AN ABSTRACT OF THE DISSERTATION OF

Sue Ellen DeChenne for the degree of Doctor of Philosophy in Science Education presented on April 9, 2010.

Title: Learning to Teach Effectively: Science, Technology, Engineering, and Mathematics Graduate Teaching Assistants' Teaching Self-Efficacy

Abstract approved:

Larry G. Enochs

Graduate teaching assistants (GTAs) from science, technology, engineering, and mathematics (STEM) are important in the teaching of undergraduate students (Golde & Dore, 2001). However, they are often poorly prepared for teaching (Luft, Kurdziel, Roehrig, & Turner, 2004). This dissertation addresses teaching effectiveness in three related manuscripts:

1. A position paper that summarizes the current research on and develops a model of GTA teaching effectiveness.
2. An adaptation and validation of two instruments; GTA perception of teaching training and STEM GTA teaching self-efficacy.
3. A model test of factors that predict STEM GTA teaching self-efficacy.

Together these three papers address key questions in the understanding of teaching effectiveness in STEM GTAs including: (a) What is our current knowledge of factors that affect the teaching effectiveness of GTAs? (b) Given that teaching self-efficacy is strongly linked to teaching performance, how can we measure STEM GTAs teaching

self-efficacy? (c) Is there a better way to measure GTA teaching training than currently exists? (d) What factors predict STEM GTA teaching self-efficacy?

An original model for GTA teaching effectiveness was developed from a thorough search of the GTA teaching literature. The two instruments – perception of training and teaching self-efficacy – were tested through self-report surveys using STEM GTAs from six different universities including Oregon State University (OSU). The data was analyzed using exploratory and confirmatory factor analysis. Using GTAs from the OSU colleges of science and engineering, the model of sources of STEM GTA teaching self-efficacy was tested by administering self-report surveys and analyzed by using OLS regression analysis.

Language and cultural proficiency, departmental teaching climate, teaching self-efficacy, GTA training, and teaching experience affect GTA teaching effectiveness. GTA teaching self-efficacy is a second-order factor combined from self-efficacy for instructional strategies and a positive learning environment. It is correlated to GTA perception of teaching training and university GTA training. The K-12 teaching experience, GTA perception of teaching training, and facilitating factors in the departmental climate predict STEM GTA teaching self-efficacy. Hours of GTA training and supervision are fully mediated by perception of GTA training. Implications for research and training of STEM GTAs are discussed.

Learning to Teach Effectively: Science, Technology, Engineering, and Mathematics Graduate Teaching Assistants' Teaching Self-Efficacy

by
Sue Ellen DeChenne

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APPROVED:

Major Professor, representing Science Education

Chair of the Department of Science and Mathematics Education

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Sue Ellen DeChenne, Author

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"For I know the plans I have for you," declares the LORD, "plans to prosper you and not to harm you, plans to give you hope and a future." (Jeremiah 29:11)

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Dr. Larry Enochs contributed to the design and validation of the GTA Teaching Self-Efficacy Instrument and to the interpretation of the path analysis of teaching self-efficacy in STEM GTAs. Dr. Mark Needham contributed to the statistical data analysis of the GTA Teaching Self-Efficacy Instrument and path analysis of teaching self-efficacy in STEM GTAs.

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CHAPTER I

INTRODUCTION

INTRODUCTION

The scene is a familiar one at a university, a chemistry laboratory filled with freshman, dressed in white lab coats with safety goggles causing rings that will stay around their eyes for the next few hours. These students are intent on their work and a graduate teaching assistant (GTA), dressed similarly, is walking around helping them. She has participated in the TA training in the department and has taught this class for a year. This is a popular GTA; she is from the local area, young, and hip. She is joking with the students and is relaxed and friendly. She always scores highly in her student evaluations; however, her students routinely perform below average compared to other chemistry GTA's students.

Down the hallway teaching similar students, is another chemistry GTA. His students are working intently and he is also walking around helping them. He participated in the same GTA training with the previous GTA, and has also taught this class for a year. He is not a popular GTA; he is an international student, and although he has been in the United States for five years, he still has an appreciable accent. He is much more formal with his students. His students routinely score him average in their student evaluations, but his students perform better than the average chemistry GTA's students.

This dissertation is about these two hypothetical GTAs and others like them. It is concerned with what develops a good science, technology, engineering, and mathematics (STEM) GTA. What do we currently understand about what makes an

effective GTA? Even more specifically, what in their environment and past experiences develops STEM GTA's beliefs about their ability to teach?

GTAs have been studied for over 40 years (e.g. Costin, 1968; Saroyan, Dagenais, & Zhou, 2009). While some of the research has focused on STEM GTAs (e.g. Luft et al., 2004), much of the literature is either about all disciplines (e.g. Luo, Bellows, & Grady, 2000) or focused on GTAs from other disciplines (e.g. Prieto & Meyers, 1999). Also, the research on GTAs is strongly focused on ways to train GTAs (e.g. Hadre, 2005). However, some of this literature focuses on what makes certain GTAs more effective teachers than others (e.g. Shannon, Twale, & Moore, 1998). A common experience of this literature is the wide variety of research; many papers are published by authors that seldom contribute again to this field. These authors often are representing their specific discipline with a paper about GTA training usually published in a discipline specific journal. This leads to literature published on GTAs in virtually every type of field and journal. Another commonality in this body of literature is that most of the research is strictly empirical without a theoretical framework.

With this large body of diverse research it can be difficult to determine what the overall findings of this field are, what questions still need to be answered, and how the research is related. To understand what develops a good STEM GTA, we need to understand what we already know. Chapter two of this dissertation tackles that question and provides a theoretical framework for understanding GTA teaching effectiveness. Using the theoretical framework from social cognitive theory (Bandura,

1977, 1986, 1997, 2001), the first paper synthesizes the GTA literature to produce a model of factors that may affect GTA teaching effectiveness.

From the literature and the model generated in chapter two it becomes clear that beliefs about the ability to teach are central to developing the teaching effectiveness of GTAs. Chapters three and four are related to STEM GTA's teaching self-efficacy, which is a person's belief about their ability to teach a specific subject in a specific context (Bandura, 1977, 1986, 1997). Context is critically important to the definition of teaching self-efficacy (Bandura, 1997; Enochs & Riggs, 1990; R. K. Henson, 2002). Even within an individual, teaching self-efficacy differs depending on the subject and students being taught (Tschannen-Moran, Hoy, & Hoy, 1998).

Teaching in STEM fields is a specific context that differs from other disciplines (DeChenne et al., 2009; Golde & Dore, 2004; Lindblom-Ylanne, Trigwell, Nevgi, & Ashwin, 2006; Verleger & Velasquez, 2007). Lindbloom-Ylanne et al. find that STEM instructors teach in a significantly more information-transmission, teacher-focused way than liberal arts instructors. Golde & Dore find English doctoral students feel better prepared to teach discussion sections, create an inclusive classroom climate, and develop a teaching philosophy than chemistry doctoral students who feel better prepared to teach a lab, advise undergraduates, and incorporate technology into their classrooms. Additionally graduate students learn many of their pedagogical skills as students and therefore are apt to mimic their discipline's faculty (Handelsman et al., 2004). This tends to perpetuate differences in teaching styles. Therefore, this dissertation specifically studies the teaching self-efficacy of STEM GTAs.

In prior university research, GTA teaching self-efficacy is measured using variations of the Self-Efficacy Teaching Instrument (Prieto & Altmaier, 1994; Tollerud, 1990). This instrument was developed specifically to measure the teaching self-efficacy of counseling psychology GTAs (Tollerud, 1990). It was then adapted for general GTA use by removing the questions that measured counseling specific teaching duties (Prieto & Altmaier, 1994). Given that the context of teaching STEM teaching is different from psychology and even from general GTA (Golde & Dore, 2004; Lindbloom-Ylanne et al, 2006; Verleger & Valasquez, 2007), a measure of STEM GTA teaching self-efficacy is needed. Chapter three develops and validates that measure for STEM GTAs.

Chapter four uses that measure of STEM GTA teaching self-efficacy to determine the relationship of various factors, developed from chapter two, that contribute to STEM GTA teaching self-efficacy. The literature indicates that there are factors in the teaching environment of the GTA, such as the departmental teaching climate and GTA training experiences, that can impact GTA teaching self-efficacy. There are also prior personal experiences that can affect teaching GTA teaching self-efficacy. However, interactions between these factors and the way they affect STEM GTAs' teaching self-efficacy is not understood. A model predicting GTA teaching self-efficacy is tested in chapter four.

This dissertation extends the field of GTA teaching in three important ways. It synthesizes a large body of literature to produce a model of GTA teaching effectiveness. It extends the measurement of teaching self-efficacy, GTA training, and

GTA supervision; and adds a measurement of peer interactions. Finally, it provides a model test of sources of GTA teaching self-efficacy.

The body of literature about GTA teaching is extensive. Chapter two in this dissertation synthesizes the literature to provide a model of what is known about GTA teaching effectiveness, the sources of GTA teaching effectiveness, and possible relationships among those sources. In doing so, it provides an overview of GTA teaching effectiveness. This illustrates what we already know and where there are gaps in our understanding of GTA teaching effectiveness, which provides future research opportunities. Additionally, the model poses one possible set of relationships among sources of GTA teaching effectiveness, thus giving a testable set of relationships to investigate further.

Chapter three in this dissertation adds to the measurement of teaching self-efficacy by providing a new measure of this concept for STEM GTAs. Teaching self-efficacy is a somewhat difficult concept to measure (R. K. Henson, 2002; Tschannen-Moran & Hoy, 2001). This dissertation provides another view of the measurement of this concept. Additionally, this dissertation provides new ways of measuring GTA training, supervision, and peer interactions. These new measures can expand our understanding of these factors relationships to teaching self-efficacy and teaching effectiveness.

Chapter four provides implications for both research and practice. Testing a model of STEM GTA teaching self-efficacy raises as at least as many questions as answers. These questions provide a point for further research into both the sources

and outcomes of teaching self-efficacy. Additionally, there are implications for the training of STEM GTAs. GTA training can benefit from the insights gained throughout these three chapters, but chapter four provides some of the clearest implications for faculty who train and supervise STEM GTAs.

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CHAPTER II

GRADUATE TEACHING ASSISTANTS' TEACHING EFFECTIVENESS: TOWARD DEVELOPMENT OF A MODEL FROM RELATED RESEARCH

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GRADUATE TEACHING ASSISTANTS' TEACHING EFFECTIVENESS: TOWARD DEVELOPMENT OF A MODEL FROM RELATED RESEARCH

Abstract

The purpose of this review is to frame graduate teaching assistants' teaching in a social learning perspective. A model of the interaction of factors that affect the teaching effectiveness, based in social cognitive theory (Bandura, 1986), is proposed. Graduate teaching assistants (GTAs) are an integral part of the instructional staff within colleges and universities. They grade, teach laboratory and discussion sections, and are often completely responsible for teaching a course. However, GTAs frequently have little or no training in teaching (Golde & Dore, 2001), and the training they do receive is often not successful in producing an effective instructor (Luft et al, 2004; Shannon, Twale, & Moore, 1998). From a comprehensive review of the GTA teaching effectiveness literature, five factors are found to affect the teaching effectiveness of GTAs: language and cultural proficiency, teaching experience, teaching self-efficacy, GTA training, and departmental teaching climate. Implications of this model for further research on GTA teaching effectiveness and use of the model by GTA trainers are discussed.

Introduction

Graduate teaching assistants (GTAs) are commonly used as instructors in most research universities and colleges. Up to 38% of all undergraduate instruction in colleges and universities is done by GTAs (Nyquist, Abbott, Wulff, & Sprague, 1991). In science and engineering departments GTAs provide the majority of instruction for

laboratory and discussion sections, while in the social sciences and humanities GTAs often teach introductory course sections (Fagen & Wells, 2004; Golde & Dore, 2001). The amount and responsibility for teaching undertaken by GTAs is likely to increase as research universities struggle for money in the current economic climate, which is forcing faculty cutbacks and hiring freezes. Departments are increasing GTAs' responsibilities (Sykes, 1988). Programs are increasing requirements to provide the initial instruction for students from other majors. Additionally, faculty members are pulled away from their undergraduate teaching duties for research and graduate course instruction (Boyer, 1991; Sykes, 1988).

The routine use of GTAs for undergraduate instruction has a two-fold impact on college instruction. There is the immediate impact on the undergraduate students that participate in the GTAs' laboratory, discussion, and introductory course sections. Many early science and engineering students have more interaction with GTAs than regular faculty members. Early social science and humanities students often interact only with the GTA, as they are the main instructor in many introductory courses. This increased student interaction with GTAs can be a problem if GTAs are not as effective instructors as regular faculty members. GTAs also have a secondary impact on university instruction. Some of these GTAs will become the next generation of faculty members. Up to 80% percent of doctoral students plan on becoming college professors (Golde & Dore, 2001). Yet the GTA experience and whatever training is available within the department or university is generally the only teaching preparation they will get before becoming faculty members (Golde & Dore, 2001; Tanner &

Allen, 2006). Therefore, investing in the improvement of teaching effectiveness of GTAs is an important step in improving undergraduate instruction.

Despite the heavy reliance on GTA instruction and the potential for large impacts on student learning, there is evidence that most GTAs are poorly prepared for their role as instructors (Golde & Dore, 2001; Luft et al., 2004; Shannon et al., 1998). In fact, there is a mismatch between the use and training of GTAs. Departments having the highest usage of GTAs routinely provide the least training (Golde & Dore, 2001). Approximately half of all GTAs are placed in the classroom with little or no instruction in teaching (Golde & Dore, 2001). Compared to the extensive teacher preparation for K-12 teachers, most college faculty members are not adequately equipped for teaching when they step into the classroom for the first time (Tanner & Allen, 2006).

Improving teaching of GTAs is important for the GTA, department, and university. The GTA gains valuable personal experience in becoming a better teacher. This is a skill that could be applied to many different future endeavors. Learning to reliably impart information to other people is a skill used to present one's work to co-workers, potential funding sources outside of one's field, and the general public. For the department and university, improving teaching of GTAs keeps instructional standards high. In addition, GTAs could help keep student/instructor ratios lower and for less cost than an additional faculty member. Long-term, when GTAs become faculty members, colleges and universities also benefit from having effective instructors (Svinicki, 1995-96).

The potential impact of GTAs on student learning is not a new problem and has been of increasing concern for GTA supervisors, departments, and educational researchers for over forty years (e. g. Costin, 1968; Prieto & Scheel, 2008). During that time, a multitude of GTA training programs and ideas have been published (e. g. Davis & Kring, 2001; Heppner, 1994; Verleger & Velasquez, 2007). There has been research into GTA teaching and training experiences (e. g. Luft et al., 2004; Shannon et al., 1998) and GTA developmental teaching models have been explored (Nyquist & Sprague, 1998; Prieto, 1995). Within this wealth of knowledge, little effort has been expended to synthesize and organize the information; to determine how the pieces relate to each other. To further our understanding of GTA teaching effectiveness for both research and practice, it is important to determine how existing knowledge is related. The purpose of this study is to examine the research evidence about teaching effectiveness for GTAs, to determine what common factors can be found which influence GTA teaching effectiveness, and using social cognitive theory (Bandura, 1997) to model the relationship of those factors to GTA teaching effectiveness. Using the GTA literature as the resource, the guiding questions are: (1) What are factors that impact GTA teaching effectiveness? and (2) What relationship between those factors can be modeled?

Existing College Teaching Models

Since this research proposes to build a model from the existing literature about GTAs and their teaching, first a discussion of existing college teaching models is required. Searches for existing models were done by searching first the GTA

literature for teaching models, then following references from those papers out into the higher education literature, and checking them in a citation index. The following models are ones that can be found commonly within the higher education literature, but may not include every published model of teaching in higher education. Existing models of the process of college instructors teaching fall into two broad categories: reflective and developmental models.

Reflective Model

One model of teaching at the post-secondary level was Kane, Sandretto, and Heath's (2002; 2004) reflective practice model. This model was developed by identifying attributes of a group of excellent post-secondary science professors through interviews and observations of their teaching and then using theories of action (Argyris & Schon, 1974) as the theoretical framework for developing the model. Kane et al. used Hatton and Smith's (1995) framework of reflection (technical, descriptive, dialogic, and critical) to identify types of reflection they saw in their professors. From their research, Kane et al. saw reflective practice as the common thread that integrated the many dimensions of teaching among these professors. Their model was represented as a wheel with reflective practice as the hub and teaching skills, interpersonal relationships, the research/teaching nexus, personality, and subject knowledge as the spokes (Kane et al., 2002, 2004). The professors reflected on their instructional practice in each these areas with the goal of improving their teaching.

While not a model of the teaching of novice post-secondary instructors, it did reflect what these excellent professors had in common and was centered around an

important component in teaching, purposeful reflection (Robinson, Anderson-Harper, & Kochan, 1997; Ward & McCotter, 2004). Additionally, this model (Kane et al., 2002, 2004) indicated personal characteristics and behavioral skills that could be addressed for improvement as a teacher. However, the reflective model was missing the community aspect of teaching within a department and university. This model seemed to envision excellent teaching as a solitary activity of the professor. This was inherent in the theoretical framework utilized by Kane et al., which explained interpersonal behavior through the persons' stated reasons and through their observed actions. The interpersonal relationships described in this model were between the professor and the students. There was no acknowledgement of the environment in which the professor taught and how the department and university community might have affected the professors' teaching.

