Supporting institutional change: A two-pronged approach related to graduate teaching assistant professional development

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Graduate students teaching assistants (GTAs) are responsible for teaching a large percentage of undergraduate mathematics courses and many of them will go on to careers as educators. However, they often receive minimal training for their teaching responsibilities, and as a result often are not successful as teachers. In response, there is increased national interest in improving the way mathematics departments prepare their GTAs. In this report, we share the initial phases of joint work aimed at supporting institutions in developing or improving a GTA professional development (PD) program. We report on findings from analyses of a baseline survey designed to provide insights into the characteristics of current GTA PD programs in terms of their content, format and duration. Results indicate that there are many institutions seeking improvements to their GTA PD program, and that their needs are in line with the change strategies that the joint projects are employing.

Key words: Graduate student teaching assistants, Professional Development, Institutional Change

It is well documented that graduate student teaching assistants and associates (GTAs) play a large role in undergraduate mathematics education (Belnap & Allred, 2009; Ellis, 2014), that GTAs often hold novice beliefs about the teaching and learning of mathematics (DeFranco & McGivney-Burelle, 2001; Gutmann, 2009; Hauk et al., 2009; Raychaudhuri & Hsu, 2012), have novice knowledge related to teaching (Kung, 2010; Kung & Speer, 2009; Speer, Gutmann, & Murphy, 2005), and yet are more open to student-centered teaching practices than more experienced mathematics instructors (Ellis, 2014; Seymour, 2005). It is also well documented that many GTAs are minimally prepared to teach, and that more robust teaching preparation can result in expert-like beliefs, knowledge, and practice (Alvine et al., 2007; Barry & Dotger, 2011; Hauk et al., 2006; Kung & Speer, 2009; Luft, Kurdziel, Roehrig & Turner, 2004).

For the above-stated reasons, GTAs and their preparation to teach can play important roles in the effective teaching and learning of undergraduate mathematics. In particular, recent findings suggest that the presence of a robust GTA professional development (PD) program is characteristic of departments with successful calculus programs (Ellis, 2015). The context of two projects (under the auspices of the Mathematical Association of America (MAA) and funded by the National Science Foundation (NSF)) provides opportunities to examine the state of GTA PD nationally and the ways in which such programs interact with departmental efforts to improve the teaching and learning of calculus.

The work reported on in this proposal is the first step in the larger and longer-term efforts to understand department change and GTA PD. Here we report on findings from analyses of data from a baseline survey that was designed to provide insights into the characteristics of current GTA PD programs in terms of their content, format and duration. In addition to being a basis for future comparisons, these data provide the mathematics community with information about the prevalence and features of currently-existing efforts to prepare graduate students for their teaching-related responsibilities.

As further context for this work we briefly describe the two projects and their goals related to institutional change and GTA PD. The first project, Progress through Calculus (PtC) (NSF DUE-1430540), aims to observe and facilitate institutional change related to the Precalculus-Calculus II sequence. This project is a continuation of the Characteristics of Successful Programs in College Calculus (CSPCC) study and is specifically focused on observing and supporting graduate-degree granting mathematics departments in implementing the characteristics found to be related to student success in calculus through the CSPCC project. As noted above, one such characteristic was robust GTA PD programs (Ellis, 2015). The second project, College Mathematics Instructor Development Source (CoMInDS) (NSF DUE-1432381), aims to support mathematics departments in developing and improving GTA PD programs by broadening access to resources related to GTA PD and to support for individuals and departments implementing these resources.

Together, these two projects aim to increase awareness of the need for GTA PD, help institutions think about how to implement robust GTA PD in relation to other needs of their departments, learn about different types of GTA PD programs, and have the resources to successfully implement such programs. As a first step in documenting and understanding departmental change, the two projects have collaborated to understand the current national landscape of existing GTA PD programs and the GTA PD-related needs of mathematics departments.

