Setting and Sustaining Intentions: Two Stories of MGTAs' Growth as Instructors

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Mathematics graduate teaching assistants (MGTAs) often teach or support undergraduate courses and can have a significant impact on learners' experiences in mathematics. However, professional development (PD) programs rarely provide MGTAs with supportive, extended opportunities to learn about, enact, reflect on, and grow in evidence-based teaching practices. We designed a multi-year PD program for MGTAs focused on engaging students in mathematics and enacting equity-focused practices. We analyzed multiple sources of data to investigate shifts in MGTAs' teaching practices using principles of the PD. Applying the Theory of Planned Behavior, we describe the growth of two participating MGTAs. Both participants set and sustained intentions, modified their behaviors to align with their intentions to support engaging group work and empower women, respectively, and experienced positive shifts in their attitude and perceived behavioral control. Key implications include the importance of opportunities for MGTAs to reflect on their intentions and teaching practices in long-term PD.

Keywords: mathematics graduate teaching assistants, equity, active learning, teaching practices, theory of planned behavior

Mathematics departments in the United States rely heavily on mathematics graduate students (also known as mathematics graduate teaching assistants or MGTAs) to teach or to support large lecture-based courses such as Pre-Calculus and Calculus. MGTAs might lead problem-solving sessions associated with lecture courses or be assigned to teach a course as the lead instructor. In some doctorate-granting institutions, MGTAs teach up to 68% of Calculus I courses (Selinski & Milbourne, 2015). Yet, MGTAs rarely receive substantive preparation for teaching mathematics (Deshler et al., 2015; Ellis, 2014; Speer et al., 2017). Professional Development (PD) programs that exist do not typically extend beyond the MGTAs' first year in graduate school (Bookman & Braley, 2022; Deshler et al., 2015; Ellis, 2014; Harris et al., 2009; Kung & Speer, 2009). Preparation for a broad scope of evidence-based teaching practices (e.g., active learning, supporting student engagement in mathematical practices, facilitating collaboration) is crucial as many MGTAs represent future faculty and play an important role in teaching practices at post-secondary institutions (Ellis, 2014; Golbeck et al., 2016; Speer et al., 2017).

The proliferation of PD programs for MGTAs, although slow-going over the past fifty years, has more recently gained speed, as researchers have begun focusing on MGTAs' development as teachers (e.g., Beisiegel et al., 2019; Belnap, 2005; Speer, 2001). In a study of mathematics graduate programs in the U.S., Braley et al. (2023) observed that a greater number of graduate programs now offer some form of PD, such as an orientation to the department and teaching duties (79%) and/or a term-long teaching seminar (75%) as well as occasional workshops (73%). As the field has turned its attention to issues of equity (Brown, 2018), we see a similar focus in PD programs for MGTAs, with 65% of programs now offering some PD about equity (Braley et al., 2023, p. 1046). However, little is known about the equity-focused content in these programs.

Engaging in equitable mathematics teaching practices means accounting for students' identities in the classroom (Gutiérrez, 2009). For instance, a wealth of research demonstrates that active learning teaching practices do not inherently support female students in collegiate mathematics courses (Johnson, 2024). Rather, equitable instructors offer deliberate opportunities

for women to explain and justify their mathematics solutions uninterrupted (Johnson, 2024). While some PD has supported MGTAs in increasing their use of equity-focused teaching practices (Coles & Piccolo, 2025; Pilgrim et al., 2025) few studies have investigated MGTAs' general understanding of teaching practices (Beisiegel, 2017; Miller et al., 2018; Speer, 2001; Speer et al., 2010) and, more specifically, how PD programs can help MGTAs learn about and enact teaching practices that contribute to improved student outcomes.

Theoretical Framework: Theory of Planned Behavior

Despite MGTAs' impact on learners, only a handful of studies have investigated their understanding of and growth in teaching practices. As one example, Miller (2018) conducted a case study of experienced MGTAs, most of whom had experienced a year-long PD program focused on active learning and were teaching a Pre-Calculus course for the third time. While the MGTAs were provided lesson guides that emphasized active learning, Miller found that they often reverted back to lecturing when students were not engaging in group work. Another example (Beisiegel et al., 2019) investigated MGTAs' growth in their knowledge of teaching over the course of five years. They found that novice MGTAs were often unable to consider teaching practices that support active engaged learning as they needed time to adjust to routines of teaching (e.g., lesson planning) before adopting practices they had not yet experienced.

