

The Pennsylvania State University

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**UNDERSTANDING FACTORS THAT INFLUENCE STEM GRADUATE STUDENT
TEACHING ASSISTANT BUY-IN TO PEDAGOGICAL TRAINING**

A Thesis in

Curriculum and Instruction

by

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ABSTRACT

Graduate teaching assistants (GTAs) are often the frontline instructors for large enrollment STEM courses at research universities. However, they often receive little training (Luft, et al., 2004). Because of the competing demands on their time and their varied career goals (Gardner & Jones, 2011), it cannot be assumed that GTAs value their teaching experience and any associated training. Little work has been done to articulate why a GTA may or may not value his or her teaching experiences and associated professional development (PD). The phenomenon of valuing pedagogical PD will be referred to as buy-in. This thesis will unpack both external and internal factors that affect buy-in as articulated in literature and compile these factors into a proposed theoretical framework. The study found that GTAs valued their PD if they perceived their teaching as a relevant experience to help them develop professional skills that would translate to their intended career path. Additionally, GTAs valued their pedagogical training if they believed it was improving their own learning or assisting them in fulfilling a responsibility to their students. These new findings are integrated into an expanded theoretical framework that better explains the phenomenon of GTA buy-in to pedagogical training.

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Chapter 1

Introduction

At many large research universities, introductory science courses (both laboratory and recitation) are taught primarily by graduate student teaching assistants (GTAs) or other non-doctoral instructors (Gardner & Jones, 2011). Often, these GTAs find themselves teaching a course in their area of study before they have begun their graduate research. They are expected to have expert knowledge of their field as well as possess appropriate pedagogical knowledge (Luft, Kurdziel, Roehrig, & Turner, 2004), despite the fact that most GTAs have only recently completed their own undergraduate degree and may not have any prior teaching experience. This creates a structure where many of the frontline instructors for introductory STEM courses have shallow content knowledge and also lack the pedagogical skill to effectively teach the course.

Research has shown that nearly half of the students who begin undergraduate degrees in STEM fields ultimately either switch to non-STEM degrees or discontinue their degrees (Olsen & Riordan, 2012). Because of this, much research has been done to investigate causes of this attrition. One of the most common student-reported reasons for this transition is unengaging introductory courses (Seymour, 1997). While GTAs are typically not in control of the curriculum, they are often tasked to deliver it at large research universities. Research shows that interactions with GTAs have a large impact on students' perception of their course work. A study (O'Neal, Wright, Cook, Perorazio, & Purkiss, 2007) found that there was a correlation between what students viewed as a positive

laboratory environment and interest in STEM. Conversely, if students participated in a lab course they viewed as frustrating or unwelcoming, there was an increased incidence of STEM attrition. As the frontline instructors for most introductory courses, universities must invest in the training of their GTAs if STEM attrition is to be decreased.

In recent years, many universities have begun to offer programs to help prepare GTAs for their roles as instructors, but these vary greatly from multi-departmental orientation sessions about university policies to yearlong pedagogy courses (Parker, Ashe, Boersma, Hicks, & Bennett, 2015). In a survey of 4000 doctoral students in the sciences at 27 universities, only one third of students reported that they participated in a training session that helped to prepare them for their teaching responsibilities (Luft et al., 2004). This variation in training leaves GTAs largely underprepared for their teaching roles, creating an environment where a university's most vulnerable students are likely paired with its least skilled instructors. Often, this is logistically necessary in order to meet enrollment needs of large service courses; however, much can still be done to improve the training for GTAs.

As the concern with GTA professional development (PD) has grown, work has been done to assess the efficacy of GTA training programs at individual universities. These studies typically focus on assessing the implementation of a training intervention and attempt to correlate the study with improved student outcomes (Reeves, Marbach-Ad, Miller, Ridgway, Gardner, Schussler, Wischusen, & Stains, 2016). Many studies have shown that through a variety of interventions measurable improvements in student learning can be correlated to GTA training programs. While this is a laudable and gains in student achievement is one of the ultimate goals of GTA training, this means that data collected is

highly contextualized to the particular intervention and perhaps more difficult to translate to other programs. There has been little work done to characterize what GTAs experience and determine which factors influence the way they respond to GTA training.

The purpose of this study is to unpack some of these influencing factors and fill in some gaps within the literature about what factors are likely to influence GTAs' buy-in to pedagogical training as demonstrated in Figure 1 below. One may argue that GTA training programs could borrow from training for preservice teachers as the population groups have some similarities in context such as experience, educational background, and sociocultural context. However, training preservice teachers is significantly different, as many GTAs do not plan to pursue careers in education and may not find the skill set personally valuable. While most STEM graduate students are required to teach as a part of their scholarship, only a fraction of the GTAs plan to pursue teaching as a career (National Science Board, 2018). For many GTAs, teaching responsibilities are seen as a departmental requirement at best and a punishment at worst. This coupled with all the competing responsibilities of STEM graduate students (personal classes, research, publishing) can reinforce a belief that large universities do not value GTA teaching, while still expecting them to be successful (Gardner & Jones, 2011). The fundamental difference between preservice teachers choosing to teach and GTAs being forced to teach can greatly alter a person's perception of the training they are receiving.

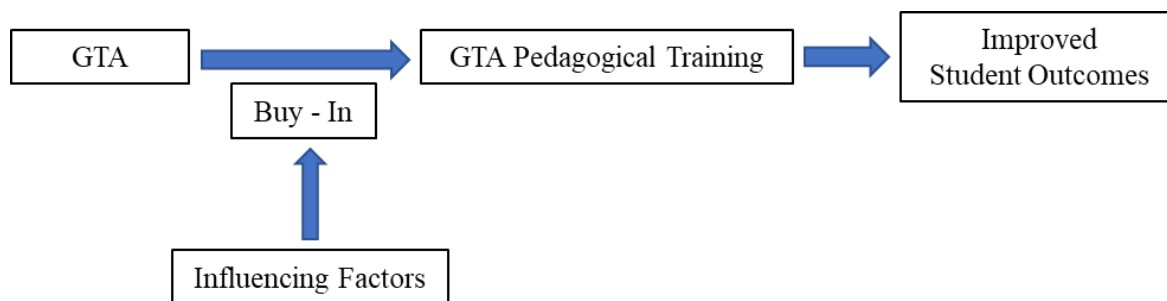


Figure 1: Basic Framework for Understanding Effect of Buy-In on Pedagogical Training

Work has been done to characterize the way a teacher’s beliefs affect his or her perception of PD (Maskit, 2011; Desimone, 2009). If a graduate student believes that teaching is solely something she or he must “get through,” this will undoubtedly be reflected in his or her teaching and their perception of any training program designed to help them. When developing a GTA training program, one cannot assume that the GTAs value pedagogical training in the same way a preservice teacher will, due to differences in career goals. Whether or not a person fundamentally values training cannot be ignored. However, as Maskit claims increased commitment to PD correlates with increased implementation. With an ultimate goal of improving undergraduate STEM student outcomes, instructors for pedagogical training programs must find ways to help GTAs value their training. In order to improve the GTA training programs offered at universities, one must move past understanding what is working in a particular intervention to better understand why some GTAs value their teaching in order to find ways to encourage this behavior in other GTAs.

As the phenomena of “valuing” something is complex and highly contextualized, it is a difficult concept to research. For the purposes of this study, the disposition of valuing pedagogical training will be referred to as “buy-in.” Little research has been done on the

relationship between buy-in and PD for GTAs; however, the few studies that exist in literature argue that there is a relationship between attitude and the efficacy of a particular intervention (Marbach-Ad, Schaefer, Kumi, Friedman, Thompson, Doyle, 2012). Goertzen, Scherr, & Elby, (2009) conducted a case study that concerned a GTA who did not buy-in to a particular intervention, which then in turn he implemented poorly. For this study, buy-in was defined as the alignment between how a GTA and an instructor thought the course should be taught. Wilcox, Yang, and Chini (2016) expanded on this and developed a method for assessing factors that influence buy-in among physics GTAs. However, all the factors that were named in the framework were pedagogical in nature. Research has shown that attitudes toward PD are more complicated than pedagogical values (Maskit, 2011) and factors such as career stage and applicability must be considered. In order to develop GTA training programs to improve student outcomes, a more nuanced framework for understanding buy-in must be developed. Graduate teaching assistants have a complex and often contradictory social and professional environment which informs their pedagogical training. The focus of this study will be to better understand factors that promote GTA buy-in to pedagogical training in the hope of increasing fidelity of GTA PD.

