ABSTRACT

SMITH, CODY REED. Exploring Sources of and Changes in Graduate Teaching Assistant Teacher Efficacy Throughout a Semester: A Mixed Methods Study (Under the direction of Dr. Cesar Delgado).

The quality of undergraduate Science Technology Engineering and Mathematics (STEM) learning is impacted by the teaching performance of graduate teaching assistants (TAs). Research suggests that instructional quality affects the retention of students in their degree programs. TAs with little to no teaching experience are underdeveloped for their roles as instructors of entry level, undergraduate courses. While teacher efficacy has predicted performance in the K-12 setting, there is uncertainty regarding TA teacher efficacy and its relationship with teaching performance. Little is also known about how TA teacher efficacy changes over time, as well as which sources of teacher efficacy are predominantly used by TAs. Bridging these gaps in the literature will inform best practices in developing and implementing professional development for TAs. Using a sequential exploratory mixed-methods design, this dissertation sought to explore the relationship between TA teacher efficacy and their students’ evaluations, as well as the sources of teacher efficacy and factors that may influence any changes in teacher efficacy over the course of a semester. The following research questions were addressed: 1) How does teacher efficacy compare among STEM TA demographics? 2) How does STEM TA teacher efficacy relate to student evaluations? 3) How does STEM TA teacher efficacy change over the course of a semester? 4) What are the main sources of teacher efficacy for STEM TAs? A demographic survey was administered to collect data regarding TAs’ gender, ethnicity, and teaching experience. Teacher efficacy was measured at the pre-, mid-, and post-semester using the Graduate Teaching Assistant Teacher Self Efficacy Scale (GTA-TSES). TAs were instructed to distribute an evaluation survey to their students at the end of the semester.
Eight TAs were selected to participate in an end of semester interview based on their pre- and mid-semester GTA-TSES scores (2 remaining high, 2 remaining low, 2 from low to high, and 2 from high to low). The interview protocol addressed how their experiences as a TA, as well as any teacher development experiences they may have, influenced their confidence in their teaching abilities. There were no significant differences in teacher efficacy among gender and ethnicity, and there was only a significant difference between TAs with the least amount of experience and TAs with the most experience. Students evaluated their TAs relatively high regardless of teacher efficacy level, and there was not a significant correlation between teacher efficacy level and student evaluation score. However, a positive and significant correlation was found between student response rate and student evaluation score. Teacher efficacy significantly increased from pre- to mid-semester with a slight decrease from mid- to post-semester. TAs who were higher in teacher efficacy were influenced by sources associated with mastery experience, vicarious experience, and verbal and social persuasions from reliable sources such as professors and accomplished peers. The language of high-efficacy TAs demonstrated evidence of focusing outwardly on the impact they were having on student learning. TAs who were lower in teacher efficacy were influenced by sources associated with mastery experience of self-oriented teaching skills such as grading and public speaking, vicarious experience, and verbal and social persuasions from students. The lack of mastery experience and the lack of content knowledge emerged as sources of confidence for low efficacy TAs. The language of low-efficacy TAs demonstrated evidence of focusing inwardly upon their own selves over how they were impacting student learning. A proposed model of teacher efficacy was developed from the main findings of this study in order to inform future research provide suggestions for TA PD opportunities.
Exploring Sources of and Changes in Graduate Teaching Assistant Teacher Efficacy Throughout a Semester: A Mixed Methods Study

by
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DEDICATION

To my bride, Alaina Rainey Smith, who has unconditionally loved, supported, and motivated me through completion of this dissertation. I am overwhelmed by the sacrifices you have made for and the joy you have shared with me. I love you and I like you.
BIOGRAPHY

Cody Smith was born and raised in El Dorado, Arkansas. He attended the University of Arkansas, Fayetteville where he earned bachelor’s and master’s degrees in Exercise Physiology. His passion for improving teaching and learning in STEM motivated him to pursue a Ph.D., and he looks forward to furthering this passion as an educator and a researcher.
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CHAPTER 1: INTRODUCTION

Experienced teachers have been found to have higher self-efficacy in their positions than novice teachers (Prieto & Altmaeir, 1994; Carleton, Fitch, & Krockover, 2008; Morris & Usher, 2011). Self-efficacy is a key concept linked to performance, as belief in one’s capabilities influences one’s actions toward performing well in a given task, as well as perseverance and resilience to obstacles and adversity (Bandura, 1997). Tschannen-Moran, Hoy, and Hoy (1998) refer to self-efficacy among teachers as “teacher efficacy” and define it as a teacher’s perception of his or her own ability to accomplish specific teaching tasks in a particular context. Therefore, understanding one’s level of teacher efficacy is telling of one’s level of teaching performance, and a teacher with high self-efficacy would, in theory, execute teaching strategies effectively to elicit greater achievement from their students. Bandura (1986, 1997) proposed four sources of self-efficacy (mastery experience, vicarious experience, verbal and social persuasions, and emotional and physiological states) that contribute to the confidence one has in their abilities. An understanding of these sources and how teachers use them could contribute to the knowledge of how to better prepare teachers to perform well.

The quality of undergraduate Science, Technology, Engineering, and Mathematics (STEM) education is in jeopardy when instructors of these courses are not well developed as teachers. Quality education is vital to the advancement of the STEM workforce in an attempt to compete in global markets, as well as improve the science literacy of the general public (National Research Council, 2012). According to the Committee on Science and Teaching (2010), half of the students who begin a science degree leave the STEM field by the time they are seniors, outpacing social sciences and humanities by 20 percentage points. While student interest and ability are contributing factors, teacher development should also be considered as a means of
improving retention. According to Seymour and Hewitt (1997), 90 percent of students leaving STEM fields had concerns with the quality of teaching. However, major research universities influence faculty to focus more heavily on their research work than their teaching practice. It is rare for institutions to provide as many incentives, support, or rewards for faculty to improve their teaching as there are for conducting research (Bradforth et al., 2015). Savkar and Lokere (2010) reported that even among science faculty who value education and research evenly, their decisions are often aligned with the needs of research rather than education.

That research is emphasized over teaching is further evidenced by the requirement of graduate students to complete a thesis or dissertation, along with other research requirements determined by the college, without the requirement of teacher professional development (PD). If teaching were valued as highly as research, graduate students would be offered as much credit to take teaching courses as they receive for dissertation work, and mentorship for teaching would be emphasized as much as mentorship for conducting a research study. Requiring research without requiring PD implies that teaching is valued less than research in higher education.

Experienced faculty do not always teach undergraduate STEM courses. Tuition waivers and stipends are provided for many graduate students in exchange for teaching introductory science courses in their department as graduate teaching assistants (TAs). TAs with prior PD experiences have been shown to have higher levels of self-efficacy than those with no training, yet PD still is not a major focus of the graduate student’s plan of work (Prieto & Altmaier, 1994). Although the literature has covered the link between PD and teacher efficacy among TAs, and has shown that K-12 teacher efficacy positively affects student achievement (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Evans, 2011, Mojavezi & Tamiz, 2012), there is a gap in the literature regarding the relationship between TA teacher efficacy and student perception of TAs’
effectiveness, how TA teacher efficacy changes over a semester, and which sources of teacher
efficacy are most influential to TAs of various levels of efficacy. This study sought to fill this
gap by sampling STEM TAs at a major research university, surveying their teacher efficacy
throughout a semester, and comparing the data with student evaluations and TA interviews.

Problem Statement

With only half of the students who begin a STEM degree remaining in the field by the
time they are seniors, there is great cause for concern regarding the future of science and science
education (Committee on Science and Teaching, 2010). A portion of this problem might be
attributed to introductory courses being taught by TAs with low teacher efficacy, as freshman
STEM majors are changing majors or withdrawing from college at a higher rate than any other
major (Higher Education Research Institute, 2010). Without knowing how TA teacher efficacy
develops over time or relates to performance, it is difficult to gauge the impact that it has on the
high attrition rates in STEM programs. There is clearly a need to study how TA teacher efficacy
influences teaching performance.

Purpose and Research Questions

After conducting a comprehensive literature review regarding the topic of TA teacher
efficacy (as will be discussed in more detail in chapter 2), I found that exploring how teacher
efficacy develops over time is largely missing from the literature on STEM TAs. Not every TA
is pursuing a career in teaching, which leads to varying degrees of commitment and confidence
to teach. This study took a vital next step in the literature by empirically exploring the
relationship between TA teacher efficacy and their students’ evaluations, and factors that may
influence teacher efficacy over the semester while answering the following research questions:

1) How does teacher efficacy compare among STEM TA demographics?
2) How does STEM TA teacher efficacy relate to student evaluations of performance?

3) How does STEM TA teacher efficacy change over the course of a semester?

4) What are the main sources of teacher efficacy for STEM TAs?

Overview of Methodology

This study employed a sequential exploratory mixed-methods research design, by which quantitative data is collected first and is followed by qualitative data collection (Creswell, 2014). This qualitative aspect of this design allowed for further exploration of the data and interpretation of the findings from the quantitative phase of data collection. Participants were sampled from a major research university in the southeastern United States. Quantitative data was collected via online survey. A demographic survey collected data regarding TAs’ age, gender, race/ethnicity, and years of teaching experience. The GTA-TSES was used to measure teacher efficacy among the TAs (DeChenne, Enochs, & Needham, 2012). A student evaluation survey adopted from the university’s Office of Institutional Research and Planning was used to measure student perception of teaching performance. The efficacy survey was collected at three time points: pre-semester, mid-semester and post-semester. Student evaluations of their TA were collected slightly post-semester. Eight TAs were selected based on their levels of teacher efficacy to participate in a post-semester interview.

Rationale and Significance

Understanding how TA teacher efficacy changes over time and relates to their performance will help bridge gaps in our understanding of the role of TA teacher efficacy and how this understanding can inform PD opportunities. The problem addressed in this study is significant due to the teaching quality of STEM TAs affecting the education quality of students who are to become the future leaders in their field. High attrition rates among undergraduate
STEM students are due in part to this issue of teaching quality resulting from the lack of preparation of TAs to instruct their courses (Gardner & Jones, 2011). The rationale for this study hinges on the lack of understanding which sources of teacher efficacy are most impactful, so that they can be emphasized in the development of and support for TAs as instructors. Bridging gaps in the literature and investigating the links between teacher efficacy and indirect measures of teacher quality could focus the literature toward what factors actually enhance the quality of instruction by both TAs and future faculty, thus combatting the attrition rates in STEM fields.

**Role of the Researcher**

I hold the position that more support is needed for TAs to teach more effectively. This position is based upon my own experience as a TA in a science department. In this particular department there was no requirement for TA PD, and TAs were appointed to teach full introductory courses alone.

**Researcher Assumptions**

It was hypothesized that teacher efficacy would be positively correlated with student evaluations, and that there would be differences in teacher efficacy among TAs of different race/ethnicity, but not gender. Furthermore, it was believed that vicarious experience and verbal persuasion would be the most common sources of teacher efficacy among participants.

**Definitions of Key Terminology**

*Teacher Efficacy:* According to the social cognitive theory, skill development is dependent upon self-efficacy beliefs (Bandura, 1997). As defined by Tschannen-Moran and colleagues (1998), teacher efficacy is a teacher’s perception of his or her own ability to accomplish specific teaching tasks in a particular context. Therefore, teacher efficacy is vital to the development of teaching skills. This term will be used interchangeably with confidence.
Mastery Experience. The completion of a task followed by the interpretation and evaluation of the results obtained in order to determine whether corrections are necessary.

Vicarious Experience. Observing another performing a task and interpreting and evaluating the results obtained for comparison to oneself.

Verbal and Social Persuasions. Receiving encouragement or praise of capabilities from a trusted other.

Emotional and Physiological States. Responding to surrounding stimuli affecting one’s mood or physical condition.

Graduate Teaching Assistants (TAs): Graduate students who instruct undergraduate courses and may or may not seek a faculty position upon graduation.

Professional Development (PD): Any formal course or workshop consisting of a transfer of information and/or active participation in activities in order to develop teaching beliefs and/or improve teaching practice. In some instances professional development and training are separated but for the purposes of this study they will both be considered as opportunities for improving teaching and learning.

Organization of the Dissertation

Following this introduction is a review of relevant literature in chapter two on the topic of teacher efficacy and its role in teacher quality and student achievement before thoroughly laying out the methods of data collection and analysis in chapter three. Next, the findings will be reported in chapter four before ending with a discussion of the findings and concluding statements in chapter five.
Chapter 2: REVIEW OF THE LITERATURE

Introduction

This study was framed by the literature on self-efficacy, its theoretical background, and how self-efficacy impacts teachers. Research addressing TA development and effectiveness is relatively new but growing, and the topic of teacher efficacy and its relation to student evaluations and teaching performance is largely missing. While the literature shows that PD is linked to improvements in TA teacher efficacy, and that K-12 student achievement is improved by increases in teacher efficacy, there is still a need to connect the implications of increased TA teacher efficacy on their teaching performance and students’ evaluations (Prieto & Altmaier, 1994; Bruce et al., 2010; Evans, 2011, Mojavezi & Tamiz, 2012; Boman 2013). This chapter discusses studies that have investigated teacher efficacy in other settings, such as K-12 education or higher education faculty, in order to make inferences on TA teacher efficacy. To further apply the findings on efficacy, the benefits of TA training and development are included in order to situate this study within the topic of the effect teacher efficacy has on undergraduate learning. Specifically, the literature involving the theory behind teacher efficacy and its relationship with teacher demographics, teaching experience, pedagogical and content knowledge, student feedback and achievement, and PD guide this chapter.

Overview

Research has shown that an important factor linked to effective teaching is teacher efficacy, or the teacher’s perception of his or her own ability to accomplish specific teaching tasks in a particular context (Tschannen-Moran, Hoy, & Hoy, 1998). Using this overarching concept as a theoretical construct, this chapter examines the extant literature on relationships between teacher efficacy and demographics, experiences, knowledge, development, and student
feedback and achievement in the K-12 setting in order to present the need for studying the same relationships largely missing in the research of the TA setting.

**Social Cognitive Theory**

Bandura’s theory of social learning (Bandura, 1977) states that motivation to perform an action relies on the belief in a favorable result of that action and the confidence to successfully perform it. Both the outcome expectation (of a favorable result) and the self-efficacy expectation (confidence to successfully perform) work in concert to convince one that the result of the action is both important and attainable. Bandura’s social cognitive theory (SCT), which is based on the premise that self-reflection on one’s own experiences and thoughts influences future actions based on present understanding, has furthered the concept of self-efficacy (Bandura, 1986). SCT emphasizes self-regulation as a means to modify behavior. Through reflection on one’s own experiences and thoughts, individuals form beliefs about their knowledge and skills, which influence their performance on future tasks. According to Bandura (1986, 1997), there are four sources of self-efficacy: mastery experience, vicarious experience, verbal and social persuasions, and emotional and physiological states.

Discussing all four sources, Bandura (1986) stated that the most powerful source of self-efficacy is mastery experience, or one’s own experience succeeding on a task. Reflecting on past accomplishments and the feelings associated with them contribute to believing that they can be achieved again, especially when the tasks are mastered while overcoming challenges. Comparing oneself to others through vicarious experiences can benefit or hinder self-efficacy depending on how well others are doing in comparison to oneself. These experiences, however, are dependent upon whether or not the comparison is being made with someone similar to oneself. Receiving words of encouragement or affirmation from trustworthy sources – verbal and social persuasions
- can impact even those who are not yet experienced enough to make accurate self-assessments. Emotional and physiological states also affect self-efficacy, in non-linear ways; there are optimal levels of response to anxiety, stress, fatigue, and mood.

**Teacher Efficacy**

Teaching is a position that includes many complex tasks that can be quite challenging. In the K-12 setting it has been reported that 40% to 50% of novice teachers leave the profession within the first 5 years of teaching (Harris & Associates, 1993; DeAngelis & Presley, 2011). Thus, many teachers may never have access to mastery experience as a source of efficacy. The same could be said for TAs, who have little to no experience teaching.

A teacher who observes a peer successfully implementing a lesson plan, and believes that the teacher is similar in ability to his or herself, is likely to believe that they too can teach that lesson well. While TAs may discuss with one another how well or poorly they are instructing their courses, the main sources of vicarious experience most graduate students have is their previous professors, who are not of the same experience and knowledge as them.

Even inexperienced TAs’ teacher efficacy levels can be raised through words of encouragement. Faculty mentorship has also shown to improve teacher as well as academic career efficacy (Curtin, Malley & Stewart, 2016). Types of mentorship studied included instrumental, psychosocial, and sponsorship. This shows that feeling supported by professionals established in one’s career field can have a positive effect on their ability to educate students more effectively.

There are many circumstances in a classroom that can alter a TA’s emotional and physiological states, such as assuming the responsibility of students for the first time or managing time between planning for class and working on one’s own class project or research.
Learning strategies for dealing with these emotional and physiological states likely takes time. Based on the nature of the two settings, full time K-12 teachers tend to have more time to learn and adjust than TAs.

The skills, tasks, domains, and contexts that Bong (2006) says influence self-efficacy differ among K-12 educators and TAs, so any assumptions that K-12 and TA teacher efficacy can be directly compared should be made with caution.

**Connection Between Teacher Efficacy And Teacher Effectiveness**

The relationship between teacher efficacy and teacher effectiveness (as measured by student achievement) has been researched in the K-12 setting. In a study of secondary math teachers, higher teacher efficacy, content knowledge, and attitudes were found to be associated with higher student achievement (Evans, 2011). Bruce and colleagues (2010) reported that primary math teachers with high teacher efficacy demonstrated challenging but effective teaching techniques, expected high quality results from their students, and were effective classroom managers, all of which were contributing factors to increased student achievement in math. Goddard, Hoy, & Hoy (2000) developed and tested a measure of collective efficacy among a group of primary school teachers from the same school and found a positive association between collective efficacy and differences in student achievement among schools. Ross (1992) studied the relationship between 7th and 8th grade teacher efficacy and student achievement and found that student achievement was higher in classrooms in which teachers had higher measures of efficacy as a result of more contact with their coach. It has also been shown that teacher efficacy can influence secondary students’ motivation and lead to greater student achievement (Mojavezi & Tamiz, 2012).
While there is ample research in the K-12 setting that demonstrates a link between teacher efficacy and student achievement, there is a lack of literature on the same effects between TAs and their students. However, Tournaki and Podell (2005) found that student feedback can be a reliable tool to explore teacher effectiveness as students recognize the positive and negative characteristics of their teachers. Comparing students’ evaluations of their TAs to the TAs’ efficacy could test whether the linkage demonstrated for K-12 teachers holds for TAs.

**Assessing Teacher Efficacy**

Multiple instruments have been developed to measure teacher efficacy of certain populations in specific settings. The Science Teaching Efficacy Belief Instrument (STEBI) was designed by Enochs and Riggs (1990) specifically for preservice elementary science teachers. The Teacher Sense of Efficacy Scale (TSES) was designed by Tchannen-Moran and Hoy (2001) to assess teacher self-efficacy beliefs of K-12 teachers. The Self-Efficacy Toward Teaching Inventory - Adapted (SETI-A; Prieto & Altmaier, 1994) was adapted for general use from an instrument aimed at counseling psychology educators. The College Teaching Self-Efficacy Scale (CTSES; Prieto Navarro, 2005) was developed for general post-secondary use. None of these instruments are specifically aimed at the target population of this study, however. In contrast, the GTA-TSES is specifically for STEM graduate teaching assistants. It was developed by modifying and removing items from the CTSES to adapt it to apply directly to STEM TAs. The GTA-TSES was demonstrated to be a valid and reliable measurement of teacher efficacy (DeChenne, Enochs, & Needham, 2012). This 15-item survey addresses the respondent’s current level of confidence for each item, and responses are given on a 5-point Likert scale from not at all confident to very confident. There are two subscales of teacher efficacy measured by the GTA-TSES: instructional strategies and positive learning environment. These two subscales
allow for a better understanding of which specific areas TAs are more or less efficacious in, and how they might relate to other variables. The GTA-TSES was selected due to its specific purpose for the context and population being studied in this dissertation.

