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Assessing Graduate Teaching Assistants' Beliefs and Practices

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Graduate teaching assistants (GTAs) play a crucial role in North American colleges. At a mid-Atlantic, land grant institution, GTAs instruct 34,000 undergraduates per semester. Given this scope, GTAs exert a powerful influence on undergraduate learning, yet little is known about their teaching beliefs in relation to their classroom practices. This exploratory study aims to address this gap. Eleven GTAs were interviewed, and their teaching was videotaped to compare their teaching beliefs and classroom practices. The results revealed that GTAs hold teacher-centered beliefs about content but more student-centered beliefs about learning. The implications of these findings regarding GTA training are described.

Introduction

The Role of Graduate Teaching Assistants

At large research universities, graduate teaching assistants (GTAs) often carry a significant portion of the teaching load, meaning that the quality of undergraduate education relies heavily on this cadre of student instructors. Nationally, GTAs are report to teach 91% of lab courses, and they teach 25-50% of undergraduate courses as a whole (Nicklow, Marikunte, & Chevalier, 2007). GTAs often instruct general education requirements and introductory courses, exercising a major impact on undergraduate success and retention. Thus, GTAs are often the first college instructors

that first-year students encounter, and they are crucial in helping fledgling college students develop fundamental skills (Nicklow et al., 2007). At West Virginia University, a mid-Atlantic, public, land grant institution with a Carnegie Research High ranking, GTAs instruct 34,000 undergraduates per semester, constituting 21.3% of the university's undergraduate instruction (Institutional Research, 2012). While most science, technology, engineering, and math (STEM) GTAs serve as laboratory instructors, several departments in the humanities and social sciences designate GTAs as the instructor of record in their courses. In both settings, the GTAs' contribution to undergraduate teaching highlights the need to examine their beliefs about an instructor's role in the classroom, the ways that students learn best, as well as their teaching practices. This study approaches the issues of teaching beliefs and practices through the lens of *reformed teaching*.

Reformed Teaching Framework

Preparing undergraduate students for the 21st-century economy and equipping them with higher-order critical-thinking skills has become more pressing across disciplines (Blaich & Wise, 2011; Slavich & Zimbardo, 2012). To help students develop these skills, many educational researchers have focused on refining student-centered models of instruction. One such model of student-centered learning is *reformed teaching*. Reformed teaching relies on a constructivist epistemology that foregrounds the students' role in actively assembling knowledge (American Association for the Advancement of Science, 1989; Handelsman, Miller, Pfund, & Wisconsin Program, 2007). Reformed teaching involves both teaching beliefs and teaching practices: *Beliefs* include the role of the teacher and the way that students learn; *practices* emphasize students actively engaging in tasks that require higher-order thinking skills. In reformed teaching, teachers view their own role as facilitating students' intellectual growth by providing avenues for student exploration. These teachers believe that the classroom activity should be guided by students' questions and investigation. Reformed teaching beliefs, when implemented effectively, lead to classroom activities in which students develop questions, investigate, collect evidence, and evaluate their solutions. This model of teaching prioritizes student-to-student interaction and collaborative problem solving through hands-on and higher-order thinking activities (Sawada et al., 2002). Reformed teaching concepts align with similar models of student-centered instruction (see, for instance, the Association of American Colleges and Universities, Liberal Education and America's Promise initiative; Association of American Colleges and Universities, 2015).

One such model, the Wabash National Study of Liberal Arts, identified

several best practices for teaching that promote student learning (Blaich, 2015). According to the Wabash study, students who experienced the most gains in undergraduate education ranked their experiences high in “academic challenge and effort”; “frequency of higher-order exams and assignments”; “challenging classes and high faculty expectations”; and “integrating ideas, information, and experience” (Blaich & Wise, 2011, p. 8). These practices emphasize higher-order thinking skills, in which the instructor facilitates and coaches students toward more autonomous, self-directed learning, with the belief that students will rise to the instructor’s expectations and the challenges put forth to them.¹ In keeping with the Wabash study practices, Slavich and Zimbardo (2012) synthesized several contemporary teaching strategies into the framework of “transformational teaching,” which includes three basic principles: “(1) facilitate students’ acquisition and mastery of key course concepts; (2) enhance students’ strategies and skills for learning and discovery; and (3) promote positive learning-related attitudes, values, and beliefs in students” (p. 13). All of these practices coincide with the tenets of reformed teaching and provide the framework for assessing teaching in this study.