Our research investigates MGTA growth through the lens of Theory of Planned Behavior (Ajzen, 1991), which focuses on *behavioral intention*, *attitude toward the behavior*, *subjective norms*, and *perceived behavioral control* (see Fig. 1). In the context of the PD program, *behaviors* refer to the teaching practices that MGTAs use in the classroom and *intention* is an MGTA's plan to use certain teaching practices. While intention directly impacts resulting behavior, an MGTA's perception of their ability to employ teaching practices influences their pedagogical choices (i.e., their perceived behavioral control).

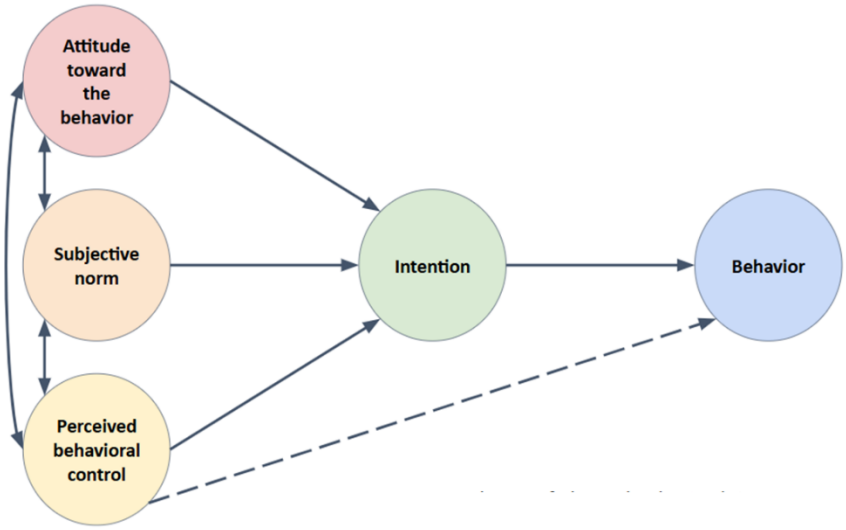

Figure 1. Theory of Planned Behavior (Ajzen, 1991, p. 182)

We implemented a PD program to support MGTAs in engaging students and enacting equity-centered teaching practices. In this report, we focus on two participants because of their commitment to setting and sustaining intentions in terms of active learning and equity. Our research question is: What change in behaviors, attitudes, and perceived behavioral control do MGTAs who set and sustain intentions in teaching experience during a two-year PD program?

Context of the Study and Methods

ELITE PD consists of five elements. In the first year of the graduate program, ELITE PD offers a three-day fall orientation as new MGTAs arrive at the university (topics include: the department and MGTAs' roles, community building with their peers, develop introductory knowledge of teaching practices focused on active group learning and dynamics) and a fall graduate teaching seminar (GTS) that is focused on their first term as an MGTA (topics include: more information about the department, the university's teaching support resources, classroom management, and how to implement small-scale instructional practices with attention to equity and active learning). The second year of the ELITE PD program offers a fall-term seminar Introduction to Active Learning and Equity (IALE; MGTAs build upon their understanding of and facility with active learning and equitable teaching practices) and a winter-term seminar Advanced Active Learning and Equity (AALE; MGTAs engage with specific research-based pedagogical approaches as well as equity research associated with teaching). We expect MGTAs to complete these seminars in the second year of their graduate programs, but some choose to focus on passing qualifying exams before taking IALE and AALE. The fifth element of ELITE PD has the MGTAs who have completed the first four elements become teaching mentors to new MGTAs. During each year of the ELITE PD program, we interview participants twice (fall and spring), video record them teaching three times (exceptions to this are when the MGTA is on a research fellowship or has an assignment as a grader for a course), and also survey their students. In IALE, the MGTAs complete journal reflections that are also used to understand their growth.