Study Context:

The study was conducted at a large research university in North America. Participants were first year graduate students in the Department of Chemistry. This particular context was chosen due to the lack of literature on chemistry GTAs in particular. Participants had varied teaching experiences prior to admission to graduate school. Participants were assigned to teach undergraduate courses covering many different chemistry topics during their first year of graduate school. It is unknown how the

composition of this cohort compares to cohorts from other departments and universities, but with their diversity of experience, the study will start to illuminate more about the graduate teaching and training experience. Study participants successfully completed a short pedagogical training course as part of their first-year seminar class. Several reflective assignments from the course were collected as data. Interviews were conducted with participants after the completion of their first year of graduate school (and teaching assignments). These data will help to elucidate some of the influencing factors that affect the GTAs' perception of their training.

Research Questions:

This study seeks to answer:

1. What factors affect GTA perception of pedagogical training?
2. Do any of these factors promote buy-in to pedagogical training for first year chemistry GTAs at a large research university?

These findings could potentially be used to reform the current pedagogy course given at the aforementioned research university and emphasize these factors in order to promote more resilient buy-in by GTAs. While some factors may be highly specific to the university, there are likely some factors that translate between universities and apply to many graduate students in other STEM fields. This research could also possibly be used across other universities and STEM departments to improve GTA PD.

In this thesis, I will articulate factors that influence GTA perception of pedagogical training that can be found in the literature. I will argue that some of these factors are not well understood and must be better characterized in order to better design pedagogical training that encourages GTA buy-in to the program. Through analysis of interviews and

reflective assignments given during a pedagogical course, I will provide a more nuanced description of these factors and present other factors that have not previously been found in literature. Finally, recommendations will be made about what could be altered about current university level pedagogy training courses in order to promote buy-in.

Chapter 2

Literature Review

Overview

As many of the frontline instructors for general chemistry courses are typically graduate teaching assistants (GTAs), one must consider their training if the scientific community hopes to see improvement in student achievement. Chemistry graduate students are in a difficult position as they have many competing responsibilities ranging from their own classes, research, teaching, and their personal lives. This context, paired with the mixed messaging of teaching importance creates an environment in which graduate students have varied commitment to their teaching assignments and any associated training.

I will first give a very brief history of the evolution of graduate training programs and some of the few examples of frameworks to understand GTA PD. Then, I will present relevant examples from literature about influencing factors for similar populations (STEM faculty, preservice teachers, teachers at career stages that share characteristics with GTAs). Finally, I will present two conceptual models from literature (Reeves et al., 2016; Wilcox et al., 2016) for understanding GTA training.

I have used ideas from these existing frameworks and additional sources to inform my own theoretical framework, as I have collected in Figure 2 below. In the following literature review, I will unpack relevant sources that describe what I am labeling as External and Internal Influencing Factors. External Factors are things within an academic department that are likely to affect GTA buy-in. Internal Factors are things that are specific

to an individual GTA and will affect their personal buy-in. These factors are generally related to the GTA's educational and personal past, so the factors will be highly specific. As many of these factors are interrelated, it may often be difficult to disentangle the effects one may have on another. However, identifying factors is the first step toward understanding these relationships and ultimately designing GTA pedagogical training which promotes buy-in. I will make an argument that several of these factors are not well understood and must be expanded in order to provide an actionable model for improving GTA PD.

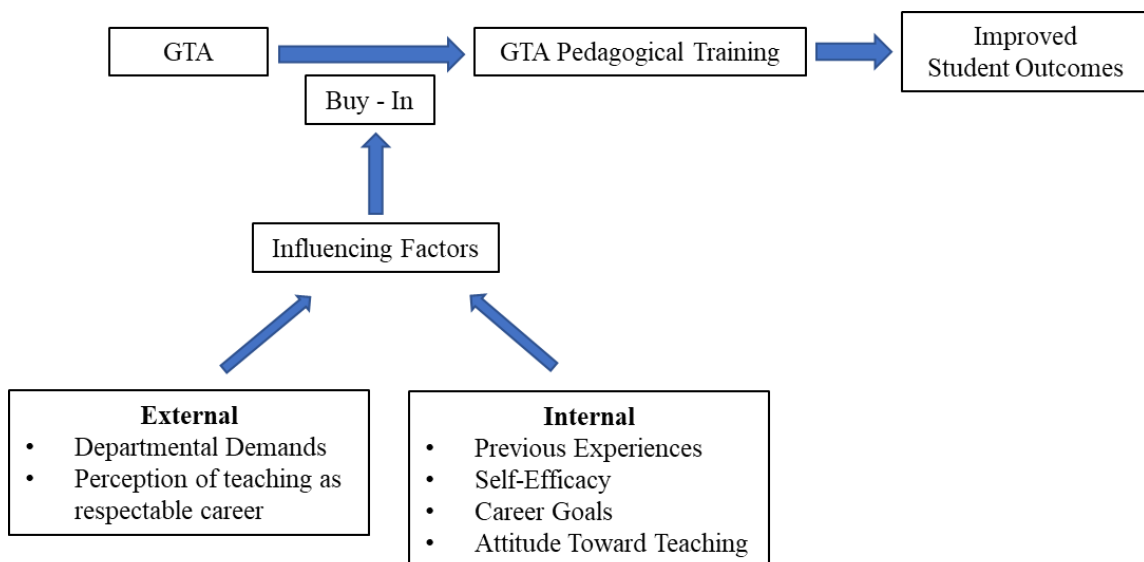


Figure 2: Literature Based Theoretical Framework of Influencing Factors on GTA Buy-In

Current State of Research on Chemistry GTA Training Programs

Through the examination of current GTA training programs, I will argue that two categories of internal influencing factors emerge, but must be more deeply examined. Although the context of the study is chemistry graduate students, there has been little research done specifically on the pedagogical training of chemistry GTAs outside of the evaluation of specific interventions. More general work has been done in the context of

biology and physics graduate programs. While the discipline context is important due the lack of existing literature regarding chemistry GTAs, these resources are the most relevant to this study. Frameworks for GTA training in these fields will be evaluated in order to seek out additional influencing factors.

Evolution of Archetypical GTA Pedagogical Training Programs

One of the first large-scale surveys done on graduate student PD at research universities was published in 1997. (Rushin, De Saix, Lumsden, Streubel, Summers, & Bernson, 1997). It focused on biology graduate students, but serves as a valuable touchstone. Of the 153 respondent universities, 49% of universities reported that GTAs were not required to participate in any formal training. The remaining universities reported a wide range of training structures from individualized training with an instructor to formal college teaching courses. In general, Rushin et al. (1997) found that training programs and workshops were often brief and had little follow-up where it existed at all.

Schussler and coauthors (Schussler, Read, Marbach-Ad, Miller, & Ferzli, 2015) carried out a similar study in 2013 to investigate many similar questions and to try to characterize what was being done across the US. One of their research questions was specifically to assess if “[there is] evidence that GTA PD has changed since 1997?” a reference to Rushin’s landmark study. Schussler et al. found that of their 152 respondents, 92% of universities required at least some presemester orientation. This is a marked increase from 1997. However, it was also found that around half of the responding schools required ten hours or less of training for their GTAs. The actual content of these programs was not assessed by the instrument in the study. However, some general questions about topics covered in these programs were asked. It was found that more programs covered

basic things like course policies and fewer covered more complex ideas such as learning theory. While the authors do make some generalizations about the data for the purposes of this study, it is enough to know that although the programs vary widely, there has been an increase in the number of universities offering some training to graduate students in biology over time. Unfortunately, it does not appear that a similar nationwide survey has been done for chemistry graduate programs. The majority of literature either looks at a specific training program or PD related to a specific intervention and considers whether or not that specific program was effective. The assessment of these programs is typically tied specifically to the intervention, so the best comparison in literature would be work done in other STEM fields about GTAs.