GTA Practices and Training

Although there is a growing body of research on reformed teaching beliefs and teaching practices (De Leone, Marion, & Ishikawa, 2006; Ellett, Monsaas, Martin-Hansen, & Demir, 2012; Flick, Sadri, Morrell, Wainwright, & Schepige, 2009; Villasenor & Etkina, 2006), little research has focused on GTAs’ teaching beliefs and practices (Ryker & McConnell, 2014). Existing research on teaching beliefs finds that novice teachers begin teaching with pre-formed beliefs about how to teach and how students learn (Kagan, 1992; Åkerlind, 2007). These beliefs are difficult to change without substantial reflection on their own teaching identity and practices. Likewise, prior beliefs influence instructors’ interpretation of new experiences, and changing this interpretation may require frequent feedback from a mentor or professional development program (Kagan, 1992; Kane, Sandretto, & Heath, 2002; Åkerlind, 2008). For most novice instructors, such as GTAs, beliefs originate from their view of themselves as students; for many instructors, this view is biased by their own motivation to succeed and positive attitude toward school. When instructors encounter negative responses from their students, they may quickly become disillusioned with student-centered teaching or focus their practices on teacher-centered areas such as classroom management strategies. Such reactions may hinder the development of student-centered

beliefs about student learning and discourage student-centered teaching practices (Kagan, 1992; Kane et al., 2002).

Furthermore, past research on the association between teaching beliefs and practices has investigated how teachers view knowledge in their subject and what strategies they employ to teach the content area. Teaching beliefs often precede and inform practices, but the two areas can co-evolve over time based on significant training and experience (Luft & Roehrig, 2007; Postareff, Lindblom-Ylänne, & Nevgi, 2008). Åkerlind's (2007) research on instructors' views of teaching identified five approaches that instructors take to develop as a university teacher, ranging from gaining more content knowledge—the most teacher-centered—to understanding which teaching strategies are “effective in facilitating student learning”—the most student-centered approach (p. 27). Åkerlind's (2007) analysis reveals that instructors who are focused primarily on deepening their own content knowledge do not value professional development opportunities addressing classroom strategies to increase student learning. The more teacher-centered the belief, the less receptive the instructor was to student-centered practices. Instructors' beliefs about the teachers' role and the way that students learn, thus, have a direct influence on their choice of teaching practices.

One study of novice instructors (Roehrig, Luft, Kurdziel, & Turner, 2003) found that chemistry GTAs who were expected to implement inquiry-based laboratory classes were limited by their lack of instructional skills and incomplete understanding of how students learn. This type of negative teaching experience might reinforce teacher-centered beliefs and deter GTAs from implementing reformed teaching practices. Likewise, Russell (2009) found that many GTAs do not feel adequately prepared or supported in their teaching, and consequently, they may not have the tools to engage in student-centered teaching practices. Other research has found that gradually increasing GTAs' responsibilities enhances their teaching effectiveness (Wulff, Austin, Nyquist, & Sprague, 2004) and that GTAs who were trained in student-centered teaching techniques became more proficient and confident in adopting these techniques (Pentecost, Langdon, Alsratham, Robus, & Parson, 2012; Wright, Bergom, & Brooks, 2011).

At West Virginia University, the disparities in department-level expectations and support are substantial. Several departments ask GTAs to serve as instructors of record in a “supervised instructor” model, and these departments often provide pedagogy courses or regular supervision meetings for their GTAs. Departments with laboratory GTAs vary widely in their pedagogical training, and some departments with both types of GTAs offer no formal training. University-wide professional development

opportunities for GTAs have increased, but most of these activities are voluntary. With a wide range of professional support and responsibilities, GTAs must navigate their role as instructors, playing a vital part in teaching undergraduates, completing the coursework in their graduate programs and, often, being active members in their research laboratories. Because of these factors, learning more about these GTAs' teaching beliefs and practices is an urgent area of inquiry.

Purpose of the Study

Kane et al. (2002) found that few studies have combined research on teaching beliefs with actual analyses of practice. In fact, many studies attempt to infer teaching practice from interviews or surveys about participants' beliefs, leading to an incomplete picture of how these beliefs interact with practice. This study draws on the model of Addy and Blanchard (2010), which addresses beliefs and practice by combining the Teacher Beliefs Interview (TBI) with the Reformed Teacher Observation Protocol (RTOP). In their sample, Addy and Blanchard examined the association between teaching beliefs and practices within a group of eight GTAs who were in the same discipline (Biology) and were receiving the same training through a reform-based certificate program on college teaching. To date, Addy and Blanchard's (2010) study is unique in publishing this combination of TBI and RTOP data with a group of GTAs. This exploratory study builds on their model by recruiting participants from different departments in order to gain a cross-disciplinary perspective. The study employs a qualitative approach that combines (1) the Teacher Beliefs Interview (TBI; Luft and Roehrig, 2007) and (2) classroom video recordings examined using the Reformed Teacher Observation Protocol (RTOP; Sawada et al., 2000).