We explore the growth of two participants, Ayla (pseudonym), in incorporating group work practices, and Athena (pseudonym) in empowering women in the classroom. We chose to report on Ayla's growth because of her choice to repeatedly reflect on a salient struggle with engaging students in group work, as well as perseverance in their efforts to modify their teaching practices. We chose to report on Athena's growth because of her awakened intention to empower women and their notable shifts in teaching practices to realize this intention.

For Ayla, we analyzed five classroom observations (O2-6) and post-observation debriefs (D2-6), two interviews (I1-2), five reflection journals (R1-5), and an exit ticket from the IALE (ET). Note that each of O2-6 and D2-6 occurred once per term from winter of their first year in ELITE PD to spring of their second year, I1 occurred during GTS, R1-5 and ET occurred during IALE, and I2 occurred during the AALE. For Athena, we analyzed three classroom observations (O1-3) and post-observation debriefs (D1-3), and two interviews (I1-2). Note that each of O1-3 and D1-3 occurred once per term from fall of their first year in ELITE PD to spring of their first year. I1 occurred during IALE and I2 occurred at the end of the spring term. We analyzed these data by identifying each MGTA's intentions, and then identifying the components of the Theory of Planned Behavior relevant to their intentions.

Findings: Ayla's Growth in Supporting Group Work

In the first year of ELITE PD, Ayla's teaching practices centered on answering the questions of students with raised hands, without specifically instructing students on how to work on mathematics, e.g., in groups, pairs, or individually (O2, O3). Primarily, Ayla's intention for teaching was to "just let them work and then answer their questions when they pop up" (D3). However, Ayla's intentions for students to collaborate and talk with each other also started to percolate in her first year. She stated that her plans were "to try to make sure every student feels heard…and then try to encourage them to ask their group mates, if possible" (D2).

During IALE, Ayla's desire for students to work in groups increased; she wanted to "inspire collaboration" (R4) and get them "talking and participating" (R5) but she faced too many

challenges to change her practices the ways she wanted. First, Ayla expressed that "forcing students to work in groups feels uncomfortable" (R1). Second, Ayla felt pressure to avoid asking students to work in groups because of perceived resistance to changing norms mid-term: "I have already set the norm [to not do group work], so I am not sure how the students will react to it" (R1). Third, Ayla indicated a perceived lack of behavioral control, stating that it's "hard to get them to work in groups" (D4). At the same time, Ayla managed to make incremental progress towards her goal by asking every pair or group of students to check each other's answers (O4).

By AALE, and in the subsequent term, Ayla had experienced shifts in attitude, subjective norms, perceived behavioral control, and she began to incorporate co-constructing and revisiting group work norms (O5, O6). Ayla felt "empowered to try new things with students" (Fall ET), believed that she encouraged students to get "into groups pretty easily" and have "lots of conversations" (D6), and exuded confidence in describing her new teaching practice:

> My favorite one was the norms… like, 'these are the norms' and 'are there any other norms that you as students wanna add?'...it is one of the big reasons why I went from having almost no group work in the last term to really great and productive group work this term. (I2)

Table 1 shows an overview of Ayla's shifts towards supporting group work throughout years one and two of ELITE PD, which she ultimately credited for much of her growth:

> I've taken a lot of things from our seminar and tried to incorporate them into my classes…at the beginning of the term, I did group work norms, and I did it in the first class…and then I did it again when we came back from the snow day. Because I was like, 'I wanna remind everyone of the norms that we agreed on.' And I really think that helped develop equitable work and group activities. Because part of my norms were 'no one's done until everyone's done', making sure people don't get left behind...there's no dumb questions…And I think just doing that at the beginning of the term, really helped develop my, like, facilitating the group work that's been going on in my class. (D5)

Table 1. Ayla's Growth in Supporting Group Work

	Year 1 of ELITE PD			Year 2 of ELITE PD		
	GTS			IALE	ALE	
	Fall	Winter	Spring	Fall	Winter	Spring
Attitude				Uncomfortable with forcing group work (R1)	Empowered to try new things (Fall ET)	Frustrated but confident (O6)
Subjective Norm	Students may resist group work given that no group work norms have been established (R1)				Students easily work in groups when norms are set (D6)	
Perceived Behavioral Control				Hard to get students to work in groups (D4)	Confident in supporting productive group work (I2)	
Intention	Wants students to collaborate and talk with each other					
Behavior		Not promoting group work (O2, O3)		Asks students to check other's answers (O4)	Co-constructs and revisits group work norms (O5, O6)	

