How Different is Different? Examining Institutional Differences Prior to Scaling Up a Graduate Teacher Training Program to Improve Undergraduate Mathematics Outcomes

Leigh Harrell-Williams
University of Memphis

Gary Olson
University of Colorado Denver

Jessica Webb
University of Memphis

Scotty Houston
University of Memphis

Josias Gomez
University of Memphis

A comprehensive graduate teaching assistant (GTA) training program in mathematical sciences designed at one institution is being replicated at two peer institutions. This paper presents the findings of a baseline comparison of the three universities undertaken at the start of the project to inform its adaptation and implementation at each institution and the evaluation of its impact. Program components include a first-year teaching seminar, peer mentoring and support from a peer TA coach, a Critical Issues in STEM Education seminar, and K-12 outreach to inform understanding of the pipeline. Differences in undergraduate demographics and performance in introductory mathematics courses, GTA responsibilities, prior departmental GTA training elements, and GTAs attitudes towards teaching mathematics/statistics are presented. Implications for program implementation and assessment of study goals related to institution differences are presented.

Keywords: professional development, teaching assistants, instruction, graduate education

Recent national efforts have focused on graduate teaching assistant (GTA) professional development (PD) (Ellis, Deshler, & Speer, 2016a,b; Olson, Ferrara, Jacobson, Manzanares, 2016; Speer, Ellis, & Deshler, 2017; Speer & Murphy, 2009) and mentoring (Rogers & Yee, 2018; Reinholz, 2017; Yee & Rogers, 2017) to improve academic outcomes for undergraduate students and build both perspective and a pedagogical skill base for graduate student instructors in preparation for future roles as mentors and faculty in the mathematical sciences. Although many programs have been developed for and by specific institutions (Childs, 2008; Childs & Milbourne, 2019; Griffith, O'Loughlin, Kearns, Braun, & Heacock, 2010; Kaplan & Roland, 2018), few GTA PD programs have been translated across multiple institutions.

The goal of our *NSF*-funded project, Promoting Success in Undergraduate Mathematics through Graduate Teaching Assistant Training (PSUM-GTT), is to study how the structure and training components of a program developed at one large university can be adapted for implementation at two peer institutions with different student demographics and distinct geographical locations. In this preliminary paper, we focus on the development of a shared understanding on how to best adapt a model across institutions while embracing the complexities and differences between schools, GTAs and student population. Hence, this paper provides an example of some preliminary baseline comparisons across the three schools conducted prior to the start of the 2019-2020 academic year.

The GTA Training Program

Desired Program Outcomes

The program goal is to strengthen the teaching capabilities of mathematical sciences GTAs in order to improve the academic outcomes of the undergraduates that they teach. Intended

outcomes include GTAs' increased preference for student-focused instruction, satisfaction with their teaching training and mentoring, increased attention to equity and inclusive pedagogy in the classroom, and decreased rates of their undergraduate students earning grades of D or F or withdrawing.

The Program Components

The first component is a course that GTAs take about how to teach effectively to support student learning. This GTA training seminar focuses on inclusive pedagogy and best practices in classroom instruction. Common themes in the seminar will provide continuity across universities and opportunities for cross-institution discussion, feedback, comparison and training. Specifically, common articles will be used to guide discussion, reflection and seminar topics. Through a combination of both practitioner and research articles, GTAs will be asked to critically reflect on classroom issues such as assessment, equity, inclusive practices, and classroom culture. Seminar instructors will model specific pedagogical techniques throughout the seminar to highlight how one can facilitate active learning strategies and student-centered pedagogy to promote engagement and inclusivity in classroom practices. GTAs will also work toward the development of an initial teaching philosophy as a final product for the seminar.

Based on research indicating that individualized mentoring and coaching can increase teaching effectiveness, the second component involves one-to-one peer mentoring and instructional support provided by a TA Coach. Each GTA in the program will receive one-to-one peer mentoring on a consistent basis from a GTA who has taught at the university the prior year. The mentoring is designed around a series of "Office Talks" topics to facilitate their discussions, together with at least two classroom observations and post-observation feedback each semester. In addition, an experienced GTA designated as TA Coach at each university will serve as a peer leader for new GTAs and provide in-class instructional support during the facilitation of new instructional practices and activities in a supportive and non-evaluative manner.