Our initial research question was this: *Will GTAs' beliefs about their role as a teacher and the way students learn, as stated in their Teacher Beliefs Interview, align with their observed teaching practice, as categorized by the Reformed Teacher Observation Protocol?*

Method

To examine GTAs' beliefs and practices, this exploratory study used a multi-method, qualitative research approach. Strauss and Corbin (1998) described qualitative research as "any type of research that produces findings not arrived at by statistical procedures or other. It can refer to research about persons' lives, lived experiences, behaviors, emotions, and

feelings as well as about organizational functioning, social movements, cultural phenomena, and interactions between nations" (pp. 10-11). The qualitative method provides researchers with opportunities to engage with participants and collect rich data. In this study, the researchers used interviews to understand GTAs' beliefs about teaching. The Teacher Beliefs Interview uses the reformed teaching paradigm to define "beliefs" along a continuum from teacher-centered to student-centered; interview questions ask subjects to discuss two distinct epistemological areas: their own role as instructor in the classroom and the ways their students learn best. Through this series of questions, the interview seeks to establish instructors' beliefs about effective modes of teaching and learning (Luft & Roehrig, 2007). The RTOP codifies the practices of reformed teaching (Sawada et al., 2002) and has been used in both K-12 and higher education settings to observe teaching practices from a reformed perspective (Derting & Ebert-May, 2010).

Procedure

Data were collected at West Virginia University, a mid-Atlantic, land grant institution with a Carnegie Research High ranking. GTAs from across the university were invited to participate in the study at the beginning of fall 2012 semester, and 11 GTAs volunteered to participate in both components of the study. Participants completed an interview and agreed to be videotaped during one of their class sessions.

Participants

All 11 participants, seven females and four males, were full-time graduate students. The majority of the GTAs were in their early 30s, and all indicated that English was their primary language. Nine of the GTAs were pursuing doctoral degrees; the others were pursuing master's degrees. Five of the GTAs were pursuing degrees in a STEM field, four in humanities and the arts, and two in social sciences or education. Of the 11 GTAs, only two were laboratory instructors (one in Biology and one in Statistics); the rest were supervised instructors of lecture-based courses (Economics, English, First-Year Seminar, Mathematics, Music, and Women's Studies). All GTAs lectured and graded; however, fewer were involved in designing exams and assignments or assisting with the development of the course curriculum. Of the 11 GTAs, nine had previously taught the course they were teaching during the study. Ten GTAs mentioned that their respective departments provided them with assistance preparing for the class or training as instructors.

Data Collection

Two data collection sources (Teacher Beliefs Interview and Reformed Teacher Observation Protocol) were utilized to determine the GTAs' beliefs about teaching and how they align with their practices in the classroom. Data were collected by the authors, with the first and second author conducting most of the interviews, and the first and third author video-recording most of the classes.

Interview Measures

The GTAs were interviewed using the Teacher Beliefs Interview as described by Luft and Roehrig (2007) to examine their perceptions about their own role as teachers and the ways that students learn best. The interview consisted of seven open-answer questions in the order listed by Luft and Roehrig:

1. How do you maximize student learning in your classroom?
2. How do you describe your role as a teacher?
3. How do you know when your students understand?
4. In your course, how do you decide what to teach and what not to teach?
5. How do you decide when to move on to a new topic in your classroom?
6. How do your students learn best?
7. How do you know when learning is occurring in your classroom?

The GTAs were asked to answer the questions as they interpreted them. The interviewer (one of the authors) audio recorded their answers and also took notes on their responses. GTAs spent, on average, 10-20 minutes completing the interview.

Coding of Interviews

Luft and Roehrig (2007) state that individuals' answers can be coded along a continuum from traditional and teacher-focused (that is, teacher as deliverer of information) to reform-based and student-focused (that is, teacher as provider of experiences to mediate knowledge). The questions

can also be grouped based on their focus on teaching (questions 1 to 5) or focus on learning (questions 6 and 7). Transcriptions of participants' answers were coded independently by the second and third authors. At research team meetings, the second and third authors shared their coding of the transcriptions. When discrepancies arose, they reviewed the transcript with the first author to come to an agreement. Teacher Beliefs Interview transcripts were analyzed using the pre-existing categories scheme defined by Luft and Roehrig (2007) as shown in Table 1.

Videotape Measures

To ascertain GTAs' teaching practices, one class session during the middle of the semester (class length = either 50 minutes or 75 minutes) was video recorded. The recording was then coded using the Reformed Teaching Observation Protocol aspects as described by Sawada et al. (2000). Five aspects of teaching were evaluated:

- Lesson design and implementation
- Propositional knowledge
- Procedural knowledge
- Communicative interactions
- Student/teacher relationships

Sample criteria that illustrate the reformed teaching model include the following: "In this lesson, student exploration preceded formal presentation," and "Intellectual rigor, constructive criticism, and the challenging of ideas were valued" (Sawada et al., 2000). Within each aspect of teaching, the coders evaluated specific criteria on a scale from 0 (*never occurred*) to 4 (*very descriptive of class*) and took detailed notes about classroom activities.