Findings: Athena's Growth in Empowering Women

After the first interview with Athena, it was clear that she was sharply aware and growing in awareness of gender (in)equity. When asked how she first learned about gender equity, she immediately responded that she learned about it "because I'm female, and the science field is dominated by men" and reflected on how her unique background and experiences moving to the U.S. for graduate school made her realize that women deserve more:

> I come from [Anonymized Country], so the women just have less, you know. So there's… not too many expectations. Not until I came to the US, and I'm like, 'Okay, equity is something to think about.'…it has become important to me, especially as I go through a lot of stress right now in my PhD…it wouldn't be fair to, um, just not get the same treatment a man would get, or the same recognition… (I1)

Athena's lived experiences seemed to motivate her awakened intention to empower women in mathematics. However, her shift to enacting behaviors in alignment with her intention was not immediate. Rather, her shift followed deliberate reflection on her teaching. When asked what she learned about her teaching from the first observation, she said, "I really approach this teaching thing in a very different way, in a wrong way…I don't even go to learn. I go to do my work and just, just get home….I'm not focusing on learning…that's not great" (D1).

Although Athena may not have focused on learning from her teaching that day, she reflected on her teaching during the post-observation debrief interview. When asked about unforeseen challenges with regard to equity and inclusivity, Athena's reflection included perceived behavioral control related to opportunities for women to present on mathematics:

> One of the group's that's only girls…they're like, 'Oh, is it okay to present something like that?'...I think they had the harder problem…I was very like, 'Okay, I get it. It's a hard problem. I'll do it on the board for everybody'…I did not have a problem with it, because they were just unlucky that day. (D1)

Athena's reflection appeared to prompt changes in her teaching practices, because in the next two terms Athena adjusted the ways she enacted group work to provide more opportunities for women to present mathematics. In the fall, Athena had permitted groups to self-select individuals to go up to the board and present solutions, which did not guarantee that women would present solutions (O1). But in the winter, Athena specifically encouraged women to talk about mathematics with the whole class listening (O2). For instance, during the second observation, Athena persisted in encouraging a woman to answer a question despite this student's shyness and lack of confidence, and despite seeing another raised hand from a man sitting in the front of the classroom (who would later present his work at the board):

> *Athena*: How are we doing on 1C? Did we get an answer? Um, does anyone have the answer for 1C, or…? [Athena nods head and looks with a smile to a woman near the back] What's your answer? [Student laughs a bit nervously] It could be right, you know? [Student(s) mumbling] Huh?
>
> *Student (woman)*: We did it but we're not feeling, like, confident.
>
> *Athena*: [Man near front raises hand, and Athena looks his direction, then looks back to woman, raises eyebrows in earnest, and gently waves her hand downwards towards the man, which prompts him to lower his hand. Athena continues to make eye contact with the woman.] One sec… What answer did you get?

Athena additionally offered opportunities for women to present mathematics at the board. She later reflected on this choice, revoicing her intention: "the girls should also get involved…not

just the guys" (D2), and expressing a happy attitude as she excitedly relived the moment when one of the women got an answer right:

> The guys were coming to the board to share their answers, and I just offered a girl, and she got the right answer. But she was so shy, you know…I gave her the morale and the motivation she needed to go to the board. Because she got it right, you know?…the worst part was that she got it first before the guys…they're not shy, you know…Yes, I felt good about it and she did feel good. I noticed she was happy. I looked at her, you know, because she felt like, I don't know why. I just felt she was happy, and I liked it. (D2)

By the spring term, Athena had modified presentation norms so that the individual(s) presenting within a group would rotate from one class to the next (D3). By making these changes, Athena ensured that women in groups of men would also have the chance to present their work, and furthermore, that every student would have a chance to talk about mathematics. Additionally, Athena continued to verbally encourage women presenters. For instance, Athena encouraged two women to discuss their solution at the board, saying, "you can teach us" (O3).

