Mentor Professional Development for Mathematics Graduate Student Instructors

Sean P. Yee  
University of South Carolina

Kimberly Cervello Rogers  
Bowling Green State University

Abstract
To develop graduate student instructors’ (GSIs) skills and abilities as collegiate mathematics instructors, researchers at two universities implemented a peer-mentorship model where experienced GSIs completed a 15-week professional development (PD) to learn how to mentor novice GSIs in teaching undergraduate mathematics. Using pre-survey, post-survey, and semi-structured reflective interviews, we studied changes in 11 mentor GSIs’ perspectives on teaching and learning practices and what aspects of the mentor PD were deemed valuable by the mentors. Results suggest that this mentor PD, as a peer-mentorship model, helped GSIs deconstruct the dichotic mathematical paradigm of statements being true or false when discussing teaching. Moreover, mentor GSIs valued how the mentor PD helped guide them to facilitate novice GSI post-observation discussions.

Key words: Graduate Student Instructors, Professional Development, Peer-Mentoring

A key ingredient in a successful collegiate mathematics department is the “effective training of graduate teaching assistants” (Bressound, Mesa, & Rasmussen, 2015, p. 117). This training is crucial because graduate student instructors (GSIs) serve as instructors of record for hundreds of thousands of undergraduate mathematics students each semester (Belnap & Allred, 2009; Lutzer, Rodi, Kirkman, & Maxwell, 2007) and significantly impact the quality of collegiate mathematics instruction across the US. Despite their prevalent role as instructors of undergraduate mathematics, GSIs typically lack guidance and support to teach undergraduate students effectively (Latulippe, 2009; Rogers & Steele, 2016; Speer, Gutmann, & Murphy, 2005; Speer & Murphy, 2009).

When an instructor lacks teaching support, they draw on their teaching beliefs, attitudes, and dispositions to define their pedagogy (Welder, Hodges, & Jong, 2011). Research has shown that an instructors’ initial experiences with teaching develops their beliefs and practices of teaching that may last their entire career (Lacey, 1997; Lortie, 1975; Zeichner & Tabachnick, 1985). Thus early teaching experiences of GSIs may shape how GSIs teach in the short term and in the long term as potential future faculty members. Without guidance, for instance, GSIs may struggle to distinguish between how their graduate-level mathematics courses are taught and how they should teach their undergraduate mathematics courses (Speer, King, & Howell, 2014). In order to address this critical need for early support in GSIs’ development as effective teachers, this study generated and implemented a mentor professional development (PD) at two American universities to develop experienced GSIs into mentors for novice GSIs (protégés). This paper focuses on the effect of the mentor PD on mentor GSIs’ views of teaching and learning.

1 GSI was used instead of TA (Teaching Assistant) because GSI targets the specific set of graduate students who are full instructors of record.

2 The implementation of this mentor PD was supported by a National Science Foundation grant at two universities (NSF GRANT 1544342 & 1544346).
Related Literature

GSI Guidance and Support

In K-12 teacher education, the critical role of student teaching with a mentor teacher has been recognized as a vital precursor to fully instructing a course (Council for the Accreditation of Educator Preparation, CAEP Standard 2). At the collegiate level, no such standard precursor exists across doctoral granting institutions (Speer et al., 2014). This is due, in part, to the wide variety of roles graduate students may be assigned (e.g. tutors, graders, recitation instructors, or instructors of record) and the limited resources within mathematics departments.

Consequently, researchers have determined that GSIs are unable to articulate their pedagogical decisions clearly. Rogers & Steele (2016) studied teaching mathematics content courses for preservice elementary teachers and found that GSIs:

- did not demonstrate strong abilities to articulate the reasons for their instructional decisions or identify alternative pedagogical moves that may have led to different outcomes; instead, their interview comments often focused on sufficiently covering the mathematical content and the importance of preparing PSTs with strong content knowledge to be able to teach their future elementary students.

This lack of explicitly articulating pedagogical decisions could be due, in part, to the fact that mathematics graduate students often start their doctoral program with limited pedagogical course experience (Speer et al., 2014).