Coding of Videotapes

These detailed observation notes were used in conjunction with RTOP items to assess the nature of classroom practices. GTAs' teaching practices were classified into one of five teaching types in line with Ebert-May and colleagues (2011; see Table 2).

The video recordings were coded by the first-author, who had previous experience with the RTOP, and the third author. At research team meetings, the coders shared their coding of the video recordings. When discrepancies arose, they reviewed the recording and their notes to reach an agreement.

Table 1
Categorization Scheme of TBI

<i>TBI Category</i>	<i>Type of Instruction</i>
Teacher-Focused	Traditional (deliverer of information) Instructive (provider of experiences)
Transitional	Foster Teacher/Student Relationships
Student-Focused	Responsive (promote collaboration) Reform-Based (mediator of student knowledge or interactions)

Source: Adapted from Luft & Roehrig (2007), Teacher Beliefs Interview (TBI)

Table 2
Categorization of RTOP Scores

<i>RTOP Category</i>	<i>Typical RTOP Score</i>	<i>Type of Teaching</i>
I	0-30	Straight lecture
II	31-45	Lecture with some demonstration and minor student participation
III	46-60	Significant student engagement with some minds-on as well as hands-on involvement
IV	61-75	Active student participation in the critique as well as the carrying out of experiments
V	76-100	Active student involvement in open-ended inquiry, resulting in alternative hypotheses, several explanations, and critical reflection

Source: Adapted from Sawada (2002) and Ebert-May et al. (2011), Reformed Teaching Observation Protocol (RTOP)

Results

This section presents qualitative responses regarding GTAs' beliefs about teaching and student learning, followed by evaluations of their classroom practices. The section concludes by examining the integration of GTAs' beliefs and practices.

GTAs' Beliefs About the Role of the Teacher

Specifically examining participants' responses about their teaching, GTAs' descriptions of themselves as a teacher (TBI question 2) were, on average, *transitional* (somewhat student-focused). Six GTAs described themselves in terms that were *transitional* (that is, GTAs value teacher / student relationships). Two GTAs were coded as mostly teacher-focused and *traditional* (that is, GTAs describe themselves as a deliverer of information). Other participants' responses represented a range from teacher-focused to student-focused beliefs.

For example, an *instructive response* (categorized as teacher-focused) from a GTA in Economics explained the role of an instructor as a conveyer of knowledge:

With more freshmen they feel like our role is similar to a role that a high school teacher will have. . . . I feel like when you are in a college setting the role of the instructor is to pass across information from one person . . . it's not my job to make sure they are learning . . . if they are not coming to me for help, if they are not putting in any effort to come see me, then it's not my responsibility to make sure they are learning.

An example of *transitional response* (categorized as somewhat student-focused) provided by a GTA in Biology described the role of an instructor as a coach or a facilitator:

As a teacher, I see myself more as some kind of a coach helping people work their way through knowledge rather than just giving people knowledge that doesn't work kind of guiding with questions and prompting, helping folks getting where they need to be when you give them questions.

An example of *responsive response* (categorized as student-focused) provided by a GTA in Music conceptualized an instructor as a co-learner and a guide:

I encourage [students] to share their material with me as well because I am still learning. . . . I am trying to make it more rele-

vant for them but I am also guiding them because a lot of them don't feel comfortable with music or they are not really confident in singing . . . so guiding, [being a] co-learner.

Another GTA in Music provided a *reform-based response* (categorized as mostly student-focused):

I am there . . . to help them discover their best way of learning the information and because I have a lot of education students not just performance people. . . . I try to use it as a [real life] learning course as well giving the multiple examples of ways they could teach the same topic to their own students more so with respect to some of the exercises and things we do with reciting and music exercises. . . . I try to show them different ways to approach things that I hope they will be able to use with their own students, so I am there as a mentor. . . . I feel like my examples could be carried over into other classes.

GTAs' Responses About Their Control Over the Curriculum and Pace in the Course

More than half of GTAs' responses regarding how they decide what to teach and what not to teach (TBI question 4) were in the teacher-focused category: *traditional* (that is, GTAs' decisions are guided by the adopted curriculum) and *instructive* (that is, decisions are based on the teacher's authority). For example, nine GTAs remarked that the course was already laid out for them and that they have a relatively strict schedule to follow. In addition, the majority of GTAs' responses regarding when to introduce the next topic (TBI question 5) were teacher-focused: *traditional* (that is, the decision to introduce the next topic is directed by the curriculum) and *instructive* (that is, the decision to introduce the next topic is based on basic student understanding).