Most studies of teacher efficacy measured it at one point - typically at the end of the year or semester only (Ross, 1992; DeChenne, Enochs, & Needham, 2012; Mojavezi & Tamiz, 2012). Other studies do not specify when efficacy was measured (Morris & Usher, 2010; Poore, Stripling, & Stephens, 2014). There is a gap in the literature concerning how teacher efficacy may vary across a semester.

**Contributing Factors to Teacher Efficacy**

**Gender.** Research on self-efficacy has included explorations of differences by gender, race, and ethnicity. Usher and Pajares (2008) reviewed the literature for sources of self-efficacy in students and found that the level of self-efficacy is different among gender in specific domains. For example, males have higher self-efficacy in math and science, whereas females show higher levels in writing. This domain-specific effect would have little influence on teachers as they are specialists in the domain in which they are teaching. Therefore, there would likely be no difference in self-efficacy among male and female teachers. Klassen and Chiu (2010) looked at specific contexts of teacher efficacy and found that the only difference was that males have higher classroom management efficacy than females. The authors also found that classroom management efficacy was inversely related to work-related stress, which females have a much higher level of, perhaps due to the role conflict of combined work and family roles. These findings could be telling of the effects of the stress TAs have outside of teaching their courses such as attending class, working on their own school work, and working on any research projects they are tasked with. There are also differences in the sources of self-efficacy among gender.
Usher and Pajares (2008) reported that mastery experience is the main source for males, while females tend to depend more on verbal persuasions. Males spoke about their personal accomplishments, natural abilities, and talents in the domains in which they worked. Vicarious experiences did play a role in leading men to understand how to approach their careers, but ultimately these experiences had little influence on how capable they perceived themselves. Any mention of the influence of verbal and social persuasions were done so passively by men as opposed to women who relied more heavily on words of affirmation from others. Women also relied heavily on vicarious experiences, which suggest that the main sources of self-efficacy for women revolve around influences outside of mastery experience, especially in male-dominated fields.

**Race/Ethnicity.** Race/ethnicity has been found to have an influence on which sources of self-efficacy have a greater effect (Klassen, 2004). Immigrant populations tend to gain more confidence from others, either through vicarious experiences or verbal persuasions, than they do from themselves, by mastery experience as nonimmigrant populations do. This is perhaps due to nonimmigrant populations having more mastery experience and thus a sense of how to succeed in the given setting. African Americans’ self-efficacy is predicted mostly by their own mastery experiences as well as social persuasions of others, while White populations’ self-efficacy is not predominantly determined by any one source but rather by an even mix of all. Understanding the varying sources of self-efficacy that are most effective among different demographics is beneficial to both knowing the role that teacher efficacy is playing in their performance, as well as informing ways in which self-efficacy can be positively influenced.

**Teaching experience.** Research has shown that teaching experience is positively correlated with teacher efficacy, and that the development and maintenance of teacher efficacy
may differ among preservice and inservice teachers (Prieto & Altmaier, 1994; Carleton, Fitch, & Krockover, 2008; Morris & Usher, 2011). Klassen and Chiu (2010) reported that mean teacher efficacy continually increases from year 0 through year 23 of a K-12 teacher’s career before peaking and gradually declining due to motivation issues in the latter part of careers. These findings, along with the rate of teachers leaving within their first 5 years, suggests that mastery experiences are important for the confidence of teachers. Based on their findings that novice teachers were less efficacious compared to experienced teachers, Tschannen-Moran and Hoy (2007) concluded that those teachers who begin their careers with low teacher efficacy but who identify and work to improve weak areas are more likely to stay in teaching, while those who do not practice this will choose to leave the field.

TAs who lack the years of experience necessary to build teacher efficacy are a unique group that needs to be further studied. It is still largely unclear whether higher teacher efficacy among TAs is necessary to effectively perform their tasks and support greater achievement among their students. The unique opportunity TAs have to instruct courses or labs without being required to go through pedagogical training could conceivably cause them to have high initial efficacy due to ignorance of the difficulties of teaching.

Tschannen-Moran, Woolfolk-Hoy, and Hoy’s (1998) position that teacher efficacy is related to the effort put into teaching and overcoming obstacles applies to TAs whose teacher efficacy may be built upon sources other than mastery experiences. The teacher efficacy of preservice teachers (a population similar to TAs in their inexperience) can be increased through extracurricular experiences as well as through active learning experiences as a student (Ramey-Gassert & Shroyer, 1992; Johnston, 2003). Bandura (1997) suggested that having slightly higher perception of skills than actual skills favors the teacher’s ability to make the most of the skills
they do possess. Without experience and training, TAs are likely to possess few honed skills for teaching. Whether or not the absence of these skills is consequential to their own performance as assessed by their students’ evaluations needs further exploration.

**Teacher professional knowledge.** Although teacher knowledge is not a factor being empirically measured in this study, including the different types of knowledge is important to understand the impact of teacher efficacy on TAs who have little opportunity to develop all of the important types of teacher knowledge. Content knowledge is important for teaching (Shulman, 1986). TAs are graduate students who likely are teaching in their own department, and therefore are familiar with and perhaps have a good understanding of the content they will be teaching. However, increased content knowledge by itself does not result in greater teacher efficacy (Moore & Watson, 1999; Schoon & Boone, 1998).

Pedagogical knowledge includes understanding how people learn so that better teaching practices can be utilized for the student to make strong connections with the information. Linenberger et al. (2014) found that TAs in a learning community program placed importance on pedagogical knowledge for their development as effective instructors. While not all TAs share this goal, being presented with the impact of teaching styles and beliefs on teaching performance may increase implicit interest from TAs in wanting to learn more in order to teach well.

Many of the workshops offered for inexperienced TAs do not include in-depth information of teaching strategies for given subjects. Instead, they tend to focus more on the management of a class and best practices for completing the tasks involved with teaching (i.e., pedagogical knowledge). Shulman (1986) combined content knowledge with pedagogical knowledge to propose a third teaching knowledge: pedagogical content knowledge (PCK), which includes the understanding of what makes specific topics easy or difficult to learn. Park and
Oliver (2008) identified six components of PCK: Orientation to teaching science, knowledge of instructional strategies for teaching, teacher efficacy, knowledge of assessment of science learning, knowledge of science curriculum, and knowledge of students’ understanding in science. Although the PCK model has not been widely applied to TAs, considering the component of teacher efficacy may prove beneficial in exploring TA PCK and teaching performance. Shidler (2009) reported that coaching teachers on strategies for enhancing student understanding in specific content, or PCK, provided the greatest improvements in teacher efficacy and subsequent student achievement.

Teaching orientations (or beliefs about teaching and learning) of untrained teachers are developed by observing how they were taught and are adjusted based on aspects of their professors they may or may not have found effective. This concept has been referred to in the literature as the “apprenticeship of observation” (Lortie, 1975) or “teachers teach the way they were taught” (Heaton & Mickelson, 2002, p. 51). Because of this, many science professors who were once taught by academic researchers have developed traditional, lecture style instruction methods. Gilmore et al. (2014) explored four factors to determine if they could change the teaching orientations of science TAs. These factors included mentor involvement, departmental or college training, prior teaching experience, and prior research experience. They found that mentorship was the only factor significantly related to changes in teaching orientation. Furthermore, they hypothesized that the nature or quality of teaching experience may be more important than the years of experience. As previously mentioned, the nature of required skills and tasks that influence teacher efficacy differ between TAs and more experienced teachers. The skills and tasks required of TAs within their unique context of teaching are perhaps relatively
easily mastered without a great amount of experience necessary, and TA teacher efficacy might be less impacted by the lack of teaching experiences they have had.

Since many science graduate students have had few to no opportunities to teach prior to becoming a TA, the importance of teacher efficacy is heightened in order for them to develop effective teaching orientations. The education of the undergraduate students they will be teaching depends on it, not only in their TA positions but also in future faculty roles, as there is a tendency for teacher orientations to endure from the time of their initial development (Boice, 1996). Because of this, addressing pedagogy of future faculty while in their Ph.D. programs becomes even more urgent. The science literacy of undergraduate students relies upon whether or not their professors practice effective teaching strategies (DeHaan, 2005).

**Professional development.** The literature on TAs has shown that PD positively affects teacher efficacy. In a study of the effects of PD on TAs, Boman (2013) found increases in teacher efficacy, greater self- and observer-ratings of effective teaching practices, and a shift from self-oriented concerns (e.g., acquiring teaching skills) to concern about student learning. Boman suggested, however, that teaching experience and mastery of teaching skills and techniques are necessary for shifting the TA’s focus fully toward student outcomes. According to Pentecost and colleagues (2012) PD improves the confidence and skills with which TAs are able to implement more student-centered pedagogy in their classes. TAs benefit from quality PD experiences by attaining an increased sense of preparedness to teach, feeling well supported in their teaching, and taking ownership of their own teaching by learning to be critically reflective of the implementation of their lessons (Ridgway, Ligocki, Horn, Szyller, & Breitenberger, 2017). These characteristics play into the psyche of the TA by affecting their teacher efficacy.
TA self-perception has also been a topic of study related to their PD. Cho, Kim, Svinicki, and Decker (2011) studied predictors of TA teaching concerns related to teaching-related issues such as experience, efficacy, and participation in PD. They found that TAs are more concerned with impact-related issues (i.e., how their students learn) when they perceive the teaching-related issues as manageable, and are more concerned with their skill, task, and context-related issues when they perceive the teaching-related issues as challenging (Cho et al., 2011). These findings show that well trained TAs are better prepared to handle challenging teacher-related issues while maintaining concern for the impact of their instructional techniques on student learning.

Prieto and Altmaier (1994) found that previous teaching experience was positively correlated with TA teacher efficacy, and prior teaching experience that included teacher training improved the efficacy of the TAs even more. These findings further support the notion that TA PD is necessary to provide TAs with the best opportunity to more confidently instruct their students, which might lead to more effective teaching and learning and ultimately increased retention in science programs of study.

This literature indicates that teacher efficacy is an important psychological construct that might have functional implications in a TA’s ability to teach confidently and effectively. Nyquist and Sprague (1998) modeled a framework of TA development indicating that as TAs develop (as they would in a PD program) their concerns shift from inward (issues about their pedagogy) toward student learning (how well the content is being understood). A positive PD experience is one that would evoke this shift in TAs, especially those TAs without teaching experience. Ideally TAs would reach a point of considering only how their teaching is affecting their students instead of concerning themselves only with their own teaching methods. Understanding the role teacher efficacy plays in eliciting the shift in concerns from inward to outward concerns and the
shift in focus from self-oriented to student outcome could improve the design of professional development for TAs and better prepare them for their teaching roles.

The role that PD plays in enhancing the teacher efficacy in K-12 teachers is drastically different than for TAs, as K-12 teachers have more time and resources for development, as well as a greater likelihood that they have teaching experience. Even first year K-12 teachers have more experience and development in teaching within their education programs than TAs, with the exception of lateral entry teachers. In the absence of experience, TAs belong to a community of novice teachers who share similar experiences with varying levels of knowledge and confidence. Bruce and colleagues (2010) researched primary math teachers in two school districts, one whose teachers participated in a math professional learning program and the other whose teachers did not participate. It was found that the district who participated in the professional learning program had more efficacious math teachers with students who reached higher achievement than the other district. Collective efficacy, or the belief in a group of teachers’ efforts as a whole to have a positive effect on students, has a positive effect on individual teacher efficacy (Bandura, 1982; Goddard, Hoy, & Woolfolk-Hoy, 2004). The general lack of experience and development among TAs compared to K-12 teachers provides an interesting context to investigate whether or not TA teacher efficacy affects how effective they are as instructors. While we know that TA teacher efficacy is enhanced by PD, and that K-12 student achievement is positively affected by teacher efficacy, there is still a need to study the relationship between TA teacher efficacy and teaching performance. Knowing that teacher efficacy is improved with PD tells half of the story of how TA PD affects teaching effectiveness and thus student learning. Demonstrating any positive effect that teacher efficacy has on undergraduate learning would strengthen the case for the importance of implementing TA PD.
Summary

The current literature clearly highlights the importance of teacher efficacy to enhance student achievement through improved teaching performance in the K-12 setting, but there is still work to be done in order to understand whether and how efficacy and effectiveness are related in the case of TAs. Studying TA teacher efficacy and its effect on teaching performance as assessed through student evaluations could inform TA PD efforts, leading to improvements in undergraduate education and contribute to the retention of STEM majors, thus enhancing competition in global markets as well as improving the science literacy of the general public. Upon reviewing the literature it is understood that demographics have very specific effects on teacher efficacy depending on which of the four sources of self-efficacy is being utilized. Teaching experience is important in improving teacher efficacy, but TAs are not likely to have the opportunity to leverage these experiences as students. PD improves TA and K-12 teacher efficacy, which, in K-12 settings, has been shown to positively affect student achievement. While TAs may be knowledgeable of the content that they must deliver, being prepared pedagogically is necessary to develop the PCK needed to confidently and effectively facilitate constructive, student led class discussions. K-12 teachers with high teacher efficacy are more confident in their ability to instruct a course and therefore are more likely to effectively perform their tasks. Additionally, learning how TA teacher efficacy relates to student evaluation feedback could reveal whether or not the TA’s confidence is telling of their performance as perceived by students. Whether and how TA efficacy varies across the span of a semester is also unknown.

This study takes a vital next step in the literature by empirically exploring the relationship between TA teacher efficacy and their students’ evaluations, and factors that may influence any changes in teacher efficacy over the semester while answering the following research
questions: How does teacher efficacy compare among STEM TAs of varying demographics? How does STEM TA teacher efficacy relate to student evaluations of performance? How does STEM TA teacher efficacy change over the course of a semester? What are the main sources of teacher efficacy for STEM TAs? The results of this study will inform the field about the importance of teacher efficacy among TAs in order to improve teacher quality and student learning. Understanding these outcomes will be telling of how important it is to improve TA teacher efficacy. The following chapter (3) details the methods involved in this study.
CHAPTER 3: METHODOLOGY

Introduction

With the extant literature on the effects of teacher efficacy prominently focusing on the K-12 setting, this study addressed how TA teacher efficacy relates both to students’ evaluations and to the sources of teacher efficacy based on interviews with participants of varying teacher efficacy levels, as well as how TA teacher efficacy changes over time and differs among demographics. This chapter begins with a description of the research design and the rationale for using it. Next, the setting, context, sample, and data sources are explained, followed by the methods of data collection and analysis, as well as the comparison of both data types. Finally, issues of trustworthiness, the significance of the study, and potential limitations are discussed.

Rationale for Research Approach

This study employed a sequential exploratory mixed methods research design, in which quantitative data was collected first and informed the qualitative data collection and analysis procedures, followed by qualitative data collection and analysis (Creswell, 2014). This design allowed for qualitative data to be purposely collected in order to further explain and interpret the findings from the quantitative phase of data collection. With this data, I was able to reach a high level of understanding about TA teacher efficacy, how it changes throughout the semester, the differences among demographics, as well as a more in-depth understanding of the sources of efficacy that TAs primarily use.

Research Setting/Context

This research study was conducted at a major research university in the southeastern United States over the course of one semester. The study focused on STEM TAs and their students as these academic fields are found to be most susceptible to student attrition as
mentioned in previous chapters. Participation was completely voluntary, and recruiting and data collection procedures were conducted exclusively online through email and the Qualtrics survey platform.

**Research Sample and Data Sources**

IRB approval was received to conduct this study. I sought a sample of TAs in STEM departments to complete the GTA-TSES (Appendix A) pre-, mid-, and post- semester, and as many as who were interested were given the opportunity to participate. The GTA-TSES was created specifically for measuring STEM TAs’ teacher efficacy. It was demonstrated to be a valid and reliable measurement of teacher efficacy ($\alpha = .92$; DeChenne, Enochs, & Needham, 2012). An exploratory factor analysis indicated that all factor loadings were between .49 to .77 ($p < .05$) according to DeChenne, Enochs, and Needham (2012). This 15-item survey addresses the respondent’s current level of confidence for each item, and responses are given on a 5-point Likert scale from not at all confident to very confident. The GTA-TSES was selected due to its specific purpose for the context and population being studied in this dissertation.

Those who responded to the pre-semester survey ($N = 104$) were emailed the mid-semester survey, and those who respond to the mid-semester survey ($N = 45$) were emailed the post-semester survey. Seventeen participants completed the survey at all three time points. Additional recruiting was conducted to increase the number of responses to the post-semester survey ($N = 67$) beyond those who complete the pre- and mid- semester surveys. An incentive was offered for those who completed all three surveys (enter a drawing for one of three $50$ gift cards) and for those who completed the post-survey only ($5$ gift card). Along with the email regarding the post-semester GTA-TSES survey, there were instructions for the TAs to send the student evaluation survey to their students with a script of instructions for the student
respondents, as previously described. A total of 139 students (12% of total students) responded to student evaluations for 17 TAs.

The GTA-TSES survey was self-administered online via Qualtrics for security and convenience purposes. Each survey item required a response in order to proceed through the survey to prevent missing data as a result of non-response. Participants received a link to the survey through email, which included specific instructions about how to access the survey, how to respond to the items, and how to submit the survey. The data were then transferred to a spreadsheet for storage and analysis. The format of the spreadsheet included the participant numbers down the far left column and the survey item numbers along the top row. Number scores reflecting the Likert scale responses were filled in for each cell within the matrix. Teacher efficacy from each survey for each participant was reported as an average out of five, as represented by the 5-point Likert scale. Although many TAs did not have teaching experience to reflect upon when answering the initial surveys, they could have drawn from the other three sources of self-efficacy to complete them. Throughout the semester they gained experiences that might have influenced their responses for the remaining two surveys.

In addition, the students of the TAs who completed the post-semester GTA-TSES were asked to complete a 5-point Likert scale student evaluation survey (Appendix B) at the end of the semester. The 8 questions in this survey address the instructor’s teaching performance. Specifically, their alignment with course objectives, receptiveness and feedback to students, enthusiasm and preparedness to teach, and effectiveness were explicitly inquired of in the survey. These aspects of the survey align it with the GTA-TSES, which provides a close connection of two sources regarding how confident the TA is in their ability to perform teaching tasks and how the students perceived them to be performing on those tasks. The student
evaluation also had an open ended question regarding the strengths and weaknesses of the TA as an instructor. The survey was developed by the university’s Office of Institutional Research and Planning, and is used for student evaluations of all instructors at the university. The student evaluation is psychometrically evaluated every three years to ensure its validity and reliability, however, no statistics are provided online by the university (Office of Institutional Research and Planning, 2019). The student data allowed for an analysis of any relationship between students’ perceptions of TA performance with TA teacher efficacy data. An email script was sent to the TAs with instructions to be forwarded along to their students. Within this script, the students were made aware that their anonymous feedback would help an IRB-approved research study examining issues surrounding TA teacher efficacy in order to improve teaching and learning, and the script included a link to the student evaluation for students to self-administer in an online Qualtrics survey. Students were not asked to identify themselves within the survey, but were asked the name of the TA for which they were responding. Student feedback data was recorded in the same spreadsheet as the GTA-TSES survey data and matched to the TA for which the response was given.