Although there can be many individuals who offer general advice about teaching to graduate students, including mathematics faculty members and course coordinators, rarely is this advice individualized enough for the GSI to justify and reflect on their pedagogical decisions (Speer et al., 2014). Shulman (1986) reminds us that for GSIs to justify pedagogical decisions within mathematics requires an understanding of pedagogical content knowledge, “which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching” (p. 9). The links between content and pedagogy do not develop automatically in teaching (Ball, Thames, & Phelps, 2008) and teachers need to be aware of the goals orienting their decisions from the teacher’s and student’s perspective (Schoenfeld, 2010). This is where a mentor teacher can be helpful by offering specific advice and justifying that advice with the necessary pedagogical decisions. Many universities have used faculty as mentors for GSIs, however Johnson and Nelson (1999) found that such relationships are ethically complicated and multifaceted because of other hegemonic roles faculty must play, such as doctoral advisors and qualifying exam evaluators. We posit that to be genuinely aware of the individualized pedagogical decisions requires a mentor closely in tune with a protégé’s current experiences. To that end, we focused on a mentor PD for experienced GSIs to guide and support protégés.

Mentoring GSIs

Research has indicated that mentoring has social and cultural benefits if mentor GSIs were inclined to help protégés learn how to teach. Johnson and Nelson (1999) indicate that mentoring is central to “quality graduate education” (p. 205), a key component of a successful mathematics department (Bressound et al., 2015). Crisp and Cruz’s (2009) meta-analysis of mentoring literature from 1990 through 2007 found that certain subgroups (minorities and females) benefited greatly from peer mentoring, as mentors offer support to socialize professionally, work, navigate, reflect on academic discourse, and help alleviate stress within doctoral programs. Zaniewski and Reinholz (2016) looked at mentoring from a cultural perspective of identity in a peer mentoring program. Admittedly, Zaniewski and Reinholz’s study focused on a different
population, experienced undergraduates mentoring freshman undergraduates in the physical sciences, but their results demonstrated positive psychosocial and academic interactions resulting in friendships that generated a community of practice (Kensington-Miller, Sneddon, & Stewart, 2014) amongst certain majors. Such results are desired within doctoral programs. Thus the literature supports the design and implementation of peer-mentoring for GSIs, yet raises the question: How do we mentor the mentors?

**Mentoring curricula**

Although teaching experience is necessary, it is not sufficient for mentoring because mentors need to understand their role and purpose in facilitating meaningful pedagogical decision-making conversations with protégés (Rogers & Steele, 2016). Consequentially, the design of a mentor PD curriculum should focus training mentors to guide and support protégés’ understanding of their pedagogical decisions. Despite the small body of literature structuring mentor PD curricula (Crisp & Cruz, 2009), we note Boyle and Boice’s (1998) seminal work on mentor PD that studied mentoring both novice faculty and novice GSIs with tenured faculty where they considered mentoring as the “cousin of faculty development” (p. 158). These researchers compared spontaneous mentoring (talk to the mentor if there are problems) and systematic mentoring (meeting regularly every week) and found that the systematic mentoring was more effective in supporting GSIs and faculty because the mentor could not prepare appropriately when it was spontaneous. Boyle and Boice also observed the topics that dominated mentor meetings in decreasing order of frequency were (1) discussions of undergraduates, (2) teaching styles, (3) teaching-related goals, (4) grading issues, and (5) course preparation.

Boyle and Boice’s (1998) results informed the framework of our mentor PD because all five frequented topics could be discussed within the mentor PD through two main responsibilities: observing protégés teach and running small group protégé meetings systematically (not spontaneously). Thus our mentor PD curriculum revolved around observing protégés (including post-observation discussions) and facilitating small group discussions. A natural next question becomes, what impact did the mentor PD have on experienced GSIs? This study examines the results of a 15-week mentor PD around two research questions:

(RQ1) How did the mentor PD change mentors’ perceptions of student behavior, student learning, and effective teaching?

(RQ2) What specific aspects of the mentor PD curriculum did the mentors view as most valuable in their preparation as mentors?