The GTAs' responses to these last two questions indicated that very few had control over the curriculum and pace in the course. For example, *traditional* and *instructive* responses for TBI questions 4 and 5 were similar to the following two statements, respectively:

I don't have very much control of the content I am going to teach; [it is] pretty much decided [for me].

We obviously have deadlines; about every 4-weeks we move on to the next section, so I have to make sure I get through all the material.

GTAs' Beliefs About Student's Learning

GTAs' responses about student learning, specifically, about how they know their students understand (TBI question 3), were between teacher-focused and *transitional* (somewhat student-focused). Five GTAs' responses were coded as teacher-focused: one as *instructive* (that is, students mimic the teacher) and four *transitional* (that is, students use procedures and guidelines). GTAs referred to students' ability to demonstrate their knowledge through various assessments (for example, quizzes, group work, reflection papers) or the ways students behave (for example, blank stares, questions) to show whether or not they understand the material.

On the other hand, GTAs' responses about how they know when learning is occurring (TBI question 7) and how students learn best (TBI question 6) were between *transitional* and student-focused (*responsive* and *reform-based*), noting students' actions or reactions during the class. Specifically eight GTAs' responses about how students learn best were coded as student-focused: *responsive* (that is, students can interpret phenomena) and *reform-based* (i.e., students can elicit their ideas about phenomena). Along the same lines, five GTAs' responses about how and when learning is occurring in the classroom were coded as student focused (*responsive* and *reform-based*) and four *transitional*.

A GTA in Biology provided an example of students interacting: "Hearing questions from students . . . is when I know students are really learning and [others] can answer those questions." Another GTA in English provided an example of a student reaction:

Usually you can see on their faces. . . . [I] usually say to someone, "I just saw a lightning bolt." So I am pretty good at looking at facial clues; that's one very practical way you learn to know when students are [understanding].

The techniques from which GTAs believed students learn best included group discussion, hands-on activities, peer-to-peer teaching, and coaching. Table 3 summarizes GTAs' responses regarding how students learn best and the role of the teacher. Representative quotes across TBI categories show the range of responses from student-focused to teacher-focused.

Reformed Teaching Observation Protocol (RTOP)

The coding of GTAs' teaching practices during class revealed that most engaged students with moderate to high levels of interaction by using interspersed activities, discussions, and demonstrations. Across classes, though, these interactions varied in the degree to which they involved

Table 3
TBI: Representative Examples of GTAs' Beliefs About Their Roles and Students' Learning

<i>Questions</i>	<i>Examples</i>	<i>TBI Category</i>
How students learn best	<p>"My students learn best through discussion and they really like videos. . . . I typically don't lecture for an entire class. . . . I am consistently bringing up new videos, or bringing in statistics and maps and other readings so I can keep them on their toes."</p>	<p>Responsive: Focus on collaboration, feedback, or knowledge development.</p> <p>Student-Focused</p>
	<p>"They learn best through doing. This comes from my philosophy and music teacher I follow a certain method called the Orff Schulwerk method . . . it's based on active participation and using things that children like."</p>	<p>Transitional: Focus on teacher / student relationships, subjective decisions, or affective response</p> <p>Transitional</p>
	<p>"I think they learn best by examples I always try to present the main material first like in definition form or whatever and then so I say like this is what we are going to do and then I do examples and I do examples that are very similar to the examples in their weekly homework assignment that they have to do so I think they learn best by doing examples and by seeing how to handle certain problems in certain situations."</p>	<p>Instructive: Focus on providing experiences, teacher-focus, or teacher decision.</p> <p>Teacher-Focused</p>

Table 3 (continued)
TBI: Representative Examples of GTAs' Beliefs About Their Roles and Students' Learning

<i>Questions</i>	<i>Examples</i>	<i>TBI Category</i>
Role as a Teacher	<p>"I see [myself] as a guide . . . and also a co-learner [because] they bring to the table very different experiences than I have . . . I am very interested in to see what materials they know I encourage them to share their material with me as well because I am still learning I am trying to make it more relevant for them but I am also guiding them because a lot of them don't feel comfortable with music or they are not really confident in singing. . . ."</p>	<p>Responsive: Focus on collaboration, feedback, or knowledge development.</p> <p>Student-Focused</p>
	<p>"As a teacher, I see myself more as some kind of a coach helping people work their way through knowledge rather than just giving people knowledge."</p>	<p>Transitional: Focus on teacher/student relationships, subjective decisions, or affective response.</p> <p>Transitional</p>

<p>"I am definitely not one of those who feel like I am the fountainhead of learning. I like to consider my role as more as a conversationalist than a strict lecture."</p>	<p>Transitional: Focus on teacher / student relationships, subjective decisions, or affective response.</p>	<p>Transitional</p>
<p>"My role as a teacher really is to get these students know what they need to know it's not to get them through a class or a grade I think that is a common misconception by students."</p>	<p>Instructive: Focus on providing experiences, teacher-focus, or teacher decision.</p>	<p>Teacher-Focused</p>

