeping, etc?)
  2. Have any of your students ever walked out of your classroom early?
  3. When did these instances occur? Which class were you teaching?
  4. How did these events make you feel? Did you do anything about it?
12. Were you ever assigned to teach a course where you were uncomfortable with some of the material?
  1. (Yes) What was the content specifically? What did you do? How did it play out?
  2. (No) How would you handle it if this were to happen sometime in the near future?
13. Have you ever caught one of your students cheating?
  1. (Yes) How did you handle it?
    1. Did you have someone you felt comfortable reporting the instance to? If so, what did they do with the information?
    2. Was the situation resolved?

2. (No) What if this did occur? How do you think you would handle it?
14. How do you divide your time between your teaching responsibilities and being a student?
  1. Is it an even 50-50 split? 60-40?
  2. Do you wish this were different? (You could spend more time on being a student and less on teaching? Or maybe more time on being a teacher?)
15. How much time on average do you spend preparing to teach?
  1. What about with grading?
  2. Has this changed since you've began?
    1. (Yes) In what way? Why do you think the change occurred?
    2. (No) Do you want it to change? In what ways? How do you think you can implement those changes?
16. Who do you feel closest to at the university?
  1. Fellow grad students, instructors?
  2. Why?
17. How often do you make time for doing things and seeing people that are not school related?
  1. How important is this for you?
  2. Do you feel that it is possible to re-organize your time/schedule to do this more often? If not, why?
18. What do you think is the most important component of graduate school that will help you get a career in the future?
  1. Teaching, research, learning? Why?
19. Do you feel your experiences are preparing you well for your future career?
  1. Why or why not? (Heavy teaching load, not enough teaching, not enough research, too much research, etc).
  2. If not, what could you do to change this?
20. How do you perceive your position at UConn?
  1. Do you see yourself more as a student or instructor?
21. What do you consider good teaching practices?
  1. What makes someone a good teacher?
  2. In what ways do you incorporate these practices in your own teaching?
22. Do you intend on continuing to pursue academia?
  1. Has this decision changed from your beginning teaching experiences?
  2. Do you picture yourself in a research focused institution or teaching oriented one?
23. Thinking back on what has been discussed, what would you identify as the most challenging aspects of beginning teaching?
24. Is there anything else you want to add that we didn't get a chance to talk about?

## APPENDIX B

### INTERVIEW PROTOCOL FOR EXPERIENCED MTAS

1. First, I would like to gather some background information.
  1. How old are you?
  2. Which classes have you taught as a discussion/recitation leader?
  3. Which classes have you taught as a lead instructor?
  4. Did you have any prior teaching experience before starting here?
2. Describe your overall teaching style or strategies you use.
  1. Has this changed at all since starting out? If so, in what ways?  
(communicating with students, preparing for class, presentation of content)
  2. What does a typical lesson look like?
  3. How do you feel these teaching strategies make the classroom successful?
3. Describe a good/memorable teaching moment you had within the past year.
  1. When did this moment occur?
  2. Which class was this? How many students were there in the class? What was your rapport with them?
  3. What was the math topic being taught? Do you particularly like this topic?
  4. What was the teaching style you used during this event?
4. Describe a challenging/difficult teaching moment you had within the past year.
  1. When did this moment occur?
  2. Which class was this? How many students were there in the class? What was your rapport with them?
  3. What was the math topic being taught? Do you particularly like this topic?
  4. What was the teaching style you used during this event?
  5. How did you handle this?
  6. Which would you say was the most contributing factor to the challenge: the class, the topic, or your approach?

The following questions pertain to your experiences in roughly your first two years of teaching.

5. Describe one of your first good/memorable teaching moments.
6. Describe one of your first difficult/challenging teaching moments.
7. Did you have any formal teaching preparation?
  1. (Yes) What did it consist of?
    1. Do you think it helped? Why or why not?
  2. (No) Would you have liked to have some?
    1. What would it consist of?
    2. In what way would it have helped you?