Developmental Models

One of the earliest models of professors' development as a teacher was Sherman, Armistead, Fowler, Barksdale, and Reif's (1987) theoretical model of teaching excellence based on adult developmental theory, cognitive science, and teacher education research. Sherman et al. used the framework from an early study on professor's development as a faculty member, which included, but was not limited to, teaching (Ralph, 1978). Kugel (1993) proposed a similar model for the development of college teaching, based on his and other professors' reflections on their experiences in teaching. All of these models had phases through which a person progressed, generally moving from teacher-centered to student-centered teaching. Each model

broke down this progression slightly differently and had somewhat different characteristics, but generally the models were very similar. Each phase in these models was a more complex schema of information about teaching the particular discipline in which the professors engaged. As the professor progressed through the phases of these models they also developed a more complex metacognition about teaching. Ralph and Sherman et al. believed that phases could not be skipped, each phase was important and a full comprehension of that phase was required before movement to the next stage. Kugel however believed there was no fixed order to his model, that not all professors went through all the phases, and indicated that deep development in one phase could still make a dynamic popular instructor.

The previous models included two phases of teaching, teacher-centered and learner-centered. Robertson (1999; 2000) proposed a model that added a third phase, "teacher/learner-centered." He indicated that all previous models did not include the fact that good instructors (those that impacted a student positively) came in all forms and that one person's good instructor was the next person's bad instructor. He envisioned teaching development with three phases and a professor able to develop along any one phase or to develop a new phase. He saw the third phase, teacher/learner-centered, as an instructor who balanced the lived experience of the learner with the lived experiences of the teacher and saw how those experiences interacted. He did not see these phases as sequential, although he acknowledged that many professors went through these phases in a teacher-centered, learner-centered, and then teacher/learner-centered way. Nor did he see that professors had to start in a

particular phase. His metaphor was a line (development in one phase), a square (development in two phases), or a box (development in three phases). He believed that professors' developed along one, two, or all three of these phases; and that deep development of a single phase could make an effective teacher, probably better than shallow development of all three phases. In this, he expanded on the previous models by adding another phase for the professor to develop in as a teacher. Like Kugel (1993), there was no single way to become an excellent teacher; instead it was possible to develop teaching excellence in multiple different ways.

Although models of college professors' teaching fell into both categories, GTA models of teaching were developmental. There were two developmental models of graduate students teaching, one (Prieto, 1995, 1999) which built on the other (Nyquist et al., 1991). Nyquist et al.'s model was developed in the context of literature on other types of professional development and research with GTAs. As communication experts, this model was proposed from the ways that GTAs talk about themselves and their teaching; gleaned from interviews and observations done with GTAs. Like the other developmental models the graduate students moved through stages; senior-learner, colleague-in-training, and junior-colleague. The senior-learner was concerned with how to survive in the classroom, mostly saw him/herself as a student, and was dependent on authority. The colleague-in-training was concerned with the mechanics of teaching, was detached from students, and usually preferred to be independent of, or even was in conflict with, authority. The junior-colleague was concerned with student outcomes, had a professional relationship with the students, and was collegial

with authority. Nyquist et al. saw the model as a spiral, rather than sequential, with GTAs revisiting issues throughout each stage and even after they reached the final stage.

Building on Nyquist et al.'s (1991) model, Prieto (1995; 1999) combined it with Stoltenberg and Delworth's (1987) Integrated Developmental Model from psychology. Prieto proposed two other dimensions to Nyquist and Sprague's model, adapted for teaching, from the dimensions in Stoltenberg and Delworth's model. One dimension was teaching skills in which GTAs needed to be proficient. The other dimension was personal developmental structures of the GTA such as their sense of themselves and others, their motivation, and their autonomy. Like Robertson (1999; 2000), Prieto saw teaching development in a three dimensional aspect, he envisioned a cube with personal development structures on one axis, teaching domains on the next axis, and the stages from Nyquist and Sprague on the final axis. Like Sherman et al. (1987), Prieto saw development of GTAs as linear stages along these three dimensions. GTAs could be in different areas of development for the different dimensions, but generally the development was linear, again from teacher-centered to student-centered.

All of these models describe development of teaching from one stage to another. However, they are not very useful in determining what might cause the behavioral changes from one stage to another. Although Prieto (1995; 1999) begins to develop personal aspects in his structures dimension, these models generally do not indicate how the professor or GTA is interacting with components within their person

or in their environment, to move from one stage to another. Instead, they describe the characteristic stages of development for the professor or GTA. Additionally the two GTA models (Nyquist et al., 1991; Prieto, 1995) were specifically designed for supervising GTAs, not for understanding what affects the development of an effective GTA. Subsequent to their models' proposal, Nyquist and Sprague (1998) realized that there were factors outside of their model that affected GTA development including: (1) personal internal beliefs about teaching, (2) community messages about the importance of teaching, and (3) peer relationships.

In general, the previous models focus on a part of the whole picture of teaching in college. The reflective model focuses on the individual and does not consider the environmental mediation of personal factors. The developmental models are descriptive of stages of teaching development, but generally do not address the personal, behavioral, or environmental factors that affect the changes from one stage to another. Additionally, the GTA development models are not proposed for explaining factors that affect development of teaching effectiveness. There are more models that addressed faculty development than GTA development and there is a lack of research on GTA teaching development from various perspectives. The GTA literature uses the developmental model exclusively. Therefore, this paper proposes to determine, from the GTA literature, a new model that addresses complex multi-faceted factors that affect college teaching effectiveness in GTAs.

Theoretical Framework

Much of the GTA literature is empirical and atheoretical. Even some of the proposed models for teaching in college are based empirically rather than theoretically. To develop a new framework for studying GTAs, a solid theoretical base is needed. This theory must include the personal and environmental characteristics that affect the behavioral characteristics that make up effective teaching, which are described within the GTA teaching effectiveness literature. The previous models of college teaching include personal characteristics of effective teachers, but often ignore environmental influences on teaching effectiveness. Social cognitive theory (Bandura, 1986, 1997) provides a framework for including the personal, environmental, and behavioral characteristics found in the GTA teaching effectiveness literature. This theoretical foundation also supplies a basic model, triadic reciprocity, for the more complex model of the factors that affect GTA teaching effectiveness. Additionally, teaching self-efficacy, which has been studied with GTAs, is included within this theoretical foundation.

Triadic Reciprocity

In social cognitive theory (Bandura, 1986, 1997), humans are involved in a dynamic interplay between themselves, their environment, and their behavior, known as triadic reciprocity. In triadic reciprocity, there are three determinants; personal, environmental, and behavioral. Internal personal determinants include cognition, affect, and biological events; behavioral determinants include all observable behaviors; and environmental determinants include aspects of the environment that

affect the personal and behavioral determinants. These factors act in mutually reciprocal ways, each acting on the other. This is often represented with each determinant on an apex of a triangle and double-headed arrows between them. Reciprocity is not necessarily symmetrical in influence nor is the strength of any factor fixed. Instead, the factors interact in complex, changing, dynamic ways through time. Because of this, any one factor could be "part of different blends of condition that have different effects" (Bandura, 1986, pg. 24). Given that time is an important constituent of triadic reciprocity, it is possible to determine how various determinants affect each other without having to assess every possible determinant at the same time. When looking at a behavior, researchers can investigate sources (personal or environmental) of that behavior. In this case, triadic reciprocity provides the basic model for the interplay between personal and environmental factors that contribute to the behavioral factor of GTA teaching effectiveness.

Self-Efficacy

Self-efficacy beliefs are core to social cognitive theory. Self-efficacy is a person's belief about how well they can perform a specific task in a specific context.

> Perceived self-efficacy occupies a pivotal role in social cognitive theory because it acts upon the other classes of determinants. By influencing the choice of activities and the motivational level, beliefs of personal efficacy make an important contribution to the acquisition of knowledge structures on which skills are founded (Bandura, 1997, pg. 37).

Self-efficacy is not what a person does with their skills, but what they perceive that they can do with those skills under a variety of circumstances. It is an important

contributor to and predictor of the ability to accomplishing a specific task. Self-efficacy beliefs are personal determinants within triadic reciprocity.

There are three ways self-efficacy beliefs can affect human functioning (Bandura, 1986, 1997). Self-efficacy beliefs work through their influence on choices that people make. People tend to pursue activities in which they are highly efficacious. Self-efficacy beliefs affect perseverance, effort, and resilience in the face of difficulties. A highly efficacious person will have a much higher perseverance, effort, and resilience in a specific effort than someone with lower self-efficacy. Finally, self-efficacy beliefs affect a person's thought patterns and emotional reactions.

Self-efficacy beliefs are formed through four sources; enactive mastery experiences, vicarious experiences, social persuasions, and physiological and affective states (Bandura, 1986, 1997). Enactive mastery experiences are the most important source of self-efficacy beliefs because the person actually experiences them. These experiences need to be balanced for the developing skill level of the person. Some failure early on followed by striving and success seems to produce the highest levels of self-efficacy. However, it is not just the experiences themselves, but how the person cognitively processes those experiences that affect self-efficacy. Vicarious experiences allow people to develop self-efficacy by modeling and providing comparisons. Verbal persuasion works best to improve self-efficacy when the persuader is a personal model who is encouraging during a struggle to master a skill. Mood and physiological feedback can affect how a person cognitively processes an

experience thereby affecting their self-efficacy derived from that particular experience.

Teaching self-efficacy is a domain specific construct that focuses on the teachers' perceptions of their ability to: "organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran et al., 1998, pg. 233). Research in the K-12 literature indicates that a teacher's self-efficacy beliefs positively impact student learning and the actual success or failure of a teacher's behavior (R. K. Henson, 2002). Teacher self-efficacy beliefs are also related to instructional practices (Borko & Putnam, 1996; Haney, Czerniak, & Lumpe, 1996) and to student achievement and psychological wellbeing (Ashton & Webb, 1986; Tschannen-Moran et al., 1998). Teachers with high teaching self-efficacy perform better, are persistent in difficult tasks, and actively engage their students in inquiry.

Bandura (1997) proposed that because self-efficacy beliefs were explicitly self-referent in nature and directed toward perceived abilities about given specific tasks, they were powerful predictors of behavior. Many measures of self-efficacy address specific tasks, yet fall short of providing the particular context (Enochs & Riggs, 1990; R. K. Henson, 2002; Pajares, 1996a). Therefore, it is important that the measure of teaching self-efficacy be specific enough to actually measure the teaching self-efficacy of the specific situation. Too specific and it is measuring a teaching task and not teaching self-efficacy. However, too broad and the instrument may simply be

measuring general personality traits instead of self-efficacy specific to the task (Pajares, 1996b).

Using the theoretical framework provided within social cognitive theory, especially the basic idea of triadic reciprocity and the core idea of self-efficacy, it should be possible to determine a model of teaching effectiveness from the GTA literature. The literature contains personal and environmental determinants that affect behaviors related to teaching effectiveness. The specific situation of the GTA is important. They are teaching in a specific context within the university, neither as a student nor a professor, but somewhere in between. Given that time is required for teaching effectiveness to develop, it should be possible to model sources that affect development of teaching effectiveness that are present within the GTA personally and within their environment.

Method

For the synthesis of the factors that affect GTA teaching effectiveness, a comprehensive search of the GTA literature was performed in a three step process. First, an extensive search of the literature for papers about GTAs in all disciplines was conducted. Searches were done using Google Scholar. Google Scholar was used instead of specific databases because the literature on GTAs exists in most fields of study and Google Scholar allows the simultaneous search of multiple subject fields and databases. The specific search term used was "teaching assistant." The search was performed in all fields of study and there was no restriction on year of publication. Secondly, all the articles in the *Journal of Graduate Teaching Assistant*

Development were obtained. The third step, as described below, occurred during the development of the model. Articles were selected for inclusion in the study by the following criteria: they included graduate teaching assistants as at least part of the research sample and there was some measure (quantitative or qualitative) of GTA teaching effectiveness.

The model was developed in two stages; determining the factors and fitting them into the theoretical framework. After reading the papers first indentified through Google Scholar and in the *Journal of Graduate Teaching Assistant Development*, the findings were organized into possible factors. Then, significant papers were identified using two criteria: a strong research methodology and their frequent reference within the GTA literature. These papers bibliographies were also searched for more literature on GTA teaching effectiveness, applying the above criteria. Citation indices of these significant papers, in both Google Scholar and within their publication database (e.g. Academic Search Premier, Wiley Interscience Journals, etc.), were also searched and papers selected using the same criteria as before. Then results obtained from these articles were used to further refine the factors. This process was repeated until no new factors were generated and there was substantial evidence to support the existing factors. To generate the model, each factor was determined to be a personal, environmental, or behavioral factor and was fit into the theoretical framework using triadic reciprocity from social cognitive theory (Bandura, 1986, 1997).

Results

The factors that are found in the GTA literature fit into the three determinants from social cognitive theory (Bandura, 1986, 1997). There are three personal factors: language and cultural proficiency, teaching experience, and teaching self-efficacy; and two environmental factors: GTA training, and departmental teaching climate that affect the behavioral outcome factor of teaching effectiveness (Figure 2.1). Language and cultural proficiency is the GTAs' comfort and skill in teaching in a specific language and culture. Teaching experience encompasses the amount of time spent teaching as a GTA, college instructor, or K-12 teacher. Teaching self-efficacy is an instructors' belief that they will be able to effectively teach a given population of students a specific subject. GTA training is the departmental or university sponsored coursework or workshops on teaching related subjects or skills. Departmental teaching climate encompasses the implicit and explicit departmental messages about the importance of teaching, interactions between faculty and GTAs around teaching, and interactions between GTAs around teaching. Teaching effectiveness is a broad dynamic that encompasses many skills, including enthusiasm, effective communication, strong subject knowledge, and good interpersonal skills.

Unlike in triadic reciprocity (Bandura, 1986), there is no reciprocal exchange indicated in this model (Figure 2.1). There is without a doubt some feedback among the factors, but to be parsimonious only the most likely direction is indicated. Bandura (1986; 1997) indicates that when looking at a single point in time, usually the strength of the relationship between the determinants will be stronger in one direction

than another. While it is possible to see that over time teaching effectiveness could feedback on some of the other factors, especially teaching self-efficacy, the model attempts to explain the various factors that could contribute to how effective a GTA is at a single point in time. Therefore the arrows indicate the general direction of the factors on teaching effectiveness.

In the proposed model (Figure 2.1) the arrows do not indicate whether the

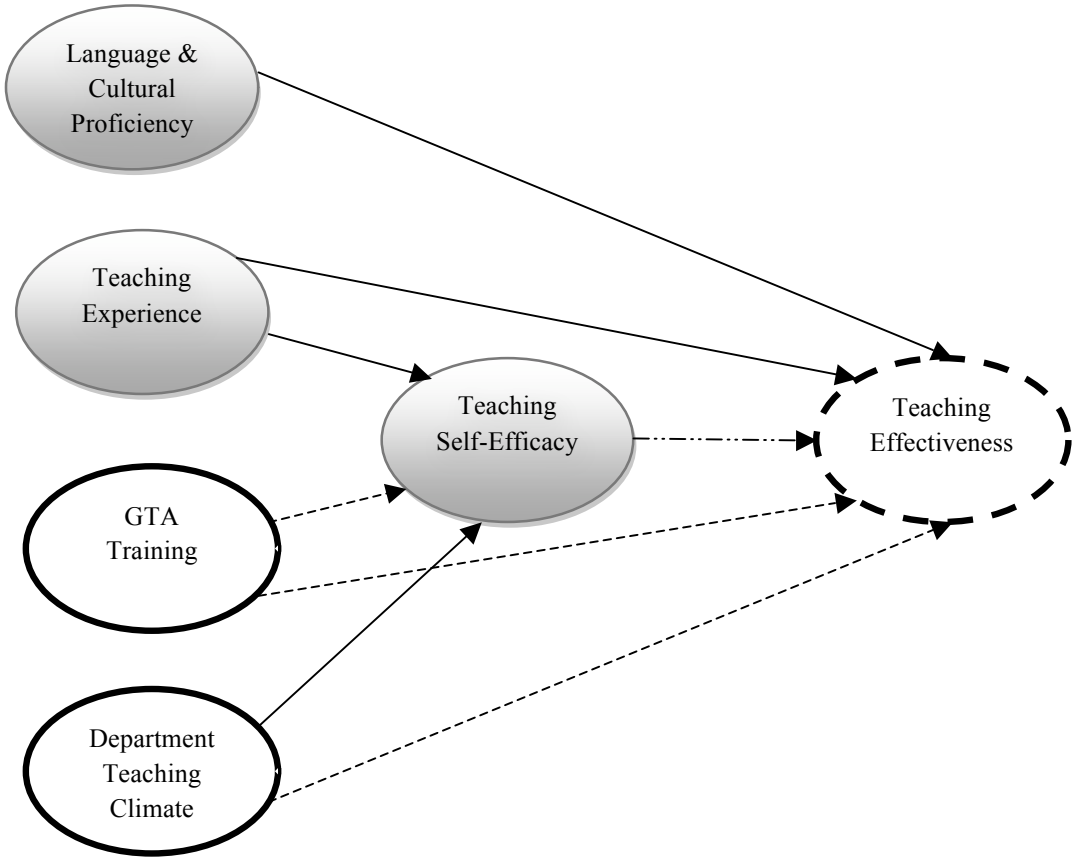

Figure 2.1 Model of Factors that Contribute to Teaching Effectiveness of GTAs

The shaded ovals are personal determinants, the heavy solid outline are environmental determinants, and the dashed oval is the behavioral determinant as fit into Bandura's (1986, 1997) triadic reciprocity. Where there is strong empirical evidence for the relationship, there is a solid arrow. A dashed arrow indicates weaker empirical evidence; and a dotted-dashed arrow indicates a theoretical evidence for the relationship.

effect of the factor on teaching effectiveness is positive or negative, and in fact there is evidence for both in some cases, but just that the factor affects teaching effectiveness. Additionally, the strength of the literature evidence supporting the relationships is indicated. A solid arrow indicates that the empirical evidence strongly supports this relationship; a dashed arrow indicates that the empirical evidence is weaker than the solid arrow; and a dotted-dashed arrow that there is mostly theoretical evidence for the relationship. Lack of an arrow indicates no empirical or theoretical evidence.