Source: Adapted from Luft & Roehrig (2007), Teacher Beliefs Interview (TBI)

teacher-centered or student-centered activities. Teacher-centered activities, as coded in the RTOP, tend to have a fixed outcome or lead students toward a pre-determined conclusion with little room for student exploration or inquiry. On the other hand, student-centered activities, as coded in the RTOP, tend to be more open-ended with opportunities for students to determine the focus and direction of the activity. Simply including a class activity is not sufficient to be evaluated as *reformed* on the RTOP scale; class activities that allow for student inquiry, autonomy, and peer-to-peer learning are those that are coded as *reformed*.

As noted in Table 4, GTAs were coded highest on *propositional knowledge* (that is, the instructors' knowledge and expertise in the content), followed by *student-teacher relationships* (that is, the instructor's willingness to wait for student responses and facilitate student learning), *lesson design and implementation* (that is, the extent to which the lesson relies on prior student knowledge and allows student ideas to determine the direction of the session), *communicative interactions* (that is, the proportion of student to student and student to teacher interaction), and *procedural knowledge* (that is, the types of activities students complete).

Two GTAs who both incorporated a high level of student activity demonstrated the nuances in coding teacher-centered and student-centered engagement. The GTA for the Music class encouraged a high proportion of student interaction by having the students apply their understanding of the concept, but activities were somewhat teacher-centered. For example, students in this music education class were asked to practice a kinesthetic interpretation of a piece of music. This type of interpretation, as explained by the instructor, would be a teaching tool for elementary school music students to help them gain understanding of rhythm, tempo, and dynamics. First, the instructor demonstrated how to use body movements to interpret a piece of music; then, students in the class practiced creating a similar kinesthetic interpretation of a piece. For these activities, the students largely followed the instructor's model to create a pre-determined type of output; thus, the activities asked the students to apply material but not necessarily to critique it or create new ideas.

On the other hand, the GTA for the Biology lab acted as a facilitator during the class. The students were actively engaged in student-centered group activities and discussion of the topic. The class session followed a progression of activities that involved peer-to-peer discussion and negotiation of meaning. For instance, groups discussed an article and identified the two most important points, then shared these points with the entire class. Small groups also drew phylogenetic trees and paired with other groups to revise their drawings. During these activities, the instructor

Table 4
**Classification of GTAs' Results
 in RTOP Subcategories From Highest to Lowest**

<i>RTOP Category</i>	<i>Description</i>
Propositional Knowledge	How teacher implements her/his knowledge—use of abstractions, connections with real world, promotes conceptual understanding, knows the subject
Student/Teacher Relationships	Environment that the teacher emphasizes—active participation by students, facilitates rather than leads learning, patience, encourages students to initiate their own thinking
Lesson Design and Implementation	Use of learning cycle approach—explore, learning community, ideas originate from students, alternative approaches by students
Communicative Interactions	Mainly what communications occur by the students—use a variety of means, different ways of solving problems or thinking, lots of student to student talk, students initiate questions and ideas
Procedural Knowledge	What students do in the class as reflective of learning—use different means of learning, make predictions/hypotheses/tests, minds-on activities, challenge and critique ideas

Source: Adapted from Sawada et al. (2000), Reformed Teaching Observation Protocol (RTOP)

circulated among groups and answered questions to help clarify their work. Because these activities relied on students constructing knowledge and performing higher-level thinking, the RTOP evaluation placed the class in a more student-centered category.

Integration of Results

Table 5 provides an overview of the participants' overall RTOP category alongside their overall TBI category. After we evaluated their interviews and classroom observations as a whole, GTAs were grouped into two categories, as follows:

- Teacher-focused behaviors and activities for RTOP and TBI
- Somewhat student-focused behaviors and activities for RTOP and TBI

The findings from the interviews tended to match the findings from the videotapings in terms of overall TBI and RTOP categories. Across the TBI and RTOP categories, GTAs exhibited traits of two primary categories: *instructive* (mostly teacher-centered) and *transitional* (somewhat student-centered). These two categories represent the middle of the spectrum, being neither fully teacher-centered (traditional lecture) nor fully student-centered (reformed).

Discussion

General Synopsis

This study used a reformed teaching paradigm to assess the teaching beliefs and practices of an interdisciplinary group of GTAs at a large research university. Although the overall TBI and RTOP results are closely grouped in two main categories, comparing the aggregate TBI and RTOP results does not fully reflect the nuances of beliefs and practices exhibited by GTAs in each question or subcategory. Closer analysis of the TBI and RTOP results reveals that both beliefs and practices are contextual and exhibit variations across a spectrum from teacher-centered to student-centered.