Factors that Affect GTA Perception of Teaching from Similar Contexts

Departmental Demands. As is common in most graduate programs, chemistry graduate students have a wide variety of responsibilities competing for their attention. GTAs are not only teaching, but taking their own classes as a student, attempting to find a lab to join and begin their research, all in addition to balancing their full personal lives (Gardener & Jones, 2011). In any given week, they may have multiple due dates for all these different responsibilities. The impact on the GTAs' time constraints on their teaching cannot be ignored. There has also been a long-standing perception that graduate students investing time in teaching would decrease their preparedness for a research career. Recent studies have shown the opposite to be true and that there may be a slight synergy between pedagogical PD and research preparedness (Shortlidge & Eddy, 2018). However, this perception is unlikely to dissipate quickly even with the new data and so the perception

that teaching (and any associated PD) is taking time away from research must still be considered.

Perception of Teaching as a Respectable Career. In addition to the time associated with teaching, there exists within some departments a climate in which teaching is valued as a second-choice career compared to research (Brownwell & Tanner, 2012). In his studies of STEM graduate students, Connolly (2010) found that many graduate students begin their programs with the intention of pursuing teaching careers, but are met with climates that treat these aspirations as second rate. These students then feel the need to conceal these goals even from their research mentors in order to fit in with the rest of the department. If students receive messaging that teaching is somehow a less desirable career path, then it is reasonable that this will impact the way in which they view their teaching and any PD.

Past Experiences. In addition to external factors within a graduate student's department, there are also likely internal factors from their experiences prior to graduate school that will also affect their perception of PD (Wheeler, Maeng, & Whitworth, 2015). It is a common expression in the education field that instructors tend to teach how they were taught. Although the study focuses specifically on STEM faculty members, rather than GTAs, Oleson and Hora found that faculty made their teaching decisions based on a variety of knowledge including instructional modeling (how their teachers taught), their previous experience in the classroom, and their previous experience as learners (2014). While graduate students may not have previous teaching experience, their experience as a learner and instructional modeling will affect how they relate to teaching and PD.

Self-Efficacy. Additionally, what a graduate student believes about his or herself will also affect their perception of teaching and the associated training. In their foundational work from 1994, Prieto and Altmaier apply the model of teacher self-efficacy, a belief that an instructor is capable of achieving goals, (Bandura, 1977) to STEM GTAs. In this study, they found a strong positive correlation between previous teaching experience and self-efficacy. Self-efficacy can be characterized as “a motivational construct associated with the willingness to try new practices, persistence, and resilience in the face of setbacks” (Tschannen-Moran & McMaster, 2009, p. 242). Because of this, I argue that graduate students with a higher level of initial self-efficacy are more likely to be receptive to instructional strategies given during pedagogical training.

Influencing Factors Present in Current Models of GTA Pedagogical Training

Reeves et al. propose one of the few conceptual models for understanding GTA PD for biology graduate students, which can be seen below in Figure 3 (2016). In this framework Reeves and coauthors argue for a direct relationship between GTA PD and student outcomes. Of particular interest for this study is collection of variables labeled as “GTA Characteristic Variables.” In this category, Reeves et al. claim that previous teaching experience, career aspirations, and attitudes toward teaching all have an impact on the efficacy of the GTA training. While the authors do not label this as “buy-in,” it is one of the few mentions in literature that describe the effect of internal variables on GTA training. In the article, the authors do little to unpack what is meant by “attitudes towards teaching” and which attitudes may be more likely to lead to positive outcome variables. However, the study does seem to imply that a GTA’s attitude about the training has an effect on the efficacy of the training. This is one of the internal influencing factors that this study will

seek to expand upon. Arguments for the inclusion of previous teaching experience and career aspirations will be made later in the literature review.

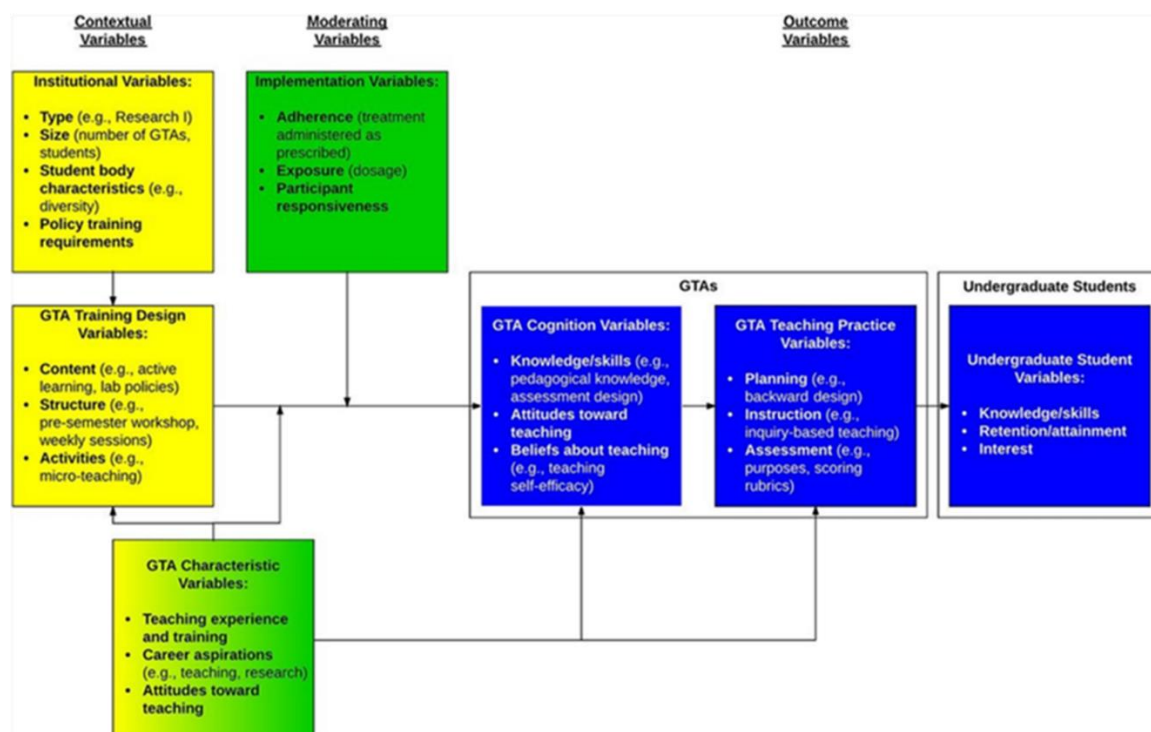


Figure 3: From Reeves et al, 2016: Framework for the relationships among GTA TPD outcome variables

A study from Goertzen et al. (2009) is one of the few instances in literature where buy-in is defined; however, the definition of buy-in provides little depth or detail. When discussing the implementation of a PD program for tutorial instruction in physics, the authors claim that “TAs who value (buy into) tutorials are more likely to convey their respect for the material and the tutorial process to students, as well as learning more themselves” (p. 020109). They go on to more specifically define buy-in as a positive alignment between how the GTA and the course designer believe the course should be taught. However, this definition is limited because it focuses on a particular program. The

Goertzen study in connection with the Reeves framework may begin to more fully characterize how GTAs' attitudes toward teaching may affect their buy-in to PD. However, due to the specific context in graduate school, investigating GTAs' attitudes and beliefs about teaching cannot be limited to pedagogical opinions, but we must ask foundational questions about why the practice of teaching would matter to them at all.

With the consideration of these models, the theoretical framework I developed (Figure 2) must include consideration for GTA's career goals and attitudes toward teaching. However, these variables are not well defined in the literature. The variable of career goals seems directly related to buy-in. If a GTA is planning for a teaching career, then the GTA is likely to believe that their pedagogical training will be helpful for their future. However, it is unclear how the GTA may perceive their PD as supporting alternate career paths.

As for attitudes towards teaching, it was difficult to find studies in literature that used a study group with a comparable positive, negative, or at least neutral views to towards teaching that were also undergoing pedagogical training. The closest approximation is a study that compared teachers' perception of PD across different phases of their career (Maskit, 2011). Maskit found that teachers in the "career frustration" stage and the "career winddown" phase had the least improvement after participating in PD. This is analogous to GTA populations as many GTAs feel that teaching is something that will neither help nor hurt them and at worst is a barrier to their other goals. The negative (or even apathetic) associations with teaching coincided with lesser developmental gains in trained teachers, so it is reasonable to conceive of a model similar for graduate students. However, it is still unclear as to what positive attitudes towards teaching the GTAs are likely to possess. More

specifically, in this study, I seek to answer what about teaching and the associated PD is valuable to them.