The literature evidence supports a partially mediated model for most of the factors that affect teaching effectiveness (Figure 2.1). Teaching self-efficacy emerged as the partial mediator. There is evidence that teaching experience, GTA training, and departmental teaching climate directly affect teaching effectiveness and teaching self-efficacy (which also affects teaching effectiveness). The effect of language and cultural proficiency on teaching self-efficacy has not been explored and therefore is not included in this model; only the direct effect of language and cultural proficiency on teaching effectiveness.

Teaching Effectiveness

The outcome of the proposed model is teaching effectiveness. Defining effective teaching is difficult. There is an extensive teaching effectiveness literature even limited to college level teaching, but no agreed upon definition. Most of the college teaching effectiveness literature is about college professors, but some relates to GTAs. In this section, definitions of effective teaching for GTAs are explored and a description of an effective GTA is developed.

Working exclusively with GTAs, a list of effective teaching competencies were developed (Simpson & Smith, 1993; K. Smith, 2001). Although both of these studies were conducted by the same researcher, the populations and methods were completely different. A Delphi method was used with a panel of national leaders in GTA training to determine six effective GTA teaching competencies (Simpson & Smith, 1993). Then using a longitudinal reflective study performed with former GTAs, five of the same six skill categories emerged; scholastic, planning, management, presentation and communication, and interpersonal (K. Smith, 2001). The Delphi study had the additional skill category of evaluation and feedback.

Other descriptions of effective GTAs originated from the study of science, technology, engineering, and mathematics (STEM) GTAs and international teaching assistants (ITAs). In *Science,* GTAs "who learn how to foster scientific curiosity, reasoning, and problem-solving will be prepared to produce a generation of science undergraduates who think scientifically…[the] methods that encourage students to construct new knowledge and to develop scientific ways of thinking, provide both students and instructors with feedback about learning, and foster success for all students" (Miller, Pfund, Pribbenow, & Handelsman, 2008, pg. 1329). Trentin (2008), in her dissertation on ITAs, defined six common expectations of teaching effectiveness in the United States (US). These were "fostering intrinsic motivation, promoting a constructivist approach to learning, inviting students to ask questions, facilitating active learning, respecting student individuality, and cultivating mutual respect between teacher and student" (pg. 10).

From these various descriptions of teaching effectiveness, some common characteristics for effective teaching by GTAs were determined. Effective GTAs were successful communicators, respectful of their students, had a strong content knowledge, and taught with a constructivist attitude. Successful communication included both interpersonally and in facilitating group interactions. These GTAs invited questions, discussion, and dialogue in their classrooms and offices. They were also well organized when presenting information. There was a mutual respect between the GTA and their students, respecting the diversity within both populations and the individuality of each student. Respecting the diversity of student learning, the effective GTA used a variety of teaching methods and fair and explicit evaluation methods. Effective teaching also required a strong content knowledge. An effective instructor would inspire student motivation through their enthusiasm for and knowledge in the subject. The effective GTAs used active learning approaches that facilitated deep learning and critical thinking, and approached student learning with a constructivist attitude recognizing that students were not empty vessels waiting to be filled, but instead were active participants in the construction of knowledge.

Language and Cultural Proficiency

The first factor affecting teaching effectiveness was language and cultural proficiency, which was related in the GTA literature specifically to the teaching of international teaching assistants (ITAs). As the use of ITAs increased at colleges and universities, there was a concern expressed by parents and students that ITAs were not as good of instructors as US teaching assistants (USTAs) (Bailey, 1984; Trentin,

2008). Early on, there was a general assumption by parents, students, and ITA trainers that language was the root of the "foreign TA problem" (Bailey, 1984; Bernhardt, 1987; Trentin, 2008; G. Williams, 2006). However, the "problem" extended beyond language to cultural proficiency within the US educational system (Ard, 1989; Bailey, 1984; Bernhardt, 1987; Sarkodie-Mensah, 1991; Tang & Sandell, 2000; Trentin, 2008; G. Williams, 2006). There were three components of communicative competence that an ITA needed to learn to become an effective instructional communicator; linguistic, cultural, and pedagogical competency (Pialorsi, 1984; Trentin, 2008). Evidence that these competencies actually affected the teaching effectiveness of the ITAs was presented.

Linguistic competency. There was a specific pattern to instructional American English that had to be learned, either from being taught in the American system or specifically learned. ""Being a competent communicator involves knowing and understanding the rules and contexts that govern the differentiating styles that people use when relaying information" (Trentin, 2008, pg. 20). Since 1982, many states have mandated some type of test of English proficiency for ITAs. ITAs were commonly evaluated using the SPEAK test (Trentin, 2008), the TOEFL and GRE (Yule & Hoffman, 1990), or university specific tests administered by English as second language teachers, administrators or even undergraduate students (Yule & Hoffman, 1993). However, this did not fix the "problem." "[M]any of them [ITAs] arrive on American university campuses with impressive English language capacity and

communication skills. Nonetheless, their classroom teaching does not necessarily improve significantly" (Tang & Sandell, 2000, pg. 164).

Cultural competency. As the linguistic competence of ITAs increased, attention focused on the two other competencies, cultural and pedagogical. Cultural competence in the US system encompassed many things including; the structure of US higher education, student behavior, instructor behavior, and student expectations. "Culture … shapes the teacher's perception of the role of the student. The conception of the role of the teacher and the purposes of education vary from culture to culture" (G. Williams, 2006, pg. 310). The US higher education system was different than many other systems worldwide. The US had a highly varied educational system, and its students came to the classroom from different educational experiences (Pialorsi, 1984). This means that many USTAs also did not completely understand the US higher education system except as they have experienced it; however, the difference with ITAs was one of degree, the USTAs usually had a minimum of 16 years in some type of US educational system. For many ITAs, graduate school was their first experience with the US educational system (Jenkins, 2000). ITAs needed to understand the history, philosophy, and goals in the institution in which they were enrolled (Bernhardt, 1987; Sarkodie-Mensah, 1991; Trentin, 2008); differences among state, private, land grant, and liberal arts institutions; and how the type of institution would affect the goals, motivations, and academic preparation of their students (Bernhardt, 1987). Most American students saw access to education as a right, an attitude many ITAs found foreign since only the best and most prepared students were

allowed access to higher education in some cultures (Bernhardt, 1987). ITAs needed to understand financing in the US educational system. Many other systems were state supported and the ITAs might have never encountered students who had to work while in school or understood the impact this would have on both the student and their behavior in the classroom (Bernhardt, 1987; Sarkodie-Mensah, 1991; Trentin, 2008).

Many ITAs came from cultures that were much more formal than the US (Luo, Grady, & Bellows, 2001). These ITAs expected formal behavior in the classroom from their students and themselves. The ITAs then found their students to be lax, unprepared, and rude (Bailey, 1982; Luo et al., 2000; Sarkodie-Mensah, 1991; Trentin, 2008). The ITAs found the students dozed off in class, which might often be related to long hours spent working, chatted or texted in class, or caused other disruptions with inappropriate behavior (Sarkodie-Mensah, 1991). When the ITA was from a culture that respected teaching and the teacher, these behaviors were disconcerting. Conversely the US students often found the ITA to be unapproachable, boring, arrogant, and impatient (Trentin, 2008). These interpretations of the ITA could stem from the nature of the formal style of instruction with little student/teacher interaction, eye contact, hand gestures, and a monotone discourse (Trentin, 2008). The ITA needed to understand the expectation of the US students for classroom discourse, instructor/student relations, body language and demeanor (Pialorsi, 1984). Bernhart (1987) described how students became upset when an Australian ITA would openly discuss the positive and negative aspects of the students' papers; and the lack of empathy shown by a Spanish ITA toward the problems encountered by older students

trying to improve themselves by attending classes during the day and working nights at a factory. It could be difficult for ITAs from cultures where exams were given once and even a medical emergency did not result in an exam retake to understand why US students felt they should be able to reschedule an exam for the next day or even a few weeks later (Sarkodie-Mensah, 1991).

Pedagogical competency. Pedagogical competency related directly to the expectations of a good instructor in the classroom. These were expectations that may vary greatly between the ITA and US students (Pialorsi, 1984). In many formal cultures the student was expected to learn the material presented by the highly knowledgeable instructor. Therefore a strong content knowledge defined a "good teacher"(Luo et al., 2000; Trentin, 2008). In the US system strong content knowledge was important, but good instruction also included improving students' intrinsic motivation, constructivist teaching style, promoting questioning, facilitating active learning, and respecting student individuality (Trentin, 2008). The areas in which conflicts could arise occurred in classroom management, organization methods, diversity of student populations, individualist/democratic learning styles, and constructivist educational philosophies (Trentin, 2008).

In a comparison of classroom management problems, Luo, Bellows, and Grady (2000) found that while most of the top ten problems and concerns were the same, there were three significant differences reported by ITAs and USTAs. In a survey of 304 GTAs, differences included: USTAs were highly concerned with students' disruptive behaviors (coming to class late, talking while the USTA was talking, and

packing up to leave before class ends), while the ITAs were highly concerned about student/ITA interactions in class (asking questions, challenging the lecture, and belligerence). Interestingly, in the open ended questions, the USTAs commented that behaviors found to be concerning to ITAs were behaviors USTAs were most hoping to encounter. Some of the differences between USTA and ITA concerns were probably due to differences in cultural expectations between US students and the ITA.

Using the same 304 GTAs, Luo, Grady, and Bellows (2001) found differences between ITAs and USTAs perceptions about their instructional roles, teaching styles, potential problems, and communication strategies. Significantly more USTAs saw themselves as facilitators (USTAs 68%, ITAs 46%) than in other instructional roles. Significantly more ITAs (52%) were formal, whereas USTAs (75%) were more informal in their teaching styles. Interestingly there were no reported differences in instructional methods used by USTAs and ITAs. However, Trentin (2008) found that ITAs reported using instructional styles that were not seen by an expert observer, so it is possible there were differences in the actual instructional methods between the USTAs and ITAs. Significantly more USTAs reported problems with student behavior, whereas ITAs reported problems with language and cultural differences. The only significant difference in communication was that the ITAs indicated more difficulty in presenting the same idea in more than one way.

Trentin (2008) found in a qualitative study of nine ITAs in a small, elite, science, technology, engineering and math (STEM) institution, that there were three themes coming from the ITAs' cultural background "organization of information,

classroom management, and the manner one addresses questions/confusion" (pg. 118). Only one ITA organized information in an explicitly American cultural manner (he had four years US undergrad and did it deliberately). Students found ITAs to be disorganized, and ITAs felt students were not taking the responsibility for their own learning. All ITAs had clear goals in classroom management to be informal, involve discussion and interaction, and promote questioning, but according to the expert observation none were able to implement this in practice. ITAs felt they addressed student questions adequately, but the students reported being more confused after class and did not feel their questions were answered thoroughly.

ITA teaching effectiveness. Given the evidence that there were language and cultural differences between ITAs and their US counterparts, what was the evidence that language and cultural differences affected the teaching effectiveness of the ITAs? There was evidence in teacher effectiveness ratings and in student achievement that language and cultural proficiency affected teaching effectiveness. However, the results were contradictory with rating systems indicating a generally lower teaching effectiveness for ITAs, whereas student achievement results were mixed.

Survey research has found that USTAs and ITAs tend to rate their teaching higher than their students do (Bailey, 1982; Trentin, 2008; Twale, Shannon, & Moore, 1997). Bailey (1982) found the 75% of ITAs rated their teaching as "good" or "very good," but that rating had only a low correlation with student evaluations of the ITAs' teaching. Using the highly validated Student Evaluation of Educational Quality (Marsh, 1982; Marsh & Dunkin, 1997), similar results were found by Twale et al.

(1997). While both ITAs and USTAs rated their own teaching effectiveness higher than their students' did, the ITAs rated themselves generally higher than USTAs, but the students rated the ITAs generally lower than the USTAs. As discussed earlier, an assumption could be made that the ITAs were rating themselves on their cultural norm for an effective teacher whereas their students were using US norms, which was possibly why the USTAs and their students were in better agreement about the teaching effectiveness of the USTA. The areas of greatest difference between the ITAs and their students were in the factors that measure interactive teaching behavior (Twale et al., 1997).

When measuring actual student achievement, it appeared that ITAs' had little or no effect on student achievement. Fleisher, Hashimoto, and Weinberg (2002) found that when adequately prepared for the US classroom, student's achievement from ITAs was slightly higher (0.1GPA) and they had a lower drop rate than USTAs. However, ITAs had lower student evaluations than USTAs. Using two different measures of student achievement (final course grades and post course standardized tests), Watts and Lynch (1989) found that there was no significant difference in students final grades, but there was a negative relationship between ITAs and the standardized test scores. In a five year longitudinal study of ITAs and USTAs (806 courses), Norris (1991) found that among GTAs who did not have control of the final course grade ITAs' students had a significant increase of 0.1 in their average GPA over USTAs' students. When divided into regions of the world, Asia and other GPA differences were still significant ($p<.05$) while European GTAs differences from

USTA was no longer significant ($p<.10$). When splitting the sample into groups before and after the implementation of a foreign GTA training program, the ITAs' students were still achieving significantly higher grades before and after the training program. However, the significant effect of teaching experience was removed after the TA training program was instituted.

Producing successful ITAs was possible. As shown by Fleisher, Hashimoto, and Weinberg (2002) and Norris (1991), well trained ITAs could be successful in the US classroom. One key to improving ITAs teaching appeared to be motivational (Jenkins, 2000; K. S. Smith & Simpson, 1993). Smith and Simpson found that when the ITA could identify a linguistic, cultural, social, or professional goal that could be accomplished by teaching, they continued to improve as an instructor. However, if the ITA did not have any goals that they perceived could be achieved by teaching, they did not take the time to improve their teaching (Jenkins, 2000). In addition to good ITA training (which covered the linguistic, cultural, and pedagogical differences in US classrooms), intercultural sensitivity training with the ITAs and their students decreased the negative perceptions of the students for their ITA (Tang & Sandell, 2000; Yook & Albert, 1999). US students whose ITA made a disclosure statement, had some role playing exercises, and/or used an Intercultural Sensitizer (scenarios of interaction with people of other cultures) at the beginning of class showed a decrease in negative emotions and an increase in positive emotions related to their ITA. This then directly positively affected US students' perceptions of the ITAs competence and assessment of the students' comprehension (Yook & Albert, 1999).

The characteristics of language and cultural proficiency for ITAs were classified as personal determinants (Bandura, 1986, 1997). Despite that these differences were a result of the environment in which the ITA was nurtured and resulted in classroom behaviors that could cause cultural conflict, the ITA brought these cultural attitudes towards education and proficiency with the US English language with them when they began teaching in the US higher education system. These traits were highly personal to each individual and while some common characteristics could be made for all ITAs, specific regions of the world, and individuals within a single country, the individual ITAs personality, experiences, and motivations would make each ITA react differently to the teaching environment in which they were placed. Therefore, this factor was classified as a personal determinant.

Language and cultural proficiency appeared to have a probable effect on the teaching effectiveness of the GTA. There was evidence that effective classroom communication depended on strong American English language skills and an understanding of the US culture of education. Whether the effect of differing language and cultural identity positively or negatively affected the teaching effectiveness of the GTA depended on the particular GTA, the environment they taught in, and the students they taught. However, when considering the teaching effectiveness of a GTA it was important to consider their language and cultural proficiency and work to improve the ITAs understanding of American English and the US higher education system and expectations.

Teaching Experience

The next factor in the GTA teaching effectiveness model was teaching experience. Intuitively, increasing teaching experience should increase an instructors' teaching effectiveness; the effect of this personal factor on GTA teaching effectiveness should be positive. More and broader experiences in the classroom should allow the instructor to improve the next time they encountered the same phenomenon. So, teaching experience with GTAs was measured against possible indicators of teaching effectiveness such as: increased teaching responsibility, GTA perception of teaching concerns and classroom management issues, student teaching evaluations, comparisons to faculty, and student achievement.