A subsample of TA participants (N = 8) was recruited to participate in an audio-recorded, semi-structured interview (See interview protocol, Appendix C). Participants were purposely sampled for interviews based on the results of their first and second GTA-TSES survey scores. This sampling incorporates the sequential aspect of the research design in order for the quantitative analysis to inform the qualitative analysis, which in turn will improve the understanding of the findings of the quantitative analysis (Creswell, 2014). The GTA-TSES survey results show the level of one’s teacher efficacy is, but they do not indicate what has influenced their level of efficacy to be higher or lower, or to change. In order to better
understand this, speaking with the participants and getting a better sense of their experiences and thoughts behind their answers to the survey can help give richer descriptions of how they came to be as efficacious as they are. Two participants who fit into each of the following four categories were recruited for interviews at the end of the semester: high first and second survey scores (high), low first and second survey scores (low), high first and low second survey scores (decrease), and low first and high second survey scores (increase). Participants who completed the interview protocol and all three surveys were offered an incentive ($25 gift card). Table 3.1 displays the descriptive characteristics of the eight participants who were interviewed.

<table>
<thead>
<tr>
<th>TA</th>
<th>Presurvey</th>
<th>Midsurvey</th>
<th>Category</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>Experience</th>
<th>ESL</th>
<th>Subject</th>
<th>Type of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dottie</td>
<td>4.87</td>
<td>4.80</td>
<td>High</td>
<td>Female</td>
<td>Asian</td>
<td>3 years</td>
<td>Yes</td>
<td>Statistics</td>
<td>Lecture</td>
</tr>
<tr>
<td>Mae</td>
<td>4.67</td>
<td>4.60</td>
<td>High</td>
<td>Female</td>
<td>White</td>
<td>6 years</td>
<td>No</td>
<td>Biology</td>
<td>Lab</td>
</tr>
<tr>
<td>Kit</td>
<td>2.80</td>
<td>3.27</td>
<td>Low</td>
<td>Female</td>
<td>White</td>
<td>0 years</td>
<td>No</td>
<td>Psychology</td>
<td>Lecture</td>
</tr>
<tr>
<td>Jimmy</td>
<td>2.93</td>
<td>3.53</td>
<td>Low</td>
<td>Male</td>
<td>White</td>
<td>0 years</td>
<td>No</td>
<td>Statistics</td>
<td>Lecture</td>
</tr>
<tr>
<td>Stilwell</td>
<td>3.67</td>
<td>4.67</td>
<td>Increase</td>
<td>Male</td>
<td>White</td>
<td>1 year</td>
<td>No</td>
<td>Biology</td>
<td>Lab</td>
</tr>
<tr>
<td>Lou</td>
<td>4.40</td>
<td>4.60</td>
<td>Increase</td>
<td>Male</td>
<td>White</td>
<td>3 years</td>
<td>No</td>
<td>Crop Sci.</td>
<td>Lab</td>
</tr>
<tr>
<td>Doris</td>
<td>4.07</td>
<td>3.67</td>
<td>Decrease</td>
<td>Female</td>
<td>White</td>
<td>0 years</td>
<td>No</td>
<td>Plant Bio.</td>
<td>Lab</td>
</tr>
<tr>
<td>Marla</td>
<td>4.60</td>
<td>4.47</td>
<td>Decrease</td>
<td>Female</td>
<td>White</td>
<td>1.5 years</td>
<td>No</td>
<td>STEM Ed.</td>
<td>Lecture</td>
</tr>
</tbody>
</table>

The questions in the interview protocol were worded in such a way as to elicit responses that thoroughly explained the factors that influenced the development of their teacher efficacy. The protocol emphasized the sources of self-efficacy found in the literature (Bandura, 1986, 1997), but more common language was used so that the participants could reflect easily upon their experiences (e.g., the word confidence was used in place of self-efficacy). I developed the
questions for the protocol with the intention of aligning TA responses to the teaching concepts addressed in the GTA-TSES. The beginning of the interview was designed to have the participants talk about themselves and how the semester went in order to provide an easy topic for them to become familiar with sharing information throughout the interview. The term confidence was used in place of teacher efficacy in the interview questions in order to use a more common term associated with one’s belief in their abilities, and to avoid any ambiguity in what I was asking the TAs to think about while answering. The remainder of the interview consisted of questions revolving around explaining any changes in their GTA-TSES scores from pre- to mid-semester, tasks they were most confident in performing, how their experience teaching in that semester influenced their confidence, whether any experiences or interactions affected their confidence, how they compare their teaching to others, and anything that might have affected how they view their teaching. These topics of discussion were chosen to elicit responses related to the TAs’ experiences, and how those experiences affected their confidence in their ability to teach. Three Science Education professors reviewed an initial draft of the protocol and revisions were made based on their suggestions. The purpose of these interviews was to understand which of the four established sources of efficacy and any new emerging sources of efficacy those TAs used.

A sample of TAs who did not participate throughout the semester were recruited to complete the GTA-TSES post-semester that included three open response questions (Appendix D) that allowed all respondents to give a brief response regarding the sources of efficacy they used throughout the semester. I developed the three open response questions based on the literature on sources of self-efficacy (Bandura, 1986, 1997) with the purpose of better understanding how TAs developed their perceptions of their own abilities as instructors. Like the
interview protocol, these questions also used every day language to facilitate the responses by the participants. These questions were also reviewed by the same professors and revised according to their suggestions. These open-response items were valuable in capturing a larger sample of TAs’ sources of efficacy. These open response questions addressed: 1) what the participants might have experienced that influenced their survey responses, 2) anything that might have affected their confidence as an instructor, and 3) any obstacles they had to overcome and the measures that they took to do so in order to improve their confidence.

Coordinators for STEM programs at the university were contacted by email to request access to contact information for all departmental TAs. Contact information was obtained from those who were willing to participate, and consent using an IRB- approved form was obtained from each interested TA prior to participation. Participants were not included or excluded based on any demographic information. Each participant was assigned a number and was referred to by this number throughout data analysis. This made data collection and analysis simpler while also providing anonymity of the participants to ensure confidentiality of responses. Participants selected for interviews were assigned a pseudonym for the purposes of maintaining anonymity throughout data analysis and reporting the data. Additionally, all data and demographic information was held confidential in secure, password protected online files by the researcher. Only co-researchers were allowed access to this information to protect the identity and information of the participants. Each participant was informed of exactly what was expected of him/her and were allowed to drop out of the study at any time. There was little to no risk involved with participating in this study. In order to improve response rate, those who participated in the study from beginning to end were entered to win one of three $50 gift cards. Those who chose to participate in interviews received a $25 gift card as compensation for their
time. Participants who completed only the post-semester survey received a $5 gift card. Data
collection and analysis is detailed below and ordered by research question.

**Data Analysis Methods**

IBM SPSS Statistics 25 was used to run all statistical tests for quantitative analysis.
Correlation coefficients of .70 or greater were considered strongly related, and an alpha level of
.05 was used to determine statistical significance. The Shapiro-Wilk test was conducted to
determine whether or not the data were normally distributed in order to accurately choose what
statistical tests to run.

Qualitative analysis of interview transcripts and responses to open-response questions
were performed by two coders (myself and another doctoral candidate) using *a priori* codes
based on the four sources of self-efficacy and any emergent variations of these codes that came
from the data, which were developed into a codebook (Appendix E, Corbin & Strauss 2008).
According to Corbin and Strauss, coding is the process of “extracting concepts from raw data
and developing them in terms of their properties and dimensions” (p. 159). Furthermore, codes
can be categorized into “themes” that “represent relevant phenomena and enable the analyst to
reduce and combine data” (p. 159). The coders discussed the *a priori* codes being used to extract
concepts from the data, and at least 20% of the data (depending on research question) was coded
together in order to come to an agreement upon the appropriate use of each code and to
determine any emergent codes. This process included each coder reading alone to become
familiar with the data, and open coding the data, or “delineating concepts to stand for blocks of
raw data” (p. 195), using *a priori* codes and noting any potential emergent codes (Corbin &
Strauss, 2008). After coming together to discuss this process and our use of the codes, it became
apparent that emergent codes as sub-codes of *a priori* codes were in the language of the
respondents. Bringing our own emergent codes together for discussion, we then conducted an axial coding process to “relate concepts to each other” (p. 198) in order to develop more elaborate concepts. The final emergent codes that we agreed upon include (1) lack of mastery experience and (2) lack of content knowledge as sub-categories that align with mastery experience, and (3) verbal and social persuasions from students and (4) verbal and social persuasions from peers and professors as sub-categories that align with verbal and social persuasions. Figure 3.1 illustrates the relationship between the a priori codes and the emergent codes.

![Figure 3.1. Diagram of the relationship between codes](image)

The lack of mastery experience came out of mastery experience seamlessly as language from participants who had little to no prior teaching experience to draw upon as an influence of their teacher efficacy stated so explicitly. Not only so, but the language in describing this
influence provided evidence that, were they to have the mastery experience, they would likely have more confidence in their teaching abilities. The lack of content knowledge was also included under mastery experience because TAs’ experiences within a classroom up to this point primarily involve being a student themselves. Therefore, not having an understanding of the content they are teaching is a reflection of the lack of experience with that content either as an instructor or, and perhaps more prominently, as a student. The emergent codes tied to verbal and social persuasions were more obvious in their relationship to the a priori code. Responses that included language pertaining to verbal and social persuasions clearly fit into two sub-categories: language that concentrated more on student feedback and language that concentrated more on feedback from peers or professors. Percent agreement between the two of us is presented by research question below as needed. I then comparatively analyzed the full set of codes to the full dataset to determine similarities and differences among the data (Corbin & Strauss, 2008).

The a priori and emergent codes were combined based on their relationship with one another to develop categories, or themes, of an inward and outward focus of teaching by the participant, which are related to previous findings by Sprague and Nyquist (1998). Explanations of the application of both inward and outward focus will be discussed specifically in relation to the findings of this study in later chapters, but the inward focus of teaching emphasizes focusing on one’s self and their role, task, and communication, while the outward focus of teaching emphasizes one’s ability to impact learning in their students. Chapter four includes a narrative that explains the relationships between the quantitative and qualitative findings of this study in order to better understand what influences the teacher efficacy of TAs with varying characteristics and experiences.
**Research question 1.** How does teacher efficacy compare among STEM TA demographics?

To answer this question, the responses of TAs who completed the pre-semester GTA-TSES and demographics survey were analyzed. Descriptive statistics including mean and standard deviation across all participants were calculated for the GTA-TSES results. Demographic data analyzed included gender, race/ethnicity, and teaching experience, and were chosen based on the previous literature showing differences in sources and levels of efficacy (Prieto & Altmaier, 1994; Klassen, 2004; Tschannen-Moran & Hoy, 2007; Usher & Pajares, 2008; Klassen & Chiu, 2010). Demographic data from the pre-semester survey was analyzed in order to generalize the results of this study to the broader population of TAs. The preliminary analysis of the Shapiro-Wilk test indicated that the GTA-TSES data was normally distributed, therefore an independent samples t-test was run to determine any differences in teacher efficacy among TAs’ gender. A one-way analysis of variance (ANOVA) was used to analyze any differences in teacher efficacy among the four categories of TAs’ race/ethnicity (Asian, White, Black/African American, Hispanic/Latinx). Individual race/ethnicity categories were also combined into two categories consisting of those who were overrepresented (Asian and White) and those who were underrepresented (Black/African American and Hispanic/Latinx) relative to NCSU STEM demographics in this study. An independent samples t-test was used to determine any difference between these two categories. Differences in teaching experience were explored by first coding experience into four ranges (Table 4.4); these four ranges were developed based on the amount of teaching experience of TAs in this study, in order to split the population into four groups of similar size. This generated an ordinal-level variable. A one-way ANOVA was
used to analyze any differences in teacher efficacy among TAs’ experience, and post-hoc tests among each pair of groups were used to determine specifically where any significant differences in teacher efficacy among the levels of experience lay. Based on the literature that states that self-efficacy can be influenced by race/ethnicity, it was hypothesized that the TAs’ race/ethnicity would be a predictor of their teacher efficacy levels (Klassen, 2004). Klassen and Chiu (2010) found that gender determined differences in self-efficacy of certain contexts (e.g., males were more efficacious in their classroom management than females), but this study only measure teacher efficacy in general and therefore no differences between gender were expected.

Research question 2. How does STEM TA teacher efficacy relate to student evaluations of performance?

Data from TAs who completed the GTA-TSES post-semester and whose students responded to the student evaluation survey were used to answer this question. Correlations between teacher efficacy and student evaluation scores were calculated by the nonparametric Spearman's rank correlation coefficient because the student evaluation data were not normally distributed (Cohen, Cohen, West, & Aiken, 2003, p. 31). Two coders coded the responses to the open response item on the student evaluation for TAs in the upper and lower quartiles of post-semester teacher efficacy score to determine any emerging subcategories or themes. The inclusion of evaluations of TAs in these two quartiles was intended to better capture responses from students of low and high teacher efficacy TAs. We each coded the entire dataset, resulting in a high percent of agreement (83%) between our coding (Creswell, 2012). The literature has shown that student evaluations can be reliable in exploring teacher effectiveness, as students are
able to tell the difference between positive and negative teaching characteristics (Tournaki & Podell, 2005). Because of this, it was hypothesized that teacher efficacy would positively correlated with student evaluations of their performance.

**Research question 3.** How does STEM TA teacher efficacy change over the course of a semester?

Data from TAs who completed the GTA-TSES pre-, mid- and post-semester were analyzed to determine any statistically significant changes in teacher efficacy over the course of the semester. Because these data were normally distributed, a one-way repeated measures ANOVA was used to determine any differences in teacher efficacy across time points. This statistical test is intended for data collected in the form of an interval dependent variable of one population (participating TAs). Due to the dependent variable being collected from a summated rating scale generated by averaging 15 Likert 5-point items, the scale was treated as interval. Post-hoc pairwise comparisons were also used to determine between which times points any statistically significant changes were found. Additionally, a two-step cluster analysis determined how many clusters arose from the data, and a K-Means cluster analysis was used to determine varying patterns of change in teacher efficacy across the three time points among TAs. A high percent of agreement (87%) between our coding was calculated.

**Research question 4.** What are the main sources of teacher efficacy for STEM TAs?
To answer this question, multiple coders (a doctoral student in science education and me) coded transcriptions of the interviews and responses from the open-ended survey questions of both high and low efficacy TAs using the same procedures detailed in RQ3 (change in efficacy over time) above. Open-ended survey questions were analyzed to further support the findings associated with the analysis of the interview data. The interviews were analyzed to determine sources of teacher efficacy for high and low efficacy TAs. While mastery experience is said to be the most influential, Bandura’s (1986) sources of self-efficacy are applicable to those who have little to no experience as well. Therefore, it was hypothesized that TAs in this study, who likely do not have much teaching experience, would rely more heavily upon vicarious experiences and verbal and social persuasions as sources of their teacher efficacy, and they emotional and physiological states would not be strong influences.

**Issues of Trustworthiness**

The surveys that were used in this study added validity because they were developed and validated in the extant literature (GTA-TSES), and continue to be used by those researching teacher efficacy and evaluating higher education instructors, or continue to be modified by the university (student evaluation). Anonymous responses from students alleviated any issues surrounding students’ ability to respond honestly to a survey about their TA. Anonymity was used to elicit genuine, accurate responses. Using both TA interviews and student evaluations of TA performance triangulates the data by hearing from TAs both what their teacher efficacy level is and the influencing factors for that level, as well as hearing from students who see the manifestation of these factors playing out in the classroom (Creswell, 2013). Combining these data sources together brings about multiple perspectives and angles to understand not only the TAs’ teacher efficacy but how it impacts their performance in the classroom, which contributes
to more reliable findings. The use of multiple coders exploring the data independently before coming together to discuss and agree upon the use of codes and emergent codes enhances the validity and reliability of the findings (Creswell, 2013). This study was conducted independently of any institutional agenda that might bias the data collection procedures, analysis, or findings.
CHAPTER 4: RESULTS

This chapter includes the results of the statistical tests and qualitative analysis of the four research questions. The findings are ordered by research question.

**Research Question 1.** How does teacher efficacy compare among STEM TA demographics?

All TAs who completed the GTA-TSES pre-semester (N = 104) were included in the dataset for RQ4 (sources of efficacy). The results of the independent samples t-test showed that there were no statistically significant differences in teacher efficacy for gender; \( t(101) = 1.46, p = 0.15 \) (Table 4.1).

Table 4.1

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>40</td>
<td>3.89</td>
<td>0.71</td>
</tr>
<tr>
<td>Female</td>
<td>63</td>
<td>3.70</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Race/ethnicity was analyzed both by individual demographic (Asian, Black/African American, Hispanic/Latinx, White) and by combining those that are overrepresented in STEM (White and Asian) and those that are underrepresented in STEM (Black/African American and Hispanic/Latinx) relative to NCSU STEM demographics in this study. The results of the one-way ANOVA showed that there were no statistically significant differences found in teacher efficacy for individual race/ethnicity categories [\( F(3, 95) = 1.103, p = 0.352 \)] (Table 4.2). The results of the independent samples t-test also showed no significant differences in teacher efficacy between the combined race/ethnicity categories \( t(97) = 1.482, p = 0.141 \) (Table 4.3).
Table 4.2
*GTA-TSES mean and standard deviation by individual race/ethnicity categories*

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>18</td>
<td>3.89</td>
<td>0.76</td>
</tr>
<tr>
<td>Black/African American</td>
<td>10</td>
<td>3.68</td>
<td>0.58</td>
</tr>
<tr>
<td>Hispanic/Latinx</td>
<td>6</td>
<td>3.37</td>
<td>0.40</td>
</tr>
<tr>
<td>White</td>
<td>65</td>
<td>3.80</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Table 4.3
*GTA-TSES mean and standard deviation by combined race/ethnicity categories*

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian and White</td>
<td>83</td>
<td>3.82</td>
<td>0.66</td>
</tr>
<tr>
<td>Black/African American and Hispanic/Latinx</td>
<td>16</td>
<td>3.56</td>
<td>0.53</td>
</tr>
</tbody>
</table>

The results of the one-way ANOVA showed that there was a significant difference in teacher efficacy for teaching experience \(F(3) = 5.058, p = 0.003\). Post-hoc tests determined that the only difference in teacher efficacy found among the various categories of teaching experience was between the least experienced and the most experienced TAs; \(\text{Std Err} = 0.15, p = 0.003\) (Table 4.4).

Table 4.4
*GTA-TSES code, mean, and standard deviation by teaching experience*

<table>
<thead>
<tr>
<th>Reported Teaching Experience (yrs)</th>
<th>Code</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0, No Answer, Grading, Public Speaking</td>
<td>0</td>
<td>39</td>
<td>3.56</td>
<td>0.64</td>
</tr>
<tr>
<td>&gt; 0 – 1</td>
<td>1</td>
<td>24</td>
<td>3.67</td>
<td>0.57</td>
</tr>
<tr>
<td>&gt; 1 – 2</td>
<td>2</td>
<td>14</td>
<td>3.98</td>
<td>0.62</td>
</tr>
<tr>
<td>&gt; 2</td>
<td>3</td>
<td>27</td>
<td>4.11</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Research Question 2.** How does STEM TA teacher efficacy relate to student evaluations of performance?
TAs with primary instructor roles were selected from the dataset to analyze the correlation between their teacher efficacy scores and student evaluations. The Spearman rank correlation coefficient between TA post-semester teacher efficacy score (M = 4.03, N = 17) and student evaluation score (M = 4.55, N = 139) was small and did not reach statistical significance (\(\rho = .144, p = 0.29\)). Another Spearman rank correlation coefficient between student response rate and both teacher efficacy score and student evaluation score was run to determine any relationships between these variables that might improve the understanding of the previous correlation results. The findings showed that there was a significant and positive correlation between the student response rate and the student evaluation score (\(\rho = .502, p = 0.40\)). There was no significant relationship between response rate and teacher efficacy score (\(\rho = -.088, p = 0.74\)).