8. Did you have anyone guiding you or mentoring you at the beginning stages of your teaching career?
9. Were you ever assigned to teach a course where you were uncomfortable with some of the material?
  1. (Yes) What was the content specifically? What did you do? How did it play out?
  2. (No) How would you handle it if this were to happen sometime in the near future?
10. Did you ever catch one of your students cheating?
  1. (Yes) How did you handle it?
    1. Did you have someone you felt comfortable reporting the instance to? If so, what did they do with the information?
    2. Was the situation resolved?
  2. (No) What if this did occur? How do you think you would handle it?
11. How has your time management evolved to accommodate your teaching and student responsibilities?
12. How much time on average do you spend preparing to teach?
  1. Has this changed since you began?
    1. (Yes) In what way? Why do you think the change occurred?
    2. (No) Do you want it to change? In what ways? How do you think you can implement those changes?
13. What do you think the most important component of graduate school is that will help you get a career in the future?
  1. Teaching, research, learning? Why?
14. Do you feel your experiences here have prepared you well for your future career?
  1. Why or why not? (Heavy teaching load, not enough teaching, not enough research, too much research, etc).
  2. If not, what could you do to change this?
15. How do you perceive your position at UConn?
  1. Do you see yourself more as a student or instructor?
16. What do you consider good teaching practices?
  1. What makes someone a good teacher?
  2. In what ways do you incorporate these practices in your own teaching?
17. Do you intend on continuing to pursue academia?
  1. Has this decision changed from your beginning teaching experiences?
  2. Do you picture yourself in a research focused institution or teaching oriented one?
18. After interviewing beginning teachers, some common challenges they face are engaging students in the classroom, balancing their teaching and student

responsibilities, managing their time in class, lacking confidence in themselves, and being unclear of what to do in their role as a TA. Were any of these challenges for you?

1. (Yes) How did you deal with them?
  2. (No) What do you think you did to avoid these?
19. Do you have any other challenges you thought of that haven't already been mentioned that you'd like to add?
1. With respect to mathematics?
  2. With respect to the students?
  3. With respect to your teaching style (identity)?
20. What are some possible solutions to the challenges already stated and perhaps the new one(s) you offered? [Restate top 5 challenges if needed]
21. Let us now talk about some solutions to these challenges that have previously been provided by other participants. Solutions discussed so far are having MTAs observe professors and experienced TAs before starting out and throughout the semester, having beginning MTAs observed and given feedback, having them practice teaching in front of peers, and providing a more rigorous orientation/training program.
1. Do you agree or disagree with each of these?
  2. Why do you feel this way?
  3. Would you alter any of these solutions to better fit the given challenges discussed?
22. What other suggestions do you have for beginning teachers?
1. Do you want to add anything about the mathematics content and material?
  2. Interactions with the students?
  3. Their teaching style (identity)?
23. Is there anything else you want to add that we did not get a chance to talk about?

APPENDIX C

CODEBOOK FOR CHALLENGES

Code (category)	Description	Sample quote	Frequency
Attention (engaging students)	Keeping students focused and interested during class.	"...they would come, take the quiz, and then the rest of the class it would be obvious that they weren't paying attention." Pat 3	Number of different MTAs who mentioned it: 7  Number of times mentioned total: 14
Participation (engaging students)	Motivating students to actively participate in class.	"I just got really burnt out from everything. So I pretty much just got up there, talked, didn't ask them so many questions, and that was it." Terry 6	Number of different MTAs who mentioned it: 9  Number of times mentioned total: 18
Student versus teacher (balancing responsibilities)	Managing time between teaching and other graduate student responsibilities.	"I don't manage my time extremely well... There's just a bunch of things I need to do and I do them all at various times." Skylar 13	Number of different MTAs who mentioned it: 9  Number of times mentioned total: 14
Life outside of school (balancing responsibilities)	Dedicating time to experiences unrelated to school.	"It's hard to do that, but I try to go home when I can. Well I think certain days, especially like closer to the weekend, I'll try to not stay at school all day..." Ashton 13	Number of different MTAs who mentioned it: 7  Number of times mentioned total: 11
Confidence	Feeling confidence in themselves when first starting out teaching.	"Sometimes I would cry before I went to teach cause I was so nervous." Jamie 3	Number of different MTAs who mentioned it: 10  Number of times mentioned total: 25
Role as a TA	Understanding what the role and	"...when I started, I wasn't really sure	Number of different MTAs who mentioned