During the third debrief, when asked what went well in terms of equity, Athena first described how she ensured that everyone would get a chance to present and how she scaffolded solutions with some women to prepare them to present their work. She said, "if I did not do that they might have not been able to present their work on the board, and they might have just been left out" (D3). The interviewer then asked a follow-up question, saying, "I remember from the last time I did a debrief interview with you, you mentioned having the girls and women in your class feel really included. Do you have thoughts on how that's going this term?" (D3). In response, Athena again articulated her intention to provide opportunities for women and expressed confidence in doing so:

> I pretty much have learned how to navigate that…it's no longer a problem for me. I just treat everyone equally. I also make the ladies present their work, even if they are in, like, a group of men, for example. Like, it's okay if you, if there are, like, four guys and two girls. It's not okay for just the guys to present. The girls can also present the answer. You know what I mean? Like, on the board, not just the guys (D3).

Along with Athena's shifts in behaviors and perceived behavioral control, Athena's attitude towards teaching more generally shifted in positive directions over the course of the year. By the third debrief interview, Athena described enjoying and looking forward to teaching, saying she was "beginning to enjoy the process," "meeting my students makes me happy," and "I fell in love with a pattern I've been using, and that's been working" (D3). Similar to Ayla, Athena credits ELITE PD for her growth in enacting equitable teaching practices:

> Before I joined ELITE PD program, I was not very aware of inclusivity and equity, like, I just designed, I just did my job, you know what I mean? I just showed up to class to do my job, irrespective of how the student felt, or, like, I did not think about 'Oh, I should think about my students' feelings, or who they are.' You know what I mean, I just did my job. But having been part of ELITE PD, I'm able to understand that every student is different, and so are their needs. (I2)

Table 2 shows an overview of Athena's growth in empowering women in her classroom in year one of ELITE PD.

Table 2. Athena's Growth in Empowering Women

Year 1 of ELITE PD			
	IALE	AALE	
	Fall	Winter	Spring
Attitude	Tired after teaching, generally (D1, D3)	Likes to see shy women happy they are right (D2)	Excited for teaching and students, generally (D3)
Subjective Norm		Men always raise hands or present solutions at the board (D2, D3, I2)	
Perceived Behavioral Control	Challenging to support women in presenting difficult solutions (D1)		Confident in supporting women to present solutions (D3)
Intention	Empowering women in mathematics		
Behavior	Groups self-select student presenters (O1, D1)	Chooses women to talk and present when raising hands (O2, D2)	Rotating who presents within groups (D3) Preparing women to present (O3, D3)

Discussion

The Theory of Planned Behavior (Ajzen, 1991) helped us to observe shifts in MGTAs' attitudes, thoughts, intentions, and behaviors. Regularly interviewing and inquiring into each MGTA's experiences provided us with opportunities to follow their narrative threads–the major changes in various components of the theoretical framework, and the reflections and classroom experiences that instigated those changes. Ayla's attitude of discomfort with group work shifted, as she maintained her belief in its benefits for students, and persevered in her intention to enact, and ultimate enactment of, engaging group work strategies. Further shifts of her perceptions of students' perceptions of group work (subjective norms), as well as increased confidence (perceived behavioral control), influenced Ayla to grow in enacting group work strategies in subsequent courses. In contrast, Athena began her year in the program with a strong desire to empower women, which was sparked in terms of her intentions for teaching in the fall. Having set her intentions on empowering women by providing them with opportunities to talk about mathematics, Athena enacted new teaching practices in the winter and sustained her intention with further modification to her behaviors in the spring. Together, Ayla and Athena's stories of growth suggest implications for the potential benefits of reflection and extended PD.

The lessons we learned from analyzing Ayla and Athena's experiences and observing their growth have implications for other PD providers. In particular, regular observations and post-observation debriefs have the potential to sustain MGTAs' attention to their teaching. In addition, we find it noteworthy that reflection journals in IALE and observation debriefs provided opportunities for MGTAs to consider their values and intentions for teaching and whether or not their teaching practices are in alignment with those intentions. Specifically, reflection on challenges and successes with teaching supported both Ayla and Athena to consider ways to develop engaging and equitable teaching practices. This finding aligns with other research on the benefits of deliberate reflection for MGTAs and instructors of mathematics, more generally (e.g., Quaisley, 2024; Rogers, 2014). Future analyses will investigate patterns of growth across additional participants.

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