To get a better sense of the students' evaluations and how they might relate to teacher efficacy scores, I looked at the responses to the single open-ended question for TAs of higher and lower teacher efficacy. For TAs with high levels of teacher efficacy (N = 4), the feedback received focused on their ability to promote learning in the course. For example, a few responses received by highly efficacious TAs were:

[She] is great at breaking down complicated topics and brings lots of energy to any given problem session. Her techniques are effective and helped me through my class this semester.

He did a good job of explaining topics in a way that was easier for students to understand.

[She] was one of the best instructors I’ve ever had. She explained concepts and procedures with clarity and directness, and did a fantastic job bridging the gap between theory and practice. She helped us with lecture topics in our spare time, and also mentored us in student/life skills. She consistently treated us with respect and certainly earned our respect of her.
For TAs with low levels of teacher efficacy (N = 4), the feedback received focused on the TA’s personality and relatability over their ability to teach new information with effective techniques. Below are a few examples of responses received by TAs with lower teacher efficacy:

[He] is flawless. Genuinely, I have never met someone so kindhearted, well educated, and respectful. The way in which he explains concepts in calculus is very understandable and helpful. He is an angel and I'm so sad that I will likely never be friends with him because he truly is one of a kind.

She was great! Very sweet and helpful.

She was amazing!! She was so willing to help everyone and made my lab fun but also taught me so much. I want to take more science classes after having a class with her.

The differences in responses between the two groups of TAs give greater insight into how student evaluations can reveal the same information about a TA as a result of different influences. Therefore, student survey feedback, while beneficial, must be utilized more carefully in order to make inferences about TA performance. The differences in responses from students of the two groups of TAs were categorized into two themes called Inward Focus and Outward Focus, which are described in greater detail under research question 4. Appendix F gives further examples of student responses that were determined to fit within each of these themes.

**Research Question 3.** How does STEM TA teacher efficacy change over the course of a semester?

TAs who completed the pre-, mid-, and post-semester GTA-TSES (N = 17) were included in the dataset to answer RQ3 (changes in efficacy over time). Table 4.6 shows the mean scores of the survey at each time point in the semester. The results of the one-way repeated measures ANOVA indicated a statistically significant difference within the three time points
[F(2) = 4.107, p = 0.026]. The post-hoc pairwise comparison indicated there was a significant increase from pre- to mid-semester (p = 0.04), but not from mid- to post-semester (p > 0.05) or pre- to post-semester (p > 0.05).

Table 4.5
**GTA-TSES data from pre-, mid-, and post-semester**

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-semester</td>
<td>3.98</td>
<td>0.67</td>
</tr>
<tr>
<td>Mid-semester</td>
<td>4.24</td>
<td>0.50</td>
</tr>
<tr>
<td>Post-semester</td>
<td>4.18</td>
<td>0.53</td>
</tr>
</tbody>
</table>

*Note. N = 17*

The two-step cluster analysis results determined that there were two main clusters of the three teacher efficacy scores over the course of the semester as shown by the silhouette measures of cohesion and separation (Figure 4.1) and the scree plot (Figure 4.2) below.
The K-Means cluster analysis was then run using two clusters, and resulted in one cluster on the high end of the scale and the other approximately one point lower. In both clusters, there was an increase from pre- to mid-semester GTA-TSES, with a slight decrease from mid- to post-semester. In cluster one (N = 9), GTA-TSES scores increased from 4.44 to 4.62 and then decreased to 4.54. In cluster two (N = 8), GTA-TSES scores increased from 3.48 to 3.82 and then decreased to 3.78. These clusters show that TAs who were high and low in teacher efficacy still changed over the semester in the same way as reflected by the overall measures of change in teacher efficacy.

In addition to the quantitative analyses, four interviews with TAs whose teacher efficacy changed over the semester were coded. The coding process for RQ3 (changes in efficacy over time) added the emerging subcategories of lack of mastery experience and lack of content knowledge, to the *a priori* codes of mastery experience, vicarious experience, verbal and social persuasions, and emotional and physiological states (Bandura, 1986, 1997). The RQ3 coding
process also further subcategorized verbal and social persuasions into those by students and those by professors or peers. Two of the interview participants’ GTA-TSES scores increased from the pre-semester survey to mid-semester and the other two decreased.

**Increasing teacher efficacy.** The TAs whose teacher efficacy increased over the semester started at different levels, with Lou (4.40) having a higher level of efficacy than the pre-semester mean score (3.98) and Stilwell (3.67) having a lower level. Lou was very open about his experiences, but it took asking follow up questions for him to share out more. He obviously cared very much about teaching and his students, and wanted to see them succeed. Lou held a particular professor of his in high esteem and especially admired the energy with which the professor taught. It was found that Lou’s primary sources of teacher efficacy were vicarious experiences of his professors and his own mastery experience instructing as a TA. This was his third semester as a TA, and though he mentioned it is always different each semester, with each new class he is able to draw on the experiences from the previous one to adjust and excel. He emphasized that the experiences he has had are the real confidence builders. In the quote below he explains his point of view:

> You never really know how it's going to go until you're the one that's up there. That's actually a teaching, interacting with the students, all that kind of stuff. I think that's, that's the most important aspect of, of this learning for me.

Retrospectively, Lou was able to see how valuable independent responsibility of a course was to his development as an instructor. While learning by observing and hearing what works best for others has been beneficial in developing his teacher efficacy, it cannot fully replace the benefits of learning from his own experiences actively carrying out the role of an instructor. He explains that his teaching style was heavily influenced by professors he has worked with as a TA in the past. Those vicarious experiences are valuable as a resource to contribute to one’s own teaching
style, but are less influential than mastery experience. As Lou points out in the following quote, there was a difference in being more of an assistant to a professor and being in charge of his own class:

So I will say compared to my previous two experiences TAing, which were both very hands on with the students, they were both different classes than the one I TA’ed this semester. Both of those were more structured by the professor and I just did what was told of me, whereas this semester was pretty much just completely left up to me. Um, and in some ways that was hard at the beginning of the semester, but now looking back, I’m really glad that I had the opportunity to do that. Like I had the opportunity to write the syllabus and to write all the assignments and do everything and that, uh, that really helped I think me, uh, to learn more about teaching and my teaching style and things like that.

It is interesting that Lou does not say he jumped right in and was able to take charge of his own class confidently day one. He mentions the difficulty of having that opportunity but that ultimately it built his confidence and solidified the style and techniques with which he wants to teach in the future.

Lou also mentioned verbal and social persuasions from his students as a source of confidence in teaching this semester. Specifically, he pointed out the feedback from students focusing on how he helped them to learn through interactive teaching techniques and adjusting assignments as unforeseen personal issues arose that required him to determine the best course of action in dealing with these issues. This was evidence that Lou was confident enough that he could concentrate on the students and their learning (outward focus) instead of what they thought about him and the way he dealt with the situation (inward focus). Overall, Lou demonstrated evidence that he was confident in his own teaching ability as a result of the experiences he had, and it was manifest in the issues that he focused on when discussing his interactions with students.
Stilwell had low but increasing teacher efficacy. He was an explorer who enjoyed being in the outdoors. In fact, he was on a camping trip while I interviewed him, and his willingness to talk with me during a camping trip with his friends demonstrates the importance he put on this research study and ultimately undergraduate education in general. He felt very strongly that education was important and has valued it since he was young watching his father as a professor. He realized at an early age that he wanted to pursue a similar career and takes his TA role very seriously in preparation. Because he knows what it takes to be a good teacher, and due to his lack of teaching experience, he consciously scored himself modestly on the GTA-TSES when considering his confidence in his abilities to teach. Stilwell also showed evidence of mastery experience when discussing his confidence in teaching, but his examples were quite different than Lou’s. Stilwell mostly discussed soft skills and organizational tasks when describing what he felt most confident in doing as a TA:

I think I was most confident in going in and grading accurately and making sure everything was graded.

I think that helped with classroom management a bit because people did, you know, have their phone out every now and then, but some students did have more than others. I was able to go out and just address them one on one, walked around like, “Hey”, I tried to be a little bit more involved.

I knew that I like public speaking, I wasn't nervous about giving lectures or anything like that, so that definitely made it better.

In contrast to Lou explaining his confidence in taking control of a course, developing the syllabus, carrying out lessons, and learning more about teaching, Stilwell focuses on the aspects of being a TA that are not as complex or skill dependent. While grading, managing the classroom, and public speaking are important aspects of teaching, they do not require a great amount of understanding of how students learn and the best way to go about teaching them.
Along with the differences in mastery experiences, emphasis on the student feedback was a major difference in the sources of confidence between Lou and Stilwell. While Lou was concerned with the learning of his students and the feedback from them associated with their learning, Stilwell was more concerned with the students’ experience in the class as it related to his teaching style. He mentioned several times that the students’ rapport with him and how much they enjoyed class was of great importance:

Some of the students I had a better rapport with I would walk up to them and ask them like hey did you, like do okay, did you feel okay about that lab? And they would tell me like, well, that one was pretty hard or that one was a lot of fun. I would get feedback that way.

I like public speaking, but I felt like I was a boring teacher that nobody wants to listen to. And I know that's not necessarily the case, but I got in my head about that a little bit.

And just the bored face at some of the time, you know, that was one of the biggest hits that my confidence was. Sometimes I would stop after one of those long days and be like, I dunno if they like, I don't know if they think I'm doing a good job.

These quotes regarding student feedback and interaction show that Stilwell is very much concerned with how well he is received as opposed to how well the students are receiving and learning the information in the course. This drastic difference from Lou perhaps could explain the differences between their levels of teacher efficacy, despite them both increasing over the semester. Another major factor to consider is Stilwell’s quote that shows evidence of a lack of mastery experience contributing to his teacher efficacy:

But I really do think that if I could have 100% control of the course that I, I could do even better than I was just as a lab TA because I would know exactly what's going into it. I would be able to decide what material was important and you know, how to line that up.

Stilwell expresses that the possibility of having more autonomy in the classroom would improve his confidence. Having to teach a course that was designed and structured by someone
else is the role of many TAs, and is likely the best way to go about designing these courses. Courses in which one does not have the authority to decide what will be taught are still beneficial for the instructor to gain experience teaching on their own. However, as Lou agrees by stating that his experience taking the course into his own hands improved his confidence, until one is tasked with full autonomy, there may continue to be a gap between the ability and the confidence of the TA to instruct the course. Examples of Lou’s and Stillwell’s statements regarding their teacher efficacy are shown in Appendix G and Appendix H, respectively.

**Decreasing teacher efficacy.** The TAs whose teacher efficacy decreased over the semester also started at different levels, with Marla (4.60) having a higher level of efficacy than the pre-semester mean (3.98) and Doris (4.07) having a lower level. Marla was quite easy to talk with and provided reflective feedback as she recalled the events of the semester. She returned to graduate school to pursue a career teaching in higher education. She was very excited going into the semester and enjoyed the time she spent in the classroom. Marla’s previous experience mainly involved developing self-oriented skills such as grading, managing the classroom, and communicating with students. Because of this, Marla was able to take on more responsibilities and have more confidence in leading the class to promote learning among the students. The following quotes display that Marla was able to draw on previous experiences as a TA and developing the underlying skills necessary to prepare to take on her own course.

So I worked under another graduate student. Um, and I did. So I did a lot of the grading. I did some teaching, um, but a lot of assisting and that really helped me a lot to kind of adjust to a new university and kind of how the way things are done here versus other institutions.

I would say very confident because I had done it before, um, at another institution. I had done it for a few semesters and then also because I was a TA in the more traditional TA role.
Marla also mentioned something interesting that paralleled what Lou had to say about actually teaching being the best preparation for teaching:

One of the classes I'm teaching again in the spring and then I'll be totally fine, totally confident with it because you've already been through it once.

While her comment is more speculative, it speaks to the experiences she has had prior to the semester and how they prepared her for the role she is in now. She is demonstrating that mastery experience has been the best confidence builder for her so far, and that the difference it has made will continue to benefit her in the future.

Like Lou, Marla also found that student feedback regarding their understanding of the material was helpful in believing she was doing a good job. She used a mid-semester evaluation to gauge how she was doing from the perspective of her students and what they were learning. The following quotes are clear indicators that this evaluation, which she developed and implemented on her own, influenced her confidence as well as helped her to modify her teaching:

[I administer a] mid-semester evaluation slash assessment for the students so I can get feedback on not only the class and what they like and they don't like and what they're learning and what they want to learn.

When I got the results of the midyear evaluations and I knew, I clearly had to address what was said and stuff like that.

Hearing some students say how much they liked what we were doing, the material that was being covered and they thought it was interesting and they were learning a lot.

Marla’s initiative to implement this evaluation to better understand how her teaching is affecting her students’ learning is a relatively advanced technique for TAs. While her teacher efficacy was one of the higher scores among the participants in this study, she did mention that her confidence decreased as a result of the feedback she received. However, she was able to use the feedback for
the benefit of her students and her teaching approach for the rest of the semester. Marla also expressed concern over the lack of K-12 teaching experience and experience instructing a course on her own before:

Being a newer teacher, um, and not having taught K-12, um, and wanting that feedback because I want to make sure the students are getting something out of the class.

I think that probably would have helped… just more familiarity in general with some of the topics.

This related to her not being as familiar with the content of the course, as well as not having a solid understanding of the theory of teaching and learning. While TAs do generally teach within their subject, it is also common for them to fill courses outside of their expertise. In Marla’s case it affected her confidence but she was ultimately able to utilize the experiences TAing that she did have, as well as the professors she has had in the past and personal relationships with friends and family who are educators.

Doris’ teacher efficacy started lower than Marla and near the mean, and decreased over the semester. She was less talkative and seemed unsure of herself as a TA compared to other participants. She mentioned that she prefers doing research over teaching and that after this year she would be returning to that role outside of the classroom. She enjoyed her time and interactions with the students, but was teaching content that she was not knowledgeable of, which compounded the doubt she already had in herself to teach well.

I didn't have the knowledge of the coursework and a lot of the students were very understanding, they were always like, it's okay, we don't either but not that, it didn't really help me in the moment. But I think like as they kept saying it and like they just, they didn't ever make me feel like I was down. So just like the students were really nice.
Doris, like Stilwell, relied heavily upon student feedback dealing with how well they thought she was managing the class, and was most confident in the self-oriented skills such as presentation skills, grading, and other administrative tasks. It was clear from her interview that she was not expecting to be tasked with instructing a course as part of her assistantship, and although she wanted to do the best job possible, she had little to no preparation for the job. As a result, the emphasis she put on needing to be seen by her students as relatable and adequate hindered her from demonstrating true confidence in herself as an instructor. The following quotes best show how she relied upon student feedback for feeling that she was doing a good job, as opposed to focusing on her teaching techniques and student outcomes:

I guess I did a good job because no one ever came back to me and said, I don't agree with your grading here or there.

A student emailed me and was like, she was a freshman, which like that's not like a freshman class. And I just felt that she kind of like struggled and didn't understand it this semester, but she emailed me and said that she like was feeling very confident about the major and she really, really enjoyed the lab. She was always looking forward to going to it. So that is stellar feedback.

This reliance upon students for validation in one’s own teaching demonstrates that the instructor is likely not confident or skilled in their teaching. Furthermore, the decrease in teacher efficacy for Doris suggests that her inexperience caused her to have unrealistic expectations for how leading a course would go. Not being able to draw upon previous failures and successes hinders one’s ability to accurately determine how effective they will be at teaching or which teaching techniques are best for a given setting.

Doris did attend a pre-semester TA workshop, but found that the topics covered were too general to fully benefit from. Learning the basics of being a TA is valuable to a certain point, but when being assigned a full instructor role as your first TA position, there is a great need for more
discipline-specific development. In addition to not being prepared as an instructor, Doris was also placed in charge of a course that was outside of her academic expertise. Based on the following quotes, she did not feel as if she was set up to succeed as a TA:

I don't really know too much like formally about plants. And I was teaching plant biology so it was really interesting and I didn't really know what, um, what the course exactly entailed.

Whenever they would, you know, ask me questions about like course material, I that was not fun. Because usually I didn't know the answer.

Understanding how ill prepared she was to instruct a course, along with not having a firm understanding of the content, it is easy to see why Doris’ teacher efficacy was not very high to begin the semester and also why it decreased. The difference in level of teacher efficacy between Marla and Doris, despite them both decreasing over the semester, can be attributed to Marla having the prior experience and knowledge of what to look for within her own teaching to improve, and Doris only considering the students’ feedback regarding how much they are enjoying their time in class. Based on this finding, opportunities for TAs to gain experience teaching the subject they are assigned to with peer feedback and the opportunity to adjust problematic techniques is suggested. Examples of Marla’s and Doris’ statements regarding their teacher efficacy are shown in Appendix I and Appendix J, respectively.

Research Question 4. What are the main sources of teacher efficacy for STEM TAs?

Interviews with four TAs (two high efficacy TAs and two low efficacy TAs, whose efficacy remained high or low over the semester) were coded using the same a priori codes and emerging subcategories as used for RQ3 (changes in efficacy over time). Additionally, responses to open-ended questions on the post-semester GTA-TSES were coded to triangulate the results
with the sources found in the interview data. I will first provide the results of the high teacher efficacy interviews (Dottie, 4.87 and Mae, 4.67) and the high teacher efficacy open-ended question responses. Then, I will provide the results of the low teacher efficacy interviews (Kit, 2.80 and Jimmy, 2.93) and the low teacher efficacy open-ended question responses.

**High teacher efficacy TAs.** The TAs interviewed in this study who had high teacher efficacy mainly focused on how much their own previous teaching experiences contributed to their confidence as a TA. Dottie was clearly one of the more confident participants, both by the way she talked about teaching and what she had to say. She grew up in India and mentioned how much more strict the education system was for students there, and how that affected her expectations when starting as a TA in the U.S. Her concern for her teaching quality was evident, which told me a lot about the importance she places on education. I was very impressed with the way she described handling feedback from students who looked past her ability and focused on her speech and nationality. She seemed determined to look past such shallow comments and focus on becoming a better teacher for the whole class. Dottie talked about her own experiences as a TA in previous semesters and what teaching techniques she found to be effective and ineffective. She was able to recognize these aspects of her teaching and highlight what worked and adjust what did not. She also discussed overcoming the failures that she has experienced in the past to be more strategically selective of her current teaching techniques:

I was a little more pedantic in my first semester of teaching and I changed to a little bit more casual.

There are times when I would come up with activities that I would fail at. But I think that's, that's part of it, you know, not being afraid of taking those chances, but also being very mindful that you need to introspect after every single lecture and go about it.
Dottie is an example of how mastery experience, whether successful or not, can help to improve upon future teaching through a lack of apprehension to taking on new tasks or teaching a class for the second or third time. Along with utilizing her experience to her benefit, Dottie also found ways to utilize feedback from peers and professors to improve her effectiveness in promoting learning within her classroom, as evidenced in the following quotes:

I had peer reviews, I had my friends sit in my classes to observe me. I asked my faculty member to sit in and observe me.

I’ve had like, you know, amazing faculty members around me who listened to what I wanted to do and were ready to help and you know, give me positions to get there.