For teaching experience to have impacted teaching effectiveness, the GTAs needed to teach repeatedly and as they gained experience they should have been given increasing teaching responsibilities (Fagen & Wells, 2004; Golde & Dore, 2001). Increased responsibility within the teaching experience should enhance GTAs teaching effectiveness. "TAs who experienced progressively challenging assignments, involving new and additional responsibilities over time, appeared to benefit the most from their formal assignments" (Fagen & Wells, 2004, pg. 55). In contrast, Golde and Dore (2001; 2004), in a nationwide study of doctoral education, found that over 50% of GTAs had no opportunity for progressively responsible teaching roles. The opportunities varied greatly among disciplines ranging from 20% of molecular biology to 67% of philosophy GTAs. The science disciplines were all below 40% while the social sciences and humanities, with the exception of art history (50%), were all above

59%. These results were mirrored in Fagen and Wells' (2004) national study of doctoral education; 43% of life science GTAs felt their teaching experiences prepared them for an academic teaching career, whereas 72% of the humanities students indicated their GTA experiences prepared them to be professors.

As GTAs gain teaching experience, their teaching and classroom management concerns might change. Yet in one study, teaching experience made no difference in what GTAs perceived as the most important teaching and classroom management concerns they faced (D. E. Williams & Schaller, 1994). Alternatively in a second study, the number of classroom management problems and concerns for GTAs was significantly higher for GTAs with more teaching experience (Luo et al., 2000). This finding seemed counter-intuitive; it seemed that inexperience GTAs would report more problems and concerns. The results in this study were a measurement of the number of problems encountered and their level of concern (high or low) with student behaviors in class. So, one possible explanation for this result was that increased teaching experience provided more opportunities for the GTAs to encounter problems in the classroom. The differences between the two studies might have been a result of the type of problems and concerns used in each study. Williams and Schaller asked a mixture of global teaching items (syllabus development, test construction, etc.) and global management items (handling student complaints or plagiarism/cheating, etc.). While Luo et al. had very specific student behavior items (comes to class late, yawns or reads the newspaper during lecture, etc.). At the global level it appeared that teaching experience made no difference in the GTAs classroom problems and

concerns, but when the study was brought down to specific classroom behaviors, teaching experience made a difference.

In a study of 129 GTAs independently responsible for their course from a cross-section of university department, Shannon, Twale, and Moore (1998) found various effects for prior teaching experience on student evaluations of the GTAs. The dependent measure for the study was the SEEQ (Marsh, 1982). Teaching experience was determined for K-12, college level (not including GTA experiences) and GTA experience, which was measured as any prior experience or first time GTA. A possible limitation of the study was the low percentage of the GTAs that had non-GTA teaching experience: 17% K-12, and 25% college. Sixty percent of the GTAs in this study were GTAs for the first time. There were significant positive effects across all nine Marsh factors for both K-12 and college teaching experience. However, there was a significant negative effect for having prior teaching experience as a GTA on student ratings of teaching effectiveness. The authors suggested than the prior TA experience negative effect was probably because these GTAs generally received no feedback on their teaching and continued to teach ineffectively. The authors concluded "The results of this study suggest that there is little substitute for actual teaching experience, because TAs with either K-12 or college teaching experience were consistently rated as more effective than those without such teaching experience" (pg. 456). Still, working with physical education GTAs, Bos et. al (1980) found a positive effect on student evaluations of teaching for both K-12 and GTA teaching

experience. But, they did not indicate the reliability of their student evaluation questionnaire although it included concentrations similar to the SEEQ.

On average, faculty have more teaching experience than GTAs. In the early 1970's three comparison studies of faculty and GTAs in introductory economics courses were published. In the first study, using GTAs who were in the first two years of their coursework and received no supervision or mentoring, the GTAs students' performed significantly lower on an achievement exam than the faculties' students (Lamphear & McConnell, 1970). Alternatively, at Purdue with GTAs who had passed their preliminary exams and participated in weekly meetings on instructional matters pertaining to the course; there was no consistent predictable effect of type of instructor on student final exam scores. Out of eight terms, four times neither was significantly better, twice the faculty were better and twice the GTAs students' had better final exam scores (Oates & Quandt, 1970). In an institutional situation described by the author as between the prior two studies, the GTAs' students had significantly higher final grades than the faculty, but they did not perform any differently on a standardized, ungraded, content exam (Saunders, 1971). In this study all the required readings and final exam were common, but the assignments, quizzes, and mid-term exams were at the instructor's discretion. Additionally, the instructor did all the grading. Therefore, the results from the standardized ungraded content exam would be a better indicator of the lack of difference in student achievement between the GTAs and the faculty members.

When comparing GTA teaching experience though, the evidence suggested that some teaching experience positively affected student achievement. Oates and Quandt (1970) found significant differences in economic students' final exam scores when comparing GTAs with no experience to those with prior TA experience. The experienced GTAs students' performed better two out of the three terms studied. In a study of 806 GTAs who were not primarily responsible for a course, Norris (1991) found that teaching experience was significant in student final course grades. Students' enrolled in inexperienced GTAs' courses average .05 GPA less than those in experienced GTAs' courses. While not a large difference, finding any significant difference was surprising considering that these GTAs were not in charge of the course; they taught in discussion or recitation sections, and did not give course grades. Even without a large responsibility for the course, it appeared that their teaching experience affected their student's achievement.

Teaching experience was classified as a personal determinant (Bandura, 1986, 1997). The teaching experience that each GTA brought to the classroom was highly personal and consisted of the various experiences that the GTA had in front of students, including teaching experiences outside of their GTA role. The types of teaching roles within the GTAs' teaching experience could affect their teaching effectiveness. Additionally there were many features of the GTAs' environment including their access to training, supervision, and mentoring that could interact with their teaching experience to mold each individual GTA's unique and personal teaching experience.

From the weight of the evidence, teaching experience had an effect on teaching effectiveness. The exact interaction between teaching effectiveness and teaching experience was complex. When comparing faculty experience with GTA experience (Lamphear & McConnell, 1970; Oates & Quandt, 1970; Saunders, 1971), it appeared that faculty teaching experience did not make much difference in student achievement. However, the two university-wide studies (Norris, 1991; Shannon et al., 1998) indicated that teaching experience was positive (only K-12 and college in Shannon et al.), as was GTA teaching experience in two of the department specific studies (Bos et al., 1980; Oates & Quandt, 1970). There were opposite results for effects of GTA experience on teaching effectiveness in the two university-wide studies. But, these studies were not comparable; Shannon et al. used GTAs primarily responsible for a course and measured student teaching evaluations, whereas Norris used teaching assistants not primarily responsible for a course and measured final course grade. They were not conducted at the same university although nothing in the papers indicated that the universities were outside the norm as described in Golde and Dore (2001) in the way they treated their GTAs. Compared to the student teaching evaluations in Shannon et al., the difference in GPA reported in Norris was evidence in favor of a positive effect of GTA teaching experience on teaching effectiveness.

Teaching Self-Efficacy

Teaching self-efficacy, the last personal factor, had been shown to be influenced by GTA training, teaching experience, and supervision (Hadre, 2003; Heppner, 1994; Meyers, Lansu, Hundal, Lekkos, & Prieto, 2007; Prieto & Altmaier,

1994; Prieto & Meyers, 1999; Prieto, Yamokoski, & Meyers, 2007; Tollerud, 1990). While the effect of language and cultural proficiency on teaching self-efficacy had not been directly studied, preliminary results from a study of self-confidence indicated that language and cultural proficiency might also affect teaching self-efficacy (Salinas, Kozuh, & Seraphine, 1999). The effect of teaching self-efficacy on teaching effectiveness had not been studied with GTAs, but evidence from the K-12 literature (Ashton & Webb, 1986; Borko & Putnam, 1996; Haney et al., 1996; R. K. Henson, 2002; Tschannen-Moran et al., 1998) supported this connection in the model.

The effects of GTA training, teaching experience, and supervision factors were complex. It was often difficult to separate in a study where the changes in self-efficacy originated because the GTAs were often teaching, under supervision, and taking a GTA training course. However, Heppner (1994) studied the sources of teaching self-efficacy of five psychology GTAs. When asked what contributed to their teaching self-efficacy, the GTAs reported 20 positive and 10 negative experiences. Heppner classified these 30 experiences according to the sources of self-efficacy (Bandura, 1986, 1997). Seventy-five percent of the positive experiences resulted from verbal persuasion (from the course, their students, and their peers), the other 25% were mastery experiences (exclusively within their classroom). Ninety percent of the negative experiences were from mastery experiences (also within their classroom). The students self-reported that mastery experiences had the most significant impact on their teaching self-efficacy. This study gave a unique insight into how teaching self-efficacy was produced and also demonstrated that the

interactions of variables contributing to self-efficacy in quantitative studies might be complex.

Between 1990 and 2007, a series of studies of GTA training, teaching experience, and supervision on GTA teaching self-efficacy were published (Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007; Tollerud, 1990) Tollerud developed a counseling psychology teaching self-efficacy instrument (SETI). Using advanced GTAs and recently graduated students from counselor education programs, several variables were shown to significantly affect teaching self efficacy. Not surprisingly, having no teaching experience decreased the teaching self-efficacy compared to recent graduates with teaching experience. Interestingly, prior professional teaching experience was not significant but the amount of time spent teaching as a GTA was, with increasing terms of GTA experience increasing the teaching self-efficacy. There was no significant difference in teaching self-efficacy by the number of teaching training courses taken.

Prieto and Altmaier (1994) modified the SETI for general use by GTAs (SETI-A). Using this with 78 GTAs across a university, there were no significant differences in teaching self-efficacy by amount of teaching responsibility (primary, assistant, or general instructor). There was a significant positive difference by having prior training versus no training. There were small significant correlations (Cohen, 1988) between teaching self-efficacy and prior training (r=.22) and teaching self-efficacy and previous experience (r=.25). In a regression analysis of teaching self-efficacy, teaching experience was significant but it only explained 5% of the variance. In a

study of psychology GTA training, training and teaching experience were positively associated with teaching self-efficacy (Meyers et al., 2007). Prieto and Meyers (1999) surveyed 176 GTAs from 116 psychology departments across the US. They found that GTAs in non-instructive roles (e.g. graders) had significantly lower teaching self-efficacy scores than those who had teaching roles (either assistant or primary instructors). Using the GTAs with teaching roles, they found a significant effect for GTA training, but not supervision on teaching self-efficacy.

Using 149 GTAs from across a Midwestern university, the interactions between GTA training, teaching experience, and supervision were explored (Prieto et al., 2007). Supervision was reported by the GTAs as being provided some type of faculty oversight of their teaching (about half had weekly meetings with a supervisor – often the course instructor). Increasing teaching experience was correlated with increasing teaching self-efficacy. Again, the teaching self-efficacy scores varied significantly for levels of teaching. This time, however, the difference was between those GTAs with a primary role and the assistants and graders. GTA training and supervision had variable effects depending on the teaching role of the GTA. In the assistant/grader group there was no effect on teaching self-efficacy for training or supervision, but prior teaching experience accounted for a significant amount of the variance. In the primary group, prior teaching experience did not account for a significant amount of the variance in the teaching self-efficacy scores, but there was a significant interaction effect for supervision and training. A further breakdown of the supervision and training interactions with the primary group showed supervision had

no effect on teaching self-efficacy when there was training, but had a positive effect on teaching self-efficacy when there was no training. Receiving both training and supervision produced lower teaching self-efficacy than just supervision alone. Training had no effect on the teaching self-efficacy of students who were not receiving supervision.

In summary, it appeared that the interactions between GTA training, supervision, teaching roles, teaching experience, and teaching self-efficacy were complex. In general, increasing amounts of teaching responsibility, GTA training, teaching experience, and supervision appeared to make a positive difference in teaching self-efficacy. Prieto et al. (2007) suggested that the reason that supervision alone produced higher teaching self-efficacy might have been due to information overload for the GTAs. An alternative explanation, however, could be that when one or more of these sources (supervisor or trainer) gave conflicting messages to the GTA it might cause a decrease in GTAs' teaching self-efficacy compared to receiving similar messages from all sources. For GTA supervisors and GTA training course providers, it was important to make sure the messages the GTAs receive about teaching were complementary.

Teaching self-efficacy had not been related to language and cultural proficiency. However, using regression analysis with 74 ITAs, Salinas et al. (1999) found that English proficiency significantly predicted teaching self-confidence. They defined teaching self-confidence "as the subjective perception of the instructor of his/her abilities to teach effectively" (pg. 150) and measured it using four items related

to in-class tasks (e.g. giving a prepared lecture). Teaching self-efficacy was defined more narrowly in this study, but the two concepts were related, giving the suggestion that language and cultural proficiency would relate to an ITAs teaching self-efficacy. However, with only this tenuous link, language and cultural proficiency was not indicated as effecting teaching self-efficacy in this model. Further research of the relationship between language and teaching self efficacy and comfort in the culture of the American classroom and teaching self efficacy was needed.

The connection between teaching effectiveness and teaching self-efficacy rested on studies from the K-12 literature and the theoretical basis of self-efficacy (Bandura, 1986, 1997). While the evidence from social cognitive theory, self-efficacy studies in many different fields, and K-12 teaching clearly indicated that increased self-efficacy was correlated with improved performance (Bandura, 1997), this link needed to be firmly established for GTAs. Nor had teaching self-efficacy been related to language and cultural proficiency. Further research into relationships between language, cultural teaching proficiency, and teaching self efficacy was needed.

Teaching self-efficacy was the last personal determinant in this model. From the prior literature it was obvious that many environmental variables can affect a GTAs teaching self-efficacy. However, each GTAs' teaching self-efficacy was a personal and changing factor that could impact their teaching behaviors and impact their teaching effectiveness.

GTA Training

GTA training, the first environmental factor, was the largest focus of the GTA literature with many descriptive papers focused on specific training programs and best practices (e. g. Bernhardt, 1987; Druger, 1997; McComas & Cox-Petersen, 1999; Roach & Jensen, 1997 - 98; Verleger & Velasquez, 2007). The type and amount of GTA training varied across disciplines and universities. In a national survey five models of GTA training were found (Rushin et al., 1997). The first and most common model was no training required. Other models of training included; individual training by a supervisor with occasional seminars/workshops, pre-academic orientation workshop, term-long seminar in college teaching, or formal college coursework in college teaching. Golde and Dore (2001) in their nationwide survey of doctoral students, found that 49% had no access to discipline specific teaching training. More recently, in one Midwestern university, 52% of GTAs received no training (Prieto et al., 2007); 38% of GTAs reported no training at a Pacific Northwest university (DeChenne et al., 2009); and in a national survey of psychology GTAs, 38% had no training (Prieto & Scheel, 2008). So, despite a strong emphasis in the literature, teaching training was not available to many GTAs, especially in many of the sciences that use the most GTAs (Golde & Dore, 2001). Additionally, evidence that GTA training programs directly impacted teaching effectiveness was slim, most studies focused on specific programs and two looked across departments. For this model, only GTA training studies that provided evidence of GTA training not only on the GTAs' learning about teaching, but also on the GTAs' teaching effectiveness were included.

Early research in GTA training focused on quantitative measures of teaching effectiveness. As reported in Bray and Howard (1980), there were five truly experimental designs prior to their study, with mixed results reported. Two (Haber, 1973; Koffman, 1974) found no significant effects of GTA training programs on measures of teaching behavior or student teaching evaluations. Two others (Daniels, 1970; Tubb, 1974) found significant effects of GTA training on measures of teaching ability. The latest study (Carroll, 1977) found significant improvement in the GTAs interactional teaching styles and student teaching evaluations from a GTA training program. Bray and Howard randomly assigned GTAs to four groups; full-treatment, 3 hour videotape feedback group, two hour student feedback group, and a no training control. The full treatment group received both types of feedback and 10 hours of training on teaching. There were significant differences between the four groups; on self-reports of teaching, student ratings of teaching, and expert observations of teaching. The full treatment and videotape feedback groups scored the highest. The expert observers noted that the GTAs improved in teaching skills and student rapport.

More recently, studies of individual GTA programs found positive effects on the teaching of GTAs. In case studies of instructional design GTA training programs, Hadre and Chen (2005a; 2005b) found there was a relationship between GTA learning and positive changes in teaching behavior. Davis and Kring (2001) described a selective GTA training program that included intensive summer coursework, continued coursework throughout the school year, and had both supervisor and peer mentoring. They randomly sampled three spring semester teaching evaluations and

compared GTAs to departmental faculty. There was no difference in student teaching evaluations between the GTAs and the faculty; however, the faculty had a significantly higher variance than the GTAs. Davis and Kring interpreted this to mean that the GTA training program was "successful in producing a uniform, high level of teaching performance" (pg. 49).

Despite evidence that individual GTA training programs positively affected GTAs, studies of multiple programs did not agree. Shannon, Twale and Moore (1998) found that GTA training had no significant effect on student evaluations of teaching. The only type of training that provided a significant effect was an undergraduate degree in education. In a qualitative study of science GTAs, Luft et al. (2004) found that the GTA training to be ineffective in improving the GTAs teaching effectiveness. The university wide training was too general and diffuse to help the GTAs; and the departmental training did not address their instructional needs, was not applicable in the classroom, and repeated the university training.