Within the current STEM model of higher education, if we want improved instruction provided by our graduate students, we have to assess what aspects of teaching and pedagogical training are most helpful to them and reinforce these ideas. While there are external factors within departments that also affect GTA perception of teaching and PD, these can only be combated by slow cultural changes within the departments. This study will focus on what can be changed specifically about the PD to improve the GTA perception of it.

To this end, this study surveyed a group of graduate students at a large research university in the United States. Student responses to several reflective assignments graduate students completed within their pedagogical training were collected. Additionally, in-person interviews were conducted after the completion of their teaching assignments. Graduate students were asked questions about their background to determine how well the data set fit with existing literature and also sought to unpack the more ambiguous factors in the model: career goals and attitudes toward teaching. This work will help to inform pedagogical training at large universities which will in turn improve undergraduate student learning gains.

Chapter 3

Methodology

This is a qualitative study that sought to determine the factors that contribute to chemistry graduate teaching assistant buy-in to pedagogical training.

The Setting

This study was conducted at a large research university in the mid-Atlantic region of the United States. The study focused on a seminar course required of all first-year chemistry graduate students at said university. This course, CHEM 500, provided graduate instruction on a variety of units including pedagogy, written communication, verbal communication, and research ethics. The pedagogy portion of the class (seven weeks) took place at the beginning of the fall 2018 semester and preceded all other units in the course. CHEM 500 met once a week for seventy-five minutes. I co-taught the pedagogy portion of the course with another faculty member. After the pedagogy portion of the course was complete, I had minimal contact with students from the course other than those few I supervised them directly in their teaching assignment.

The Participants

All participants in this study were students in CHEM 500, described above. Interviews were conducted during summer 2019. This was directly following the GTAs first year of graduate teaching experiences. The GTAs taught a wide variety of courses that ranged from introductory general chemistry lecture (first year course) to advanced physical chemistry lab (senior level course). The graduate cohort contained thirty students, four of

whom did not teach, so they were unable to participate in the study. Of the remaining twenty-six students, thirteen chose to participate. For reference, some categorical information can be found for all participants in Table 1 below.

Table 1: Categorical Information Regarding Study Participants

Participant	Gender	Domestic vs. International	Formal Teaching Experience	Informal Teaching Experience	Previous Pedagogical Training	Interest in teaching career
Abby	Female	Domestic	Yes	Yes	No	Yes
Alex	Female	Domestic	Yes	No	No	No
Brittany	Female	Domestic	Yes	Yes	No	No
Carrie	Female	Domestic	Yes	Yes	No	No
Conner	Male	Domestic	Yes	No	No	Yes
Drew	Male	International	No	Yes	No	Unavailable ¹
Jack	Male	International	Yes	Yes	No	Yes
Jen	Female	Domestic	Yes	Yes	No	No
Lisa	Female	Domestic	Yes	Yes	Yes	Yes
Nikki	Female	Domestic	Yes	Yes	No	Yes
Rick	Male	Domestic	Yes	Yes	No	No ²
Scott	Male	International ³	No	Yes	No	Yes
Tara	Female	Domestic	Yes	Yes	Yes	No

Note: 1: There was a small disruption in the audio file and Drew's response to his career plans was lost. 2: Rick's answer about his career plans was vague. He communicated that he would be more interested in teaching than industry if teaching salaries were higher. 3: Scott is technically labeled as an international student. However, his first language was English and socio-educational background shared more in common with domestic students

Data Sources

I used several data sources in this study. During the course, participants completed several reflective assignments and responded on several written discussion boards. Additionally, after the conclusion of the participants year of teaching experience, I conducted in-person interviews. The primary data source for this study are the transcripts from the in-person interviews. However, the written artifacts from CHEM 500 were used to triangulate the data.

Expectations Survey. At the beginning of CHEM 500, before graduate students completed any assignments related to pedagogy, participants completed the Survey 1 (Appendix). This survey gathered information about graduate students' perception of teaching at the beginning of graduate school. It also assessed some basic ideas the graduate students may have had about teaching and learning.

Discussion Posts. Each week, graduate students were asked to post short responses to questions related to the week's topic. These discussion posts covered a wide variety of topics, but often asked the graduate students in either reflect on their own experience teaching or learning.

In-Person Interviews. Interviews served as the primary data source for this study. After the graduate students completed their first-year teaching, in-person interviews were conducted on campus. The interviews were relatively informal, but followed Protocol 1 (Appendix). As many of the topics related to buy-in are fairly nuanced, this provided an opportunity for me to ask participants to elaborate on responses. During the interview, participants were asked to recall a topic from CHEM 500 that they found valuable. After an initial response, I gave the participants a short list of some of the topics that we

emphasized in the class to jog the participants' memories. This list can be found in the Appendix.

Data Collection

Toward the end of the 2019 Spring semester I visited CHEM 500 again and re-introduced myself to the graduate students. I described the study and asked which graduate students were interested in participating. Thirteen of the twenty-four possible graduate students agreed to participate in the study. At the introduction of the study, graduate students were given a copy of the interview protocol to read over before they agreed to participate. These copies of the interview protocols were then collected. Participants were then contacted after the end of the semester to schedule in-person interviews. I conducted these interviews in an office on campus. The interviews ranged from 20-90 minutes depending on the length of the participants' responses. All interviews were audio recorded and then transcribed. The interviews were initially transcribed using voice transcription software, but then I manually corrected the transcripts where necessary.

Data Analysis

All classroom artifacts were compiled and relevant information was coded. The expectations survey had the greatest content overlap with the research question and this data was used to triangulate the interview data. Interview transcripts were coded and then answers to similar questions were compiled. The codes assigned to these data were then analyzed and a new framework for understanding GTA buy-in to pedagogical training was formed.

Positionality of the Researcher

Due to the qualitative nature of the study, both the context in which the data was generated and the relationship between the researcher and participants must be understood. I conducted the following study at a large, research university during the 2018-2019 school year and the following summer. My position at the university is as a chemistry laboratory supervisor. This job entails leading course specific training for general chemistry lab courses, which many of the participants were assigned to teach. Additionally, I co-taught the pedagogy portion of the first-year seminar class (CHEM 500) in which the participants were enrolled. I had varying levels of contact with the participants based on the teaching assignment. GTAs participated in the pedagogy course in Fall 2018. GTAs were recruited during Spring 2019 and interviews were conducted during Summer 2019. At the time of the course, GTAs were unaware of the study and at the time of the interviews, grades for CHEM 500 had long since been submitted. Participants were also informed that I had recused myself from any job responsibilities that would impact their future teaching assignments. While the familiarity between the researcher and participants must be considered as part of the context for the data, measures were taken to assure participants that there were no possible positive or negative consequences of participating in the study.

Chapter 4

Findings

In this section, I will report trends observed in participant responses using participant pseudonyms to provide examples of those trends. I will first present findings that consider factors previously identified in the literature as influencing GTA buy-in. I will then present evidence for new factors that emerged from the data.

Departmental Demands

As Gardner and Jones argue (2011), the variety of demands placed on graduate students make it difficult for GTAs to focus on teaching. While questions were not directly asked during either the interviews or the class assignments about what demands the participants had on their time, the inclusion criteria for the study selected only participants with a similar context as those described in the Gardner and Jones article. All participants had completed a full year of teaching assignments at the large research university. While the teaching duties vary from class to class, each assignment was estimated at twenty hours of work per week. Additionally, chemistry graduate students at this university typically take four or five classes as a student during their first year, do rotations through research labs, and ultimately align themselves with a research preceptor and start their doctoral work. This is sufficient context to argue that the participants in the study likely had a similar level of competing responsibilities as those studied by Gardner and Jones and therefore likely did not have the resources to fully focus on their teaching.

Perception of Research as More Valuable Than Teaching

Because the focus of the study was on examining and unpacking internal influencing factors, questions about the GTAs perception of the value culture within the department were not asked. However, in one of the interviews, the topic came up organically in an interview. When discussing what he valued about his pedagogical training, Scott veered to talking about his peers and faculty members in the department.

Scott: “Most people come to grad school and teaching is like the lowest of low priorities. For most faculty that you work with – teaching is the lowest of priorities. Like, they don’t care, which is a whole separate issue...A lot of mentors put a lot of pressure on their students to get work done even though they are teaching...I think there is a divide there and if you’re on the wrong side of it I personally don’t know how much a class like CHEM 500 can change that.”

