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Research Reports (A-K)

Editors:

Mellony Graven, Hamsa Venkat, Anthony A Essien and
Pamela Vale

**Proceedings of the 43rd Conference of the International Group
for the Psychology of Mathematics Education**

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RESEARCH REPORTS (A – K)

TEACHER INTERRUPTED: HOW MATHEMATICS GRADUATE TEACHING ASSISTANTS (DON'T) LEARN ABOUT TEACHING

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Despite their impact on undergraduate learners, few studies have investigated mathematics graduate teaching assistants' (MGTAs) needs for professional development as they learn about teaching. In this study, we surveyed and interviewed MGTAs longitudinally as they progressed through their graduate programs. With surveys and interviews, we aimed to capture changes in MGTAs' views of mathematics and teaching, whether they felt that they received adequate support, and what other support they feel they needed to grow as teachers. Using two phases of thematic analysis, we found several issues that interrupted MGTAs' progress as teachers.

INTRODUCTION

Researchers have shown that mathematics teaching in post-secondary contexts has a considerable impact on learners. In particular, lecture-based teaching frequently results in lower success rates in mathematics courses and lower retention in Science, Technology, Engineering, and Mathematics (STEM) degree programs. In comparison, active learning experiences contribute to better student outcomes, such as pass rates, higher retention, and improved self-efficacy (Chen, 2013; Flick, Sadri, Morrell, Wainwright, & Schepige, 2009; Freeman et al., 2014; Laursen, Hassi, Kogan, & Weston, 2014; 2012; Saxe & Braddy, 2015). Despite this research base, mathematics graduate teaching assistants (MGTAs), who generally represent future instructors and professors of mathematics, are not provided with substantive professional development experiences that would teach them how to engage learners in active mathematical learning experiences. As a result, MGTAs' teaching remains rooted in lectures and undergraduate students in STEM disciplines do not experience the proven benefits of evidence-based teaching practices (e.g., Miller et al., 2018; Stains et al., 2018).

MGTAs, who often find work as faculty members in mathematics departments, exert a significant impact on undergraduate learners' trajectories in STEM fields (Belnap & Allred, 2009; Ellis, 2014), and can negatively impact students' enrolment and choice of major in STEM fields (Bettinger & Long, 2004). Yet, experts in MGTA professional development have not reached consensus on the breadth and scope of programs that prepare MGTAs to teach. Professional development programs that aim to teach MGTAs about teaching vary significantly across institutions, both in the approach to teaching and the amount of time spent. In addition, few programs extend beyond MGTAs' first year in graduate school (Deshler, Hauk, & Speer, 2015; Ellis, 2014; Harris, Froman, & Surles, 2009; Kung & Speer, 2009; McGivney-Burrelle, DeFranco, Vinsonhaler, & Santucci, 2001).

Miller and colleagues (2018) completed a review of the literature of professional development for MGTAs so that they could characterize the types of research conducted regarding MGTAs' growth as teachers. They identified 26 peer-reviewed articles published since 2005 that investigate MGTAs' teaching development, only 17 of which attend to growth. Thus, the authors concluded that "GTAs' growth as teachers is a largely unexamined practice" (Miller et al., 2018, p. 2) and suggest that this area of study would benefit from longitudinal studies that make explicit a model of growth.

With this in mind, the purpose of this study is to investigate MGTAs' development as teachers, what and how they learn about teaching, and changes in their thinking about teaching and learning longitudinally as they progress through their degree programs. The research questions that guide this study are: (1) What are the developmental stages for teaching that MGTAs go through over the course of their graduate programs? (2) What features of their graduate school and teaching experiences support or hinder their learning about teaching and their development as teachers?

THEORETICAL FRAMEWORK

Because research has not yet addressed MGTAs growth as teachers, we looked to the K-12 literature, where researchers have studied schoolteachers' experiences in order to gain an understanding of teachers' growth over time. Katz (1972) described four developmental stages, which include: (1) *survival* of the first year of teaching, with particular focus on classroom management and the routines of classrooms and schools; (2) *consolidation*, in which teachers begin to understand which skills they have mastered, and what tasks they still need to master; (3) a period of *renewal*, when teachers become tired of their routines and start to think of how things might happen differently; and (4) reaching *maturity*, where teachers think more broadly about the contexts of schools and students' learning (p. 52-53).

CONTEXT AND METHODS OF THE STUDY

At the beginning of the academic years in 2015-2018, participants were recruited from the mathematics department at a large, doctorate-granting institution. Approximately 5,000 undergraduate students enrol in courses such as Pre-calculus, Differential, Integral or Vector Calculus, Business Calculus, or Differential Equations each year. Most of these courses are structured as three hours of lecture with 150-250 students per class and are taught by an instructor. MGTAs are generally assigned to run recitations (60-80 minute workshops each week) of smaller groups of students from the large lecture sections. MGTAs are not assigned to courses based on knowledge, skill, or experience; their assignments to courses mostly depend upon scheduling.