In a survey of the perceptions of GTAs about a highly touted university GTA training program, GTAs indicated that the program was less than neutral in effectiveness (Jones, 1993). These results mirrored the teaching self efficacy and training results with some, but not all studies finding increasing teaching self efficacy with GTA training. It is probable that many GTA training programs have not included elements of best practices that could improve the teaching self efficacy and effectiveness of the GTAs. So, despite some evidence of effective GTA training programs, many were not increasing their GTAs' teaching skills. With the cross-

discipline evidence indicating there was no affect for GTA training, and only exemplary programs indicating positive effect, this relationship in the model was weak.

GTA training was an environmental determinant. In the literature, the quality of the training was highly variable to nonexistent. This factor made up a part of the teaching environment that the GTA was immersed in during their GTA experiences. It appeared that done well, GTA training could improve GTA teaching effectiveness. However, when not done well it seemed to have little or no effect, except to occupy the limited time of the GTA.

Departmental Teaching Climate

The second environmental factor, departmental teaching climate, was composed of features in the environment of the department that could affect teaching of GTAs. Main elements of this included: explicit and implicit messages about teaching present in the GTAs' environment, mentoring, and supervision of GTAs. Both GTAs and faculty recognized good supervision and mentoring were needed in any effort to improve GTAs' teaching (Commander, Hart, & Singer, 2000). Although research looked at the impact supervision had on teaching self-efficacy, measures of teaching effectiveness were rarely studied directly. It appeared that there was an underlying assumption that department teaching climate affected teaching effectiveness but it was not explicitly examined.

In the research university, departmental climate with its emphasis on research rather than teaching (Gray, Froh, & Diamond, 1992), faculty ignorance of reform

efforts in instruction (Luft et al., 2004), lack of support from supervisors and peers (Notarianni-Girad, 1999), and lack of cooperation with education departments or Centers for Teaching and Learning (Milner-Bolotin, 2001), sent the GTAs a subtle message about the relative importance of teaching and research (Gray et al., 1992). This conflicted with the messages about the importance of teaching received from the supervisors, academic staff, and faculty (Gray et al., 1992; Notarianni-Girad, 1999; Nyquist & Sprague, 1998). Both messages often appeared in the same teaching climate. Examples of these implicit and explicit messages from actual faculty included: "Teaching counts for less than nothing," and "Without x number of journals publications you will not get tenure even if you walk on water in the classroom," versus "I find the two [research and teaching] are symbiotic, each nourishing the other," or "I believe they [research and teaching] are complementary, or should be. The best researchers are often those who can integrate material and demonstrate a passion for their research area in the classroom" (Gray et al. pp 13-14).

In a study of a GTA created teaching community within a physics department, Milner-Bolotin (2001) cited three problems relating to the department teaching climate for GTAs. There was rarely collaboration between local Centers for Teaching and Learning and the science departments, conveying the subtle message that these courses and teaching itself were not important. GTAs did not see teaching as important because it took away from their research and coursework. Finally, many GTAs underestimated the personal benefits of teaching.

Luft et al. (2004) conducted a qualitative study of the educational environments of three science departments as perceived by 17 GTAs in one Southwestern doctoral/research university. Three themes emerged about the GTAs' instructional and education environments: (1) GTAs worked independently without support from the faculty and this neglect resulted from the presence of a research culture within these departments, (2) The curriculum and instruction given by the GTAs was "primarily directive and instructive" (pg. 223), and (3) "Experiential and intuitive notions about undergraduate learning, motivation and abilities were prevalent in the GTA environment" (pg. 226). Most faculty in these environments held naïve views of student learning and motivation, ascribing to their students their own learning styles and motivations. Many faculty felt that teaching was innate and did not need to be learned. GTAs that were interested in teaching found their best support in other GTAs. The teaching climate created in these departments was bleak:

> The GTAs…wanted to create effective learning environments but were constrained by the existing conditions and could not actively advance their knowledge of learning and teaching in science. There were few incentives to pursue such knowledge; financial support was not available…. Ultimately, the knowledge base regarding science teaching and learning was detached from the daily instructional practice and curriculum development. (pg. 229)

Notarianni-Girad (1999) conducted a survey of facilitating and inhibiting factors in 462 GTAs from 12 universities' environment that they perceived impacted the transfer of their GTA training to the classroom. GTAs agreed that there were facilitating factors within their environment relating support for new ideas, support for training, and time/resources for teaching. Interestingly, the GTAs generally disagreed

with the presence of various variables relating to inhibition of their teaching. The GTAs reported lack of support from both supervisors and peers. However, the GTAs did not feel strongly about any of these variables. All of these variables were measured on a 4 point strongly disagree to strongly agree scales. Most of the variables measured had averages at the midpoint between disagree and agree (range for all variables reported was 1.8 to 3.2). These results showed support for the conclusions from the single university study about lack of supervisor support (Luft et al., 2004), but not of other factors within the climate that might impact the teaching environment. However, since this paper specifically targeted variables in the transfer of learning from GTA training to the GTAs' teaching, the inhibiting variables were related to that and not any other possible inhibiting variables. As shown in the studies on the effects of supervision, GTA training, and teaching experience on teaching self-efficacy (Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007; Tollerud, 1990), supervision usually appeared to have more effect than GTA training.

Two of the most common factors mentioned in the GTAs environment that contributed to the teaching climate were mentoring (peer and/or faculty) and supervision (e.g. Bomotti, 1994; Calkins & Kelly, 2005; Commander et al., 2000; Myers, 1995; Nyquist & Sprague, 1998; K. Smith, 1993). In a survey at a metropolitan university, both GTAs and faculty recognized good supervision and mentoring is needed in any effort to improve GTAs' teaching (Commander et al., 2000). That was the mostly highly requested need by both groups. Often, however, faculty rarely had

any training about how to supervise or mentor GTAs, few faculty solicited advice on how to mentor, and usually placed the burden of the relationship on the GTA (Calkins & Kelly, 2005).

Where there was mentoring, it was supplied by the GTA training program, a particular individual, or through the efforts of the GTAs themselves. The intensive GTA training program described earlier, (Davis & Kring, 2001) included both peer and faculty mentoring with observation and feedback to the GTAs about their teaching. This program was shown to produce GTAs who taught as well as their faculty. At the University of Georgia, GTAs who had been recognized as outstanding teachers were invited to participate in a year-long mentoring program (K. Smith, 1993). In this program they were mentored by existing faculty, provided mentoring to new GTAs, and finally developed a mentoring program for their own department. One focus of the program was to provide more mentoring opportunities. The GTAs who participated felt the "sense of community and support for teaching" to be one of the valuable outcomes of the program. In another university, when their teaching training needs were not met, a group of physics GTAs created their teaching community to support their teaching efforts through weekly meetings where the group became peer mentors for each other (Milner-Bolotin, 2001).

Individual mentoring experiences have also been discussed. In his unusual career to become one of the early pioneers in chemical education, Brian Coppola found and developed many mentoring relationships with excellent teachers who provided him with valuable insights into teaching, educational theory, and

methodology (Huber, 2004). Two participants of a mentoring program at North Carolina State University found the relationship benefited both of them (Beaudoin & Felder, 1997). The graduate student was given time and encouragement to begin to use active learning strategies in his classroom. An additional benefit of the mentorship was the offer of his first faculty position where his teaching excellence was the factor that decided the job for him. The mentor learned to incorporate some of the active learning strategies of the GTA into his own courses. In a similar study of a semester long mentorship of a GTA in a inquiry-based physics course (Volkmann & Zgagacz, 2004), the mentorship of the course professor provided the GTA the opportunity to begin to shift her view that teaching means telling to a more constructivist viewpoint. By the end of the semester her teaching had moved from direct instruction to sometimes resembling conceptual change or guided inquiry.

Supervisors could provide mentorship to their GTAs and helped improve their teaching. The style of supervision affected how well the GTAs received it. Overall GTAs preferred an open and collegial supervisory style (Prieto, 1999; Prieto, Scheel, & Meyers, 2001). However when divided by teaching experience there were significant differences in the supervisory style preferred. While the experienced GTAs preferred the open and collegial supervisory style, the novice GTAs preferred a more structured and directive style (Prieto, 1999). In studying an instructional design GTA training course, Hadre & Chen (2005b) found that the implementation of the training was partly dependent on the supervisory support the GTA received. In examining this closer Hadre & Chen (2005a) found that elements in the GTAs work

climate affected how well they implemented the training within the classroom. GTAs with at least a moderate sense of control of their classroom and who had at least a moderate level of perceived autonomy from their supervisors were more likely to try implementing new ideas they learned in their GTA training, than those GTAs with lower control and autonomy.

Bomotti (1994) studied the effects of various factors (GTA training, supervision, department, peer relationships, student relationships, pragmatic constraints, and the role of GTA as a teacher) on the various career aspirations of GTAs. Bomotti found that the most powerful factor on wanting an academic career was a positive supervisor relationship. Interestingly, there was a strong negative relationship between those GTAs who did not want to teach after they graduated and the positive supervisor relationship scale. This indicated that the lack of a strong positive relationship with a supervisor correlated with wanting to do something besides teach after graduation. While not a direct measure of teaching effectiveness, this study showed the effect the supervisor relationship could have on the GTA.

Social cognitive theory (Bandura, 1986, 1997) suggested that these environmental determinants which make up the departmental teaching climate would have a direct effect on the teaching behaviors of the GTAs and therefore their teaching effectiveness. GTAs that taught in an environment where they were encouraged and given the resources and support for their teaching were much more likely to be effective teachers than those who were shorted time and resources. Nyquist and Sprague (1998) acknowledged that there were other factors outside of their

developmental model that influence GTAs including; “messages TAs receive about teaching and how they process them, and the influence of other graduate students on a TA’s development” (pg. 64). GTAs that had positive supervisory and mentoring experiences were likely to learn more about teaching than those who received little or no supervision or mentoring. Good supervisors and mentors provided feedback to the GTA on their teaching, helped with questions, and gave encouragement when needed.

The evidence in the literature for the direct effect of the departmental teaching climate was thin. While Luft et al.(2004) painted a very bleak picture of one university’s science departments’ climate, there was no actual measure of teaching effectiveness in that study. Case studies of mentoring which did affect the teaching behaviors indicated that positive departmental climate conditions did improve teaching; however, continued research on this needed to be done. Given this paucity of direct evidence, the relationship between departmental teaching climate and teaching effectiveness was weak.

Other Possible Factors

Three other factors that had limited attention in the GTA literature about teaching effectiveness were reflective practice, gender, and GTA teaching beliefs. In each of these cases there was either not enough evidence to indicate that this was a factor the impacted the teaching effectiveness of GTAs or the evidence indicated it didn’t impact it.

Reflective practice. Reflective practice was generally taught to pre-service teachers (Ward & McCotter, 2004; Weshah, 2007) and was recommended in the

training of GTAs (Luft et al., 2004; Park, 2004). In a case study of creating a teaching community, the GTAs indicated that the weekly meeting on teaching helped them to become reflective teachers (Milner-Bolotin, 2001). Two other GTAs who were involved in long-term individual mentoring also indicated that reflective practice was important in their development as a teacher (Robinson et al., 1997; Volkmann & Zgagacz, 2004). The best training programs, those that had evidence of improving teaching, included reflective components (Bray & Howard, 1980; Davis & Kring, 2001; Hadre & Chen, 2005a). Nyquist and Sprague (1998) indicated that as they developed, the GTAs they studied usually but not always become more reflective. However, evidence that reflective practice was widespread among GTAs or that it directly affected teaching effectiveness was not available. This was definitely an area that needed further study.

Gender. Although there was evidence that there were gender differences in faculty and GTA teaching styles, classroom interactions, and classroom management issues (Boggs & Wiemann, 1994; Luo et al., 2000; Luo et al., 2001; Statham, Richardson, & Cook, 1991), there was little evidence that gender affected the overall teaching effectiveness of GTAs. Nor did gender affect teaching self-efficacy (Prieto & Altmaier, 1994). Gender also has no significant effect on overall student evaluations of teaching (Boggs & Wiemann, 1994; Bos et al., 1980), but had been show to affect the selection of best and worst GTA . Significantly more male GTAs were selected best GTA and more female GTAs selected worst GTA (Boggs & Wiemann, 1994). When comparing teaching styles of GTAs, there were significant

differences in teaching style by gender. Luo et al. (2001) found that females were descriptively more informal, used significantly more discussions groups, and less small group and student presentations . While McDowell (1993) found that males used more lecture methods, were dominant and precise compared to the females in the study who were more committed to teaching, informal, and friendly toward students. However these differences could have also been partially related to academic discipline. There were similar differences in teaching style between the hard and soft disciplines (Luo et al., 2001) and less females in the hard disciplines. Female GTAs also reported significantly different problems in classroom management areas related to student challenges in class and being held responsible for poor student behavior. Female GTAs were also significantly different than male GTAs in their lower concern about students eating and drinking in class (Luo et al., 2000). Despite the classroom differences, there appeared to be no direct evidence of the effect of gender on GTA teaching effectiveness, leaving this a fruitful arena for further research.

GTA Teaching Beliefs. There had been only a few studies on GTA teaching beliefs (Hammrich, 1996; McDowell, 1993; Saroyan et al., 2009), none of which examined the impact of the GTA teaching beliefs on teaching effectiveness. In a survey of GTAs at a Midwestern university, McDowell (1993) found that 70% of GTAs felt their students learned the most from lectures; when it had been shown in the literature that active learning strategies were better than lecture only (eg. Armbruster, Patel, Johnson, & Weiss, 2009; Preszler, 2009). GTA training that focused on teaching and learning had been shown to change GTAs' teaching beliefs (Hammrich,

1996; Saroyan et al., 2009). In both studies, the GTAs moved from a teacher-centered set of beliefs to a more student-centered set of beliefs. While these were interesting initial findings, further research on the impact of GTAs teaching beliefs on their teaching effectiveness needed to be performed.

Discussion

Combining the empirical evidence for GTA teaching effectiveness, and placing it within social cognitive theory, produces a model of our current understanding of the factors which affect GTA teaching effectiveness. This model allows us to determine areas for further research. Although there are many descriptions in the literature of GTA training programs, there are few rigorous studies of the effects of these programs on teaching effectiveness. Additional research is also needed in the following areas; the complex role of teaching self-efficacy, the effects of department teaching climate and GTA training on teaching effectiveness, reflective practice, gender, and GTA teaching beliefs. One especially important weak empirical link, at the college level, is the relationship between teaching self-efficacy and teaching effectiveness. While this is strongly supported theoretically and from the K-12 teaching literature, this association also needs to be firmly established within the college literature. Establishing this relationship will strengthen the use of teaching self-efficacy as a proxy for teaching effectiveness in further research. Also, this model allows the comparison to the large literature base on producing K-12 teachers, which could be mined for other areas of productive research with GTAs including, but not limited to:

motivation, pedagogical content knowledge, identity, small groups, classroom discourse, and scaffolding.

Language and cultural proficiency appear to have an effect on the teaching effectiveness of the GTA. There is evidence that effective classroom communication depends on strong American English language skills and an understanding of the US culture of higher education. Whether the effect of differing language and cultural identity positively or negatively influences the teaching effectiveness of the GTA depends on the particular GTA, the environment in which they teach, and the students they teach.

The teaching experience of the GTAs' is intimately intertwined with the departmental teaching climate and the GTA training opportunities provided. These three factors have interactions and complex effects on both teaching self efficacy and teaching effectiveness. What is apparent is that extensive teaching experience and training, such as that encountered in a K-12 classroom or teaching experienced as a professional college instructor has a positive effect. Increasing the responsibilities of GTAs during the time they teach could help simulate this experience and also produce positive outcomes from GTA teaching experiences. Research supports that a strong training program with elements of reflective practice, peer mentoring, supervisor support, and appropriate feedback can improve the teaching of GTAs. In general, increasing amounts of teaching responsibility, GTA training, teaching experience, and supervision appears to make a positive difference in teaching self-efficacy. However, when one or more of these areas give conflicting messages to the GTA there may be a

decrease in teaching self-efficacy compared to having similar messages from all experiences. For GTA supervisors and training course providers, it becomes important to make sure that messages GTAs receive about teaching are complementary.

A limitation of this study is that the articles used covered all doctoral granting institution types, graduate students from all major fields of study (science, engineering, social sciences, liberal arts, and humanities), and both master's and doctoral students. Therefore, this is a overall model that may look different when studying GTAs in a small doctoral granting institution with mostly master's students and few GTAs, compared to a large research institution with thousands of doctoral and master's students and many GTAs. Also, major field of study might affect this model especially in the strength of the departmental climate factor. Finally, being a doctoral versus master's student could affect the strength of the factors as their motivations for being a GTA could be very different. It is important to test this model in the various institutional settings to determine how well it describes the situation in each institution. Additionally, a statistical analysis of the model will provide an estimation of the strength of the effect of each factor on teaching effectiveness and teaching self-efficacy.