Specifically, GTAs' teaching beliefs tended to be teacher-centered regarding their role as instructors. In the TBI, GTAs described themselves in mostly "instructive" terms that emphasize the teacher providing experiences to the students and making decisions about classroom activities. One possible explanation for this trend is that GTAs need to establish authority in the classroom because they are not considered professors and because they are often close in age to their students. This authoritative stance may lead to more teacher-centered beliefs about their role. Furthermore, as indicated above in GTAs' responses, many times the course syllabus and schedule were already designed for the GTA, allowing them little flexibility in format and progression.

Table 5
Overview of GTA's Beliefs and Practices Break-Down

<i>RTOP Category and Type of Teaching</i>	<i>Break-Down</i>	<i>TBI Category</i>
I. Straight Lecture—no interactions between students and professors (e.g., questions asked and answered)		Traditional: focus on information, transmission, structure, or sources
II. Lecture with some demonstration and minor student participation (e.g., asking students questions, some lower-level clickers questions, responding to student questions)	GTA 4 (lecture) GTA 5 (lecture) GTA 7 (lab) GTA 10 (lecture) GTA 11 (lecture)	Instructive: Focus on providing experiences, teacher-focus, or teacher decision
III. Significant student engagement with some minds-on as well as hands-on involvement (e.g., students are actively engaged for a majority of the class period)	GTA 1 (lecture) GTA 2 (lab) GTA 3 (lecture) GTA 6 (lecture) GTA 8 (lecture) GTA 9 (lecture)	Transitional: Focus on teacher/student relationships, subjective decisions, or affective response
IV. Active student participation in the critique as well as the carrying out of experiments		Responsive: Focus on collaboration, feedback, or knowledge development
V. Active student involvement in open-ended inquiry resulting in alternative hypotheses, several explanations, and critical reflection		Reform-Based: Focus on mediating student knowledge or interactions

Source: Adapted from Luft and Roehrig (2007), Teacher Beliefs Interview (TBI); and Ebert-May et al. (2011), Reformed Teaching Observation Protocol (RTOP)

By contrast, GTAs' beliefs about students' learning were more student-centered. TBI responses on how to maximize student learning and how students learn best were coded as *transitional, responsive, or reform-based*. For the most part, these GTAs recognize reformed practices for student learning—engaging in application, discussion, active learning activities, and problem solving. The discrepancy between the teacher-centered beliefs about the teacher's role and the student-centered beliefs about the students' role may indicate that GTAs observe how student learning occurs, but they may not be able to implement class activities due to lack of course independence, lack of knowledge about how to integrate the practices, or inability to relinquish their teacher-centered perception of instructors.

RTOP observations support that GTAs also exhibit teacher-centered behaviors in some aspects of teaching and student-centered behaviors in other aspects of teaching. During class sessions, GTAs included varying amounts of interaction, but, in general, the student activities included more teacher-centered than student-centered interactions. In other words, activities were fairly pre-determined and closed-ended rather than requiring high levels of student inquiry or problem solving.

GTA instructors were successful at demonstrating their own content knowledge ("propositional knowledge"), but they varied in their ability to lead students toward independent inquiry in the reformed teaching mode. In the RTOP, *procedural knowledge* was the lowest-rated category for all participants because the criteria require that students consistently engage in analysis, synthesis, and evaluation level activities, to use Bloom's Taxonomy terms (Bloom, 1956). Specifically, to meet the RTOP criteria for a high-level *procedural knowledge* evaluation, students must consider alternative viewpoints, solve open-ended problems, and construct knowledge through hands-on activities. For any instructor, whether experienced or not, maintaining a high level of critical thinking throughout a class period is difficult. Learning how to design activities with high-level critical thinking requires training, practice, and patience. The GTAs in our study exhibited many promising teaching practices, including discussions, problem solving, and application exercises; extending these activities to a fully reformed model would mean putting more onus on the students to develop questions, investigate potential answers, and evaluate information throughout a class.

Implications for GTA Training

The 11 participants who completed the study were self-selected in-

structors, some of whom specifically studied pedagogy in their programs. For instance, the Biology GTA had already earned a master of science in education before beginning the Ph.D. program, and this GTA's research focused on undergraduate STEM education as part of a faculty research lab on that subject. Likewise, one of the Music GTAs was teaching in the music education program that focused on student-centered pedagogy. Of the 11 subjects, the instructor with the least experience, the Statistics GTA, employed the most teacher-centered instructional methods. This finding indicates that enthusiasm for teaching, combined with pedagogy training, may help shape GTAs' teaching beliefs and result in more student-centered practices.