When new MGTAs first arrive to this graduate program in mathematics, they receive 2 ½ days of professional development for their teaching assignment, with a primary focus on how to support active learning and student engagement in mathematics during recitations. In the first term of their graduate program, they attend a seminar for one hour each week that addresses teaching-related concerns such as grading papers, student conduct issues, and lesson planning. In the summer after their first year, they

have the opportunity to teach their own course, then they return to the main MGTA duty of leading recitations. Only informal mentoring happens before and during the summer sessions and into the MGTAs' subsequent years.

We developed two beginning-of-the-academic-year surveys, one for new and one for experienced MGTAs, and protocols for mid-year and end-of-year interviews. Surveys are used at the beginning of the year because of logistical issues. They include open-ended questions that inquire about MGTAs' thoughts about teaching and learning mathematics, how they would describe a well-taught mathematics lesson, and what influenced the way they think about teaching. Mid- and end-of-year interviews allow a deeper investigation of MGTAs' teaching practices, their most recent teaching experiences, whether they feel that they are receiving adequate support, and what other support they feel they need to grow as teachers. The intention of the study is to survey and interview participants for the duration of their graduate programs to study their development over time. Table 1 illustrates participation in the study.

Recruitment Year	Number of Participants
2015-2016	11 new participants: 4 first year, 2 second year, 4 third year, 1 fourth year
2016-2017	11 continuing participants; 6 new participants: 4 first year, 1 third year, 1 fourth year
2017-2018	11 continuing participants; 10 new participants: 8 first year, 1 third year, 1 fifth year
2018-2019	15 continuing participants; No new participants

Table 1: Study Participants

Our research team analysed participants' responses to survey and interview questions in two rounds of coding using thematic analysis (Braun & Clarke, 2006). Thematic analysis has six stages which include: (1) familiarization with the data; (2) coding interesting features of the data in a systematic way and collating data that is appropriate for each code; (3) possibly combining codes into themes and collect data for each them; (4) reviewing the themes and supporting data for each theme; (5) continuing to analyse the themes, generating a clear definition for each; and (6) producing the report of the themes with selected data to provide evidence of each theme. In the first round of coding, we applied a deductive approach (e.g., using a pre-existing coding frame) where we looked for instances of the participants' experiences that could be elucidated with Katz's (1972) four-stage model of teacher development. In the second round of coding, we used an inductive approach that focused on codes we developed through the first round of analysis. These codes included what had an *impact on their views about teaching* (graduate course work, their students, the instructor they are assigned to, the course they are assigned to, their previous experiences as learners, office hours, their MGTA peers, and the resources they use for teaching), *issues of identity* (being a

teaching assistant versus being an instructor, resignation), and *teaching* (descriptions of their teaching practices, the transitions they have made in their teaching, what changes they would make to their teaching, and what is important for their teaching).

FINDINGS

In our first round of analysis, we found Katz's (1972) framework to be a useful lens to view MGTAs' development as teachers. We observed most of the first-year MGTAs talking about *surviving* the first year. The quote below is an exemplar of this:

By that point the quarter [midterm exams], it was just getting really hectic and I wasn't able to plan as much as I usually like to plan for courses. Sometimes I was looking at the material for about two hours before I started that day, whereas usually I like to look at it the day before or during the weekend or something. And so sometimes, though, the classes that I went to where I was kind of doing it on the fly, where I was literally looking at it like an hour or two before class.

We observed some second-year MGTAs in the *consolidation* stage. This participant is describing his approach to teaching a new course:

I think virtually the same. They would work for a little bit. It was 15 minutes. So, depending on the class, if it's longer, maybe we'll do it a different way. With 15 minutes, we can take a little bit more, take some time at the beginning. They work on something together, then back together as a class, and then quiz.

Later-year MGTAs sometimes spoke differently about their teaching experiences. For example, a third-year MGTA summarized her transition from the *survival* stage to the *renewal* stage in the following way:

I think previously, I was more focusing on, "I just want to survive my first teaching experiences." So, now that this is my fourth time teaching, I feel a little bit more comfortable trying to incorporate more active learning in my classroom, and trying non-traditional techniques whereas previously, when I taught, for example, my first time teaching my own class and I taught Calculus, I did mostly lecture because I just wanted to do what I felt most comfortable with – what I felt I could be successful at.

Another participant we saw as being in the renewal stage spoke about it in the following way: "In the few classes that I've taught, I've tried to little-by-little implement more and more activity-based learning and group-based learning and different things."

Teacher Interrupted

Despite seeing some progress, we found that only a few MGTAs spoke about teaching in a way Katz would describe as *renewal*, and only one or two of the MGTAs spoke of teaching in ways that Katz would categorize as *maturity*. Many MGTAs appeared to be stuck in the *consolidation* stage. We also found that MGTAs do not pass through Katz's developmental stages linearly. In fact, they sometimes return to the survival stage. We then conducted a second round of analysis to see what experiences prevented the MGTAs from moving through the developmental stages. We looked for what might have an impact on the MGTAs in terms of learning about teaching and moving toward the active learning strategies espoused in the 2 ½ day professional development

program. We expected that most, if not all, of the participants' work as teaching assistants would consist of leading recitations for lower-division mathematics courses and that there would be some consistency in the courses they were assigned to. However, when we looked at what work they were assigned to term-by-term and year-by-year, there was significant variation not just in the courses they were assigned to (algebra vs. differential equations), but also in what work they did (e.g., grading, assisting on research studies, assisting in online courses). This is an important finding because this variation has an impact on how the participants have the opportunity to develop as teachers. Below, we describe the issues that we interpreted as interrupting the MGTAs' teaching and learning about teaching.