**Method**

**Participants**

Experienced graduate students at two universities applied and were selected to be mentors by the researchers based on their teaching experiences (aptitude for implementing student-centered techniques), their pedagogical accolades (teaching awards and student evaluations), and most importantly their desire to help novice GSIs to improve teaching at their university (essay responses were required). The number of participants was determined by the average size of each university’s mathematics GSI program. Eleven mathematics and statistics doctoral candidates were selected to participate in the mentor PD seminars (four from one university and seven from another).
Mentor PD Curriculum

The goal of the 15-week mentor PD was to equip the 11 experienced GSIs to be effective peer-mentors. The participants and a mathematics education researcher met for 50 minutes once a week to discuss the responsibilities of the mentor as well as to generate frameworks and perspectives necessary for mentoring. Building on the GSI mentoring literature, the Mentor PD curriculum was structured around two main mentor responsibilities: (1) observing protégé GSIs including feedback, and (2) facilitating bi-weekly small group meetings (one mentor with four protégés) which provided a space to discuss teaching.

The first two weeks of the mentor PD incorporated a review of aligning lessons plans, goals, and assessments that mentor GSIs had previously learned in their mathematics teaching pedagogy courses. The next month (weeks 3-6) focused on the GSI Observation Protocol (GSIOP), which was generated by building off of the MCOP2 (Zelkowski, Gleason, & Livers, 2016) and forms used for GSI teaching evaluations. This work prepared the mentors to observe each of their four designated protégés classes three times during the protégé’s first course.

The middle of the Mentor PD (weeks 7 & 8) introduced the notion of different colored flags to help mentors prioritize observational feedback for the protégés to digest easily. Although the GSIOP offers a thorough observation, feedback was focused to not overwhelm protégés. No more than two specific issues of each color were flagged (green flag: good, yellow flag: area for growth, red flag: immediate area of concern). Flagging was revisited in the mentor PD (weeks 13 & 14) with hypothetical scenarios in which the mentors role-played post-observation discussions to understand how to approach different teaching styles and perspectives without sounding overly critical or evaluative.

Another major topic addressed was how to effectively design, organize, implement, and facilitate biweekly small group meetings (weeks 9-12). By analyzing written scenarios, mentors learned how to structure and guide their small group meetings by determining who is driving the discussion and how it is being driven. Finally, week 15 brought many ideas together around the theme of critical reflection (Brookfield, 1995) by focusing on curricular hegemony and pedagogical efficacy over efficiency. Although researchers collected rich observational data from the mentor PD, space limitations mandated this paper remain focused on the results that would answer our research questions.

Mentor PD Data Collection

At the beginning and end of the mentor PD, the 11 mentor GSIs answered a survey (adapted from Jong, Hodges, Royal, & Welder, 2015) to examine their attitudes, experiences, and conceptions about teaching collegiate mathematics. Since the original survey drew upon the Mathematics Experiences and Conceptions Survey focusing on preservice teachers, we modified Jong and colleagues’ instrument to focus on the tertiary instructors. The pre- and post-surveys shared a group of questions that asked the mentors to rate how strongly they agreed with statements in three categories: (a) beliefs about students (15 statements), (b) teacher characteristics (11 statements), and (c) lesson design (3 statements). That is, on a scale of one to five, with one being strongly disagree and five being strongly agree, participants rated their agreement with statements such as: (a) students should use multiple ways to represent concepts and solve problems (beliefs about students), (b) as a teacher I provide wait time and think time regularly (teacher characteristics), and (c) the structure of my lesson must be well organized to effectively achieve its goals (lesson design). We analyzed the mentors’ pre- and post-survey responses to help address RQ1. Additionally, we included a question unique to the post survey: “List up to three things you learned from the mentor PD that you believe will help you as a
All 11 mentors listed what they learned most and second most while only nine listed a third lesson learned. Our analysis of these responses informs RQ2.

After the conclusion of the mentor PD, an external evaluator conducted 1-hour, semi-structured reflective interviews with each mentor. The mentors were given a copy of their pre- and post-survey responses and asked to elaborate on what they saw in their own responses to triangulate the data. Mentors’ responses about how and why their attitudes changed throughout the mentor PD also informs RQ1.