(in-class pedagogical challenges)	responsibilities are of a TA in the classroom.	what my class should look like... Like what I was supposed to be doing." Jamie 5	it: 6 Number of times mentioned total: 14
Managing class time (in-class pedagogical challenge)	Being able to efficiently use class time and get through the necessary content.	"This is something that you never want to happen, but the class ended in total confusion cause that happened in the last couple of minutes." Miranda 2	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 10
Lesson planning (outside of class pedagogical challenge)	Knowing how much to prepare for a lesson beforehand.	"...I had to prepare for Monday, and I was just like 'I don't want to' then that was kind of an option as a discussion leader cause then I'd just wing it and do a worksheet." Terry 11	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 14
Grading (outside of class pedagogical challenge)	Knowing how much feedback to give when grading and how to follow the rubric, within a reasonable amount of time.	"I took off a point if you didn't explicitly write that. Which now I realize was an unfair thing to do..." Greg 3	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 16
Coordinated content (coordinated courses)	Teaching required coordinated content.	"Just the way they cover it [delta epsilon limit definition] in class, it's just a one and done thing and they never come back to it." Pat 9	Number of different MTAs who mentioned it: 5 Number of times mentioned total: 6
Communication (coordinated courses)	Communication between TA and coordinators, instructors, and/or department.	"...for example, why we have multiple choice tests, which pedagogically I can't agree with but financially at least it makes sense." Greg 4	Number of different MTAs who mentioned it: 7 Number of times mentioned total: 10
Common tests	Issues that arise in a coordinated course	"...we've had almost every exam of the	Number of different MTAs who mentioned

(coordinated courses)	with common quizzes and exams.	semester, even the final exam, with typos on it, but that should not happen.” Ashton 6	it: 3 Number of times mentioned total: 4
Cheating (student incidents)	Handling cheating incidents.	“...it was just really difficult to know how to handle the situation because I wanted to, on one hand let them know that this was not okay, that it's cheating, it's academic dishonesty...” Adam 4	Number of different MTAs who mentioned it: 9 Number of times mentioned total: 15
Respect (student incidents)	Gaining and maintaining the respect of students.	“...a couple times it's happened where a student will take a quiz, it's 15 minutes, and they'll just decide to leave right after.” Pat 8	Number of different MTAs who mentioned it: 5 Number of times mentioned total: 7
Content knowledge	Teaching topics that are unfamiliar.	“I was mostly not helpful to the students in my TA sessions... I didn't do a very good job of understanding it [complex analysis course content].” Skylar 10	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 18
Authority versus rapport	Maintaining authority in the classroom while keeping a good relationship with students.	“I'm always worried about damaging relationships with students because then they're not going to learn.” Adam 4	Number of different MTAs who mentioned it: 9 Number of times mentioned total: 23
Concepts vs computations (communicating mathematics)	Helping students gain conceptual understanding rather than solely focusing on the computations.	“But when I just have a bunch of blank faces staring at me I'm kind of like, well who gives a shit anyway? You don't	Number of different MTAs who mentioned it: 5 Number of times mentioned total: 10

		need to know this.” Terry 7	
Diverse students  (communicating mathematics)	Communicating mathematics to students of varying math backgrounds.	“I had trouble because I had many students who were very very bored and basically falling asleep in class and kind of being grumpy with me because they felt like I was just explaining stuff they already knew, but I knew what I was saying was necessary for the other half of the class.” Mac 3	Number of different MTAs who mentioned it: 5  Number of times mentioned total: 9
Sympathy	Understanding students’ struggles and frustrations.	“I really try to fight for my students and I try to give them the best product, based on what I’m given.” Greg 4	Number of different MTAs who mentioned it: 6  Number of times mentioned total: 13

APPENDIX D

CODEBOOK FOR SOLUTIONS

Code	Description	Sample quote	Frequency
Observations	Watching experienced MTAs and professors teach their classes.	"I would almost like to see a couple model lessons, like you pretend you're the first year students and someone goes and presents a lesson..." Jamie 5	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 10
Demonstrations	Watching model classes in a practice setting, with only other TAs and faculty.	"I would like to see something like that, you know, just sort of a mock presentation of how a class would run or something like that." Pat 4	Number of different MTAs who mentioned it: 2 Number of times mentioned total: 3
Schedule	Making a schedule to help manage time and stay organized.	"...be more intentional about which things I'm doing on which day." Skylar 15	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 11
Pedagogical training	Formal training for the logistics of teaching (handling student incidents, organizing boardwork, etc.)	"So I think getting some instruction on how to do other things, kind of things that you could do outside of the box as an instructor, I think that would be very useful." Terry 4	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 13
Feedback	Getting feedback from students, peers, and/or faculty members on one's own teaching	"My board work was not as organized as I thought it was. When I had people observe it, I was able to get better feedback about it." Ashton 4	Number of different MTAs who mentioned it: 5 Number of times mentioned total: 8
Positive attitude	Maintaining good energy in the	"Being more than moderately	Number of different MTAs who mentioned