These responses regarding how verbal and social persuasions led to increases in teacher efficacy over the semester are greatly contrasted with the use of the same source by low efficacy TAs, as discussed below. The main take-aways from talking to Dottie were that she was able to be more certain of expectations of how the semester would go based on her own previous experiences failing and then succeeding in her teaching, and hearing from reliable sources (professors and peers) of how to improve upon her techniques in the classroom. As a result of all of this, Dottie was able to manage the teaching issues that came about in this semester and maintain a high level of teacher efficacy while keeping a focus on the impact she was having on her students’ learning.

Mae had the most experience (6 years as a TA or adjunct instructor) of all participants I interviewed and it was evident in her directness while discussing teaching. She seemed very busy and required follow up questions to elaborate on several answers. Her career goal is to be a practitioner or professor of forensic anthropology. It was interesting to hear her discuss using student feedback as a tool for teaching and understand what content to reiterate instead of as a measure of her performance. She was very confident in her teaching ability, which directed her
answers to the interview questions toward policies and class structure. As with Dottie, Mae’s own mastery experience was the driving source of confidence that led to her high levels of teacher efficacy throughout the semester. She reiterated what Dottie said about how failing in one’s experiences and overcoming to learn from the mistake and do better the next time is one of the best ways to become better and more confident in one’s teaching. The following quotes are evidence of this and lack concern for the self-oriented skills that allow her to focus on the impact she is making in her students’ achievement:

Sometimes we learn from our mistakes as soon as we make them, uh, you know, and so, I mean, honestly to me experiences is a huge factor.

Actually digging into the educational objectives outside of the specific objectives of the class.

I would say I'm more invested in my students’ overall grasp of the knowledge.

Mae has had more experience than the typical TA likely would, but I think her responses are worth emphasizing to show the contrast between her and low teacher efficacy TAs. Her responses also show how similar she is to Dottie who does have teaching experience, albeit not near the amount that Mae does. Overall, these two TAs who scored high on the GTA-TSES have shown that their experience has led to their high level of confidence in their teaching which allows them to be more concerned with the impact they have on their students’ learning. Having realistic expectations is important for TAs to not become overwhelmingly challenged by teaching issues, and having quality experience prior to teaching one’s own class can improve those expectations for the first time instructing alone.

Dottie and Mae both drew upon vicarious experiences of professors and peers that they saw as successful in their own teaching to gauge how well they were doing in their own teaching. Modeling after those who are doing well and believing that you can successfully incorporate the
techniques and strategies of others can improve one’s confidence. Those who responded to the GTA-TSES additional question post-semester supported the findings in the two interviews discussed above that TAs with high teacher efficacy are able to use more reliable sources (peers and professors) of verbal and social persuasions when building their confidence which leads to a greater concern on the impact being made in their students’ learning. It is also interesting that Dottie, Mae, and other high teacher efficacy TAs all expressed how overcoming struggles while gaining teaching experience has led to a greater sense of efficacy to do well in future roles as a teacher. Examples of Dottie’s and Mae’s statements regarding their teacher efficacy are shown in Appendix K and Appendix L, respectively.

The results of the interviews indicated that the high teacher efficacy TAs are primarily influenced by mastery experience, vicarious experience, and verbal and social persuasions from peers and professors as sources of teacher efficacy. There was little evidence that emotional and physiological states influenced these TAs. The responses to the three additional open response questions of the post-semester GTA-TSES were also telling of what sources are primarily used by TAs with high and low levels of teacher efficacy, and supplement the data collected by the in-depth interviews. Those with high levels of teacher efficacy post-semester showed evidence of being concerned with student learning, and drawing upon previous experiences and modeling after other TAs and professors to develop their teaching skills and techniques and improve their confidence as a TA. Another interesting finding, specifically from the third open response question, is that those with high teacher efficacy expressed that overcoming obstacles associated with handling great amounts of responsibility contributed to increasing their confidence in themselves as instructors. Appendix M displays responses by TAs with high teacher efficacy to the open response questions post-semester.
Low teacher efficacy TAs. It was found that TAs had lower teacher efficacy due to a lack of experience that could help develop their confidence in themselves as teachers. Kit was very talkative and would elaborate for several minutes on single questions. She attributed this to her interest and prior experience in theater and on debate teams. She had a healthy understanding of her limits as a new teacher and how she could improve. Kit’s role this semester was to teach a full course alone without prior experience, which she found to be daunting but was a challenge she was willing to encounter. Her career goal of being a professor motivated her to do the best she could and improve throughout the semester. Kit talked about how the lack of experience as a teacher or TA provided great uncertainty surrounding her role as a TA and the tasks she was to carry out in this role:

I had no TA, no TA experience. No teaching experience, nothing like that.

Like I don't know what to expect. Like I don't know what I'm, what I would be, what I'll be like as a, you know, I don't know how I'll be at handling classroom conflict or scheduling, um, you know, scheduling things for the class or grading things. Like I don't know what I'll be like, cause I don't have any experience. It was like I could, I could be terrible. I could absolutely suck.

She could not draw on successful or unsuccessful experiences to give her a realistic expectation of how things would go in the classroom, and this uncertainty led to a low sense of efficacy and a focus on self-oriented skills such as handling conflict, scheduling, and grading. Her concerns surround the basic aspects of being a teacher. In addition to this feedback from Kit, she also mentions the importance of interpersonal interactions with students and how well they receive her style of instruction. In the following quotes, Kit demonstrates how much she focuses on wanting the students to think she is doing a good job instead of being confident in her work and being able to focus on the students’ learning outcomes:
Overall I think it has been a good experience and I've gotten, um, I haven't gotten a few emails from students, uh, recently, within the past week or so… that have said ‘oh hey, like I really enjoyed the class. Like thank you so much for creating like such a good environment. Like you like brought a lot of energy to the subject. And like I really, um, thought it was an interesting subject and really enjoy participating.’ So that's been, that's been really encouraging, especially since this was my first semester.

So I think that's definitely changed my self efficacy levels where it's like oh, like I can teach effectively because a lot of them seem to be responding pretty positively to how the semester went. Like I was always afraid that like they were going to get frustrated with how disorganized I was or the fact that I would like sometimes forget where I was going with a topic or that I would repeat myself or that I'd be reading straight off the power points. Like I always constantly had, this was like, I felt like I was constantly monitoring myself while I was teaching the class. To be like, oh snap, how are they responding to this? And how are they responding to this?

This focus on student feedback and need for approval of the students as an enjoyable instructor hinders her ability to develop confidence in her teaching techniques as she is looking at the issues of teaching backwards. The challenges she perceives teaching issues to be compounds the fact that she is inexperienced as an instructor and has no personal mastery teaching development to draw upon when teacher her class.

While Jimmy was willing to discuss his experiences with me, he did not seem very enthused. This caused our discussion to be short and to the point, but we were still able to cover the entire protocol. He was pursuing his PhD but was not sure exactly what career path he wanted to take upon graduating. Being a TA was something he said he wanted to do, and furthermore perhaps knew he should in order to become better at explaining things to others. Like Stilwell, Jimmy tried to keep his expectations in check without having prior experience to draw from. Jimmy had issues similar to Stilwells’ as a low teacher efficacy TA with no experience teaching in an academic setting. He, too, drew mostly from student feedback on how they enjoyed the class as a source of confidence. While he did mention that one-on-one interactions with students and answering questions in this setting were encouraging as students
expressed that he adequately explained material to improve their understanding, he also relied upon non-substantial feedback from the students as shown in the following quotes:

I took just the increase in questions as the semester went on as a good sign. It was easier just to go kind of back and forth with students.

I mean I guess I got some positive feedback throughout the semester.

Perhaps Jimmy did show signs of concern with student achievement, but he also discussed how his inexperience caused him to have some doubt over the potential impact he might have on his students’ learning:

I mean at the start of this semester I had, I mean I had taught some classes at my job, but I had an expectation that that would be pretty different. I mean, I just, I didn't want to be, I don't want to be overconfident and I wasn't really sure if I'd be able to, I mean for all I knew I was able to crash and burn and not be able to be a good instructor.

I suspect people who are actually good teachers put a lot of time and effort and training into that. And so I wasn't expecting to be a good teacher I was just hoping to be, you know, a good TA, which I don't think it's the same thing.

Jimmy also did not discuss any specific aspects of mastery experience that he used as a source of confidence in his role as a TA. It is not surprising to see that he scored low on the GTA-TSES considering his interview responses. His lack of mastery experience and lack of having a solid expectation of how things would go during the semester indicate that he likely found the issues he encountered over the semester challenging to address confidently. The post-semester additional questions to the GTA-TSES survey further supported the findings in the two interviews of TAs with low teacher efficacy. TAs who responded also showed concern with challenging tasks associated with their role as a TA, and relied heavily upon student feedback to determine how well they were doing on a day to day basis. Examples of Kit’s and Jimmy’s
statements regarding their teacher efficacy are shown in Appendix N and Appendix O, respectively.

The results of the interviews indicated that the low teacher efficacy TAs were primarily influenced by verbal and social persuasions from students, while mastery experiences and vicarious experiences did play a small role. There were also two subcategories that emerged from the data: Lack of mastery experience and lack of content knowledge. TAs with low levels of teacher efficacy who answered the post-semester GTA-TSES showed evidence in their responses to the open-ended questions of being concerned with actions associated with their role as a TA, and drawing upon student feedback and student interaction as their main sources of confidence in their performance as a TA. Appendix P displays responses by TAs with low teacher efficacy to the open response questions post-semester.

**Inward and outward focus.** Using the full dataset and the previous literature, I was able to reduce and combine the data into themes that represent relevant phenomena (Corbin & Strauss, 2008, p. 159). Combining the findings by Cho et al. (2011) with those by Nyquist and Sprague (1998), as well as considering the analysis in this dissertation, the theme of TA focus with two variations of inward focus and outward focus emerged from the data. Building upon the previous literature, this dissertation indicates that the inward and outward focus of TAs is linked not only to their development as teachers but also to their teacher efficacy. Cho and colleagues found that TAs with higher teacher efficacy considered teacher issues to be more manageable, while those with lower teacher efficacy considered teacher issues challenging. Nyquist and Sprague found that TAs who are more developed are concerned with how well content is being understood by their students, and that less developed TAs are concerned with their own
pedagogical issues in the classroom. They labeled the less developed TA concerns as inward and the more developed TA concerns as outward.

Considering the prior research along with the findings of this dissertation, I combined the evidence in the data regarding the influences and emphases placed on different aspects of teaching for the low and the high efficacy TA participants. I was able to combine the evidence of influences of high teacher efficacy TAs into the same descriptions of the previous literature to show that they, too, are outwardly concerned with student learning and how they are able to impact it. Similarly, I combined the evidence of influences of low teacher efficacy into those who are inwardly concerned with their own selves and how they are perceived in the classroom.

The high efficacy TAs in this dissertation used language that demonstrated they were developed enough to have an outward focus on how they were impacting their students’ learning. For instance, Dottie mentioned that asking students questions makes them think, which is an active learning strategy that is reflective of her development as an instructor and that she is concerned with her students’ learning. Students who responded to evaluations for high efficacy TAs reciprocated examples of this language by the TAs. One student of a high efficacy TA said:

She greatly helped me and my lab partner understand the material when we struggled.

This response further demonstrates the outward focus of the highly efficacious TAs in this study. In contrast, the low efficacy TAs in this dissertation used language that indicated they were more concerned with their own selves and thus had an inward focus while instructing in the classroom. Kit gave an example of this when she said:

I don’t really have a problem with public speaking or anything and never really have. But, um, even just being able to interact with students one on one appropriately, cause it’s been difficult for me to be like, do I, am I supposed to be like pretty casual or do I need to
be like, you know, I’m the professor and you’re the student. Like how do I, how do I do this?

This response clearly indicates that Kit was not prepared to focus outwardly on student learning, as she was unsure how to behave as an instructor in the classroom. I triangulated this language by TAs with student responses to evaluations to make the findings more robust:

One of his biggest strengths was communicating in a quick manner.

[She] was available and gave great advice.

Student responses like these support the emergence of the inward focus theme for those TAs who were lower in teacher efficacy. These examples from two data sources (TA interviews and student evaluations), along with the previous literature, indicate that TAs who are highly efficacious are influenced by experience and reliable sources to be more outwardly focused on their students’ learning, while low efficacy TAs lack experience and are influenced by less reliable sources to focus inwardly on their own pedagogy. The difference in the focus of these two groups of TAs could perhaps have an effect on their teaching performance and subsequent student achievement.

Summary

This chapter displays the quantitative and qualitative results associated with the data analysis for all four research questions. Chapter five will discuss these results to explain how they contribute to the existing literature, and give implications for future research.
CHAPTER 5: DISCUSSION AND IMPLICATIONS

This study explored changes in and sources of STEM TA teacher efficacy during a semester, as well as how teacher efficacy related to student evaluations and comparisons of teacher efficacy between TAs of different demographics. The main results were that teaching experience was the only predictor of teacher efficacy (RQ1, comparison of efficacy among demographics), teacher efficacy changed across a semester and significantly increased from pre- to mid-semester (RQ3, change in efficacy over time), TAs with high teacher efficacy rely mostly on mastery experience, vicarious experience, and verbal and social persuasions from professors and peers, and TAs with low teacher efficacy rely mostly on verbal and social persuasions from students, mastery experience of self-oriented skills, and are negatively affected by a lack of mastery experience and content knowledge (RQ4, sources of efficacy). Hypotheses were mostly not supported by the data as there were no differences in teacher efficacy among race/ethnicity, teacher efficacy and student evaluations were unrelated (RQ2, relationship between efficacy and student evaluations), and mastery experience was used as a source of teacher efficacy as much or more than vicarious experience and verbal and social persuasions. This chapter discusses the results in order of research question and explains the findings and how they relate to the existing literature. The implications for further practice and research are included.

Research Question 1. How does teacher efficacy compare among STEM TA demographics?

The hypothesis that teacher efficacy would be predicted by race/ethnicity was not met. As assumed, gender also was not a predictor of teacher efficacy. Finding differences in teacher efficacy between those who were most experienced and those who were least experienced contributes to the overall findings of this study. With experience comes the opportunity to master
the skills needed to teach effectively through learning from one’s mistakes or capitalizing on one’s successes. While most of the participants had no teaching experience coming into this study, the group that scored highest on the GTA-TSES was those with the most experience (at least two years). This information regarding the effect of experience on teacher efficacy will be used throughout chapter 5 to support the advancement of theory on variables related to TA effectiveness.

The findings of RQ1 (comparison of efficacy among demographics) agree with the previous literature that experience is a major determinant of teacher efficacy (Prieto & Altmaier, 1994; Carleton, Fitch, & Krockover, 2008; Morris & Usher, 2011). As with these studies, those who have performed teaching tasks before are able to draw upon that experience to feel confident in themselves to perform them again, and perhaps even better. Unlike Klassen and Chiu (2010), this study did not find any differences in teacher efficacy among gender. However, this dissertation did not measure teacher efficacy for specific contexts such as classroom management, so the findings are not directly comparable to those of Klassen and Chiu, who found that males have higher classroom management efficacy. While teacher efficacy was not found to be different by race/ethnicity, sources of teacher efficacy were not explored among race/ethnicity as Klassen (2004) did. He found varying sources were utilized more prominently depending on the race/ethnicity, but the sample of participants interviewed in this study was too homogeneous (65.7% White) to make meaningful comparisons.

More experienced TAs in this study reported higher levels of teacher efficacy which has been associated with the belief that teaching issues are manageable and thus allow the teacher to focus on the impact they are having on student learning (Cho et al., 2011). It was also found in this dissertation that more experienced TAs had realistic expectations that they were certain
would be met. In contrast, less experienced TAs reported lower levels of teacher efficacy that Cho and colleagues found to be associated with viewing teaching issues as challenging and leading to a focus on one’s own self and feedback received.

**Implications.** Realizing that experience is an influencer of teacher efficacy, as well as understanding the effects that teacher efficacy has on teacher performance and student learning, it can be said that only two years of experience could make a difference in the quality of learning and teaching over a typical four to six year time period a graduate student might work as TA. The potential preparation and development opportunities within these initial two years could prove valuable for improving the quality of education in undergraduate STEM. Providing inexperienced TAs with professional development and experience before appointing them as a primary instructor of a course would best prepare them to positively influence the learning of their students. While time is a considerable issue for TAs to receive the experience necessary, having systems in place that maximize support for development and learning in the first semesters of graduate school could be a worthwhile option. In this system, TAs would spend their first year to two years in supplemental instruction roles, assisting and observing experienced TAs or faculty in order to build the knowledge, skill, and confidence to teach. Then, in the remaining years of their graduate program, they would be better prepared to take on primary instructor roles while continuing to develop through a mentorship program, as well as mentoring new TAs themselves.

Future studies on the impact of previous experience should more directly measure its impact on TA teaching performance with observations, as well as student outcome measures. While teacher efficacy has been shown to improve performance and achievement in the K-12 setting, there is still a need to make this direct connection for TAs. Any findings from future
studies would be valuable for guiding the design of graduate programs towards incorporating required teaching experience and pedagogy courses for their TAs that are based on research. There may also be differences worth exploring in teacher efficacy between gender for a given context, based on the work by Klassen and Chiu (2010) mentioned above.

**Research Question 2.** How does STEM TA teacher efficacy relate to student evaluations of performance?

The student evaluation Likert scale scores were mostly high regardless of level of teacher efficacy. This led to the weak correlation that did not reach statistical significance between the two measurements, as the students who chose to respond to the student evaluation had mostly positive perceptions of their performance. It was found in this study that TAs with low teacher efficacy put a lot of emphasis on what their students think of them when considering how well they are doing as an instructor, and that students mostly evaluate TAs highly regardless of teacher efficacy level. So then it could be assumed that students evaluated their low-efficacy TA based more on the interactions and relationships they develop with them than how much they learn from the TA in the course, as was found among students of high teacher efficacy TAs.

Finding that students evaluate their TAs’ performance well regardless of the TA’s teacher efficacy is supported by the literature that shows that TAs are reported by students to be more approachable and casual than professors who are viewed as more professional and providing more knowledge (Kendall & Schussler, 2012). The dynamic between student and TA is unique since there is a narrow gap in age for most of them. TAs were only recently in the position of the students and are well able to empathize with students and the academic responsibilities and social aspects of being an undergraduate student. This could at least partially explain the lack of
a strong relationship between TA teacher efficacy and student evaluation scores. Although the student evaluation used in this study did not explicitly address student learning and achievement, it could be surmised that students reflected on what they took away from the course when responding. In the K-12 literature on teacher efficacy and student achievement, it has been shown that higher teacher efficacy is associated with higher motivation to learn and higher student achievement (Evans, 2011; Mojavezi & Tamiz, 2012). While these variables were not measured in this study, teacher efficacy could still have had an effect on student engagement and achievement.

The correlation between teacher efficacy and student evaluation may be a poor indicator of how teacher efficacy affects teaching performance. For TAs with high levels of teacher efficacy, their students viewed them as being concerned with promoting learning in the course. In contrast, students of low teacher efficacy TAs provided evidence of their TAs having self-oriented skills such as communication, but did not mention their ability to teach with effective techniques at all. This was consistent with Cho and colleagues (2011) who found that TAs who view their teaching tasks as manageable are more concerned with student learning whereas those who view teaching tasks as challenging are more concerned with their skill, task, and context-related issues. The differences in responses to the open-ended question between the two groups of TAs give greater insight than the Likert scale scores, as the Likert scores on student evaluations may be similar but be a result of different influences. Therefore, student feedback from Likert items, while beneficial, can be complemented with open-ended questions analyzed qualitatively in order to make more accurate inferences about TA performance.