Course assignments and expectations had significant impacts on the MGTAs. More specifically, how the instructors designed courses, the assignments, and exams had a disruptive impact on the MGTAs. This first-year MGTA describes what it was like:

From term to term, depending on the instructor mostly – not necessarily the class, but the instructor – their expectations of the TA are different in terms of what they want you to do. When I designed my materials, I knew where the solution was, what the problem was, what kind of outcome was expected from the students, what kind of mistakes I will see. So, the grading was faster in my opinion. But when everything is given to me, I have to first solve it and then figure out all of those details in the goal. And then I start to grade and then I encounter things that I didn't expect.

Because of the inconsistent ways they were assigned to courses, the MGTAs did not have the opportunity to work with the same group of students from one academic term to the next. A participant spoke of what it was like to 'lose' his first group of students:

I had all these students, I knew all their names, I was, they like me, I like them. We were really excited about this stuff and we'd been together for ten weeks and now that was all over and I had to do it all over again. And you know there's so much energy, like, that had gone into the last class and so much had come out of it. And now I was just like you know 95 more students who I don't know and I have to do this all over again. And I was, so to a certain extent I just, it was a lot harder to care that term. I was losing the students that I had so much already invested in.

Their role as graduate teaching assistants had an impact on the MGTAs' teaching, leaving them powerless to teach in the ways they wanted:

But I have no power over what happens in the recitation hour. There is a quiz that was written up, there's an activity that was written up. [...] So I'm not grumpy about that, necessarily. It's the instructor's course. That's fine. But it means I'm not choosing any of the problems, or anything like that. So what can I do? And they're working in groups, for the most part. And their group is working well. Somebody knows how to do the problem already, and they don't really need me except for the details. In that sense, I am interchangeable with any grad student. [...] I guess in a TA setting, I have such little power to actually impact their learning.

Another participant had a similar remark about feeling powerless to incorporate different teaching strategies:

Whereas a TA, you know, you're exactly that. You're an assistant. So, kind of ... you're in the in between. So, you don't have that much power, I guess, but some form of that to try incorporate [active learning] into teaching would be really interesting, but you know, I guess I don't really know exactly how.

Some MGTAs' work assignments took them out of the classroom. In particular, two of the participants who had worked as teaching assistants in the first three years of their graduate program became research assistants with no teaching duties. They both remarked that they had not had the opportunity to grow in their thinking about teaching nor in their teaching practices. One of them noted their desire to gain more teaching experience, despite being assigned to research duties:

I think the biggest thing is I just want more experience teaching because I still – because it's something that I can theorize and I can plan, but I just kind of know that's one of those things that I feel like I won't be able to intentionally get everything out of the class that I want until I've spend time teaching the class.

Another participant had a different type of interruption in his teaching experience when he was given a grading assignment: "I hadn't TA'ed for almost six months, because I didn't teach in the summer. I wasn't in the classroom with somebody for the whole summer and for the fall. It was like six months of not being a TA, so I was like, 'Oh, man. I almost have to relearn this'."

Despite the lack of attention to their teaching, we noticed that many of the participants want to learn and grow as teachers, even into the fourth and fifth year of their graduate programs. In general, they voiced a sense of familiarity with teaching and a desire to learn more about teaching, to grow their teaching practices beyond lecturing:

Because I've already gone through three years now teaching. So I'm already comfortable with coming up to class and writing things down and grading things in a reasonable enough fashion and in good time. But, yeah, it would be really great to be able to like just take it another step further.

But some participants also noted that they were not sure what that would look like:

That would be kind of nice to know how to make that work efficiently, and as a TA I don't know how to do that, or how to take this to another level. I don't know. I don't even know what that would look like. ... Something that where people are ... I mean, in my head I kind of have ... imagine like a play where it's people are engaged in having fun with it, but also being challenged and respected.

IMPLICATIONS

Researchers recommend that MGTA professional development programs be informed by research findings (Miller et al., 2018) and should take into account the needs of MGTAs at different stages of their development (Park, 2004). Additionally, DeFranco and McGivney-Burrelle (2001) noted that professional development programs should be "viewed as ongoing professional development experiences that support [MGTAs] through the long and complex process of changing their teaching practices" (p. 688). We observed that MGTAs in their assignments as teaching assistants were unable to

change the way they teach for several reasons. We recommend that professional development providers take into account the impacts described in this paper (e.g., varied and inconsistent course and work assignments, the powerless role of teaching assistants). We also recommend that professional development programs extend far beyond MGTAs' first year in graduate school, possibly into their third and later years, as they reach the renewal stage (Katz, 1972).

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