Mentor PD Data Analysis

We first examined the quantitative data by analyzing the pre- and post-survey questions. This quantitative analysis informed the design of the semi-structured reflective mentor interviews, which we qualitatively coded relative to the mentor’s responses to the attitudes, experiences, and conceptions on teaching questions. For all 29 pre and post questions, t-tests were used to determine variance before and after the mentor PD. Aggregate quantitative analyses of the pre- and post-survey data were shared during the semi-structured interviews to help answer RQ1. The additional post-survey question (top three things learned) was qualitatively analyzed relative to the topics and course design to determine what aspects of the mentor PD were deemed valuable by the mentors (RQ2).

Results

Change in Attitude (RQ1)

Paired sample t-tests were implemented on all 29 pre and post survey questions to look for variance (N=11 with alpha=5%). Although, no variance was significant (which may be due to the limited number of participants, N=11), a few descriptive statistics on change in mean offer insight into how the mentor PD affected specific mentors’ attitudes. Due to limited space, we discuss the survey question with the greatest change in attitude. Mentors attitudes that “students’ success in mathematics depends primarily on how hard they work” had the largest average negative value change after the mentor PD (ΔM=-0.64, ΔSD=1.43). This indicates that, on average, mentors agreed less with this statement after the mentor PD (not statistically significant however with alpha=5%).

In the reflective interviews, 9 of the 11 mentors did explicitly discuss their negative change in attitude on the survey relating student success and hard work. One mentor said,

When I first took this [pre-survey], I strongly agreed because it sounded right, the way it should be, but what caused me to change was the word ‘primarily’ because success in mathematics is in part how hard they work…but a good teacher certainly makes a difference, the resources available certainly makes a difference. If not, we are assuming students…are lazy and just don’t work hard, which is not true in my opinion.

A second mentor corroborated this perspective in their interview by directly connecting his negative change in attitude to the mentor PD.

I probably changed my answer after the seminar because I had seen poorer examples of instruction in the mentor PD, which leads me to believe that, despite what I would like, the quality of instruction plays a role in how well they learn the subject material.

Another mentor focused on deconstructing the word success.

The hard part for me to really piece together about this question is ‘student success’ in mathematics. If I have a student who comes in with really strong [mathematical] background
comes in and aces all the homework, aces all the exams, versus the student who improves greatly but does not get as good of a grade, what is that in terms of success? Fundamentally, we see the mentors critically reflecting (a topic from week 15 during the Mentor PD) during these interviews because the mentors are deconstructing the meaning of certain words such as “primarily” and “success” that were taken for granted prior to the mentor PD.

**Most Valuable Topics from Mentor PD (RQ2)**

In the post-survey, mentors listed the three most important things they learned from the mentor PD in free-response form. We qualitatively coded their responses relative to the curricular topics. For example, a mentor stated that they most valued learning “methods for offering constructive criticism”, which was coded under facilitating post-observation discussion. Curricular topics are listed in order of ranking by mentors in Table 1.

**Table 1**

*Top Three Things Mentors Learned from the Mentor Professional Development (PD)*

<table>
<thead>
<tr>
<th>Mentor PD Curricular Topics (Weeks of the Mentor PD Seminar Curriculum)</th>
<th>Number of Mentors who Rated This Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitating post-observation discussion (Weeks 7, 8, 13, &amp; 14)</td>
<td>Highest: 6  Second Highest: 2  Third Highest: 2</td>
</tr>
<tr>
<td>Designing, organizing, &amp; implementing small group meetings (Weeks 9 &amp; 10)</td>
<td>Highest: 2  Second Highest: 2  Third Highest: 3</td>
</tr>
<tr>
<td>Designing, organizing, &amp; implementing GSIOP (Weeks 3-6)</td>
<td>Highest: 2  Second Highest: 1  Third Highest: 3</td>
</tr>
<tr>
<td>Facilitating small group meeting discussions (Weeks 11 &amp; 12)</td>
<td>Highest: 0  Second Highest: 4  Third Highest: 0</td>
</tr>
<tr>
<td>Critical reflection during small group meetings (Week 15)</td>
<td>Highest: 1  Second Highest: 1  Third Highest: 0</td>
</tr>
<tr>
<td>Lesson goals, assessments, &amp; mathematical task alignment (Weeks 1 &amp; 2)</td>
<td>Highest: 0  Second Highest: 0  Third Highest: 0</td>
</tr>
<tr>
<td>OTHER-It is okay for people to have different teaching beliefs</td>
<td>Highest: 0  Second Highest: 1  Third Highest: 0</td>
</tr>
<tr>
<td>OTHER-Teaching is difficult and messy</td>
<td>Highest: 0  Second Highest: 0  Third Highest: 1</td>
</tr>
</tbody>
</table>