Although the proposed models' (Figure 2.1) picture of the relationships between the factors is simplistic compared to the reality of being a graduate student and teaching in a university, it provides a new way to look at GTA teaching. Using this theoretically based model researchers can explore new areas for research, continue

research in areas that remain in conflict within the model, begin to look at the complex interactions between the factors, and empirically test this model. Based in a strong theoretical framework, the model allows use of theory to discuss the implications of the empirical results. This model indicates that if improvement the teaching of GTAs is the goal, focusing on one small area could be detrimental because inhibiting factors in the other areas may not produce the effect wanted. This is the problem with many of the GTA training programs in place today. They are isolated from the GTAs environment, not well supported by the department or faculty members, ignore the research on what makes effective teachers, provide inadequate supervision or mentoring, and/or treat the ITA as if language were the only barrier to a successful classroom. It is no wonder GTAs think these programs waste their time (Jones, 1993). Looking at the larger picture of GTA teaching effectiveness can be daunting. However, this model gives researchers, GTA trainers, and supervisors a way to look at the bigger picture they are trying to change and target specific areas within their environment to improve.

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CHAPTER III

TOWARD A MEASURE OF TEACHING SELF-EFFICACY IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHMATICS GRADUATE TEACHING ASSISTANTS

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TOWARD A MEASURE OF TEACHING SELF-EFFICACY IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHMATICS GRADUATE TEACHING ASSISTANTS

Abstract

An instrument to measure teaching self-efficacy of science, technology, engineering, and mathematics (STEM) GTAs is adapted from a general college teaching instrument (Prieto Navarro, 2005) for the specific teaching environment of the STEM GTAs. The construct validity and measurement reliability of the final instrument are indicated. The final instrument has two subscales, instructional strategies and positive learning environment, but can also be used as an overall measure of STEM GTA teaching self-efficacy. Correlations to GTA training and teaching experience are demonstrated and further research and training implications are discussed.

Introduction

Graduate teaching assistants in science, technology, engineering, and mathematics (STEM) disciplines have a large influence on the teaching of undergraduates. These GTAs often have more contact hours with students than the professors, especially in large introductory undergraduate courses where GTAs are usually responsible for teaching laboratory or recitation sections (Fagen & Wells, 2004; Golde & Dore, 2001). Many of the first experiences that STEM undergraduates have in college are closely associated with their GTAs. It is important for the university, department, and students that these GTAs are competent instructors

(Svinicki, 1995-96). It is also important for the GTA that they are competent instructors. They are paying for their education with the GTA experience and many GTAs are interested in an academic faculty career. They will likely be the future professors teaching the next generation of undergraduate students. Even if the GTA is not interested in an academic career, the presentation and interpersonal skills learned in teaching can benefit other careers. Therefore, it is important that GTAs become good instructors.

Although it is important for GTAs to become good instructors, many GTAs receive no training in teaching (DeChenne et al., 2009; Golde & Dore, 2001; Meyers et al., 2007; Piccinin & Fairweather, 1996-97; Rushin et al., 1997). Even GTAs that receive teaching training often indicate it is of little or no help in improving their teaching (Jones, 1993). They are told that teaching is not important, and are not supported in their efforts to improve their teaching (Luft et al., 2004). The GTA training provided does little to help the GTAs teach. Although there are individual programs that show promising results (e.g. Davis & Kring, 2001) much GTA training is ineffectual (Luft et al., 2004; Shannon et al., 1998). A good deal of the literature about GTA training is descriptive with little measure of the effectiveness of training (DeChenne, 2009). Reliable and valid measures of constructs related to improvement are needed.

One possible construct to measure is GTA teaching self-efficacy. Teaching self-efficacy refers to a teachers' belief that they will be able to effectively teach a given population of students a specific subject. In the K-12 environment, teaching

self-efficacy has been shown to be valuable predictor for student achievement, teacher retention, and persistence in the face of teaching difficulties (for a review see Tschannen-Moran et al., 1998). Using teaching self-efficacy could also provide a measure of STEM GTAs' teaching effectiveness. However, before this can be accomplished a valid and reliable measure of STEM GTA teaching self-efficacy is needed.

Literature Review

GTA Training

Studies of GTA training in the literature show mixed results in improving the teaching of GTAs. Many individual programs report success in improving the teaching of the GTAs or demonstrate that the GTAs have learned the material presented in the class (e.g. Carroll, 1977; Daniels, 1970; Davis & Kring, 2001; Hadre & Chen, 2005a, 2005b; Tubb, 1974). Bray and Howard (1980) demonstrate that differences in how GTAs are trained affect their self-reports of teaching, student ratings of teaching, and expert observations of teaching. However, studies that look at GTA training across multiple programs find that such training is usually not effective in changing the teaching of the GTAs (Jones, 1993; Luft et al., 2004). Shannon, Twale, and Moore (1998) find that GTA training across a university has no significant effect on student evaluations of teaching. The only type of training that provides a significant effect is an undergraduate degree in education. This literature indicates that the quality of GTA training is highly variable among and across universities. While there are individual programs that report successful training of GTAs, many

GTAs are not receiving any training (DeChenne et al., 2009; Golde & Dore, 2001; Rushin et al., 1997; Shannon et al., 1998) or if they are in GTA training, that training by implication from studies across universities, is poor (Jones, 1993; Luft et al., 2004; Shannon et al., 1998).

When GTA training is studied across multiple training programs, it is either measured as a dichotomous variable (GTA training or not) (e.g. Prieto & Altmaier, 1994) or as the amount of time in GTA training (e g. Shannon et al., 1998). This type of measure of GTA training yields minimal information regarding the quality of the GTA training program. The actual impact of GTA training on a GTA's teaching is important and having a narrow understanding limits the researchers' conclusions from the data. Rather than just measuring the presence/absence or time in GTA training, it is important to evaluate the learning the GTAs encountered. It should be possible to get a more complete understanding of how well the GTAs learned about teaching using survey items (Table 3.1) initially developed to determine what GTAs want to learn in their training (DeChenne et al., 2009). This should provide a better measure of the quality of the overall GTA teaching training than currently exists.

Teaching Self-Efficacy

Development of teaching skills is an important part of GTA training. Social cognitive theory (Bandura, 1986, 1997) offers a causal structure that provides for both the development of skills and regulation of actions. Self-efficacy is a central component in this theoretical framework. Research has demonstrated that when

training for a specific skill, high self-efficacy is positively correlated with performance (Bandura, 1997; Gist, Schwoerer, & Rosen, 1989; Pajares, 1996a).

According to Bandura (1997)

> Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments….[self-efficacy] beliefs influence the courses of action people choose to pursue, how much effort they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishments they realize (pg. 3).

Self-efficacy as conceived by Bandura is the theoretical base for teaching self-efficacy and the development of a STEM GTA Teaching Self-Efficacy Scale (GTA-TSES) used in this study.

Teaching self-efficacy research has followed two strands, the first resulting from powerful predictive results of just two questions on an early study of teacher characteristics (RAND study) and student learning (Berman & McLaughlin, 1977) and the second based in Bandura's (1986) social cognitive theory. The two items from the RAND study proved so powerful in predicting student performance, teacher change, and continued use of methods and materials from federally funded projects that many different multiple item instruments were developed to capture teacher efficacy (see Tschannen-Moran et al., 1998, for a review). One of the most widely used is the Gibson and Dembo (1984) instrument that was based on the RAND study items, but utilized the framework of self-efficacy from social cognitive theory (Bandura, 1977).

Using instruments such as these, research with elementary, middle, and high school teachers demonstrated that teacher's self-efficacy beliefs impacted many student outcomes and teacher behaviors. In a review of the literature on teacher self-efficacy, Tschannen-Moran et al. (1998) indicated teachers' self-efficacy beliefs were related to student outcomes such as achievement, motivation, and the students' sense of efficacy. They also indicated teaching self-efficacy was related to teacher classroom behaviors, goals set, persistence with students, and enthusiasm for and commitment to teaching. Teachers with high teaching self-efficacy performed better and their students benefited.

At the post-secondary level, teaching self-efficacy has been studied in GTAs, mainly in psychology departments, although there are two studies with GTAs across a university. However, we find no published studies using teaching self-efficacy as a measure specifically for STEM GTA training. Teaching self-efficacy in GTAs has complex interactions with teaching assistant training, previous teaching experience, and supervision (Heppner, 1994; Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007).

In studies with psychology students, variable effects of GTA training, experience, and supervision are found. Tollerud (1990) first developed an instrument to measure the teaching self-efficacy of counseling psychology GTAs which was then later adapted for general use with GTAs (Prieto & Altmaier, 1994). Tollerud indicates that in a population of advanced counseling psychology GTAs and recent graduates, having no teaching experience decreases their teaching self-efficacy. Prior

professional teaching experience does not significantly impact teaching self-efficacy, but the amount of time spent teaching as a GTA does. GTA training has no significant effect on teaching self-efficacy. In contrast, Prieto and Meyers (1999) find a significant effect for GTA training, but not supervision on teaching self-efficacy. In a further study of psychology GTAs, training and teaching experience are positively associated with teaching self-efficacy (Meyers et al., 2007).

Level of responsibility for teaching can have an effect on GTAs teaching self-efficacy. Prieto and Altmaier (1994) find there are no significant differences in teaching self-efficacy by amount of teaching responsibility (primary, assistant, or general instructor). However, in two other studies, GTAs in non-instructive roles (e.g. graders) have significantly lower teaching self-efficacy scores than GTAs who have teaching roles (either assistant or primary instructors) (Prieto & Meyers, 1999); and there are significant differences between GTAs who are graders or assistants and those who have the primary responsibility for the classroom (Prieto et al., 2007).

In studies with GTAs from across institutions, conflicting results are also evident. In one study, there are small significant correlations (Cohen, 1988) between teaching self-efficacy and prior training (r=.22) or previous experience (r=.25). However, in a regression analysis, while teaching experience is significant, it only explains 5% of the variance. Prior training is not significant at the .05 level and when forced into the model only explains 2% of the variance (Prieto & Altmaier, 1994). In a more detailed study including the effects of supervision, GTA training and supervision have variable effects depending on the teaching role of the GTA (Prieto et

al., 2007). In the assistant/grader group, there is no effect on teaching self-efficacy for training or supervision, but prior teaching experience accounts for a significant amount of the variance. In the primary group, prior teaching experience does not account for a significant amount of the variance in the teaching self-efficacy scores, but there is a significant interaction effect for supervision and training. A further breakdown of the supervision and training interactions with the primary group shows that supervision has no effect on teaching self-efficacy when there is training, but has a positive effect on teaching self-efficacy when there is no training. Receiving both training and supervision produces lower teaching self-efficacy than just supervision alone. Training has no effect on the teaching self-efficacy of students who are not receiving supervision.

Situational specificity of self-efficacy

Bandura (1997) proposed that because self-efficacy beliefs were explicitly self-referent in nature and directed toward perceived abilities about given specific tasks, they were powerful predictors of behavior. Further, he stated that self-efficacy refers to organizing and executing courses of action required to successfully accomplishing a specific teaching task in a particular context. Many measures of self-efficacy address specific tasks, yet fall short of providing the particular context (Enochs & Riggs, 1990; R. K. Henson, 2002; Pajares, 1996a).

In development of teaching self-efficacy instruments, the situational specificity of different teaching contexts and tasks is important (Bandura, 1997; R. K. Henson, 2002; Pajares, 1996a). There is a balance between the general and the specific.

Overly specific and the instrument is not measuring teaching self-efficacy, just a specific task in a specific context. A measure of a genetics GTA's belief in their ability to teach how too load DNA samples into an agarose gel for electophoresis to junior level biochemistry students is too specific. However, too broad and the instrument may simply be measuring general personality traits instead of the self-efficacy specific to the task (Pajares, 1996b). Since self-efficacy refers to a person's beliefs about their abilities to accomplish a behavior or task in a specific context, it is important to design the instrument to the context in which the person in performing the task (Bandura, 1997).

College teaching self-efficacy has been measured mostly in psychology students, but teaching styles are different among various disciplines. It has been recognized that teaching in STEM is fundamentally different from the other disciplines and that this difference should be recognized in the roles of GTAs (Golde & Dore, 2004; Lindblom-Ylanne et al., 2006; Torvi, 1994; Verleger & Velasquez, 2007). STEM GTAs are rarely responsible for a course (DeChenne et al., 2009; Torvi, 1994), but instead teach laboratory and recitation sections, and so usually act as a conduit between students and the course professor. GTAs need to understand complex grading rubrics and have skills that allow them to facilitate questions without giving the student the answer. STEM students often work independently or in small groups on complex projects that can span a term or more of coursework (Moore & Diefes-Dux, 2004; Pomalaza-Raez & Groff, 2003; Taylor, Heer, & Fiez, 2003). GTAs must understand these long-term projects, how to facilitate learning, help students at

different points of scholarship, and with frustrating problems. All of these activities require the STEM GTA to have excellent interpersonal relationship skills.

Given that the STEM GTA teaching context is different from other university teaching contexts, measuring teaching self-efficacy in STEM GTAs arguably requires a context specific instrument. Additionally, when comparing the GTA training across more than one program, it is important to measure GTAs' perceptions of the quality of that training rather than simply the number of hours of training or whether or not training occurred. According to social cognitive theory, the two measures should be correlated. The development and validation of these instruments is the focus of this paper. The research objectives are as follows:

1. Measure GTA perceptions of their learning in GTA training.
2. Adapt the College Teaching Self-Efficacy Scale (CTSES) for the STEM GTA context.
3. Determine the reliability of the GTA Teaching Self-Efficacy Survey (GTA-TSES).
4. Determine the content and construct validity of the GTA-TSES.

Methods

Instrument Modification

There were two college teaching self-efficacy instruments. The instrument used in most of the GTA teaching self-efficacy studies was the Self-Efficacy Toward Teaching Inventory – Adapted (SETI-A) (Prieto & Altmaier, 1994), which was adapted for general GTA use from a teaching self-efficacy instrument that was

specific for counseling psychology educators (Tollerud, 1990). A second college teaching self-efficacy instrument, CTSES, was more recently developed (Prieto Navarro, 2005). After discussing what types of items should be included in a STEM GTA teaching self-efficacy scale; a team, including two science educators and two engineering education faculty, reviewed the items on the CTSES and the SETI-A. The CTSES was chosen since it required less extensive modification. The team collaborated to adapt the CTSES to the STEM GTA context.

As part of a larger study of STEM GTA teaching self-efficacy, the CTSES needed to be streamlined; items specific to STEM GTA teaching added or modified from the general college instructor context; and items not usually part of a STEM GTA duties removed. The CTSES was long (44 items) and contained two six-point scales, one for self-efficacy and one measuring actual instructor action for each item. STEM GTAs were rarely involved in course design or were the primary instructors responsible for a course, therefore items related to overall course design and planning were removed (seven items). The CTSES contained items on reflective practice, many of which required teaching the same course repeatedly. Many GTAs, especially in engineering, did not teach the same course repeatedly, so these items were removed (five items). Items that were unclear to the researchers or included technical pedagogical language were also removed (three items). There were two pairs of redundant items; one from each pair was removed. Four items were rewritten to be more specific to the STEM GTA context. Given the large amount of group work in STEM laboratory classes, one item relating to student interaction was added. Finally,

only the self-efficacy scale was retained, but changed to a five point scale because of the limitations of data collection (the scantrons included A to E). The face validity of the items was reviewed by two additional social science faculty with knowledge of both social cognitive theory and instrument design. They were asked to evaluate whether each item represented an aspect of the GTA's teaching self-efficacy, to comment on clarity, and suggest revisions or additions. The instrument as administered contained 28 items, measured on a five point scale of A (no confidence) to E (complete confidence).

Participants

The GTA-TSES was administered to GTAs in various STEM departments at six USA universities; three in the Pacific Northwest, two in the Southwest and one in the Midwest. Five universities had a Carnegie basic classification of RU/VH (Research Universities with Very High research activity) and one was a DRU (Doctoral/Research University). Engineering and technology GTAs taught across the engineering disciplines including: aerospace, biological, biomedical, chemical, civil, computer, construction, industrial, electrical, environmental, manufacturing, mechanical, and petroleum. Science GTAs taught in biology, chemistry, geosciences, microbiology, molecular biology, and physics. Also included in the sample were GTAs who taught in mathematics.

Administration

The GTAs were administered the GTA-TSES once, near the end of the semester or quarter. Data was collected during each term from Fall 2008 through Fall

2009. One of two administration techniques was used depending on location. The survey was distributed to the GTAs through the department mail system, collected in a sealed container in the departmental office, and returned to the researcher through the US mail (or collected directly by a researcher). Alternatively, the survey was administered during a GTA training class and collected by one of the researchers at that time. All protocols were approved by the institutional review board at the originating university.

Data Analysis

Study 1. The GTA-TSES was administered to STEM GTAs at five institutions outside the originating university as previously described. In addition to the items in the GTA-TSES, three additional questions were asked; two demographic questions (university and department affiliation) and a question indicating the GTA's primary role as laboratory, recitation, lecturer, course instructor, or grader. There were 76 participants, including 48 engineering GTAs and 28 science GTAs. Twenty percent of the GTAs described themselves as graders, the rest indicated classroom instructional roles, with laboratory instructor the most common (56%). Using SPSS version 16, the 28 items on the self-efficacy instrument were analyzed using principle components exploratory factor analysis with varimax rotation.

Study 2. The survey instrument was administered to STEM GTAs at the originating university as previously described. The survey instrument contained the following measures: GTA-TSES, GTA training, GTA teaching experience, and additional demographic questions included gender, nationality, and career interest.