As this question was not asked of all participants, this piece of data may or may not be representative of the rest of the cohort. However, Scott has the perception that a subset of his peers and the majority of faculty members do not value teaching. This is supported in literature (Connolly, 2012). However, because this is nuanced, varied, and difficult problem to unpack and it was not the focus of this study, future work would have to be done to make this relationship clearer.

Previous Experiences

All participants were asked a series of questions about whether or not they had teaching experiences prior to graduate school as these are likely to affect their perception of teaching and PD in a variety of ways from promoting their self-efficacy (Preito & Altmaier, 1994) to informing what they view as good teaching (Oleson & Hora, 2014). All

participants claimed to have either formal or informal teaching experience prior to graduate school. This ranged from previous pedagogical training in order to assist with class in undergrad to informal tutoring of dormmates. Some participants also communicated that their experiences training fellow students on analytical instrument usage and other research activities ultimately informed their teaching in graduate school.

The prevalence of prior teaching experience may be linked to perhaps the most significant sampling bias of the study. All participants self-reported that they enjoyed teaching. As I am an instructor for a pedagogical course who values and enjoys education it makes it less likely that GTAs who do not enjoy teaching will sign up to participate in my study. During the recruitment phase, it was clearly communicated that there were no positive or negative repercussions of participation. It was also communicated that insights from GTAs who do not enjoy teaching would be very meaningful. However, none of these GTAs signed up. It is theoretically possible that the entire cohort really does enjoy teaching and the sample is representative. However, based on some statements made by GTAs regarding the rest of their cohort, this seems unlikely.

Self-Efficacy

While self-efficacy is linked to previous teaching experience in the literature, this is not the only source of self-efficacy, so a series of questions was asked about how the GTAs felt about beginning their teaching assignment. On the Expectations Survey the graduate students were given a Likert scale prompt that asked them to respond to the statement: “I am confident that I am able to teach someone else chemistry.” Of the thirteen participants, 54% responded strongly agree, 38% responded agree, and 8% (one participant) responded disagree. This is important to the study, because in order for

graduate students to relate well to their pedagogical training, they must believe that is something they are capable of enacting.

Attitudes about Teaching

Pedagogical training assumes that the instructor can have an impact on student learning through the use of different interventions that are able to be researched and implemented. It could not be taken for granted that the graduate student participants believed this. In both the interviews and expectations survey, a series of questions was asked to characterize the participants' understanding of the relationship between the instructor and student learning. Then, a series of questions about why pedagogical training may or may not be valuable was asked.

Relationship between instructor and student learning. Before one can really investigate why a GTA may or may not buy-in to pedagogical training, one needs to understand generally how the GTAs conceive of phenomena such as student learning and the role of the instructor in that phenomena. For example, in order for GTAs to buy-in to pedagogical training, they must first believe that student learning is something that can be influenced. If a GTA has a fixed mindset rather than a growth mindset (Dweck, 2008) about student ability, then they are less likely to believe that their teaching ability can affect student learning and are therefore less likely to buy-in to pedagogical training.

In order to determine GTAs' view of student learning, broad open-ended questions were asked to have GTAs characterize what they thought student learning "looked like." The phrase was chosen for its ambiguity to give GTAs freedom to describe student learning in their own terms. While none of the GTAs used terms such as growth mindset, in all responses there was an emphasis placed on the effort of the student. GTAs used terms like

“struggle” and “build connections” to describe their characterization of learning. Others characterized it in terms of practicing tasks. This communicates that most of the GTAs viewed learning as a process that students work towards, rather than some sort of innate ability. An excerpt from Abby’s interview is given below which illustrates this particularly well.

Abby: And so I think there are definitely like repetition is a big part of it. Being able to get multiple lots of exposure to something to help kind of solidify an idea. Being able to kind of let them struggle with the material a little bit as well and I think-not that confusion is good. But I think letting them wrestle with the material and really try to work through it themselves is really beneficial.

Though she is not labeling herself as having a growth mindset, this quote demonstrates that Abby believes that learning is something students actively work towards and get better at, rather than something that is naturally gifted.

While many of the responses did seem to imply a growth mindset about learning, the responses about the actual mechanics about the process of learning was varied. This was even directly stated by several of the GTAs. Of the thirteen participants, five characterized student learning as something that is highly individualized and this can be seen in the sample data below.

Abby: “So again, I think it really is based on individual student needs.”

Jen: “Honestly, I think it is different for everybody.”

Nikki: “Definitely different from student to student...”

Again, we can see that our GTAs have a largely student-centered view of learning, which helps to support the idea that there are things that they can do as instructors that will influence student learning outcomes. Each of these GTAs went on to give at least a few examples of different educational strategies that may be better for different students.

Once GTAs were given an opportunity to discuss how they conceptualized student learning, they were asked a follow up question about what an instructor could do to promote the process. One GTA had a clear link between their conception of student learning and good instruction. Abby emphasized that student learning was highly individualized and when she described a good instructor her first characteristic was awareness of students' varied learning styles. Interestingly, few GTAs responded with a strategy that was directly linked to their conceptualization of learning. For example, Carrie gave a conceptualization of learning and compared it to an inverse triangle. She argued that students learn big concepts first and then learn more detailed information about the concepts later. With this emphasis on learning, one may have expected Carrie to respond that good teachers encourage this process through the use of scaffolding or other framework tools. However, all of the information Carrie gave about good instructors was linked to interpersonal skills. She said that good instructors were compassionate, nice, and developed a feeling of mutual respect.

The emphasis on the personality of the instructor in relation to their quality was echoed by several other participants. Nine of the thirteen participants referenced personality traits or inspirational quality as a characteristic of a good instructor. While some of these participants mentioned other skills that a good instructor may have, this was the most prevalent response. In several instances, participants even reflected back on their

past instructors' performance as metric for what a "good" instructor was. This communicates that rather than formulating an idea of a good instructor based on their understanding of student learning, our GTAs are placing a lot of their emphasis on their past personal connections to instructors. This is a natural relationship that occurs often with young teachers; however, if the goal is to promote buy-in to pedagogical training, one must make the connection between learning and teaching clearer.

Despite the disconnect between the GTAs' definitions of student learning and their characterizations of what makes a good instructor, all the participants did articulate at least one strategy that an instructor could use to influence student learning. This means that GTAs believe that instructors can have an effect on student learning, which in turn would make pedagogical training a useful endeavor. Intellectually, they can appreciate that pedagogical training is useful for instructors, even if they are not making connections to useful strategies at this point. Once this foundational commitment is established, then one can begin to start unpacking why pedagogical training may or may not be valuable to GTAs.

Career Goals. As described in the literature (Reeves et al., 2016), career aspirations have an effect on the way in which GTAs view their teaching experience and pedagogical training. As half of the participants self-reported that teaching was at least a part of their career plan, this personal relevance argument is easy to make. Teaching during graduate school is an opportunity for this subset of GTAs to develop professional skills that are directly applicable. GTAs were asked questions about how/if they saw their pedagogical training relating to their future career plans. Of those with academic aspirations, the answers were fairly direct. An example of the relationship between

pedagogical training and Abby's career plans was expressed in the following quote. This can be clearly seen in some of the following statements.

Abby: So I actually want to be more of a teaching professor. I know that there are some people who are professors and are more like research intensive. I definitely want to be research professor probably like a PUI or something like that. So it's very - I mean just the connection to a lot of new concepts like a metacognition. I never learned a I've never heard about that before and just being able to be introduced to some new concepts and stuff that even during - I mean I have a list on my phone of like when we were going through chem 500 - I have, I have on my phone in my notes a "Professor to-do" list of things to keep in mind. So like these are things that I genuinely would want to implement when I start teaching.

Because Abby plans to be a teaching professor it is predictable that she would value pedagogical training. If GTAs are planning to pursue education, it makes sense that they would value an opportunity to participate in PD for their future career.

Of the GTAs who are pursuing non-academic employment, there does still seem to be a belief that teaching opportunities and pedagogical training are a valuable part of their PD. This is largely grounded in the view of teaching as an opportunity to develop the "soft-skills" that GTAs believe will help them be successful in their intended career path. In the follow quote, Brittany is reflecting on her teaching experience and pedagogical training and the way it may relate to her career trajectory working in industry or a governmental research lab.