Theoretical Background

With the long-term goal of analyzing factors that influence how and why departments change, we approach this work with an eye towards *change strategies*. Henderson, Beach, and Finklestein (2010) conducted a large-scale meta-analysis of research on facilitating change in undergraduate science, technology, engineering, and mathematics (STEM) instruction. Through this work they determined four broad categories of change strategies: disseminating curriculum and pedagogy, developing reflective teachers, enacting policy, and developing shared vision. The change strategy of *disseminating curriculum and pedagogy* is focused on sharing experts' knowledge with individuals and encouraging the implementation of the strategy, such as through journal articles, workshops, and research presentations. The change strategy of *developing reflective teachers* is focused on encouraging and supporting reflective practices by individual instructors that lead to instructor-identified and defined change outcomes. The strategy of *enacting policy* is focused on prescribing a new environment that requires or strongly encourages new practices. The last strategy, *developing a shared vision*, is focused on empowering and supporting stakeholders to collectively develop a new environment that encourages instructional change.

The least successful change strategies were developing and testing "best practice" curricular materials and then making these materials available to other faculty and "top-down" policy-making meant to influence instructional practices. Successful strategies involve shifting the focus from strategies with exact intended outcomes before implementation to those that acknowledge that the final outcomes will be shaped by the individuals and/or environment involved in the system. The most effective change strategies were aligned with or sought to change the beliefs of the individuals involved, were long-term interventions, sought to understand the system that was trying to be changed and designed a strategy that is compatible with the system.

The larger PtC project involves identifying departments where changes are planned for their calculus sequence and documenting those efforts with a particular focus on the role that the

creation or enhancement of GTA PD programs plays in those efforts. The larger CoMInDS project involves identifying individuals within departments who are implementing changes to their GTA PD programs and working with their perspectives towards GTA PD in ways compatible with their university systems. Both projects seek to work with the beliefs of the change agents involved and work within the larger systems to implement changes. The lens of *change strategies* serves as a guiding framework for our baseline survey instrument design and data analysis that supports both larger projects' goals.

Methods

A survey was sent to department chairs at all graduate-degree granting mathematics departments in the US (n = 341). The survey has three parts: Part I requested a list of all courses in the department's mainstream precalculus/calculus sequence, Part II asked about departmental practices in support of the precalculus/calculus sequence and contained 18 questions about GTA PD and Part III asked for enrollment data and other specific information about each of these courses. The questions related to GTA PD were jointly designed by members of the CoMInDS and PtC teams and were designed to provide insights into the following questions:

(a) What GTA PD programs are currently being implemented across the country?; and

(b) What are the interests and needs of mathematics departments related to GTA PD?

Department chairs were encouraged to have local experts in his or her department fill out the components of the survey with which they were most knowledgeable. For instance, many of the questions about GTA PD may not be known by the chair but instead by the facilitator of the GTA PD program, and so this person would hopefully be the one filling out this section of the survey. The survey was administered using Qualtrics and distributed by the MAA. Follow up emails and phone calls are ongoing to encourage full participation and response rate – currently, 56.3% (n=192) of all institutions have responded, 63% (n=114) of PhD-granting and 48.8% (n=78) of Master's-granting. The questions about GTA PD included multiple choice questions, Likert scale questions, and open-ended questions. In this report we discuss responses to the multiple choice and Likert scale questions.

Results

Results are reported from descriptive analyses of the survey response data that were aimed at addressing the two questions listed above.

What GTA PD programs are currently being implemented across the country?

There were eight questions on the survey to address various aspects of the structure and context of the department-lead GTA PD programs (we did not ask questions related to university-lead, non-mathematics specific GTA PD.) These questions addressed who the primary audience of the GTA PD is, how many GTAs participate and when, the format and activities included in the PD, the source(s) of the materials used in and who facilitated the PD. As shown in Table 1, three-quarters of PhD-granting institutions have department specific GTA PD, while only 35% of Master's-granting institutions do. For the remainder of this report, we attend to the PhD-granting institutions unless otherwise noted.

The primary audience for the department specific GTA PD was lead instructors (60%) and recitation leaders (59%). The majority of these programs were geared to all GTAs (61%), and most often before they teach the first time (67%) or during their first term of teaching (37%).

Almost half of these programs consist of a term-long course or seminar, while 28% involve a multi-day workshop and 17% involve a one- to four-hour long workshop or orientation. Although what is done during this time varies widely across institutions, it is uplifting to know that many departments have a specific course for preparing GTAs, and that it is possible to target efforts at improving these courses rather than convincing universities that such courses are helpful. The most common aspects reported as part of the programs were: Student evaluations of GTAs required by the institution or department (69%), GTAs observed by an experienced instructor while teaching in the classroom and receive feedback on their teaching (60%), GTAs are observed by a faculty member while teaching in the classroom (57%), GTAs practice teaching and receive feedback on their teaching (56%), GTAs develop lesson plans (35%), and GTAs learn classroom assessment methods (31%). The majority of departments use in-house materials for the teaching preparation (67%) while 31% use published materials. The majority of these programs are facilitated by one or more individuals for whom this is part of their official responsibilities for multiple years (61%).