	classroom and being excited about the material.	enthusiastic with the class, if you don't care they're not going to care." Miranda 17	it: 8 Number of times mentioned total: 11
Relating to students	Relating self or the math content to the students.	"...try to show them why it might be useful, especially if they're an engineering or physics major. Like look it's going to be part of your academics going forward." Pat 8	Number of different MTAs who mentioned it: 9 Number of times mentioned total: 20
Support	Receiving teaching advice from peers, experienced TAs, and professors.	"Everyone's just really supportive and they always have good advice, like if I don't do well on something, there's always someone there that's like "it's going to be okay and you're not going to get punished for not doing well" or something." Miranda 15	Number of different MTAs who mentioned it: 7 Number of times mentioned total: 17
Coordinated courses	Common exams, quizzes, and homeworks throughout all sections, which are created by the coordinator.	"It helps when someone's just setting up the classroom, instead of me having to do everything on my own." Pat 5	Number of different MTAs who mentioned it: 8 Number of times mentioned total: 14
Online	Using online platforms to connect with students outside of class.	"I ended up writing out the entire problem and the concepts behind it and why we choose this function and emailing that to them that night." Miranda 2	Number of different MTAs who mentioned it: 5 Number of times mentioned total: 7

## APPENDIX E

### SURVEY QUESTIONS

Please select your gender.

- Male
- Female
- Prefer not to disclose

Please indicate your age range.

- 20-24
- 25-29
- 30+
- Prefer not to disclose

Please indicate the total number of semesters you have been a **discussion leader** of a math course at any institution.

- 0
- 1-3
- 4-7
- 8+

Please indicate the courses taught at any institution as a **discussion leader** by checking all that apply.

- College Algebra
- Discrete Math
- Pre-Calculus
- Online Business Math
- Business Calculus
- Calculus I
- Online Calculus I
- Calculus II
- Online Calculus II
- Calculus III (multi-variable)
- Linear Algebra
- Differential Equations
- Other (separate with commas)

Please indicate the total number of semesters you have been the main **instructor** of a math course at any institution.

- 0
- 1-3
- 4-7
- 8+

Please indicate the courses taught at any institution as the main **instructor** by checking all that apply.

- College Algebra
- Discrete Math
- Problem Solving

- Pre-Calculus
- Business Calculus
- Calculus I
- Calculus II
- Calculus III (multi-variable)
- Linear Algebra
- Differential Equations
- Other (separate with commas)

Please rate your level of **agreement** with each of the next few statements and then the level of **importance** it holds for you in order to perform your TA duties to the best of your ability. For experienced TAs, please respond as you would have when you were in your *first two years* of teaching.

As a discussion leader, it's unclear what I should be doing in class.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to make sure you know what to do in the classroom as a discussion leader?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I am often unsure of how to keep my students engaged during lessons.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to keep your students engaged during lessons?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I am often unsure of how to deal with incidents in the classroom, such as cheating or class disruptions.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to know what to do in the case of incidents in the classroom?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often have a hard time maintaining authority in the classroom.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to maintain authority in the classroom?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often find I'm unable to stay on track with my planned lessons each class period.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree
- Not applicable

How important is it to you to get through all of your planned lessons each class period?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often find it difficult to communicate basic mathematical concepts/procedures to undergraduate students.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to be able to effectively communicate basic mathematics to undergraduate students?

- Extremely important
- Very important

- Moderately important
- Slightly important
- Not at all important

I feel that most undergraduate students do not want to hear about the theory behind the math being taught.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to discuss the theory behind math topics with undergraduate students?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often find it difficult to meaningfully teach topics that appear to be disconnected from the rest of the course curriculum.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to be able to create meaning to topics that appear to be disconnected from the rest of the curriculum?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often struggle when teaching topics that I have not encountered before or have not seen in a while.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to adequately prepare in order to be able to teach topics that you haven't encountered before or haven't seen in a while?

- Extremely important
- Very important
- Moderately important
- Slightly important

- Not at all important

I have a hard time relating to the struggles my students face with learning introductory level mathematics.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to relate to your students struggles with learning math?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often find it difficult to know how much feedback to provide students on their graded assignments.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to provide sufficient feedback to students on graded assignments?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I want to be a well-liked person by all of my students.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to be well-liked by all of your students?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I struggle to reach a sufficient level of confidence in myself as an educator.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How important is it to you to be sufficiently confident in yourself as an educator?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often feel that my suggestions for changes in course material, policies, and/or exams are not taken into consideration.

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree
- Not applicable

How important is it to you that your suggestions for changes are taken into consideration?

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important

I often struggle to balance my teaching load with other academic duties (research, homework, studying, etc).

- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

How much improvement have you noticed you've made towards finding the right balance with respect to your teaching load and other academic duties from the start of your TA experience to now? (Experienced TAs, for this question, answer according to your *current level of experience*, not as though you're in your first two years.)