Brittany: If you're leading a team you would definitely need to have to explain something at some point or another. So if you can't explain things well you shouldn't be in charge of anybody for sure. So, that would be a good skill to have I guess.

In the previous quote, Brittany relates her experience explaining concepts to her students and compares this to explaining information to lab members she may manage in the future. Several other GTAs echoed this idea. It seems that in general, GTAs see the most basic application of their teaching experience and communication skill development for their non-academic careers.

In many of the statements about communication development GTAs give fairly general audiences with which they will have to communicate in their future positions. Carrie, however, demonstrates a more concrete example in the excerpt listed below. After reflecting on trying to explain chemistry concepts to her students, she draws a connection to how this skill will help her in a future career in industry.

Carrie: Because that's what I found difficult, too. Still it's like you know what's the best way to explain this to someone who has no idea what I'm doing. So, people in industry, business people, with all the money don't know anything about what you are doing.

In her view of her career, Carrie is anticipating that she will have to communicate complicated scientific ideas to a wide variety of stake holders ranging from scientists she will at some point be training to “business people.” This provides a concrete example of how her teaching experience will be personally valuable to her in the future.

Similarly, Alex communicated that she viewed her teaching experience as a way to prepare her for what she referred to generally as a leadership position she hopes to have after she completed her doctoral work.

Alex: So, I think because I am kind of going for a leadership position after grad school - I think teaching is, you know, sort of leadership position and you're kind of learning how you're interacting with other people that are kind of doing experiments and that are kind of thinking about things and I think that's also applied to whatever you're trying to lead a lab group or a project.

Alex communicated that she hoped to work in industry within a research group. In this statement, she is demonstrating that she believes the interpersonal skills she is developing during teaching will be useful to her later on in her career.

During the pedagogy course the participants completed, connections were drawn between teaching and a variety of non-teaching careers. Often, these connections were communicated by myself or the co-instructor for the pedagogy portion of the class. (While we both have an educational background in chemistry, our main focus is education.) The lead instructor for the course was a chemistry research faculty member and would also make comments about the transferability of teaching skills. Over the course of the interviews, it started to become clear that the graduate students valued the statements about the applicability of pedagogical skills as more reliable if they were made by the chemistry research faculty member. This is reasonable considering that the chemistry research faculty member did have more experience running a research lab and therefore had a better understanding of the skills that are required to do it effectively.

This data is particularly important when we consider the competing priorities and messaging that GTAs hear from their graduate programs. The university where this study was conducted is fairly typical in that first-year graduate students are required to teach, take classes, and find a research group to begin their doctoral work. Typically, there is departmental pressure to focus on research as this will comprise the majority of a student's doctoral work. Teaching is often communicated to be a lower priority as it does not directly contribute to being awarded a Ph. D. In literature, it is argued that departmental valuation of teaching influences GTA's perception (Connolly, 2012).

Once I had this realization about the chemistry research professor's perceived reliability, I began to indirectly ask GTAs who were interested in industrial careers about who's opinion about teaching they were more likely to value. GTAs were presented with a scenario of bringing in an industry representative to discuss their perception of the connections between teaching and industry. All GTAs who were given the prompt responded positively and confirmed that this would be meaningful for them. A particularly clear example can be seen in the quote from Brittany below.

Brittany: Oh, definitely. I think if you brought in somebody who is like actually in charge of a lab in industry, who might have maybe either some teaching experience or might even be retired and might now be teaching. Somebody that's like that would be probably really valuable because they would be able to translate like from teaching to industry what are like the overlapping skills. Because I'm sure there's gonna be a lot of them.

As the graduate students are smart, logical individuals, it is reasonable that they weighing the reliability of the source of their information. The data suggests that by changing the source of information about why teaching may be valuable to them, GTA buy-in can be encouraged.

In general, these data serve to unpack a bit more about the way that career goals influence GTA buy-in to pedagogical training. It is expected that GTAs that are planning for a career in academia would value pedagogical training because this helps to better prepare them for their future goals. However, it is not as immediately evident that GTAs are viewing their teaching responsibilities as an opportunity for PD in non-academic fields. As many graduate students are likely pursue jobs in governmental labs, industry, and other assorted paths, helping graduate students see the value in this professional opportunity will ultimately help promote buy-in.

Emerging Factors

After assessing for known factors that have been referenced in literature, I asked open-ended questions were asked of the graduate students about what they found valuable about their pedagogical training. The following sections are an explanation of new factors that emerged mainly during the in-person interviews.

Effect of Pedagogical Training on GTA learning. A theme emerged from several GTAs reflecting on how pedagogical training had affected their own learning. This can be seen in the statement from Scott given below.

Scott: I think for me what I took of value was that actually it made me reflect on how I learn. Maybe a lot more than how I was teaching. I think it actually helped me more in that sense.

There was not a dedicated question in the interview protocol to assess the effect of pedagogical training on GTAs' own learning; however, the phenomenon was known to exist (Sandi-Urena, Cooper, & Gatlin, 2010). As many graduate students are very high achieving individuals, they may not feel particularly challenged prior to graduate school. When graduate students are met with a new more rigorous set of responsibilities, they often struggle to develop new learning strategies. Although this was not thoroughly investigated in this study, it provides a very interesting future direction that may prove to be very helpful to graduate students.

Social Commitment to Students. There is data from nearly all the GTAs interviewed, that express a complicated phenomenon, which here will be labeled as “social commitment.” Social commitment was manifested in a variety of ways ranging from, altruistic behaviors to a desire to not be the GTA that “ruins a class” for the students. As there were not interview questions designed to probe this idea, it is difficult to disentangle, but it seems that GTAs wanted to be “good” GTAs because of a commitment to their students.

During her second semester teaching, Abby's students had an assignment with a particularly low average. She knew that all of her students really struggled and had another similar assignment due in the coming weeks. Abby wanted to offer her students an option to submit a draft of the new assignment for comments to help them better understand, but

struggled with the additional work that would mean for her, but ultimately decided to make the offer. There were practical considerations, such as possibly making some of the reports easier to grade at the end of the semester, but it seems that the most heavily weighted factor was the students' well-being as indicated in this example.

Abby: I mean, I've been in their shoes. I would be panicking if I had a bad grade going into a final like that and so it's like "I'll do it".

Because Abby was able to identify with the students' experience, she created more work for herself in order to help them.

In a different context, Scott also communicated a similar connection to his students' experience. When reflecting on fellow graduate students who do not value teaching, Scott made the following statement:

Scott: It baffles me. We all had TAs our whole lives and definitely good TAs made our lives better and bad TAs made our lives way worse. So, it baffles me that that doesn't translate now. Now you have the chance to not be that bad TA, because I had TAs that ruined courses.

Here, again, Scott is looking at his teaching through the lens of the student he very recently was. He is giving himself a responsibility to provide a good experience for his students. While this was not probed directly by the interview protocol, it seems to be an interesting direction for inquiry. Because the GTAs can so easily identify with their students' experience, this may create within them a desire to be a better instructor for altruistic reasons, which in turn may promote buy-in to pedagogical training.

These two novel influencing factors, effect on learning and social commitment, are useful in that they provide an additional way to encourage buy-in on behalf of the GTAs. However, these variables do seem that they highly GTA specific. It is possible that a GTA feels completely satisfied with their own learning and therefore would be less likely to value pedagogical training in order to improve their own approach to learning. Additionally, GTAs who feel a social responsibility to their students are exhibiting empathic behaviors by considering their students' experience in light of their own. This sense of social responsibility has a complicated origin that is outside the scope of this study. As this is a deep-rooted disposition, it is unlikely that we could use a short pedagogical training course to help develop this. However, if teaching is presented as a way of enacting social responsibility, then it may help encourage GTAs with this disposition to enact it.

Chapter 5

Discussion

Because GTAs' perception of training has a clear impact on student outcomes (Wheeler, Maeng, Chiu, & Bell, 2017), buy-in (characterized as a general valuing of pedagogical training) must be better understood. Because the body of literature about GTAs is relatively small, I also considered literature on educational PD for K-12 teachers or higher education faculty for my study (Brownwell & Tanner, 2012; Maskit, 2011). These population groups have personal interest in learning to be a better instructor; however, this cannot be assumed of GTAs who receive competing messaging about what their graduate school goals and responsibilities should be. This complex context prompted my first research question: What factors affect GTA perception of pedagogical training?