The GTA-TSES items were analyzed using principle components exploratory factor analysis with varimax rotation, and a scree test.

There were 177 participants; 61% were engineering and 39% science or mathematics GTAs. Twenty-six percent of the GTAs described their primary role as grading, the rest indicated classroom instructional roles, with laboratory instructor (36%) the most common. Twenty-seven percent of the GTAs were female and 64% were interested in college/university teaching as a career. The sample was split almost evenly between international teaching assistants (ITAs - 47%) and US teaching assistants (USTAs - 53%). Thirteen percent of the sample had no GTA training of any kind; university, department, or college coursework.

GTA training was measured two ways;: (a) number of hours spent in teaching training measured in university-wide and department GTA training, and university coursework in teaching, and (b) by the GTA's overall perception of their GTA training. This was measured by rating the both overall GTA training and how well the GTAs learned different items directly related to teaching. These items were generated from a prior study of GTA training (DeChenne et al., 2009). Confirmatory factor analysis (CFA) of the items about GTA training was used to examine whether the variables measuring this latent factor provided a good fit and demonstrated construct validity. EQS 6.1 software and Satorra-Bentler robust estimation to correct for multivariate non-normality was used for the CFA analysis (Byrne, 1994). Robust corrected comparative fit index (CFI), non-normed fit index (NNFI), and root mean square error of approximation (RMSEA) were used to assess model fit. CFI and NNFI

values ≥ 0.90 and RMSEA values ≤ 0.08 suggested acceptable fit (Browne & Cudeck, 1993).

Teaching experience was measured by the number of quarters taught and the amount of responsibility for the course the GTAs had in their teaching (from none to complete responsibility). Additionally, two items that asked the GTAs to rate their own experience were used. One item asked the GTAs to compare themselves to other GTAs in the department and the other asked them to rate their own experience (from beginner to expert).

Validity and Reliability. The GTAs from both studies were combined and the construct validity of the GTA-TSES was determined and a second-order factor analysis of the data done. Confirmatory factor analysis (CFA) was used to examine whether the variables measuring the latent factors provided a good fit and demonstrated construct validity. The possibility of a second order factor structure was examined using both second order CFA and principle components explanatory factor analysis with varimax rotation forcing one factor.

Internal consistency of multiple-item indices measuring these concepts was examined with Cronbach alpha reliability coefficients. An alpha coefficient ≥ 0.65 indicated that items were measuring the same concept and justified combining items into a single index (Cortina, 1993). Using the GTAs from Study 2, Pearson's Product Moment Correlations (*r*) between the GTA-TSES and teaching experience or GTA training measures were determined. The differences in teaching self-efficacy by nationality, teaching experience, gender, teaching responsibility, GTA training, and

career plans were compared using t-tests and effect sizes were determined using point-biserial correlations.

Results

Study 1

The 28 items were subjected to exploratory factor analysis as described above. Five factors explained 69% of the variance in the GTAs scores. The rotation failed to converge in 25 iterations so the unrotated factors were examined. The first factor had an eigenvalue of 13.312 and an explained 48% of the variance. Costello and Osborne (2005) suggested, for small sample sizes in EFA, to select strong factor loadings when determining what items to retain in a factor; therefore items with factor loadings below .60 were removed (two items). Additionally, upon reading the items again one more item was removed due to poorly worded language. There were 25 items available for further analysis.

Study 2

The 25 items were subjected to exploratory factor analysis as described above. Five factors explained 62% of the variance in the GTAs scores. A scree test (Cattell, 1966) suggested that two or three factors could be found in the data. The two factor analysis found items relating to a positive learning environment loading on one factor with items relating to instructional strategies loading on the other. The three factor solution split up the instructional strategies factor into two with some of the items from the positive learning environment also loading on the third factor. Given that the two factors were more defined and clearly represented the tasks of teaching for STEM

GTAs, the two factor structure was used. Additionally, the two factors found were similar to two of the factors determined for pre-service and in-service teachers (Tschannen-Moran & Hoy, 2001). They found three factors, efficacy for instructional strategies, student engagement, and classroom management. We did not include any items relating to classroom management in this instrument since GTAs are teaching adults not children, but the other two factors were similar.

The initial two factor solution explained 48% of the variance in the GTAs scores. To strengthen the factors, all of the items that cross-loaded between the two factors and the items with the lowest factor loadings within each factor were removed (Costello & Osborne, 2005). This left 15 items. Another exploratory factor analysis with those 15 items gave two clean factors that explained 53% of the variance. The factors were labeled self-efficacy for instructional strategies (*is*=8 items), and positive learning environment (*ple*=7 items).

Validity and Reliability of the GTA-TSES

The data from the two studies of GTAs was combined to explore the validity, reliability, and possible second-order factor structure of the teaching self-efficacy instrument. An exploratory factor analysis of the combined data gave two clean factors that explained 54% of the variance in GTAs scores (Table 3.1). All of the variables loaded between .59 to .77 for instructional strategies and .64 to .79 for positive learning environment. Both factors were highly reliable (*is* α=.87, *ple* α=.86); all the variables met the criterion of item total item correlations being greater than .40 and deletion of any item did not improve the reliability. A CFA for each

Table 3.1
Exploratory Factor Analysis of GTA-TSES subscales with all GTAs

		Factor Loadings[1]	
How confident am I in my ability too[2]…	Variable #	Factor 1: Instructional Strategies	Factor 2: Positive Learning Environment
Appropriately grade my students' exams/assignments?	1	.77	
Spend the time necessary to plan my classes?	2	.74	
Select appropriate materials for class activities?	3	.69	
Evaluate accurately my students" academic capabilities?	4	.66	
Prepare the teaching materials I will use?	5	.64	
Stay current in my knowledge of the subject I am teaching?	6	.61	
Provide my students with detailed feedback about their academic progress?	7	.61	
Specify the learning goals that I expect my students to attain?	8	.59	
Think of my students as active learners, which is to say knowledge builders rather than information receivers?	9		.79
Promote a positive attitude towards learning in my students?	10		.71
Ensure that my students consider themselves capable of learning the material in the course?	11		.67
Promote my students' confidence in themselves?	12		.66
Create a positive classroom climate for learning?	13		.66
Encourage the students to interact with each other?	14		.64
Let students take initiative for their own learning?	15		.64
Eigenvalue		4.13	3.95
Percent (%) of total variance explained		27.50	26.31
Cumulative percent (%) of variance		27.50	53.81
Factor Mean[2]		4.12	3.98
Cronbach α		.87	.86

[1] Principal components factor analysis with Varimax rotation.
[2]Items coded on a 5 point scale of 1=not at all confidence to 5=very confident.

factor demonstrated good model fit, indicating good construct validity for each factor (*is,* NNFI=.916, CFI=.940, RMSEA=.064; *ple,* NNFI=.949, CFI=.966,

RMSEA=.059). All variables loaded between .61 to .78 for instructional strategies and .62 to .74 for positive learning environment and were significant at the $p<.05$ level. Means for each factor were high (*is*=4.13, *ple*=3.95), indicating that in each factor the GTAs were confident in their ability to carry out these teaching duties and responsibilities.

Given the strong correlation (Cohen, 1988) between the instructional strategies and positive learning environment with all the GTA data (r=.69), a exploratory factor analysis forcing one component was conducted to determine if these factors measured a single concept of GTA teaching self-efficacy. All items loaded on one factor with factor loadings ranging from .61 to .76, explaining 45% of the variance in the GTAs responses. To confirm the measure of GTA teaching self-efficacy, a 2nd order CFA was performed on the items (Figure 3.1). There was a good fit of the second order structure (NNFI=.910, CFI=.924, RMSEA=.052). All the variables loaded between .63 to .74 for instructional strategies, .63 to .76 for positive learning environment, and each factor loaded on the second order GTA teaching self-efficacy at .90. All factor loadings were significant at the $p<.05$ level. The reliability of the single factor structure was .91 with a mean of 4.06. All the variables met the criterion of item total item correlations being greater than .40 and deletion of any item did not improve the reliability. These results suggested that this instrument could be used to measure the underlying concept of GTA teaching self-efficacy and that a total teaching self-efficacy as well as subscale self-efficacies could be measured.

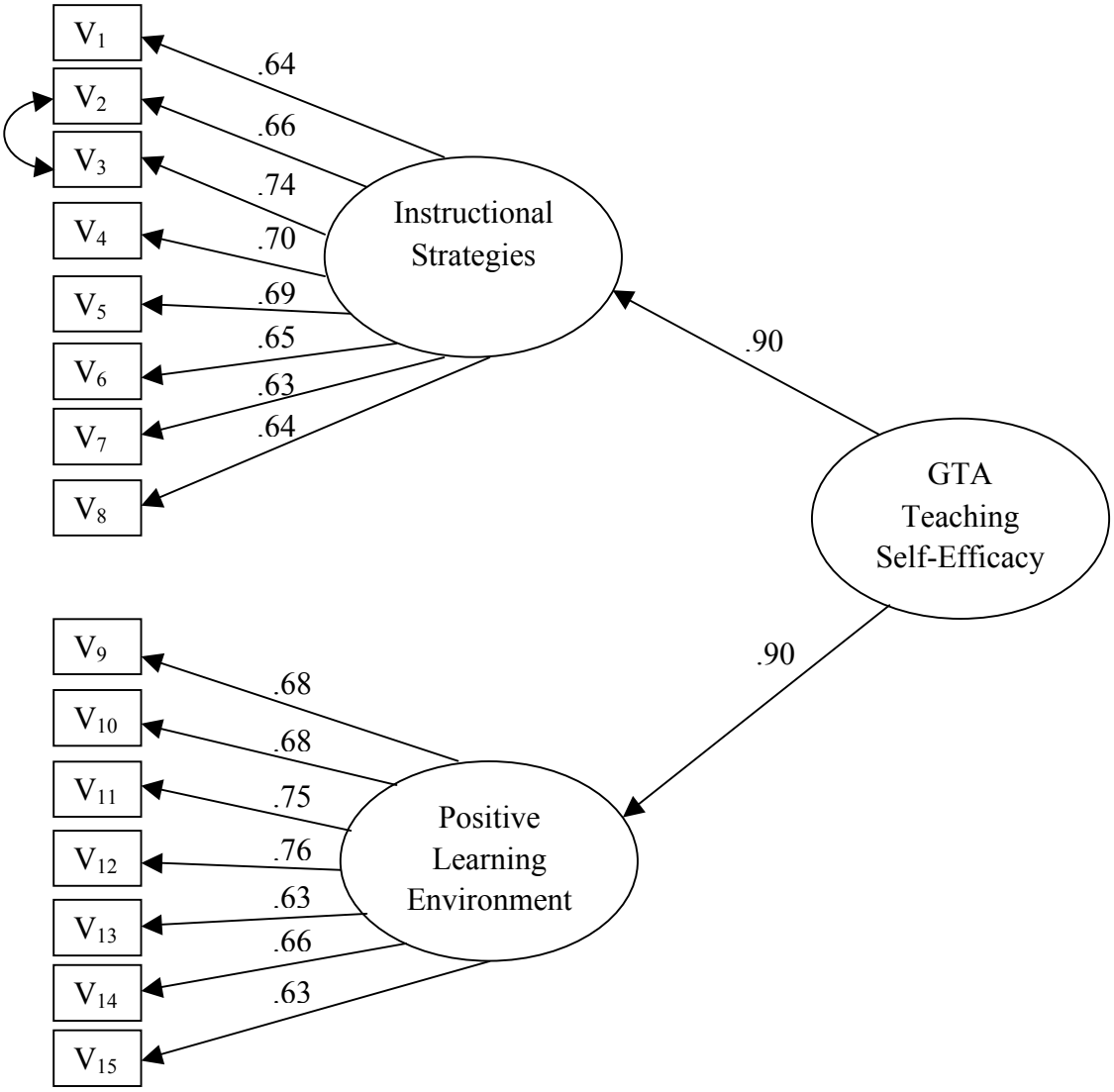

Figure 3.1: 2nd Order Confirmatory Factor Analysis of GTA Teaching Self-Efficacy

See Table 3.2 for variables corresponding to codes (e.g., V_1). All factor loadings indicated are significant at $p<.05$. Model fit indices are NNFI=.910, CFI=.924, & RMSEA=.052. To achieve these fit indices the errors between V_2 and V_3 were allowed to covary.

Validity and Reliability of GTA Perception of Training Instrument

Using the study 2 GTAs, a CFA demonstrated an acceptable model fit and supported the construct validity of the GTA perception of training factor (NNFI=.925, CFI=.935, RMSEA=.083) (Table 3.2). All of the variables loaded between .60 to .86

Table 3.2

Confirmatory Factor Analysis of GTA Perception of Training with Study 2 GTAs

Of the following teaching topics and skills, please rate how well you have learned these in GTA training?[1]	Factor Loadings[2]
Facilitating group discussions	.86
Learning styles	.83
Motivating students	.82
Teaching students with different skill/knowledge	.82
Managing disruptive students	.81
Interacting professionally one-on-one with your students	.81
Teaching styles	.81
Teaching culturally diverse students	.80
Power/authority relationships in the classroom	.77
Assisting distressed students	.75
Communicating with course lead instructor	.71
Presenting material to large groups of students	.70
Harassment	.67
Grading	.60
Developing quizzes/exams	.60
Overall Questions on GTA training[3]	
Overall, how effective has the TA training you have received been in preparing you to work with students?[4]	.69
Overall, how effective has the TA training you have received been in preparing you to teach? [4]	.66
Mean	3.15
Cronbach α	.96

[1]Items coded on a 5 point scale of 1=never learned to 5=learned very well.
[2]All factor loadings are significant at p<.05. Model fit indices are NNFI=.925, CFI=.935, & RMSEA=.083.
[3]Items coded on a 5 point scale of 1=not effective to 5=very effective.
[4]Errors allowed to covary to achieve fit indices.

and were significant at $p<.05$. The GTA perception of training factor was highly reliable ($\alpha=.96$); all the variables met the criterion of item total item correlations being

greater than .40 and deletion of any item did not improve the reliability. The GTAs indicated they learned various skills in their GTA training moderately well (*M*=3.15 on a 5 point scale of never learned to learned very well).

Correlational and Comparison Analysis

The overall GTA teaching self-efficacy scale (GTA-TSES) and the instructional strategies and positive learning subscales correlated significantly with several measures of teaching training and teaching experience (Table 3.3). These measures, with the study 2 GTA sample, indicated significant small to moderate correlations (Cohen, 1988) of the GTA-TSES and both subscales with the GTAs perception of GTA training. There was also a small correlation (Cohen, 1988) of the number of hours reported in university GTA training with the positive learning scale and amount of university coursework in teaching with the GTA-TSES. There were significant moderate correlations (Cohen, 1988) of the GTA-TSES and both subscales with measures of teaching experience that asked the GTAs to rate themselves compared to their peers and on a scale from beginner to expert. There was a small significant correlation (Cohen, 1988) with the instructional strategies subscale and the number of quarters the GTAs taught and the amount of course responsibility.

The data collected with Study 2 GTAs indicated no differences in mean scores on the GTA-TSES or the *is* and *ple* subscales. There was no significant difference by

Table 3.3
Correlational Analysis with Study 2 GTAs

Measures	Mean	GTA[2] TSES	A	B	C	D	E	F	G	H	I
Self-Efficacy											
A Instructional Strategies[1]	4.16	.91**									
B Positive Learning Environment[1]	4.00	.91 **	.65**								
Training											
C Perception[1,3]	3.16	.33**	.32**	.25**							
D University[4]	2.21	.13	.08	.15*	.23**						
E Department[4]	7.67	.07	.06	-.01	.11	.23**					
F Course Credit[4]	9.01	.15*	.14	.14	.15	.06	-.03				
Experience											
G Compare[1,5]	3.34	.35**	.38**	.24**	.04	.10	.07	.10			
H Rating[1,6]	2.93	.44**	.43**	.35**	.22**	.12	.12	.17*	.67**		
I Quarters[7]	5.22	.12	.16*	.03	.00	-.05	.23*	.03	.46**	.46**	
Responsible[1,8]	3.87	.12	.17*	.10	.06	.03	.03	-.03	.19*	.25**	.17*

*p<.05 (2 tailed), **p<.01 (2-tailed)
[1]All scales were rated on a scale of 1 to 5, with 5 being the best in each scale.
[2]GTA-Teaching Self-Efficacy Scale
[3]GTA ratings of how well they learned teaching skills, see Table 3.3.1
[4]Hours of training
[5]Item asking; Compared to other GTAs how much teaching experience do you have?
[6]Item asking; Rate your own teaching experience?
[7]Numbers of quarters as a GTA
[8]Item-For the course in which you had the most responsibility as a GTA, how much responsibility did you have?

gender (GTA-TSES males=4.10, females=4.05; t=.51, p=.61, r_{pb}=.04), career goals (GTA-TSES academic=4.12, other=4.02; t=1.46, p=.25, r_{pb}=.09), GTA training (no training=4.08, training=4.09; t=.02, p=.99, r_{pb}=.001) or nationality (GTA-TSES ITA=4.16, USTA=4.02; t=1.63, p=.11, r_{pb}=.12). When the GTAs from both studies were combined there were no significant differences in GTA-TSES or the *is* and *ple* subscales by classroom role (GTA-TSES graders=4.13, classroom instruction=4.06;

t=.86, p=.39, r_{pb}=.06) or college of instruction (GTA-TSES science/math=4.00, engineering=4.09; t=1.03, p=.28, r_{pb}=.07).