- Extreme improvement
- Significant improvement
- Moderate improvement
- Slight improvement
- No noticeable improvement

Please rank each of the following items in order (from 1 to 15) of what is most **challenging** for you in your first two years of teaching, where 1 represents the most challenging and 15 the least challenging. If you truly believe that multiple items are equally as challenging, you may use the same number for them. If an item has not been a challenge for you, please enter 0.

- Having confidence in yourself as an educator.
- Keeping students engaged.
- Communicating basic math concepts/procedures.
- Managing your time in class.
- Being well-liked by students.
- Having your suggestions taken into consideration.
- Maintaining authority in the classroom.
- Knowing how to handle incidents in the classroom.
- Understanding your role as a discussion leader.
- Explaining the theory behind math topics.
- Creating meaning to topics that are disconnected from curriculum.
- Teaching unfamiliar topics well.
- Relating to students' struggles.
- Providing sufficient feedback on graded assignments.
- Balancing teaching duties with other responsibilities.

Please rank each of the following items in order (from 1 to 15) of the level of **importance** it holds for you to perform your TA duties to the best of your ability, where 1 represents the most important and 15 the least important. If you truly believe that multiple items are equally as important, you may use the same number for them. If an item is not important to you, please enter 0.

- Having confidence in yourself as an educator.
- Keeping students engaged.
- Communicating basic math concepts/procedures.
- Managing your time in class.
- Being well-liked by students.
- Having your suggestions taken into consideration.
- Maintaining authority in the classroom.
- Knowing how to handle incidents in the classroom.
- Understanding your role as a discussion leader.
- Explaining the theory behind math topics.
- Creating meaning to topics that are disconnected from curriculum.
- Teaching unfamiliar topics well.
- Relating to students' struggles.
- Providing sufficient feedback on graded assignments.
- Balancing teaching duties with other responsibilities.

Is there another challenge that you faced in your first two years of teaching that was not addressed in the previous questions? If so, please explain.

Is there a solution you have in mind for addressing the new challenge you added? If so, please explain.

The following statements have to do with possible solutions to alleviate the challenges of beginning teaching. Please indicate the level of **helpfulness** that you think each would have had (or that it did have) **to you personally** when you first began as a TA.

Observing classes of experienced TAs.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Being exposed to examples of different approaches to effectively run the classroom as a discussion leader.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Having teacher training throughout your entire first year as a TA.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Getting feedback on your own teaching through peer observations.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Getting feedback on your own teaching from experienced TAs/professors who observe your class.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Making a schedule for yourself to know what days/times to work on teaching duties versus other responsibilities.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful

- Not helpful at all

Having coordinated courses to alleviate your workload.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Having a peer social group to be able to discuss all things teaching related.

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Asking experienced TAs/professors for advice when needed (e.g. classroom issues, teaching strategies, etc.)

- Extremely helpful
- Very helpful
- Moderately helpful
- Slightly helpful
- Not helpful at all

Please check off all items that you **experienced** in your first two years of teaching.

- Observing experienced TAs.
- Getting peer feedback on teaching.
- Getting feedback from experienced TAs/professors.
- Making a schedule to balance all responsibilities.
- Having coordinated courses.
- Having a peer social group to discuss teaching.
- Being exposed to different approaches to teaching as a discussion leader.
- Having teacher training in first year.
- Asking for advice from experienced TAs/professors.

Please check off all items that you **would have liked** to have experienced (or experienced more of) in your first two years of teaching to help you perform your TA duties.

- Observing experienced TAs.
- Getting peer feedback on teaching.
- Getting feedback from experienced TAs/professors.
- Making a schedule to balance all responsibilities.
- Having coordinated courses.
- Having a peer social group to discuss teaching.
- Being exposed to different approaches to teaching as a discussion leader.
- Having teacher training in first year.
- Asking for advice from experienced TAs/professors.

Please rank each of the following items in order (from 1 to 9) of the level of **importance** it would have held (or did hold) in helping you perform your TA duties to the best of your ability, where 1 represents the most important and 9 the least important. If you truly believe that multiple items are equally as important, you may use the same number for them. If an item would not have held any importance to you, please enter 0.

- Observing experienced TAs.
- Getting peer feedback on teaching.
- Getting feedback from experienced TAs/professors.
- Making a schedule to balance all responsibilities.
- Having coordinated courses.
- Having a peer social group to discuss teaching.
- Being exposed to different approaches to teaching as a discussion leader.
- Having teacher training in first year.
- Asking for advice from experienced TAs/professors.