In order to help GTAs become reflective practitioners, the third component is the Critical Issues in STEM Education seminar, which is held four times throughout the academic year for all GTAs, to provide the opportunity to interact with invited researchers and practitioners about current issues surrounding undergraduate student instruction.

The final component provides students with outreach opportunities in local K-12 schools and after-school programs to help them attain an understanding of the mathematics pipeline that their students take to college.

Initial Results for College Algebra DFW Rates at Founding Institution

Initial results from the institution that developed this training program indicate that the model has a positive impact on the performance of the undergraduates whom the GTAs teach. GTAs at this institution are typically tasked with teaching two sections of college algebra recitation during each semester of their first year in the program. Rates of students who receive a grade of D or F or withdraw from the course after the census date (DFW rates) are detailed below, including the three years prior to this program and the three years since its inception. Overall, DFW rates have decreased by approximately 11 percentage points since the implementation of the training model.

Table 1. DFW Rates for College Algebra Before and After Implementation

	2013/2014/2015	2016/2017/2018
Fall Semester Aggregate	43.1%	32.6%
Spring Semester Aggregate	42.3%	30.8%
Overall Aggregate	42.8%	31.9%

Exploring Baseline Institutional Differences

In order to accurately frame the results when evaluating the implementation and impact of the training program at the end of the project, the differences among the institutions prior to implementation need to be acknowledged, as the program will be modified to fit within the current structures of the programs at the two new project sites and as some differences among the universities would be expected to influence program results.

Undergraduate Student Demographics

University A, where the graduate teacher training program was developed, is a public institution located in an urban area in the Midwest. Approximately 57% of first-time students and 47% of all undergraduates identify as people of color, approximately half of whom identify as Hispanic and a quarter of whom identify as Asian American. Approximately 50% of all students are first generation. Approximately 50% are transfer students. Approximately 43% of first-time students and 26% of all undergraduates receive Pell Grants. Approximately 80% of the first-time students entering in Fall 2018 took the SAT. The 1st and 3rd quartiles for SAT Math scores were 510 and 600, respectively.

University B is a public institution located in an urban area in the Mid-South. Approximately 40% of first-time students and 41% of undergraduate students identify as Black or Hispanic. The majority of these students identify as Black and the institution has a Predominantly Black (PBI) designation. Approximately 38.5% are first generation students, and 44% are Pell Grant eligible. Approximately 96% of the first-time students entering in Fall 2018 took the ACT. The 1st and 3rd quartiles for ACT Math scores were 19 and 26, respectively.

University C is a public, land-grant institution located in a college town in the South. Approximately 76% of first-time students and 79% of all undergraduate students identify as White. Approximately 15% of all undergraduates receive Pell Grants, and 13% of first-time entering freshmen identify as first-generation college students. Approximately 84% of the first-time students entering in Fall 2018 took the ACT. The 1st and 3rd quartiles for ACT Math scores were 23 and 28, respectively.

Undergraduate Student Outcomes in Mathematics

Table 2 summarizes the DFW rate for each institution for a variety of developmental and introductory mathematics courses. The rates are similar for College Algebra and Calc 1, but have observable differences for PreCalc, Trig, and Calc 2. The current DFW rates for College Algebra for University B and C are lower than University A's DFW rate prior to their implementation of the training program. It should be noted that at University A, prior to Fall 2019, there was no math placement test for courses other than Calc I, while University B used an online placement test and University C used students' ACT or SAT scores to place them into specific math courses.

Table 2. Three-Year Average of DFW Rates for GTA-Taught Sections Prior to Fall 2019

Course Name	University A	University B	University C
College Algebra	29.3%	29.1%	30.0%
PreCalc	32.4%	30.0%	23.8%
Trig	37.3%	18.4%	-
Calc 1	27.1%	26.1%	30.1%
Calc 2	31.8%	31.1%	23.0%

Note: For University A, the three-year average includes years after pilot implementation. For Universities B and C, these are the three-year rates prior to implementation in Fall 2019.