The instructors who elected to participate in the study, then, already exhibited enthusiasm and motivation. Therefore, it is not surprising that their teaching beliefs and classroom activities would demonstrate characteristics of transitional and student-centered teaching. Even though their lack of freedom with the syllabus, pace, and topics in the course prevented them from making any large-scale course changes, they had autonomy over individual class sessions. In this supervised instructor model, they were responsible for course content while having limited ability to change the organization or assessments. Their beliefs and practices indicated commitment to facilitating learning through student engagement; at the same time, they recognized the bureaucratic constraints of their limited role in course design. This tension between pre-determined syllabi and planning effective lessons has been noted in previous literature on teaching beliefs in university teaching certificate participants (Norton, Aiyegbayo, Harrington, Elander, & Reddy, 2010).

Research indicates that extensive pedagogical support through mentoring, coursework, and self-reflection can positively impact inexperienced instructors' beliefs about their own teaching self-efficacy. Gaining self-efficacy through pedagogical knowledge and mentoring has been shown to influence teaching effectiveness by encouraging instructors to implement the student-centered methods they have learned (Postareff et al., 2008). Likewise, research on faculty has shown that short, intensive training may not produce the desired long-term change in teaching practices. In NSF-sponsored research (Ebert-May et al., 2011), STEM faculty participating in week-long summer institutes reported that they would make substantial changes to their courses in order to implement student-centered practices, but video recordings of their teaching revealed that the faculty tended to revert to teacher-centered methods rather than implement new techniques. The study indicated that lack of time, practical constraints around implementation, student attitudes, and student

evaluations deterred these participants from making substantial changes in their teaching practice. Thus, Ebert-May and colleagues recommend a sustained mentoring and support program following their intensive pedagogical training in order to influence faculty in making long-term changes. Åkerlind's research (2007, 2008) indicates that professional development programs need to delve deeply into participants' conceptions of teaching and learning in order to uncover their assumptions, promote instructor buy-in for the program, and encourage adoption of student-centered teaching practices.

For GTAs, it seems that brief orientations may not instill lasting change. However, courses or certificate programs may achieve better results through consistent mentoring and guided exploration of the nature of teaching and learning, informed by current research. Studies of university teaching certificate programs indicate gains in participants' assessment of their teaching skills (Taylor, Schönwetter, Ellis, & Roberts, 2008); similarly, GTA mentoring programs and self-assessments of classroom video recordings have positive effects for both GTAs and their faculty mentors (Cahalan, 2013; Gaia, Corts, Tatum, & Allen, 2003).

The prevailing difficulty for GTAs is lack of time. Providing scaffolding for GTAs to practice their teaching skills while being mentored could have substantial impact in shaping teaching beliefs and practices. Providing training opportunities for GTAs may also enhance their job prospects, enable them to transition more smoothly to faculty positions, and promote more reformed teaching practices. Creating an institutional culture that encourages such training should be a priority for many institutions that rely on GTAs.

Limitations

It is important to recognize this study's small sample size and the fact that it was conducted with a limited subset of GTAs who volunteered their time to participate. It is also important to note that nine of the 11 GTAs in this study served as "supervised instructors." Their beliefs and practices may be different from those who primarily grade assignments and hold recitation sessions and from those who design their own courses. Thus, the findings should not be generalized to all GTAs at our institution or to GTAs across institutions. The results should, however, be used as the basis for further research on GTAs' beliefs and practices.

To influence the beliefs and practices of GTAs in a substantial way, collaborations between departments and central resources could be further developed in order to facilitate mentoring groups, pedagogy courses, and

workshop series. Pairing graduate students with faculty master teachers or more experienced GTAs may also be a useful model.

Future Directions

Notwithstanding the noted limitations, this study promotes the need for additional research comparing the beliefs and practices of educators. For example, with previous research focused on short interventions, future researchers should follow the instructors over longer periods of time to reflect the stability or progression of beliefs and practices. While continuing to collect data on GTAs' beliefs and practices, researchers may also consider gathering data from GTAs' students and supervisor(s) on their perceptions of these instructors. In addition, future researchers should assess changes in participants' beliefs and practices across various training techniques. Finally, further comparisons of GTAs across disciplines would prove valuable to investigate disciplinary differences in teaching beliefs and practices.

Conclusions

GTAs represent a vital part of the academic workforce and play a large role in undergraduate education at many institutions. Learning more about GTAs' teaching beliefs and teaching practices provides a window into the development of novice instructors. This study reveals areas of friction between teacher-centered and student-centered beliefs and practices while also showing that GTAs are capable of exhibiting some aspects of reformed teaching. Creating professional development for GTAs to engage in reformed teaching not only impacts their institutions in the short term, but also influences the future quality of higher education as these students complete their degrees and, often, transition to other institutions.

Footnotes

¹It is important to note, though, that expectations should be appropriate to students' skill and knowledge levels; expectations that are too high could lead to feelings of learned helplessness in students, believing that nothing they do will be evaluated positively by the instructor.

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