Two mentors stated comments that spanned multiple curricular topics and were thus listed as “other” in Table 1. As no mentor was coded as indicating the same curricular topic more than once, Table 1 shows that 10 of 11 mentors valued learning how to facilitate post-observation discussion, but critical reflection during small group meetings was mentioned by only two mentors.

**Discussion**

**Summary**

In sum, our study provides valuable information about how a peer-mentorship model influenced mentor GSIs’ perspectives on teaching and learning (RQ1) and identifies aspects of the model that mentor GSIs found valuable in learning (RQ2). Although the t-tests indicated no significant variance in mentors’ perspectives on teaching and learning, the reflective interviews indicated qualitatively that the mentor PD resulted in mentors thinking about certain terms, such as “success” as relative to courses and students they were currently teaching. Thus mentors were able to deconstruct the dichotomic paradigm (true/false) prevalent in mathematical statements but not mathematics education. These results align with the results for RQ2 because the mentors suggested that they greatly valued focusing on post-observation discourse. When mentors provide constructive feedback to protégés after observing their classroom teaching, it is crucial
that they address teaching concerns with subjective understanding of words such as “success” so as not to indicate to protégé GSIs that there is an absolute correct way of teaching or defining student “success”.

Implications for Research

This study informs the field’s knowledge of GSI guidance and support by illustrating how this mentor PD in the context of a peer-mentorship model can influence experienced GSIs’ understanding of mentorship, teaching, and learning. Through the peer-mentorship model, our research illuminated that the mentor PD did influence GSIs ability to justify their pedagogical understanding of certain terms. Although this does not directly indicate that mentor GSIs were able to justify pedagogical decisions they made in their own classes, their choice to value discursive facilitation and their ability to deconstruct terms such as “primarily” and “success” indicate their ability to consider multiple factors needed to reason and justify pedagogical decisions, a crucial concern of the current literature (Rogers & Steele, 2016).

Additionally, the results of RQ2 corroborate Boyle and Boice’s (1998) recommendation that mentor meetings focus on productive discourse. That is, Boyle and Boice identified that discussion of undergraduates and teaching styles were the most frequented discussions in mentor meeting and Table 1 indicates that facilitating post-observation discourse and facilitating group meeting discussions were the most popular of the highest and second-highest learned topics, respectively. This emphasis on discourse was the foundation of Smith and Stein’s (2011) canonical work on discourse best-practices, which was used in the topics from the review weeks (1 & 2) and creation of the peer-mentorship model.

Implications for GSI Programs

The emphasis on discourse illustrated by the results of this study is an ideal way to begin in developing peer-mentoring programs for GSIs because from this discourse stems the need and value of a community of practice amongst GSIs within mathematics departments. In their research on how mathematics teaching practices shifts undergraduate instructors’ academic identities, Kensington-Miller et al. (2014) emphasize the need for a community of practices for an improvement in teaching practices to take place. These researchers define a community of practice as “a place of collaborative inquiry where various approaches to teaching can be tested through a reflective sharing process . . . [A community of practice] can contribute to deeper levels of awareness and achieve new learning that can, in turn, lead to significant change” (Kensington-Miller et al., 2014, p. 829). To work through reflective sharing for achieving awareness, a community requires a safe environment with a knowledgeable facilitator for productive discourse, which was an aspect of our mentor PD that the mentor GSIs greatly valued. Thus our data corroborates and aligns with prior research (Boyle & Boice, 1998; Kensington-Miller et al., 2014; Smith & Stein, 2011), by underscoring the need for mentors to be skilled at facilitating productive discourse in a collaborative environment and systematically organizing mentor meetings in hopes of generating a sustainable community of practice.

References