Table 1. A sample of descriptive analyses related to the structure of the program

	Total (n=192)	**PhD Granting** (n=114)	**Masters Granting** (n=78)	**Minority Serving Institutions** (n=27)
Has a department specific GTA PD	66%	75%	35%	56%
Primary audience				
Recitation leaders	44%	59%	14%	30%
Primary instructors	53%	60%	28%	52%
How many GTAs participate?				
All	54%	61%	28%	44%
When				
Before teaching for the first time (e.g., pre-term orientation)	57%	67%	31%	44%
During their first term of teaching	32%	37%	15%	33%
Format				
Term-long course or seminar	37%	47%	13%	30%
Multi-day workshop	23%	28%	10%	19%
Short workshop or orientation (1-4 hours)	17%	17%	13%	15%
Activities				
Required student evaluations	60%	69%	31%	52%
GTAs are observed by an experienced instructor while teaching in the classroom and receive feedback on their teaching	52%	60%	27%	41%
GTAs practice teaching and receive feedback on their teaching	45%	56%	18%	33%
GTAs develop lesson plans	30%	35%	17%	33%
GTAs learn classroom assessment methods	27%	31%	17%	30%
Source of materials				
Created by the providers of GTA PD	59%	67%	32%	56%
Published materials	28%	31%	15%	15%

Who facilitates				
One or more individuals for whom this is part of their official responsibilities	53%	61%	27%	41%

What are the interests and needs of mathematics departments related to GTA PD?

There were four questions on the survey to understand the interests and needs of the mathematics departments related to GTA PD. Only 19% of PhD-granting institutions reported that their GTA PD is preparing GTAs "very well," while 41% reported they did well and 39% reported that they prepared their GTAs adequately. Over 60% of PhD-granting institutions report that the department is generally satisfied with the GTA PD program, and 33% responded that they were adequate but that there was room for improvement. It is these 38 institutions and the 5% that are not satisfied with their programs for whom we will target our improvement efforts. Over a quarter of the institutions report that changes to their GTA PD program have recently been or currently are being implemented, and almost 20% report that changes are being discussed. When asked what resources would be most helpful to them in strengthening their GTA PD programs, institutions most often marked: research-based information about best practices in GTA teaching preparation (64%), tools for evaluating effectiveness of GTA teaching preparation (55%), collegial conversations or mentoring for GTA teaching preparation staff with colleagues at similar institutions (54%), professional development for GTA teaching preparation staff (e.g., workshops, conference sessions) (45%), and online library of tested resources (41%).

Discussion and Next Steps

Results indicate that there are many institutions that are seeking improvements to their GTA PD program, and that their needs are in line with the change strategies that are part of the PtC and CoMInDS projects. These findings provide both the baseline data needed to document and analyze change and substantiate the claim that there are departments that can serve as the context for carrying out studies of departmental change.

Other sections of the survey aim to generate data on a different, but related topic – to situate the interests and needs of mathematics departments related to GTA PD in relation to the larger system of first and second year undergraduate mathematics instruction (often where GTAs are involved in the teaching). To address this goal, we will continue to analyze these results in relation to the other sections of the PtC census survey. We will specifically target institutions looking to make changes to their GTA PD program and investigate what other aspects of their programs they feel confident in and what aspects they are also looking to improve. For instance, are programs looking to improve their GTA PD programs also looking to improve the coordination of their precalculus through calculus sequence? If so, then we may look into ways in which we can capitalize on this relationship to better support these institutions. In doing so, we can develop data collection methods and analysis approaches that utilize the *change strategies* framework to understand specific institutions and to generalize across institutions. These efforts can then contribute to the mathematics education community's understanding of factors that support and/or inhibit change occurring as departments strive to improve the teaching and learning of undergraduate mathematics beyond GTA PD.

Questions

- In what ways do you see this work translating to other goals of undergraduate mathematics

education reform?

- Are there other characteristics of GTA programs or aspects of departmental culture that we should gather data on as we endeavor to understand the factors that enable and inhibit change?

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