According to existing literature, buy-in seems to be influenced by a small number of external and internal factors (Figure 2). Of these, career goals and attitudes toward teaching are not well described (Reeves et al., 2016; Wilcox et al., 2016). While there has been research done to characterize some facets of GTAs' thoughts and attitudes toward teaching (Sandi-Urena & Gatlin, 2013; Volkman & Zgagacz, 2004), the work focuses specifically on pedagogical beliefs rather than whether or not teaching is a worthwhile endeavor.

In light of the factors that emerged from the data generated in the study, I propose several adjustments to the model of GTA buy-in demonstrated in Figure 2. These adjustments are summarized in the expanded framework in Figure 4. Within the internal factors, attitudes toward teaching should be expanded to three separate factors:

growth/fixe d mindset, positive effect on personal learning, and a feeling of social responsibility. Attitude toward teaching is a broad concept and even when expanded to include the trends seen in this study, it is likely still incomplete. There are likely many negative attitudes toward teaching that also affect GTA buy-in, but based on the participants in this study, these were difficult to assess as all participant had largely positive associations with teaching. Additionally, there are likely other positive attitudes toward teaching that will promote buy-in that were not found from the limited scope of this study. The expansion of these factors better answers my research question about what factors affect GTA perception of pedagogical training. However, because the phenomenon is influenced by previous experience, which can vary, more work is likely still needed to unpack this further.

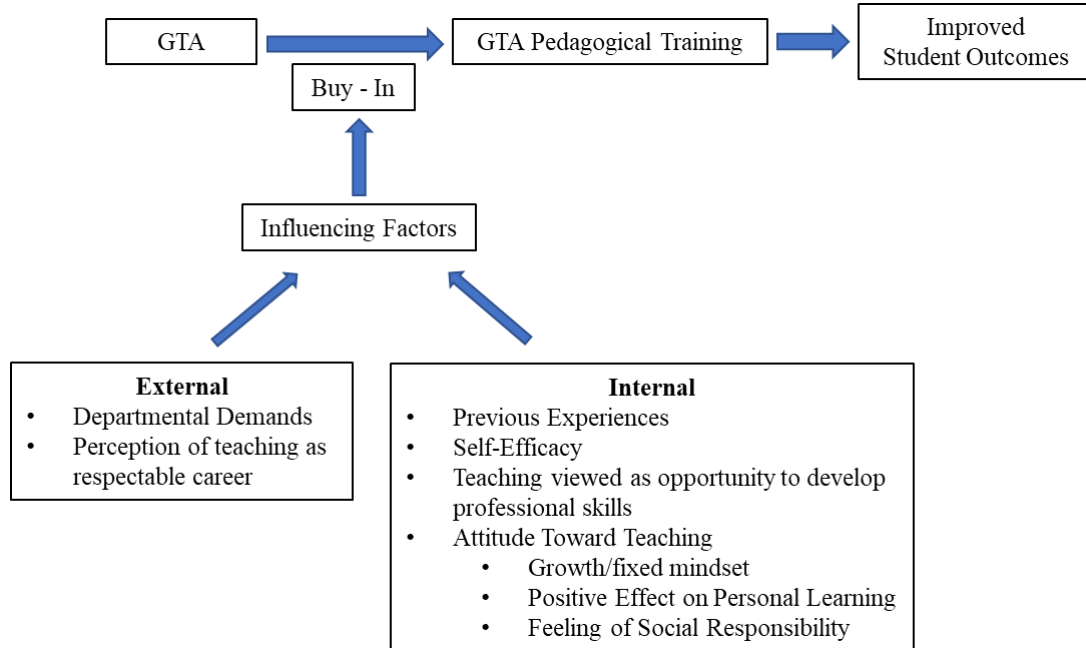


Figure 4: Improved Theoretical Framework of Influencing Factors on GTA Buy-In

The literature-based model (originally represented in Figure 2) must also be expanded to include a more nuanced approach to career aspirations. It is a common problem within the literature (and this study) that GTAs that are planning a career in teaching are more likely to participate in research about teaching (Duffy & Cooper, 2019). However, the study shows that graduate students are responding to PD in a broader way. Even graduate students who are planning careers outside academia are able to view their teaching experience as a place to develop meaningful professional skills. This provides a possible way to promote buy-in from those who may otherwise view teaching as something they must “get through”. These factors likely had not previously been considered, because in most pedagogical studies, the subjects are participants with a vested interest in improving the quality of their instruction.

Now that the factors that influence perception of GTA PD are better understood, I can begin to address my second research question: Do any of these factors promote buy-in to pedagogical training for first year chemistry GTAs at a large research university? In the responses to questions about what the GTAs valued, there is a theme of personal relevance. The GTAs self-reported that their training was valuable if it helped them learn skills that they could translate to their personal career path. Research has shown that pedagogical training can affect GTAs’ own learning (Sandi-Urena et al., 2010) and in this study when GTAs were able to recognize this effect, they found it valuable. Even the theme of social responsibility ultimately is grounded in personal relevance. The GTAs who responded that teaching was important to them because they now had the opportunity to assist other students is grounded in their personal value system. While it may seem like an obvious conclusion that GTAs buy-in to things they view as personally relevant, the fact that this

is not carefully considered in the design or assessment of pedagogical training programs means that this is a valid line of inquiry.

Sampling and Possible Study Limitations

As I reported in the Methods section, all of the participants self-reported that they enjoyed teaching. This is a predictable sampling bias as participants who enjoy an activity are more likely to sign up for a study in which it is being discussed. It is conceivable that there could be GTAs who this model does not more accurately describe their buy-in. Perhaps more likely, there are GTAs that would not categorize themselves as buying-in to pedagogical training at all, but view both the class and their teaching assignment a barrier towards their research. These individuals would be unlikely to participate in the study, because of the social discomfort of telling me that they do not value something that I have very visibly claimed to care about.

It is also worth noting, that the pool of possible participants was 42% female, but of those who chose to participate in the study 62% were female. This means that a larger than representative portion of female graduate students agreed to participate in the study. This may be significant in that teaching is often perceived as a gendered profession. At this point, data was not collected to assess why more females agreed to participate, but it may be a fruitful future direction to understand if there is a difference between the way female and male graduate students relate to their teaching assignments.

Another gender disparity in the sample set exists between the percentage of participants who plan to pursue a teaching career. Of the participants who are planning for careers outside academia, that the majority were women. Again, data were not collected to

understand this difference. It may only be an artifact of interpersonal interactions between myself and the graduate students, but it may be worth considering in future studies.

Additionally, the pool of possible participants was comprised of approximately 21% international graduate students. The actual sample set was 23% international graduate students. Therefore, the sample set is fairly representative of the cohort in terms of the international vs. domestic divide. It should be noted however, that one of the international graduate students that participated was a native English speaker from a North American country. As language is foundational aspect of teaching and greatly impacts student perception of a GTA (Plankans, 1997; Kang, Rubin, & Lindemann, 2014), this GTA's experience is likely more similar to a domestic graduate student. If this student is recategorized, the overall international representation percentages for both groups decrease in a comparable way. Compared to the national average of 39% for 2017 (National Science Board, 2018), the representation of international graduate students in both the pool of possible participants and the study are low.

A possible limitation of the sampling for the study can be found in the incidence of graduate students who are interested in teaching as a career. Nearly half of the participants communicated that they are interested in teaching being at least a part of their future career plans (either teaching faculty or research faculty with teaching responsibilities). While this data is not available for the entire pool of possible participants it can be argued that the percentage of participants interested in teaching is likely higher than for the general population of chemistry graduate students. It is difficult to find data for a strong comparison, however, according to Sauermann and Roach (2012), in 2006 only 23% of chemistry PhDs were employed in academia. This is fewer than half of the 50% of study

participants planning a career including teaching. The study sample is rather small, so fluctuation of two or three participants career desires would likely bring the distribution more in line with the general population. However, it is worth noting that the graduate students who self-selected to participate may have created a sampling bias.