First-Year Graduate Student Teaching Responsibilities

At University A, first-year graduate students are generally assigned as instructors of record for recitation sections in College Algebra. First-year students at University B and C are generally assigned as graders or mathematics tutors due to accreditation constraints (i.e. students must have completed 18 graduate hours in their content area before being able to teach).

Previous GTA Training Programs

Similar to what University A offered prior to the development of the new training program, University B offered a one-semester seminar focusing on topics such as quiz creation, grading, classroom management, instructor demeanor, and effective office hours. First-year students at University C went through a two-semester training program. The first semester covered classroom skills, including effective dialogue with students, grading and partial credit, and included two or three guest speakers on a variety of pedagogical issues. The second semester training course included micro-teaching experiences for students, wherein they were able to put lessons from the first semester into practice.

Current GTA Beliefs about Teaching Mathematics/Statistics

During the first weeks of the Fall 2019 semester (the first semester of implementation at Universities B and C), all GTAs completed an online survey, which asked about prior teaching experiences before and after entering the graduate program, previous preparation to teach (if any), and attitudes towards teaching mathematical sciences using the Approaches to Teaching Inventory (ATI; Trigwell, Prosser, & Ginns, 2005). Separate two-way ANOVAs for the ATI Student Focused and Teacher Focused scores indicated no significant main effects for university or graduate student experience (first year and second year graduate students versus students in year 3 or more in their program) and no significant interaction effect (See Tables 3 and 4).

Table 3. Means and Standard Deviations for Approaches to Teaching Inventory

ATI Subscale	University A		University B		University C	
	1st/2nd Yr. Students *(n =10)*	More Exp. Students *(n =12)*	1st/2nd Yr. Students *(n =9)*	More Exp. Students *(n =14)*	1st/2nd Yr. Students *(n = 8)*	More Exp. Students *(n = 11)*
Student Focused	35.80 (6.16)	38.58 (3.99)	41.22 (5.04)	39.43 (3.89)	39.63 (6.70)	36.36 (5.38)
Teacher Focused	38.9 (7.19)	36.92 (4.81)	39.44 (8.40)	37.21 (6.90)	40.13 (6.15)	41.36 (4.63)

Table 4. Two-Way ANOVA Results for University and Student Experience on ATI Scores

ATI Subscale	University Main Effect			Experience Main Effect			University x Exp. Interaction Effect		
	Test Stat	DF	p	Test Stat	DF	p	Test Stat	DF	p
Student Focused	2.20	2, 58	.12	0.34	1, 58	.56	1.97	2, 58	.15
Teacher Focused	1.12	2, 58	.34	0.37	1, 58	.55	0.45	2, 58	.64

Differences with Implications for Implementation and Impact

Several differences among the universities have implications for implementation of the program components at each site. Most importantly, University A and B had similar "prior versions" of training. University C had a training program that was somewhere in between those prior versions and the new comprehensive training program. Hence, Universities A and B will have a one-semester first-year training seminar and University C will keep their two-semester sequence. Secondly, due to the differences in accreditation bodies, University A's first-year graduate students gain teaching experience earlier in their graduate program, starting with their first semester in the program, as compared to later starts for University B and C. Lastly, baseline survey results, which might differ by site, will influence the first-year training seminar instruction at each university. For instance, the seminar instructors could spend time introducing the types of active learning activities that the GTAs indicate they have never heard of. Similarly, if the baseline survey indicates that GTAs are coming in with substantial outside teaching experience or training, this may influence the sequencing and pacing in the content presented in the first-year teaching seminar.

Due to differences in implementation, evaluation of the program components also needs to account for what might be considered a "dosage" effect. There are differences in length of first-year training seminar (University C's is longer) and amount of time possible to gain teaching experiences (University A students could teach more semesters). Additionally, there is a difference due to concurrent training with first semester teaching (University A) versus those with training prior to teaching (University B and C). Additionally, the diversity in the students served and the starting DFW rates (University B and C) also influence how much change could possibly be seen in the DFW rates at each institution.

Although it is the point of the funded project to identify the elements of the components that contribute to GTAs' development as instructional faculty, all of these differences in context need to be considered when exploring the efficacy of the training program and when making suggestions for implementation of the program at other institutions.

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