The significant and positive correlation found between student response rate and student evaluation score shows that students who found their TA to be performing well were more likely
to respond to their survey. The inverse could also be assumed, that those who perceived their TA to be performing poorly are less likely to complete the student evaluation. With just 12% of students responding to student evaluations, it is difficult to generalize the results to the entire dataset. This limitation, combined with the lack of relationship between student evaluation score and teacher efficacy score, places even more emphasis on the need to explore in depth, qualitative data around why students evaluated their TAs they way that they did.

Implications. Student evaluation scores remaining high regardless of teacher efficacy indicates that students’ opinions of their TAs were not significantly related to their TA’s confidence. In light of the K-12 research it is more likely that high efficacy TAs were more effective than low efficacy TAs. However, to be able to make more definitive inferences regarding the effect of TA teacher efficacy on their performance, student evaluations, and student achievement, further research focusing on these variables with more controlled procedures and more related instruments are necessary. The qualitative findings of this research question also show that student evaluation scores are not the clearest picture of how well TAs are performing. Hearing more from the students and the reasons why they score their TA the way they do would improve upon this research question in a future study.

Research Question 3. How does STEM TA teacher efficacy change over the course of a semester?

The results of the one-way repeated measures ANOVA indicate that teacher efficacy significantly increases by the middle of the semester, and decreased slightly but not significantly to the end of semester. Therefore, it can be said that, based on this sample of TAs, teacher efficacy peaks by the middle of the semester and is maintained through the end of the semester. The two clusters found in this sample showed the same pattern of increasing significantly before
slightly decreasing over the three time points, despite having quite different starting points. As an exploration of teacher efficacy over time, these findings show that TAs’ teacher efficacy changes over the course of a semester.

There is to my knowledge no study measuring SE multiple times over a short period of time like one semester. The research on K-12 teachers shows that teacher efficacy continues to increase over the first two decades of their careers before decreasing slightly (Klassen & Chiu, 2010). This study found a similar pattern over a much shorter time period. With opportunities for more semesters of instructing courses, TAs are likely to continue to develop their teacher efficacy and become more outwardly focused on student outcomes versus being more inwardly focused on their own selves (Cho et al., 2011; Boman, 2013). This shift in focus may increase the TAs’ likelihood of enjoying their teaching and becoming more knowledgeable of effective practices and more innovative in their techniques. Finding statistically significant increases in TA teacher efficacy after only a short period of time gaining mastery experience demonstrates the importance of these experiences very early in their TA roles.

Like with the full dataset, the two clusters of participants each increased and then slightly decreased over the semester. The two clusters show roughly a one-point difference at the beginning of the semester that narrows slightly in the two subsequent points of measure. Qualitative analysis of the interviews revealed potential causes of the differences between the two clusters. This was possible through the intentional selection of participants whose teacher efficacy increased but started at very different levels pre-semester. The high teacher efficacy TAs’ primary sources of teacher efficacy were mastery experience, vicarious experience, and verbal and social persuasions from peers or professors. Based on the data, while learning from observations and hearing what works best for others has been beneficial in developing teacher
efficacy, it cannot fully replace the benefits from one’s own experiences actively carrying out the role of an instructor. Vicarious experience is a valuable resource to contribute to one’s teacher efficacy, but mastery experience enables TAs to have a more personal connection to a successful experience that might have a greater influence on teacher efficacy. Receiving words of affirmation from those who are experienced in what they are affirming was also influential for those TAs with high teacher efficacy. Verbal persuasions are perhaps necessary in order to receive the most constructive comments and base one’s teacher efficacy in feedback from a more reliable source.

The initially lower teacher efficacy TA whose teacher efficacy increased also benefited from mastery experience, but had an inward focus as evidenced by their own language as well as the open-response feedback from student evaluations. Self-oriented skills and organizational tasks (e.g., grading, classroom management, etc.) were primarily described when referring to mastery experience. Additionally, language regarding verbal and social persuasions focused on how well the TA was received by the students as opposed to how well the students were receiving and learning the information in the course. Reliance upon students for validation in one’s own teaching indicates that the instructor is perhaps not confident in their teaching. Furthermore, the students low efficacy TAs rely on are a less reliable source of feedback as they likely have less knowledge of teaching techniques than the experienced TAs and professors high efficacy TAs rely upon.

**Implications.** Based on the findings of this study, opportunities for TAs to gain experience teaching with peer feedback and the opportunity to develop their techniques is suggested. Any improvements in the teacher orientations of TAs associated with increases in teacher efficacy should be investigated. Since it has been found that teacher orientations tend to
endure from the time they are developed (Boice, 1996), giving TAs more teaching experience with which to continue to improve their efficacy and develop their orientations is crucial. TAs, who commonly have had little classroom experience outside of being a student, primarily have vicarious experiences observing their professors to guide them in developing their orientation. With the significant improvements found in teacher efficacy within just one semester in this study, there is evidence to support the need for more teacher development opportunities for TAs prior to beginning their roles as instructors.

Future studies should measure teacher efficacy at more points throughout the semester with observations and interviews to better determine when there are acute changes in teacher efficacy, what causes them, and how they affect teaching and learning in the classroom. This information would move the field beyond simply better preparing TAs for their first semester of teaching, to being able to adapt as teachers and adjust their teaching orientations once they are on their own in the classroom. Understanding the influences of teacher efficacy at various points in a semester can help to design TA PD to maximize the use of these influences. Maximizing these influences and observing their effects on TA performance and student achievement can inform methods of incorporating TA PD to benefit teaching and learning. An important outcome of future research would be to develop TAs well enough so that they can focus more upon the impact they are making in their students’ learning.

With the knowledge that teacher efficacy is not a fixed trait but a dynamic variable that responds to multiple factors, TA development can be more strategically designed to incorporate practices that are more influential at various points in the semester. For instance, verbal and social persuasions from reliable sources could help TAs enter the semester confident in their ability to incorporate best teaching practices. Then, as they experience obstacles and have to
develop ways to overcome them, vicarious experiences of seeing how other TAs or professors handle the same obstacles could help them maintain or raise their confidence to overcome the obstacles. As TAs have successful experiences while teaching, they will become more and more confident in their ability to master the self-oriented skills and will theoretically move toward focusing on the impact their techniques are having on their students’ learning.

**Research Question 4.** What are the main sources of teacher efficacy for STEM TAs?

There were clear differences between the sources used and specifically how they were used by high and low efficacy TAs. As mentioned in the results, TAs with high teacher efficacy were primarily influenced by mastery experience as a source of teacher efficacy, and verbal and social persuasions from reliable sources such as professors and peers were also influential. High-efficacy TAs were also found to be more outward focused on their impact on student learning. Furthermore, the mastery experiences that high efficacy TAs drew upon included teaching techniques and skills that had been developed over time as a primary instructor of previous courses. In contrast, TAs with low teacher efficacy primarily used verbal and social persuasions from less reliable sources such as their students, and focused on student feedback that involved how they were enjoying the course and the *interactions* they had with their instructors. Additionally, these TAs drew upon the mastery of self-oriented skills such as grading and classroom management as sources of confidence, and also emphasized the lack of mastery experience and content knowledge as reasons for lower teacher efficacy levels. Both high and low teacher efficacy TAs found vicarious experiences useful in building their confidence as instructors. These included a wide range of experiences such as observing other professors as both students and TAs, and observing other TAs.
Applying these results to the previous literature results in some interesting developments in the theory of teacher efficacy and its effect on teaching orientation and approach to instructional technique. The theory posited by Cho et al. (2011) and their work on TA self-perception details specific differences in TAs who perceive issues surrounding their role as a teacher as challenging and those who find these issues manageable. They describe how TAs who view teacher issues as challenging look inward and are mainly concerned with their own self, task, role, and communication style, whereas those who view teacher issues as manageable look outward and are mostly concerned with the impact that they are having on their students. The findings of this study move this theory by Cho and colleagues forward to propose a more elaborate model of the role teacher efficacy plays in the concerns and foci of TAs with various quantities of experience. This dissertation has indicated that the measures and sources of teacher efficacy, as well as the open feedback from students, have a similar relationship to whether the TA has an inward or outward focus. High teacher efficacy TAs who are mainly influenced by mastery experience, vicarious experience, and verbal and social persuasions from reliable sources have demonstrated evidence of focusing on their students’ learning, which is supported by their students’ focus on teaching impact in their evaluation. Low teacher efficacy TAs who are mainly influenced by verbal and social persuasions from less reliable sources, and have indicated that the lack of mastery experience and content knowledge affect their teacher efficacy, have demonstrated evidence of focusing on their own selves. This has also been supported by their students’ feedback, focusing on the pace of the class, personal interactions with TAs, as well as communication in general.

It was found in this study that TAs with high teacher efficacy view teacher issues as manageable, which may in turn lead to higher levels of teacher efficacy, thus creating a feed
forward system. The TAs interviewed in this study who had high teacher efficacy mainly focused on how much their own previous teaching experiences contributed to their confidence as a TA. High teacher efficacy TAs were able to have realistic expectations of how the semester would go based on their own previous experiences teaching, and hearing from reliable sources of how to improve upon techniques in the classroom. As a result of all of this, they were able to manage the teaching issues that came about in this semester and maintain a high level of teacher efficacy while keeping a focus on the impact they were having on their students’ learning. They are confident in the self-oriented skills associated with teaching, which allows them to focus on the impact they were making in their students’ achievement. Having realistic expectations is important for TAs to not be overwhelmed with teaching issues. Quality teaching practice prior to teaching one’s own class can improve one’s expectations when teaching a class for the first time.

This study also provides evidence that TAs with low teacher efficacy view teaching issues as challenging, and that viewing teacher issues as challenging contributes to a low sense of efficacy for TAs, thus creating a feedback system. Differing from the high teacher efficacy TAs, these participants were focused on improving their ability to maintain the interest of students, present the material clearly, and manage the classroom efficiently. Furthermore, it was found that TAs who had lower teacher efficacy did so due to a lack of experience that could help develop their confidence in themselves as teachers. Low teacher efficacy TAs do not have a realistic expectation of how things would go in the classroom. This uncertainty led to a low sense of efficacy and being concerned with the self-oriented tasks such as handling conflict, scheduling, and grading.

**Implications.** The findings of this research question converge with the findings of the other research questions, indicating that experience is highly important for the teacher efficacy of
TAs, and that without experience they will depend on less reliable influences. It is likely that most novice TAs will go through a progression from focusing on self-oriented skills to focusing on their impact on student learning. The implication this has on practice is for PD to be designed to allow the novice TAs to have enough developmental time with the support they need in order to gain more experience, develop confidence, and start viewing teaching issues as manageable. This can be done at the department level by requiring training or a course for credit that covers strategies and techniques for teaching content (PCK). In order to do this prior to being assigned a primary instructor position, the course could be completed in the summer prior to or the first semester of beginning a graduate program. Taking time and resources to develop teaching orientations would jump start a TA’s path toward becoming more outwardly focused. This would allow them to have more concern for their students’ achievement and make them more aware of how they are influencing learning. Advising TAs of which sources of feedback to focus on could also be beneficial to their teacher efficacy. While many TAs may be interested in how their students perceive them, understanding that peer and professor feedback is more positively influential could improve their teacher efficacy and help them shift from an inward to an outward focus. PD programs could incorporate peer and professor feedback to TAs by partnering with departmental faculty and TAs to utilize their expertise. Making these resources available both in PD courses and through mentorship programs could shift TAs from being influenced by their students to being influenced by more reliable information on teaching practice.

Future studies on the sources of teacher efficacy should incorporate the emerging sub-categories found in this study: lack of mastery experience, lack of content knowledge, and splitting verbal and social persuasions into groups of reliable and unreliable sources. These sources of teacher efficacy, as discussed in this dissertation, can indicate whether an instructor
has an inward or outward focus of their teaching. Further exploration and testing of these sources in TAs as well as other novice teaching populations could improve upon the development programs for preservice teachers.

**Limitations and Delimitations**

This study was limited by the number of participants who decide to respond to the surveys and maintain participation throughout the semester, but the qualitative aspect of the study improved the depth of the findings. Without providing incentive to all participants, I partially depended on TAs to have an implicit interest in the improvement of undergraduate teaching and learning, which may have limited the response to only TAs who are interested in teaching. Using student evaluations as a measure of teaching performance in this study limits the understanding of the relationship between teacher efficacy and performance. Future research should measure performance and student outcomes more directly with teaching observations and pre- and post-assessments of the content covered in the course. Observations are a relatively simple way to document the practice of TAs for identifying areas of needed improvement and to debrief with TAs about how they can improve. Pre- and post-assessment data on content covered in the course could provide a measure of evaluation of the TA and how effective they are at explaining material and influencing learning in their students.

While this study did find key differences in the certainty and uncertainty of TAs with high or low teacher efficacy, this study lacked the data source that explicitly measured TA expectations. Learning what TA expectations are and what influences them could improve upon the proposed model of preparing TAs by providing the positive influencers and addressing the negative ones. Hearing from TAs what their expectations are prior to the semester and observing them in class to see how those expectations play out can give insight into whether or not TAs
generally have realistic expectations or not. This study spoke to the certainty of TA expectations, but taking a step further to explore whether TA expectations are realistic and how TAs deal with instances in which expectations are not met would be a valuable study that could inform how to provide realistic expectations for TAs and strategies for overcoming barriers to realizing them.

Conclusion

The main findings of this study are that: TAs are more efficacious with more previous mastery experience (RQ1), and that teacher efficacy peaks by the middle of the semester and is maintained through the end of the semester (RQ3). Additionally, it was found that those with high teacher efficacy draw upon mastery experience, vicarious experience, and verbal and social persuasions from reliable sources, such as professors and accomplished peers. Also, TAs with low teacher efficacy rely heavily upon student feedback associated with their experiences during class time, and they also draw from vicarious experience and mastery experience pertaining to self-oriented teaching skills such as class management, grading, and public speaking (RQ4). In addition to Bandura’s (1986, 1997) four sources of efficacy, subcategories that emerged from the data included the lack of mastery experience, the lack of content knowledge, and verbal and social persuasions that differentiate between those coming from professors and peers and those coming from students.

Drawing on prior literature and the findings of this dissertation, a model for TA self-efficacy is generated and presented in Figure 5.1. This model moves theory forward on how sources of self-efficacy (Bandura, 1986, 1997) and TA development (Nyquist & Sprague, 1998) interact with views on teaching issues (Cho et al., 2011) to affect TA teaching concerns.

The model developed by this study (Figure 5.1) builds upon Cho and colleagues’ (2011) model by incorporating previous experience, level of teacher efficacy, and TA expectations. The
two halves of this model are connected through parallel outcomes of this study and the previous literature. As one half models the level of experience, expectations, influences of teacher efficacy, and how teaching issues are viewed for low teacher efficacy TAs, the other half models the same components for high teacher efficacy TAs. The effects of these components on whether the TA has an inward or outward focus is also different among the two halves. With experience being a major effect in the model, it is hypothesized that TAs could progress from the left side of the model to the right as they gain experience.

In one half of the proposed model, TAs who are experienced utilize more reliable sources of confidence resulting in higher teacher efficacy as found in this study, and therefore perceive teaching issues to be manageable (Cho et al., 2011). The data from this study indicated that sources of teacher efficacy used by experienced TAs with high teacher efficacy enabled them to place more focus upon their students’ learning. Their ability to perceive teaching issues as manageable feeds forward to improve their teacher efficacy (Cho et al., 2011). This study also found that experienced TAs had more realistic expectations of how instructing their class will go, which in theory improves their ability to manage teacher issues and maintain concern with impact-related issues such as student learning (Nyquist & Sprague, 1998; Cho et al., 2011). In the other half of the proposed model, TAs who are inexperienced utilize less reliable sources of confidence resulting in lower teacher efficacy, as found in this study, and therefore perceive teaching issues to be challenging (Cho et al., 2011). I found that the sources of efficacy that mainly influence low efficacy TAs result in their focus being directed to student feedback and how they are perceived as teachers. Together, the findings of this study and the study by Cho and colleagues (2011) indicate that perceiving teaching issues to be challenging provides a feedback loop to negatively affect their teacher efficacy. Inexperienced TAs were also found to have
unrealistic expectations for how their TA appointment would go, which in theory makes teaching issues seem more challenging and enhances their concern with their own self, task, role, and communication as a teacher (Nyquist & Sprague, 1998; Cho et al., 2011). The TA’s focus, then, remains on the feedback they receive from their students regarding their concerns.

This model is similar to the previous literature in that it includes the findings from Cho and colleagues (2011) regarding the differing concerns of TAs based on their view of teaching issues. The main difference from the literature is that it makes a connection from the concerns of the TAs to whether they focus inwardly or outwardly on their teaching. The model also pushes the field forward by including the TAs’ level of experience, level and sources of teacher efficacy, and expectations in the model. How these variables act upon one another as well as influence TAs’ foci build upon the previous literature to provide a more holistic view of the effects of TA teacher efficacy.

Figure 5.1. Proposed model of TA teacher efficacy
Implications

Future work related to this study should focus on completing the gaps in the proposed model by studying variables such as TA expectations and their effect on teacher efficacy and perceptions of teacher issues. Having a better understanding of the expectations of TAs and the role they play in teaching performance could inform the future development of instructors to include preparation for what to expect as a TA and how to overcome obstacles that get in the way of those expectations being met. Using a more reliable measure of teacher performance than student evaluations is also a need for future research. While the literature and this study have been able to adequately determine how TAs believe they are performing in their roles, objectively measuring their performance through student achievement or in class observations could enhance the findings related to how teacher efficacy influences teacher performance and effectiveness.

The model proposed in this study could also be used to inform the design of TA PD. As detailed in chapter 2, PD has been shown to improve TA preparedness and feelings of being supported (Ridgway et al., 2017). The teacher efficacy model from this study provides evidence for how to improve the preparedness and teacher efficacy of TAs, which could be incorporated through PD. Incorporating the findings of this study does not necessarily require a formal PD course. Ensuring that feedback is being given by reliable sources and that TAs are learning from others’ successes and mistakes can be carried out through an ongoing mentorship program and peer groups. This could include the TA starting in a role that positions the TA assisting a class with a more experienced peer or professor before stepping into a primary instructor role. Being given the opportunity to build upon the relatively small knowledge of teaching over time, such as was the case for Marla with her prior TA experience, could provide TAs with many opportunities
to benefit from learning through observation with little responsibility in order to build confidence in one’s own abilities. Seeing other people succeed and overcome struggles allows for vicarious experiences to build teacher efficacy before struggling through and overcoming challenges to gain their own mastery experiences. Then, once they are given more responsibility over time, and building their teacher efficacy through their own mastery experience, TAs will be more likely to have an outward focus when teaching their own class and mentoring another novice TA. Mentorships or peer groups could be set up in a way that each TA be required to identify a faculty sponsor and a group of peers to check in with occasionally throughout the semester to discuss how they think the semester is going and identify any areas of concern and how to address them.

Of course this could also be done in a more formal PD program. In addition to the aspects of the mentorship mentioned above, a formal program could dedicate time to inexperienced TAs gaining mastery experience teaching to a group of peers in order to receive feedback on their techniques in order to improve their teacher efficacy. Since TAs who are inexperienced and low in efficacy are highly concerned with their roles and tasks, giving them practice in their roles with lower stakes of not teaching to students could help refine their techniques in order to shift their focus outwardly to their students’ learning.

Gaining teaching experience has been shown to be the biggest influencer of teacher efficacy. Having this experience prior to stepping in front of students helps TAs to better know what to expect, which makes them even more confident in their abilities to handle challenges in the classroom. The model proposed in this study is intended to guide PD in a way that would allow for TAs to draw upon more positive influences of teacher efficacy in order to move from
low to high teacher efficacy and from an inward focus to an outward focus on student learning and their impact upon it.