Despite this study being relatively small, it does seem to provide a fairly representative sample of the cohort at the study institution. As many of the cohorts are similar demographically from year to year (largely domestic, fairly even gender divide) the results of the study will likely be informative for future iterations of similar pedagogy courses. However, the results may or may not be applicable to other universities with a more diverse graduate student body. Similarly, it may not be applicable across other graduate disciplines as each department likely has its own environmental context which will inform the perspective of the participants.

While this sampling biases may limit the applicability of my expanded framework, it can still be useful. As the scientific community seeks to better prepare GTAs for their roles as instructors, we must consider their needs. If GTAs are better able to see their own values reflected in their pedagogical training, they are more likely to value it. This must include ways to make their teaching experience meaningful to them personally, so it can be viewed as a growth opportunity rather than a hurdle to their research.

Future Directions

This study provides evidence for a more complete framework for understanding GTA buy-in. However, perhaps the more fruitful question that should be investigated in the future is whether or not the application of this framework to a GTA pedagogy training course promotes better teaching and ultimately higher undergraduate student achievement.

This framework could be applied to existing GTA PD in subtle ways. Universities could use existing PD programs, but build in language about the transferability of teaching skills to other career plans. This could be further developed through a series of observations and feedback cycles to help graduate students develop transferrable skills (public speaking, management, communication) during their teaching assignments. This may help a wider range of graduate students view their teaching assignment as a way to prepare for their career and ultimately invest more in improving their teaching. It should be noted that regardless of how the framework is applied to existing PD programs, the source of the messaging is important. If researchers that the graduate students respect argue that the GTAs should value their training and teaching experiences, they are more likely to do so. Similarly, if more experienced graduate students were to communicate that their pedagogical training was helpful to them, newer graduate students may be more likely to buy-in.

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Appendix

CHEM 500 Buy-In Assessment Sample Interview Protocol

1. How would you describe your race/ethnicity? How would you describe your gender?
2. Please describe any teaching/tutoring or youth mentoring experiences you had prior to beginning CHEM 500.
3. Please describe any previous experiences working with youth or peers; e.g., coaching or participating in outreach service activities or community projects?
4. If so, how did you feel about those experiences?
 - a. New Version: What did you learn about effective teaching from these experiences? How did your previous experiences impact the way you feel about your teaching assignment?
5. Before you started teaching, how did you feel about getting the teaching assignment?
6. Now that your semester is almost complete, how do you feel about teaching? Did your concerns or questions about teaching change?
7. How do you think students learn? What have you learned about how to help students learn?
8. Do you think there are things that a teacher can do differently to help students learn better? If so, what are some of the ways?
9. What do you think makes a good teacher? How do you think someone becomes a good teacher?
10. Can you think of a time this semester that your students were struggling? If so, how did you recognize it? If so, how did you respond to it?
11. Look at this overview of strategies from CHEM 500. Have you experienced your teachers or professors using any of these strategies before?
12. Which of the EBT strategies did you find helpful in your own teaching? When did you use them?
13. Were there any EBT strategies that you found unhelpful? Difficult to implement? If so, why?
14. What are your future plans?
15. How has your teaching experience helped you to develop skills and knowledge that will help you with your future plans or career?
16. Which aspects of CHEM 500 teaching assignments were most valuable to you?
17. What are some of your recommendations about how we could change the course to be more helpful?

Expectations Survey Questions

1. I am interested in strengthening my foundational content knowledge in chemistry
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
2. In no more than three sentences, define what it means to learn chemistry content.
3. I can identify the component skills required to solve chemistry problems.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
4. In no more than three sentences, describe one component skill that is needed to solve a heat of reaction problem.
5. I am comfortable contextualizing basic chemistry concepts.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
6. Provide one example of how a colligative property can be contextualized.
7. Analytical problem-solving skills cannot be taught to everyone.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
8. Great explanations are an essential part of teaching because they lead students to deeper learning.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
9. List three activities that help you learn.
10. I believe that my teaching assistant experience will provide me with an opportunity to practice essential skills for my career development.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree

11. In three sentences, describe how your teaching experience will impact your professional development.
12. I am confident that I am able to teach someone else about chemistry.
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
13. I feel comfortable asking others questions related to my teaching (content and skills).
 - a. Strongly Agree
 - b. Somewhat Agree
 - c. Agree
 - d. Disagree
14. In three sentences or less, explain why you do or do not feel comfortable asking questions related to your teaching.

Reflective Discussion Board Prompts

Teaching Scenario Reflection 9/10/2018

First off, great discussions during class on Monday! To follow up about class, please take a few minutes to respond to one/both of the scenarios listed below. Next class, we will be discussing student motivation and the impact it has on learning and student retention. Consider thinking about this as your respond to the two scenarios. Please respond in a timely manner so that we can have a meaningful discussion before next class, 9/10. (9/3 is Labor Day).

Scenario One:

You are sitting in 105 Forum before the start of Chem 110 and you two students behind you talking about how the professor is using this course to demonstrate his intelligence to the class and clearly all he cares about is his research. The student goes on to say, "I do all the homework and come to class but it is not working. My friends that started last year warned me that this course is a weed-out course. I should have listened to them." The class begins and the instructor begins his opening by sharing his disappointment in the scores from the last exam and he makes it a point to say that it is obvious to him the class is not putting forth enough effort. He goes on to add, "Many of you are repeating this course from last semester and you are obviously making the same mistakes again. Everything they need to know has been given to them in class or in the book so please don't come to me complaining about the grades."

Scenario Two:

An instructor meets with his TAs to discuss strategies for the next week's lessons. During the discussion the TAs opens up with the fact that most students are not motivated to learn and immaturity is one of the causes for the lack of motivation. The instructor shares that this is not new to the course and it is not the TAs' jobs to motivate students, rather it is more important to make sure the information from the course is translated properly and report any cases of academic integrity.

Motivating your students – 9/17/2018

To participate in this discussion, please either post a situation you have directly experienced where you found it difficult to motivate a student or respond to a scenario posted by someone else.

Posting a scenario: Please give at least a sentence to describe the context of the scenario including some information about the course and some minimal background on the student (year in school, academic interest). Do not include any information that would allow the student to be identified. These scenarios could range from a concept a student is struggling to understand to a situation where an experiment doesn't work and anything in between.

Responding to a scenario: Briefly explain why you think the student could have been demotivated by the scenario and give a suggestion for how you would consider responding. Indicate if this is a strategy you have used in the past or something that you think may target the specific demotivating factor. If you would like to expand on another student's idea, this is ok, too! The goal is to have a meaningful discussion.

As always, remember the Code of Conduct that you wrote as a class and let's keep the conversation positive about how we can work towards providing a good learning environment for our students!

Diagram Discussion – 9/24/2018

To participate in this discussion, please either post a diagram that you are likely to need to explain to students this week during your teaching assignment or respond to a post from another student.

Posting a Diagram: Give at least a sentence or two of context for the diagram. What is the diagram trying to communicate?

Responding to a Diagram: Provide feedback to the posted diagram by responding to some of the following questions. What do you expect the students to be most likely to struggle with? What prior knowledge must the student have to understand the diagram? What misconceptions are likely related to the material? What are some strategies that you could use to try to explain this to students?

Note: It is a good idea for people to post diagrams from different courses, so that everyone can have feedback on some of the things they will be teaching this week.

As always, remember the Code of Conduct that you wrote as a class and let's keep the conversation positive!

Metacognition Discussion – 10/1

To participate in this discussion please respond to the following prompt:

What are some strategies you can use to promote students' metacognition in classes where you don't have complete control of the curriculum?

Note: If you have something to add to another student's response, feel free to respond to them rather than starting your own separate reply! (Responding to another student also counts as participation.)

Active Learning Discussion – 10/8/2018

For discussion this week, let's look ahead to thinking about active learning! We will spend our next class period discussing some active learning strategies that you can use when interacting with students.

To participate in this discussion, please reflect on the following definition of active learning:

"In practice, active learning occurs when instructors stop lecturing and provide time for students to complete activities that build conceptual understanding. To facilitate active learning, instructors must assess student thinking, which includes a mixture of scientific and nonscientific ideas, and use these data to modify instruction." McCourt et. al. "What Motivates Biology Instructors to Engage and Persist in Teaching Professional Development", CBE Life Science Education, 16, ar54,2017.

Read the following article (also linked in the modules):

How do I help students engage productively in active learning classrooms?

Select an active learning strategy that you think is/could be particularly effective and explain why in your discussion post.