In addition to providing avenues for vicarious experience and mastery experience, PD opportunities should also explicitly address the issue of TAs’ roles in regards to their relationship and interaction with students. Making it clear that the TA is there to impact learning first is an important message to alleviate that issues found in this study regarding low efficacy TAs being concerned with how students are interacting with them and perceiving them in class. Shifting the desire of the TA from needing to be accepted by students to wanting to do whatever it takes to impact learning should be a major goal of PD, especially for novice TAs.

Since less experienced, low efficacy TAs reported deficits in content knowledge, it is also imperative that TAs are placed in courses with content they are familiar with, and provide resources for quickly recalling content that they may not have been exposed to for some time. Not only should there be an emphasis on ensuring the content knowledge of the TA, but also how to utilize best teaching strategies for teaching specific content. PD should include demonstration lessons or examples of how to teach specific content in whatever setting and context the course will be given in order to improve the TAs’ PCK. Providing opportunities to build these types of teacher knowledge is likely to build upon the confidence of the TA through better preparedness, and help them to focus on student achievement.

Evaluating TA performance is tantamount to improving their preparedness to teach. One form of evaluation, which was used in this study, is hearing from students about how well they perceived their TA to perform. Student evaluation should consist of items pertaining to how well the TA promoted learning in the classroom. This will point to more of the findings that were brought about in the qualitative analysis of this study. Modifying the institutional student
evaluation to include such information in quantitative format could more objectively measure the impact students believe their TAs are having on their learning. Improving upon the quantity and quality of open response items is also necessary to achieve a more in depth sense of why TAs are evaluated the way they are, so that future PD efforts can address any generalizable findings.
REFERENCES


Appendix A

GTA-TSES: Graduate Teaching Assistant Teacher Self-Efficacy Scale

Scale:

1. Not at all confident

2.

3. Somewhat confident

4.

5. Very confident

How confident am I in my ability to…

1. Appropriately grade my students' exams/assignments?

2. Spend the time necessary to plan my classes?

3. Select appropriate materials for class activities?

4. Evaluate accurately my students' academic capabilities?

5. Prepare the teaching materials I will use?

6. Stay current in my knowledge of the subject I am teaching?

7. Provide my students with detailed feedback about their academic progress?

8. Specify the learning goals that I expect my students to attain?

9. Think of my students as active learners, which is to say knowledge builders rather than information receivers?

10. Promote a positive attitude towards learning in my students?

11. Ensure that my students consider themselves capable of learning the material in the course?

12. Promote my students' confidence in themselves?

13. Create a positive classroom climate for learning?
14. Encourage the students to interact with each other?

15. Let students take initiative for their own learning?
Appendix B

Student Evaluation

Demographic questions:

1. Age
2. Gender
3. Current year of study (e.g., Freshman).
4. Current field of study/major.
5. What is your TA’s name?

Scale:
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
Not Applicable

Items:

1. The instructor’s teaching aligned with the course learning objectives/outcomes
2. The instructor was receptive to students outside the classroom
3. The instructor explained material well
4. The instructor was enthusiastic about teaching the course
5. The instructor was prepared for class
6. The instructor gave useful feedback
7. The instructor consistently treated students with respect
8. Overall, the instructor was an effective teacher

Comment on strengths and weaknesses of the instructor
Appendix C

Interview Protocol

- Will you talk about how the semester went for you as a TA?
  - Were you looking forward to this position, why?
    - Is it more of an obligation, why?
  - Good/bad experience, why?
  - What was a typical week like for you in your role as a TA?
- (Explain any changes in responses to survey)
  - What factors might have led to these changes?
- Which tasks were you confident in performing as a TA this semester?
- Did any experiences, observations, or interactions affect your confidence in yourself as an instructor?
  - Which did you find most influential?
- Please explain any obstacles or difficulties you may have overcome to improve your confidence in yourself as an instructor.
  - Please explain any measures you took to overcome these obstacles or difficulties
  - Is there anything else you can think of that might have improved your confidence?
- How confident were you in your ability to instruct a class at the beginning of the semester?
  - Prior teaching experiences
  - Prior training/developmental courses/seminars
- How would you compare your teaching techniques to those of instructors you have had?
  - Are you confident in your ability to positively influence learning with your techniques?
- Have there been any critical moments or pieces of information that have changed how you think about your teaching?
- What would you attribute your teaching style to?
- Is there any other feedback you want to give regarding your experiences as a TA this semester?
Appendix D

Addition Questions for Post-Semester GTA-TSES

1. Please explain any experiences or interactions you had this semester that might have influenced your responses to the survey. How did they influence your responses (led to higher or lower scores)?

2. Please explain any sources of support you may have found for teaching this semester. Which did you find to be most valuable?

3. Please explain any sources of obstacles or difficulties you may have encountered for teaching this semester. Which did you find to be most challenging?
## Appendix E

### Codebook

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery experience (me)</td>
<td>The completion of a task followed by the interpretation and evaluation of the results obtained in order to determine whether corrections are necessary</td>
<td>I was able to gain valuable experience teaching a course previously</td>
</tr>
<tr>
<td>Vicarious experience (ve)</td>
<td>Observing another performing a task and interpreting and evaluating the results obtained for comparison to oneself</td>
<td>I observed someone teaching a course and learned a lot from their techniques</td>
</tr>
<tr>
<td>Verbal and social persuasions (vsp)</td>
<td>Receiving encouragement or praise of capabilities from a trusted other</td>
<td>My peers observed me and provided feedback on my performance</td>
</tr>
<tr>
<td>Emotional and physiological states (eps)</td>
<td>Responding to surrounding stimuli affecting one’s mood or physical condition</td>
<td>Being so busy lately has stressed me out</td>
</tr>
<tr>
<td>Lack of mastery experience (lme)</td>
<td>Having few to no instances of completing a task followed by interpretation and evaluation of the results obtained in order to determine whether corrections are necessary</td>
<td>I have never taught my own course</td>
</tr>
<tr>
<td>Lack of content knowledge (lck)</td>
<td>Having little to no exposure to learning information pertaining to a certain topic</td>
<td>I was not familiar with the information I was teaching</td>
</tr>
<tr>
<td>Verbal and social persuasions from students (vsp)</td>
<td>Receiving encouragement or praise of capabilities specifically from one’s own students</td>
<td>The class responded well to how the course went</td>
</tr>
<tr>
<td>Verbal and social persuasions from peers/professors (vspp)</td>
<td>Receiving encouragement or praise of capabilities specifically from one’s peers or professors</td>
<td>The feedback I received from my peer observations were positive</td>
</tr>
</tbody>
</table>
Appendix F

Examples from student evaluations regarding the focus of their TAs

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sample Student Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inward TA Focus</td>
<td>• One of his biggest strengths was communicating in a quick manner.</td>
</tr>
<tr>
<td></td>
<td>• [She] was available and gave great advice.</td>
</tr>
<tr>
<td></td>
<td>• Sometimes struggled answering questions.</td>
</tr>
<tr>
<td></td>
<td>• Sometimes it would take an entire class to go over a single problem.</td>
</tr>
<tr>
<td>Outward TA Focus</td>
<td>• She greatly helped me and my lab partner understand the material when we struggled.</td>
</tr>
<tr>
<td></td>
<td>• She explained concepts and procedures with clarity and directness, and did a fantastic job bridging the gap between theory and practice.</td>
</tr>
<tr>
<td></td>
<td>• Good at explaining the problems better and asking students what they wanted to go over.</td>
</tr>
<tr>
<td></td>
<td>• [She] is great at breaking down complicated topics and brings lots of energy. Her techniques are effective and helped me through my class this semester.</td>
</tr>
</tbody>
</table>
Appendix G

Examples from Lou’s statements regarding his sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Experience</td>
<td>• I mean this was my third different time teaching or TAing and um, it's, it's always different with each class. So going into it you're a little bit less confident because you don't know how exactly the structure is going to go.</td>
</tr>
<tr>
<td></td>
<td>• Once I started to get into the swing of things with class, that really helped, uh, to raise my confidence.</td>
</tr>
<tr>
<td></td>
<td>• The professor was very hands off, so at the beginning of the semester he was like, well, here you go. And um, I was confident but definitely a little anxious to see how things would go and then by more like mid semester I was a lot more confident in how everything was going with the class.</td>
</tr>
<tr>
<td></td>
<td>• I honestly think the first day of class was a really good opportunity for me because that was the day I did the most lecturing. Like myself. Um, we did a small project at the beginning of the lab and then I walked through their poster presentations and how to make a poster and we did some fun interactive activities and uh, it went really well. And so that just really helped my confidence for the rest of the semester.</td>
</tr>
<tr>
<td></td>
<td>• You never really know how it's going to go until you're the one that's up there. That's actually a teaching, interacting with the students, all that kind of stuff. I think that's, that's the most important aspect of, of this learning for me.</td>
</tr>
<tr>
<td></td>
<td>• So I will say compared to my previous two experiences TAing, which were both very hands on with the students, they were both different classes than the one I TAed this semester. Both of those were more structured by the professor and I just did what was told of me, whereas this semester was pretty much just completely left up to me. Um, and in some ways that was hard at the beginning of the semester, but now looking back, I'm really glad that I had the opportunity to do that. Like I had the opportunity to write the syllabus and to write all the assignments and do everything and that, uh, that really helped I think me, uh, to learn more about teaching and my teaching style and things like that.</td>
</tr>
<tr>
<td></td>
<td>• I'd say that that confidence [to positively influence learning] has increased over the semester, um, based on my experiences.</td>
</tr>
<tr>
<td>Vicarious Experience</td>
<td>• A certificate program. I was a part of that during my master's and so part of that I attended several different webinars and a couple of in person seminars just about teaching and things like that. Also within our department here in horticulture, we've had a couple of seminars related to teaching and I've always tried going to those and learning as much as I can.</td>
</tr>
</tbody>
</table>
I've been to a lot of seminars and I'm constantly, uh, just observing the way that different, uh, the people do their instruction or deliver their presentation and stuff like that.

I guess I see some things in, in a lot of professors, especially older professors were they are much less interactive and much more just here's the information just going through it.

I found that when I, when I do model my behavior after [my mentor’s] teaching style, that I seem to get the best response from students.

My main, uh, thing that I've based my, my teaching style off of was [my mentor’s] teaching, but also again based off all my experiences and taking classes and seeing what professors I like, which professors I didn't and trying to model myself after that.

<table>
<thead>
<tr>
<th>Verbal and Social Persuasions</th>
<th>Anonymous feedback that I got at the end of the semester saying how much they really enjoyed the activities that I helped do with them. That really helped a lot.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional and Physiological State</td>
<td>I was excited going into the semester.</td>
</tr>
</tbody>
</table>
## Appendix H

Examples from Stilwell’s statements regarding his sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
</table>
| Mastery Experience        | • I think [addressing cell phone use] helped with classroom management a bit because people did, you know, have their phone out every now and then, but some students did have more than others. I was able to go out and just address them one on one, walked around like, Hey, I tried to be a little bit more involved.  
  • I was pretty confident that I would do a good job because if you're feeling, feeling down about it before you go and do it, you're not going to have a good time. You just have to go in there and say like, Hey, I, I spent four years of my life doing this in college. I took this course years ago and I've just built on it a since then. I know what this stuff is.  
  • Conferences would probably be the biggest one is I went to quite a few of those and I got good feedback from my friends who would go and they would tell me like, hey, like this didn't make a whole lot of sense.                                                                                                                   |
| Vicarious Experience      | • Other TAs would help me with the course that I was teaching and talking to them about like, hey, did you have any issues? Because uh, the other sections were on Monday and mine were on Tuesday.  
  • The other TAs seem to be going through the same issues that I did with like, yeah, no they just hate this lab. Sorry. That's, that's all there is to it.  
  • I came from a small school, 4,500 traditional undergrads at any time. So it was pretty small, always had small classrooms. Biggest class I ever had was like 35 people for macroeconomics. So professors always knew students' names and you know, that was an important part to me and I feel like making those personal connections.                                         |
| Verbal and Social Persuasions | • Some of the students I had a better rapport with I would walk up to them and ask them like hey did you, like do okay, did you feel okay about that lab? And they would tell me like, well, that one was pretty hard or that one was a lot of fun. I would get feedback that way.  
  • Anything I messed up she would tell me how to correct it. Um, she made sure that I went through everything and she didn't just do it herself. So she was really helpful.  
  • I know three hours is a long time and even though it's blocked off and people schedule that, they still don't necessarily want to be in the classroom that long. People lose their attention span. And so I wanted make sure to keep things going and keep things moving and be exciting.  
  • I like public speaking, but I felt like I was a boring teacher that nobody wants to listen to. And I know that's not necessarily the case, but I got in my head about that a little bit.                                                                 |
But those long days, the course material that wasn't necessarily the most exciting. Um, and then the student's reaction to that less exciting material definitely took away some of my confidence during lecture. But I knew I was doing my job and I felt like I was doing an okay job. But you can't help but second guess yourself when you see some bored looks.

And just the bored face at some of the time, you know, that was one of the biggest hits that my confidence was. Sometimes I would stop after one of those long days and be like, I dunno if they like, I don't know if they think I'm doing a good job.

The main thing I draw that from is from like when you are in those lectures and you immediately begin worrying like hey I know I am teaching this and I know I'm doing exactly what I prepared, but I don't know if they are getting it and I just need a little bit of reassurance.

Right now from what my students have told me, I'm doing a great job and it depends on what's actually going to pop up in those anonymous evaluations, whether that's completely true or not.

It really is mostly the students.

<table>
<thead>
<tr>
<th>Emotional and Physiological States</th>
<th>I knew that I like public speaking, I wasn't nervous about giving lectures or anything like that, so that definitely made it better.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Mastery Experience</td>
<td>But I really do think that if I could have 100% control of the course that I, I could do even better than I was just as a lab TA because I would know exactly what's going into it. I would be able to decide what material was important and you know, how to line that up.</td>
</tr>
</tbody>
</table>
## Appendix I

### Examples from Marla’s statements regarding her sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quote</th>
</tr>
</thead>
</table>
| Mastery Experience          | • So I worked under another graduate student. Um, and I did. So I did a lot of the grading. I did some teaching, um, but a lot of assisting and that really helped me a lot to kind of adjust to a new university and kind of how the way things are done here versus other institutions.  
  • One of the classes I'm teaching again in the spring and then I'll be totally fine, totally confident with it because you've already been through it once.  
  • I would say very confident because I had done it before, um, at another institution. I had done it for a few semesters and then also because I was a TA in the more traditional TA role.  
  • So I had done like a two day workshop kind of thing at my previous institution in preparation for teaching that other course.  
  • So a lot of the things we talked about in that workshop. I was like, Hey, I was doing that. So I, yeah, it was confidence building more so kind of after the fact that, oh, hey, that was a good teaching practice. I just did it.  
  • Just making those kinds of adjustments because you can see what is working and what isn't when you're at the front of the class.                                                                                                                                               |
| Vicarious Experience        | • I did definitely talk to, um, peers, so other TA's who had done it before, um, and kind of got a feel for it.  
  • I think knowing that you can always have people to bounce ideas off and to ask questions, even though I don't have kind of that formal supervisor person. Um, there are enough people, um, you know, faculty members, um, who are, you know, Undergrad, um, faculty teach undergrad classes and then also the graduate classes and peers who are TAs.  
  • [My professor] was very, very nice, very understanding. Students really liked him, respected him as well. So I had a great model that way.  
  • I guess it might, like I have a lot of people in my family who have been in education.  
  • Well, just from being a student for so many years and seeing different people's teaching styles and what works for me and what works for my peers.  
  • Even my husband had been a professor so I could talk to him about it, um, and get support.                                                                                                                                                                      |
| Verbal and Social Persuasions| • I think just having people around you who were supportive was probably the most important part in terms of feeling confident.  
  • Mid-semester evaluation slash assessment for the students so I can get feedback on not only the class and what they like and they don't
like and what they're learning and what they want to learn.

- When I got the results of the midyear evaluations and I knew, I clearly had to address what was said and stuff like that.
- Hearing some students say how much they liked what we were doing, the material that was being covered and they thought it was interesting and they were learning a lot.
- Um, so there were definitely some friendly faces in both, you know, both of the classes that I had recognized that I had to, well, had a TA anyway previously.
- My friends and colleagues, you know, were very encouraging, so that was nice.
- Wanting to get that feedback because I want to make sure the students are getting something out of the class.
- It was mostly reassurance that things that I had already done were good. So keep doing them.
- Just kind of seeing what [students] respond to the best.

<table>
<thead>
<tr>
<th>Emotional and Physiological State</th>
<th>The kind of undergraduate age group, I love interacting with them.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I've always found that when working with the students gives me like a lot of rewards. Um, just, you know, internally, like it gives me energy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lack of Mastery Experience</th>
<th>Being a newer teacher, um, and not having taught K-12.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>So I think the biggest obstacle in general, confidence wise and just in general with this semester was teaching two classes that I hadn't taught before is that both of them had been taught several times before.</td>
</tr>
<tr>
<td></td>
<td>I can tell you what works and what doesn't work, but I don't necessarily know the theory behind why I'm sort of feeling behind in those aspects. Um, because I haven't had the training.</td>
</tr>
</tbody>
</table>

| Lack of Content Knowledge | I think that would have probably helped and just more familiarity in general with some of the topics. |
Appendix J

Examples from Doris’ statements regarding her sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Experience</td>
<td>• I just felt like, like the behind the scenes work was like when I was at my best.</td>
</tr>
<tr>
<td></td>
<td>• I had had previous experience, like presenting my research as an Undergrad, like just in like lab meetings or something. Um, and so if I hadn't had that, it would've been so much worse. Um, but yeah, like that was like, if it weren't for that, yeah, I would have just had absolutely no confidence.</td>
</tr>
<tr>
<td>Vicarious Experience</td>
<td>• The first TAs have their lab on Tuesday and I would go and attend their, lab session and just see what she was doing, like listening in on what she was telling students and stuff like that.</td>
</tr>
<tr>
<td></td>
<td>• [A more experienced TA] came into my lab once cause it was a particularly involved lab and she was like, you guys need help cause I like this is really tough for me.</td>
</tr>
<tr>
<td></td>
<td>• I had one professor in my stats and she was very structured and very well organized.</td>
</tr>
<tr>
<td></td>
<td>• I also had a professor and he was just, he's just kind of like a nervous professor. Not that he liked was like nervous talking to us or anything. It was just more like he would just change his mind a lot. And I tried not to do that. I was definitely cognizant of it.</td>
</tr>
<tr>
<td>Verbal and Social Persuasion</td>
<td>• Interacting with [students] was enjoyable and just talking about like school in general and other stuff like that.</td>
</tr>
<tr>
<td></td>
<td>• I guess I did a good job because no one ever came back to me and said, I don't agree with your grading here or there.</td>
</tr>
<tr>
<td></td>
<td>• I didn't have the knowledge of the coursework and a lot of the students were very understanding, they were always like, it's okay, we don't either but not that, it didn't really help me in the moment. But I think like as they kept saying it and like they just, they didn't ever make me feel like I was down. So just like the students were really nice.</td>
</tr>
<tr>
<td></td>
<td>• So one of the other TAs was very experienced with the course. She taught it multiple times and so she pretty much had it down and she like constantly was like, I was like, oh man. Yeah I just, I didn't like I ask her questions all the time and she'd be like, it's okay that you don't know this. I mean like you're brand new.</td>
</tr>
<tr>
<td></td>
<td>• I definitely with the students because they're the ones that it's affecting. So yeah, I kinda care what they have to say.</td>
</tr>
<tr>
<td></td>
<td>• I really didn't want to send them anything about evaluations. I just don't want to read them honestly.</td>
</tr>
<tr>
<td></td>
<td>• A student emailed me and was like, she was a freshman, which like that's not like a freshman class. And I just felt that she kind of like struggled and didn't understand it this semester, but she emailed me</td>
</tr>
</tbody>
</table>
and said that she like was feeling very confident about the major and she really, really enjoyed the lab. She was always looking forward to going to it. So that is stellar feedback.

**Emotional and Physiological State**

- I was definitely very anxious about it because I, I have a background in biochemistry and genetics and I had previously taken one plant class that that wasn't even really about plants is more so about like, like their genetics in plants.
- It was really stressful. Um, not like when I was like, I felt like whenever I was preparing for the class, you know, like the day or so before my lab I felt okay about it. But then like during the lab it was kind of a hit or miss.
- I think like the most relevant aspect for like teaching actively teaching. Um, someone said like ask them the question and actually wait. And I definitely did do that cause I would just get really nervous

**Lack of Mastery Experience**

- Maybe [having] more like, uh, like discipline, like related topics [in the TA workshop] would be more beneficial. They were kind of more like general aspects of teaching

**Lack of Content Knowledge**

- I didn't have the knowledge of the coursework
- I don't really know too much like formally about plants. And I was teaching plant biology so it was really interesting and I didn't really know what, um, what the course exactly entailed.
- Whenever they would, you know, ask me questions about like course material, I that was not fun. Because usually I didn't know the answer.
- I just tried to read as much as I read before class. Which, I don't think it worked out very well, mainly because I just didn't exactly know what I didn't know.
- I just think that if I were to do it again, I would go back and do everything. Like I would complete the lab by myself beforehand I would just go into the lab and I would sit down and like act like a student and just like run through everything, which I didn't think I had to do but I changed my mind.
Appendix K

Examples from Dottie’s statements regarding her sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery Experience</td>
<td>• My last semester as an instructor went really well. So I was riding on that a little bit.</td>
</tr>
<tr>
<td></td>
<td>• I was a little more pedantic in my first semester of teaching and I changed to a little bit more casual.</td>
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<tr>
<td></td>
<td>• I wanted to learn, like she told me that they’ll give you mini modules to teach. So before going to like an actual class you’ll get prepared for it… Putting myself in those situations where you have nothing to lose and you know the people listening to you have nothing to lose as well.</td>
</tr>
<tr>
<td></td>
<td>• I had peer reviews, I had my friends sit in my classes to observe me. I asked my faculty member to sit in and observe me.</td>
</tr>
<tr>
<td></td>
<td>• The confidence mostly came from my last semester of teaching. The performance of my students improved. I don’t like to go to class evals again and again because I don’t, I think that reflects on how much your students like you more than how effective you are.</td>
</tr>
<tr>
<td></td>
<td>• I think, you know, the experience from one semester I knew how to handle the class then. I knew how to prepare myself for the class then… I was banking on that one semester a lot.</td>
</tr>
<tr>
<td></td>
<td>• So I think like, you know, when that semester went so well, I was like, okay, you know, bring it on. I'm ready for the next challenge.</td>
</tr>
<tr>
<td></td>
<td>• I think the first two semesters of TAing taught me that you have to work on your skills of explaining things without having to rely on equations.</td>
</tr>
<tr>
<td></td>
<td>• There are times when I would come up with activities that I would fail at. But I think that's, that's part of it, you know, not being afraid of taking those chances, but also being very mindful that you need to introspect after every single lecture and go about it.</td>
</tr>
<tr>
<td></td>
<td>• I think over time it's experience that counts because you know what works, what doesn't work.</td>
</tr>
<tr>
<td>Vicarious Experience</td>
<td>• I learned a lot from being in the presence of two faculty members… one of them in research oriented. One of them is teacher oriented… I got to observe them very closely and I think my biggest source of confidence would be them.</td>
</tr>
<tr>
<td></td>
<td>• I’m talking to other instructors who are [native speakers] like and how they deal with these things and how they prepared themselves. I think that helped me a lot.</td>
</tr>
<tr>
<td></td>
<td>• I have two friends who had taught that class before, they are both [native speakers]. So I actually sat in on their lectures and I wanted to see how they control the class. And I started jotting down things that they did better than me, which I could learn.</td>
</tr>
<tr>
<td></td>
<td>• I’ve made friends in that cohort who are teaching different classes...</td>
</tr>
</tbody>
</table>
| So I mean now, you know, building relationships and then if we come up with challenges we call each other.  
• Talking to professors, talking to teachers helps.  
• My professors have a very big role to play in whatever I am doing today.  
• Our instructions were pretty boring. It would have two hour long lectures. A faculty member would come and sit down, open her notes and dictate for two hours. We would just be writing, even if it was formulae and stuff. And I was like, it has to be better than this.  
• I think he was one of the teachers that I really liked initially. Like, you know, ask your students questions because questions make you think. |
|---|
| Verbal and Social Persuasions  
• I’ve had like, you know, amazing faculty members around me who listened to what I wanted to do and were ready to help and you know, give me positions to get there.  
• I think the most critical feedbacks would be, um, I think my professor once told me that I could manage my time better.  
• The first time when I read my evals I was like, Oh, this is how I am as a teacher… I went to my professor and I’m like, okay, you know what, I want you to read this… but then she like, she walked me through it and she was like, okay, you know, this is something you can take. This is something you can work on this for now… I think like, you know, being honest, having constructive feedback is good. |
## Appendix L

**Examples from Mae’s statements regarding her sources of teacher efficacy**

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
</table>
| Mastery Experience    | • Prior to starting my PhD as an Adjunct Instructor at Tech College (pseudonym), um, with my own actual courses, so from development, implementation and such… in terms of you know, teaching confidence.  
  • At one point I was actually hired as a TA, but I only taught one section and my other ten hours came from actual lesson plan development. Um, and because of my previous adjunct experience.  
  • Actually digging into the educational objectives outside of the specific objectives of the class.  
  • All these other things have been great and help, but just the experience itself, you know… is helpful.  
  • Sometimes we learn from our mistakes as soon as we make them, uh, you know, and so, I mean, honestly to me experience is a huge factor.  
  • My confidence as a scholar in general has increased in the last year. Um, just based on where I am in my PhD and a culmination of all the things that I've done, I'm more and more confident in my abilities as a scientist to be flexible, to be adaptive, and to know where to find answers to questions that maybe I don't know or I hadn't considered.  
  • I've also taught various groups of people.  
  • How to handle student conflict or student dissatisfaction and you know, a way that everybody is satisfied at the outcome.  
  • Workshops really helped because I had experienced some of those things and you know, you kind of learn as you go a little bit.  
  • I haven't always stayed away from more traditional teaching approaches. Um, it really just depends on the nature of the material that I am actually teaching.  
  • I don't know that anything specific contributed [to how I think about teaching], but definitely having to have a broader understanding of teaching objectives in general.                                                                                                                                                                                                                     |
| Vicarious Experience  | • I've been a student and instructors have implemented either citizen science, um, based approaches and experiential learning approaches where you learn about a concept through a project or something like that rather than just having information delivered to you.  
  • In some ways I'm better [than own previous instructors] and in some ways I'm not. I would say I'm more invested in my students’ overall grasp of the knowledge. Um, and I offer additional opportunity for feedback.  
  • I've had some [professors] that were fabulous and I learned a lot of material from them because of the way that they presented it. And
they did give resources. They did create, you know, project opportunities for us to learn concepts in a way that, you know, we can actually see it in action.

| Emotional and Physiological State | • I'm not, I'm not always super comfortable in front of a group of people. |
## Appendix M

### Responses to open response questions by TAs with high teacher efficacy

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mastery Experience</strong></td>
<td>- I think I built confidence as time went by and I understood what were the expectations I could have about me and my students’ performance. (TA #12, GTA-TSES = 4.67)</td>
</tr>
<tr>
<td></td>
<td>- I realized how it was more relevant that the students had a working knowledge of what they were doing in the lab than my lecture itself. Thus I have worked during the semester on different approaches to better inquire their knowledge and adjust my teaching. (#12, 4.67)</td>
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<tr>
<td></td>
<td>- Experience and expertise is pretty key. I’ve actively tried to hone my craft. (#4, 5.00)</td>
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<td></td>
<td>- I was observed by two faculty members every time I taught. I think it was useful to hear what they thought about it in terms of both strengths and areas that I need to work on. (Dottie, 4.87)</td>
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<td></td>
<td>- I have been working as an Adjunct Instructor at [a community college] since 2016 after my undergraduate graduation, so confidence with teaching is actually somewhat positive for me.</td>
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<td></td>
<td>- Some laboratories went better than I expected and boosted my confidence in my ability to teach. (#10, 4.73)</td>
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<td></td>
<td>- At the beginning of the semester, transitioning from [a smaller school] to [a larger school] was a bit weird for me. I went from working mostly one-on-one with students to teaching a full class. While I had led workshops at [the small school] with students numbers around 40-60, it was a strange experience having to work with a group of students consistently throughout the semester. (#10, 4.73)</td>
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<td></td>
<td>- Obstacles in the form of mistakes or issues with standardization that had to be negotiated with the supervisor on the behalf of the TA's were punted to me, and having to take the lead on those issues improved my confidence as an instructor. (Mae, 4.67)</td>
</tr>
<tr>
<td></td>
<td>- Remembering how to perform certain tasks. I had to go back and re-learn some microbiology skills that I had previously forgotten. When I taught them I became a little more confident in my ability to learn and explain. (#12, 4.67)</td>
</tr>
<tr>
<td><strong>Vicarious Experience</strong></td>
<td>- I got support from the Professor on how to approach certain tasks and resources to study. I also got support from my fellow TAs. (#2, 5.00)</td>
</tr>
<tr>
<td></td>
<td>- Shadowing different TAs to understand the expectations bar and trial-and-error. (#12, 4.67)</td>
</tr>
<tr>
<td></td>
<td>- Teaching faculty, other lab TAs. (#13, 4.67)</td>
</tr>
<tr>
<td><strong>Verbal and Social</strong></td>
<td>- A positive feedback by a senior member of staff after she had visited my class. (#3, 5.00)</td>
</tr>
<tr>
<td>Persuasions</td>
<td></td>
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<tr>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>1. I tried very hard to make my students (both lab and [supplemental instruction]) engaged in learning the materials expected of them and I feel like many of them responded well to a teacher that was interested in ensuring their students were both prepared for upcoming exams and interested in their overall well being. (#9, 4.73)</td>
<td></td>
</tr>
<tr>
<td>2. Students said they understood things better and I explained things well and that made me feel confident. (#13, 4.67)</td>
<td></td>
</tr>
<tr>
<td>3. I saw a significant growth in the majority of my students throughout the semester. I had a few who struggled with the material start coming to my office hours on a weekly basis and were comfortable with seeking help from me and working to better develop an understanding of the material. (#19, 4.47)</td>
<td></td>
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</tbody>
</table>
Appendix N

Examples from Kit’s statements regarding her sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
</table>
| Mastery Experience    | • As the semester went on, I got more confident in my ability to manage my time a little bit to actually fill the time and not just like blast through a power point in 20 minutes and be like, okay, we have another hour left of class.  
  • I was confident that I could stand up in front of people and talk and um, nerd alert. I was on the speech and debate team in high school and middle school. So I was confident in my ability to stand up and present information.  
  • The one [TA workshop] I took at East State (pseudonym) helped a little bit, but it was more in terms of feedback than anything else. So, um, uh, the two professors who taught that class would have you teach one section of that class and then give you feedback on how you did it. And that feedback helped cause they told like I speak, I know I speak really fast. So that helps because they gave me that kind of feedback.  
  • I just got really comfortable with knowing what needs to go on a slide and how a slide needs to be organized. So it's informative but not so that it's like way too much information because if it's too much information, people are going to tune out, they're going to tune out. |
| Vicarious Experience  | • Fortunately my advisor here… has taught this class before… he was my quote unquote supervisor for this, for this experience. So he was really good about giving me notes from his lectures in the past and his past power points and telling me what book he's used and answering questions I had about like as a teacher, how do I approach this situation?  
  • Speaking to other, especially other TAs who are also primary instructors and seeing like how did they approach this situation, how they approach that situation, how would they handle this?  
  • I had professors do in Undergrad that I actively tried not to do here.                                                                                                                                                                                                              |
| Verbal and Social Persuasions | • Overall I think it has been a, it has been a good experience and I've gotten, um, I have gotten a few emails from students, uh, recently, within the past week or so… that have said ‘oh hey, like I really enjoyed the class. Like thank you so much for creating like such a good environment. Like you like brought a lot of energy to the subject. And like I really, um, thought it was an interesting subject and really enjoy participating.’ So that's been, that's been really encouraging, especially since this was my first semester  
  • So I think that's definitely changed my self efficacy levels where it's like oh, like I can teach effectively because a lot of them seem to be responding pretty positively to how the semester went. Like I was |
always afraid that like they were going to get frustrated with how disorganized I was or the fact that I would like sometimes forget where I was going with a topic or that I would repeat myself or that I'd be reading straight off the power points. Like I always constantly had, this was like, I felt like I was constantly monitoring myself while I was teaching the class. To be like, oh snap, how are they responding to this? And how are they responding to this?

- I am a little bit more confident now that I've, especially that I've heard back from a few students.
- It's [source of confidence in teaching] honestly mainly in feedback from the students.
- I think it is mainly feedback from others that figures into that self confidence or confident in teaching efficacy in teaching I should say.
- I think it's mainly just like a, a few moments where students like actually want to participate in class discussions and it didn't take me being like participate in the discussion to have them say that, but where they would actually seem like invested.

<table>
<thead>
<tr>
<th>Lack of Mastery Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>- I had no TA, no TA experience. No teaching experience, nothing like that.</td>
</tr>
<tr>
<td>- Like I don't know what to expect. Like I don't know what I'm, what I would be, what I'll be like as a, you know, I don't know how I'll be at handling classroom conflict or scheduling, um, you know, scheduling things for the class or grading things. Like I don't know what I'll be like, cause I don't have any experience. It was like I could, I could be terrible. I could absolutely suck.</td>
</tr>
<tr>
<td>- I do have confidence in my presentation abilities but not necessarily my teaching abilities.</td>
</tr>
</tbody>
</table>
**Appendix O**

Examples from Jimmy’s statements regarding his sources of teacher efficacy

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
</table>
| **Vicarious Experience**    | • So I'm coming back from working and I've met quite a few people with PhDs who were not very good at explaining things to people without PhDs. And I wanted to make sure I wasn't one of them.  
• One of the TAs for this class used to be a high school math teacher and so I talked to him a lot. He gave a lot of us very valuable feedback.  
• I tried to look back I guess maybe on things that I had liked that other professors had done and or things that people didn't do. |
| **Verbal and Social Persuasions** | • I thought I was able to explain at least most of the concepts pretty well and people seemed to respond to some explanations, especially during office hours where I could kind of talk to people one on one about things they didn't understand.  
• There’s that kind of like that aha I get it moment that you can tell in people whenever things click together and those are definitely being like, all right, if people are getting to that point, I'm explaining things well or at least well enough that they're, that they came in not understanding something and they left understanding it. That's definitely confidence boosting.  
• I took just the increase in questions as the semester went on as a good sign. It was easier just to go kind of back and forth with students.  
• I mean I guess I got some positive feedback throughout the semester. |
| **Lack of Mastery Experience** | • I mean at the start of this semester I had, I mean I had taught some classes at my job, but I had an expectation that that would be pretty different. I mean, I just, I didn't want to be, I don't want to be overconfident and I wasn't really sure if I'd be able to, I mean for all I knew I was able to crash and burn and not be able to be a good instructor.  
• I suspect people who are actually good teachers put a lot of time and effort and training into that. And so I wasn't expecting to be a good teacher I was just hoping to be, you know, a good TA, which I don't think it's the same thing.  
• There are still some thing that I would love to talk to someone who knows how to explain some of these concepts that I still struggle to, I can explain it in math, but that's not helpful for people who haven't had as much math as I've had, as opposed to being able to explain it in words.  
• [On why he was not as confident] Lack of experience for sure.  
• One thing someone could have told me, ‘here are ten things I recommend for whenever you teach this kind of class in the setting
you are in.’ But it was really just actually doing it. So maybe if it was even just a mock presentation that probably would have been the most helpful thing for me looking back.

- Someone who's really good at driving a car, giving advice to a 16 year old who's never driven before. At some point you just have to try it yourself before any of that advice actually really makes sense.
### Appendix P

**Responses to open response questions by TAs with low efficacy**

<table>
<thead>
<tr>
<th>Code</th>
<th>Sample TA Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mastery Experience</strong></td>
<td>• I have some previous experience grading students’ work, so I felt more confident about it. (#42, 3.67)</td>
</tr>
<tr>
<td></td>
<td>• As more time passed I learned from my experiences that helped me gain more confidence in the end. (#31, 3.87)</td>
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<tr>
<td></td>
<td>• Definitely handling questions on the fly improved my confidence. I was worried I'd blank out or not know something basic or be an utter mess at explaining things off the cuff, but I did better than I had expected. I wouldn't say I'm great, but I did well. (Jimmy, 3.27)</td>
</tr>
<tr>
<td></td>
<td>• I made myself learn to explain things without using jargon. It's not exactly a new idea, but being able to explain things simply without using technical terms means you actually understand the material. Forcing myself to practice helped a lot. (Jimmy, 3.27)</td>
</tr>
<tr>
<td><strong>Vicarious Experience</strong></td>
<td>• I have found a lot of support from the [supervisor] and all of the Bio 181 instructors. Their advice during the weekly meetings was very helpful when preparing for lab. (#42, 3.67)</td>
</tr>
<tr>
<td></td>
<td>• An older graduate student gave me her lecture notes and classroom materials. That was incredibly helpful to have a model to go from in preparing my own material. (#44, 3.53)</td>
</tr>
<tr>
<td></td>
<td>• Asking my professor for help. (#48, 2.67)</td>
</tr>
<tr>
<td><strong>Verbal and Social Persuasions</strong></td>
<td>• With respect to explaining material, I believe I did fairly well and received many compliments through the semester. (#46, 3.27)</td>
</tr>
<tr>
<td></td>
<td>• I found it much harder to invoke curiosity in my students. The first lab was pretty difficult and I felt like many gave up from that point forward. (#43, 3.53)</td>
</tr>
<tr>
<td></td>
<td>• I have received a few emails from students and a few in-person conversations with students who said they truly enjoyed the class and the energy I brought to presenting the material. (Kit, 3.87)</td>
</tr>
<tr>
<td></td>
<td>• In office hours, a student expressed anxiety to me about an upcoming test and her ability to do well on it. I wasn't sure how exactly to reassure her and promote her confidence. (#44, 3.53)</td>
</tr>
<tr>
<td></td>
<td>• As I had more interactions with the students I realized that I might not be as good as I thought I would be. (#31, 3.87)</td>
</tr>
<tr>
<td></td>
<td>• The most positive influences were from my direct interactions with students. Learning to adjust my wording and critique to provide the clearest feedback and then seeing them make those changes to better their work was a big confidence booster as well as simply having students approach/email me questions as a sign that they respected or valued my insight. (#35, 3.80)</td>
</tr>
</tbody>
</table>
|                       | • I found it difficult to engage the students during some of the activities that were more difficult. I also found it difficult to "lay
"down the law" and be serious about following the rules and paying attention. (#42, 3.60)

- I had to talk to a student after class once because I felt like he had been disrespectful during several recitations. He was slightly better after that. (#41, 3.67)
- Motivating students who are taking the course solely because they think it will be an easy A can be quite difficult, specifically participation in group activities. (#36, 3.80)