Discussion

The purpose of this study was to develop an instrument to measure the teaching self-efficacy of STEM GTAs and to explore some of the relationships between STEM GTA teaching self-efficacy and GTA training and teaching experience. Essential to this process was to work toward the establishment of the reliability and validity of the measure. Exploration of GTA training also necessitated developing an instrument that would give a better picture of the GTA training received by STEM GTAs than a simple record of training or time in training. Assertions related to instrument validity and correlations must be viewed as sample dependent.

Instrument Modification and Development

The teaching self-efficacy instrument developed during this process has two subscales; instructional strategies and positive learning environment. These subscales can be used individually or they can be combined into a measure of the teaching self-efficacy of the STEM GTAs. This structure is not unlike the Ohio State Teacher Efficacy Scale (Tschannen-Moran & Hoy, 2001). They found when they developed a new teaching self-efficacy instrument using their theory of teaching self-efficacy (Tschannen-Moran et al., 1998) that there were three factors; student engagement, instructional strategies, and classroom management, which could be used to measure an overall teaching self-efficacy. In the GTA-TSES the two factor structure provides more flexibility in the use of the instrument. It provides a global score of teaching

self-efficacy. However, if the self-efficacy of the STEM GTAs relating to their classroom instruction or their ability to create a positive learning environment is needed then this instrument offers that option. When this instrument is used to evaluate GTA training, the subscales could be useful in determining where changes have occurred in the GTA's teaching self-efficacy.

Consistent with Prieto and Altmaier (1994), teaching self-efficacy in STEM GTAs does not vary in this study by gender, career plans, instructional role, or college of teaching appointment. In two other populations the self-efficacy of GTAs varied by instructional role (Prieto & Meyers, 1999; Prieto et al., 2007). Unlike these studies, STEM GTAs are rarely the course instructor (5% in this study), which is the group reported to have the different teaching self-efficacy in one of these studies (Prieto et al., 2007) and make up almost half of the combined assistant/full responsibility group in the other study (Prieto & Meyers, 1999). Like in Tollerud (1990), there was no difference in the teaching self-efficacy between GTAs who had attended GTA training and those who had not, although other studies have shown an effect on teaching self-efficacy for GTAs with GTA training (Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007). Additionally, the means of the GTA-TSES with this sample of STEM-GTAs is higher (4.0 to 4.2) than those reported by Prieto and Altmaier (3.2 to 3.4) but neither varies much. These means indicate that the STEM GTAs have a relatively high teaching self-efficacy. ITAs have a significant, slightly higher instructional strategies self-efficacy than the USTAs. But the overall teaching self-efficacy of ITAs and USTAs is similar.

The GTA perception of training factor also had good reliability and validity in this study. It provides a new measure of GTA training beyond the simpler measures of presence/absence of GTA training or reports in amount of time of GTA training. This factor is an evaluation of the teaching training received by the GTAs around certain teaching skills. As such, the items may reflect our biases toward important teaching skills and certainly cannot cover all the skills required for effective teaching. However, the items were generated by a broad group of individuals (DeChenne et al., 2009) and provide a way for the GTAs to assess their training. This measure gives researchers another way to estimate GTA training in quantitative studies. If the training received by GTAs was high quality and the GTAs learned about teaching then this measure should be high. A large amount of time in teaching training is not a guarantee of learning. Not surprisingly then, the GTA perception of training does not correlate significantly with all the time measures of GTA, although it does show a small correlation with university-wide training. It also has a small correlation with the GTAs' rating of their own teaching experience (from beginner to expert).

One of the possible limitations of this study is sample size. Costello and Osborne (2005) demonstrate in exploratory factor analysis that a ratio of at least ten participants to each item in the instrument provides an average of less than one (0.70) item misclassified on the wrong factor. In Study 2 there is a ratio of seven participants to each item. However, by Costello and Osborne's own categorization, the individual factors (Table 3.2) in the GTA-TSES are solid; "a factor with…5 or more strongly loaded items (.50) are desirable and indicate a solid factor" (pg. 5). Additionally, the

CFA of the combined GTAs indicates a solid first and second order factor structure. Although the strong first order factor structure could be expected since 70% of the sample is the same as used in the exploratory factor analysis, the second order factor analysis indicates that these two more specific self-efficacy scales collapse into broader teaching self-efficacy factor. This could be predicted from social cognitive theory, which indicates that teacher efficacy should be task specific (Bandura, 1997; Pajares, 1996a). As indicated by Henson (R. K. Henson, 2002), it is not surprising to find a higher order factor structure within this instrument. However, further research with this instrument should use CFA to further validate the two factor structure of the instrument.

Related Relationships

A correlational analysis suggests that the GTA-TSES and the instructional strategies (*is*) and positive learning environment (*ple*) self-efficacy factors are related to measures that theory and prior research indicate should correlate. There is a high correlation between the two subscale factors in this instrument. Since these two factors measure related activities in the classroom - instructional strategies and positive learning environment - they should be correlated. Prior research (Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto et al., 2007; Tollerud, 1990) shows a positive effect for GTA teaching experience except in one study where for GTAs with primary responsibility it did not (Prieto et al., 2007). The *is* subscale correlates with all measures of teaching experience. However the *ple* factor and the GTA-TSES only correlate with measures of teaching experience that are GTA self-reports and not with

the number of quarters or amount of responsibility. Examining the SETI-A shows that most of the items are more similar to the *is* factor than the *ple* factor, which may account for the different results of the *ple* and GTA-TSES with teaching experience.

According to social cognitive theory (Bandura, 1997), training in a task should increase the self-efficacy of the person in performing that task. As a measure of the quality of their teaching training, GTA perception of teaching should correlate with the GTAs teaching self-efficacy. It has a moderate correlation with both subscales and the complete instrument. Prior research shows variable results for the effects of GTA training on teaching self-efficacy (Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007; Tollerud, 1990). This may be because of the measure of training used. In this study only GTA perception of training correlated with both subscales and the GTA-TSES. Two of the rest of the training variables (measured in hours) had a small correlation with either the *is* subscale or the GTA-TSES.

This research includes the initial development of the GTA-TSES instrument. This instrument needs continued study using a variety of STEM GTAs to determine if the factor structure is stable and reliable with different populations of STEM GTAs. With this population of GTAs there appears to be little difference between groups in their teaching self-efficacy; the discriminatory power of this instrument needs to be further investigated. The initial correlational study shows promising results but, as Henson (2001) articulates, it is time for teaching self-efficacy studies to move beyond correlations. Research into the longitudinal effects of GTA training and teaching

experience needs to be done. Using this instrument to track changes in the long-term self-efficacy of engineering GTAs is underway, as is a study investigating the relationships between teaching self-efficacy and faculty and peer interactions. Neither instrument developed to measure GTAs teaching self-efficacy has yet explored the GTAs' interpretation on the items included in the instrument. So further research on this instrument should include qualitative studies to determine the way STEM GTAs interpret the items in the instrument.

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CHAPTER IV

EFFECTS OF DEPARTMENT CLIMATE, TRAINING, AND EXPERIENCE ON THE TEACHING SELF-EFFICACY OF STEM GTAs

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EFFECTS OF DEPARTMENT CLIMATE, TRAINING, AND EXPERIENCE ON THE TEACHING SELF-EFFICACY OF STEM GTAS

Abstract

Teaching self-efficacy is an important predictor of teaching skill and student achievement (Tschannen-Moran & Hoy, 2001). Self-efficacy is developed through mastery experiences, vicarious experience, verbal persuasions, and affective states (Bandura, 1997). There are many sources of these experiences within the graduate teaching assistants (GTAs) environment. Using the graduate teaching assistant (GTA) literature, a model predicting sources of self-efficacy is developed. The literature indicates that teaching experience, peer relationships, supervisor relationship, departmental facilitating training factors, and GTA training are sources of teaching self-efficacy for GTAs. The model is tested using ordinary least squares regression path analysis with 129 science, technology, engineering, and mathematics (STEM) GTAs from a single university. The model indicates that for this population of STEM GTAs, K-12 teaching experience, perception of GTA training, and departmental facilitating training factors predict STEM GTA teaching self-efficacy. Supervisor relationships and hours in GTA training are mediated by GTA perception of GTA training. Hours is further mediated by facilitating training factors. The model explains 23% of the variance in the GTAs responses. Implications for GTA training and further research are discussed.

Introduction

Graduate teaching assistants in science, technology, engineering, and mathematics (STEM) disciplines have a large influence on the teaching of undergraduates. These GTAs often have more contact hours with the students than the professors, especially in large introductory undergraduate courses where GTAs are usually responsible for teaching laboratory or recitation sections (Fagen & Wells, 2004; Golde & Dore, 2001). Many of the first experiences that STEM undergraduates have in college are closely associated with their GTAs.

The routine use of STEM GTAs for undergraduate instruction has a two-fold impact on college instruction. There is the immediate impact on undergraduate students who participate in the STEM GTA's laboratory, discussion, and recitation sections. It is important the STEM GTAs be effective instructors. STEM GTAs also have a secondary impact on university instruction. Many of these STEM GTAs will become the next generation of faculty members. Between 36% and 75% of STEM doctoral students, depending on discipline, plan on becoming college professors (Golde & Dore, 2001). Yet, the STEM GTA experience and whatever training is available within the department or university is generally the only teaching preparation they will get before becoming faculty members (Golde & Dore, 2001; Tanner & Allen, 2006). Therefore, investing in the improvement of teaching of GTAs is an important step in improving undergraduate instruction.

Despite the heavy reliance on STEM GTA instruction and the potential for large impacts on student learning, there is evidence that most GTAs are poorly

prepared for their role as instructors (Golde & Dore, 2001; Luft et al., 2004; Shannon et al., 1998). Approximately half of all GTAs are placed in the classroom with little or no instruction in teaching (Golde & Dore, 2001). Luft et al. find that university-wide training is too general to help the STEM GTAs and that the department training also did not address the GTAs specific teaching needs; instead it repeated the university training. As a result of the poor training and research oriented departmental climates, the STEM GTAs usually taught independently without feedback or support, taught in a primarily directive way, and had intuitive notions about student learning, motivation, and abilities.

Given that universities utilize GTAs for much of the undergraduate STEM teaching and that GTAs are poorly prepared, theoretical models exist to frame GTA preparation. Although there are GTA training programs that are effective, most are not theoretically based (K. Smith, 1993). Most GTA training is based on a list of ideas for "what works" in training teachers. Although empirical studies indicate what works, basing the training on theory allows for a reason why something works, indicates what to include, and should also provide a way to measure success. One possible theory that could be used to base GTA training on is social cognitive theory (Bandura, 1977, 1986, 1997, 2001). It is a base for predicting human behavior and has a central component, self-efficacy, which is a person's belief in their ability to perform a specific task in a specific context. Self-efficacy predicts success and is task specific. Sources of self-efficacy are known. Therefore, using the sources of self-

efficacy as a way to design a STEM GTA training class and then using self-efficacy as a measure of success should produce improved STEM GTA teaching.

Teaching self-efficacy is a domain specific construct that focuses on the teachers' perceptions of their ability to "organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran et al., 1998, pg. 233). Research in the K-12 literature indicates that a teacher's self-efficacy beliefs positively impact student learning and the actual success or failure of a teacher's behavior (R. K. Henson, 2002). Teachers' self-efficacy beliefs are also related to their instructional practices (Borko & Putnam, 1996; Haney et al., 1996) and to their students' achievement and psychological wellbeing (Ashton & Webb, 1986; Tschannen-Moran et al., 1998). Teachers with high teaching self-efficacy perform better, are persistent in difficult tasks, and actively engage their students in inquiry.

At the post-secondary level, teaching self-efficacy has been studied in GTAs, mainly in psychology departments, but there are two studies that have been done with GTAs across other disciplines. Teaching self-efficacy in GTAs has been shown to have complex interactions with GTA training, supervision, and previous teaching experience (Heppner, 1994; Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007). Based on the studies at the K-12 level, research from the post-secondary level, and the central place teaching self-efficacy holds in social cognitive theory, teaching self-efficacy is hypothesized to be an important mediator in the teaching effectiveness of GTAs (DeChenne, 2009). Despite the prior

research on teaching self-efficacy in both the K-12 and college environment, the relationships of factors that can evoke teaching self-efficacy have not been modeled or tested. The focus of this paper is to model and test possible factors in that could predict teaching self-efficacy in STEM GTAs.

Background

The various factors and variables included in the proposed model of teaching self-efficacy in GTAs (Figure 4.1) come from both the GTA literature and the teacher self-efficacy literature. The theoretical framework grounding the proposed model in this study is social cognitive theory (Bandura, 1977, 1986, 1997, 2001). In the following section, the theoretical framework for the study will be presented as will the current understanding of the effects of the GTA training, departmental teaching climate, and teaching experience on teaching self-efficacy.

Social Cognitive Theory

Social cognitive theory is rooted in human agency. According to Bandura (2001) "[a]gency embodies the endowments, belief systems, self-regulatory capabilities and distributed structures and functions through which personal influence is exercised, rather than residing as a discrete entity in a particular place" (pg. 2). Human agency happens through human intentionality (ability to plan ahead), forethought, self-reactiveness (self-motivation and self-regulation), and self-reflection. Human agency happens at both the personal and collective levels. Through agency, humans are capable of change both within themselves and within their environment; they are both the producers and products of change.

The human agents are involved in a dynamic interplay between themselves, their environment, and their behavior, known as triadic reciprocity (Bandura, 1986, 1997). In triadic reciprocity, there are three determinants - personal, environmental, and behavioral. Internal personal determinants include cognition, affect, and biological events; behavioral determinants include all observable behaviors; and environmental determinants include aspects of the environment that affect personal and behavioral determinants. These factors act in mutually reciprocal ways, each acting on the other. Reciprocity is not necessarily symmetrical in influence nor is the strength of any factor fixed. Instead, the factors interact in complex, changing, and dynamic ways through time. It takes time for an effect to be produced by a causal factor. Within triadic reciprocity, the sociocultural and personal determinants are interacting factors within a unified structure.

> It is not a dichotomy between a disembodied social structure and a decontextualized personal agency, but a dynamic interplay between individuals and those who preside over the institutional operations of social systems. (Bandura, 1997, pg. 6)

Self-efficacy beliefs are core to social cognitive theory. Self-efficacy is a person's belief about how well they can perform a specific task in a specific context.

> Perceived self-efficacy occupies a pivotal role in social cognitive theory because it acts upon the other classes of determinants. By influencing the choice of activities and the motivational level, beliefs of personal efficacy make an important contribution to the acquisition of knowledge structures on which skills are founded (Bandura, 1997, pg. 37).

Self-efficacy is not what a person does with their skills, but what they perceive that they can do with those skills under a variety of circumstances. There are three ways

that self-efficacy beliefs can affect human functioning (Bandura, 1986, 1997). Self-efficacy beliefs work through their influence on the choices that people make. People tend to pursue activities in which they are highly efficacious. Self-efficacy beliefs affect perseverance, effort, and resilience in the face of difficulties. A highly efficacious person will have a much higher perseverance, effort, and resilience in a specific endeavor than someone with lower self-efficacy. Finally, self-efficacy beliefs affect a person's thought patterns and emotional reactions. Self-efficacy is an important component in a theory that "govern[s] human thought, motivation, and action". (pg. 34)

Self-efficacy beliefs are formed through four sources; enactive mastery experiences, vicarious experiences, social persuasions, and physiological and affective states (Bandura, 1986, 1997). Enactive mastery experiences are the most important source of self-efficacy beliefs because the person actually lives through them. These experiences need to be balanced for the developing skill level of the person. Some failure early on followed by striving and success seems to produce the highest levels of self-efficacy. However, it is not just the experiences themselves, but how the person cognitively processes them that affect self-efficacy. Vicarious experiences allow people to develop self-efficacy by modeling and providing comparisons. It is important the person being watched is similar to themselves for the greatest increase in self-efficacy. Additionally, observing multiple skilled models produces a stronger self-efficacy than simply watching one person. Verbal persuasion works best to improve self-efficacy when the persuader is a personal model who is encouraging

during a struggle to master a skill. It also has a stronger impact during the early stages of skill development. Mood and physiological feedback can influence how a person cognitively processes an experience, thereby affecting their self-efficacy derived from that particular experience.

GTA Training

Prior research generally indicates a positive effect for simple measures of GTA training on GTA teaching self-efficacy (DeChenne & Enochs, 2010; Meyers et al., 2007; Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007). Only in the development paper of the Self-Efficacy for Teaching Instrument (SETI), Tollerud (1990) when looking at advanced psychology doctoral and recent graduates finds no effect for the GTA training (measured as the number of courses they had taken). GTA training does have a minimal (r=.15 and r=.27) correlation (Cohen, 1988) with teaching self-efficacy (DeChenne & Enochs, 2010; Prieto & Altmaier, 1994), but when used in a regression analysis to predict teaching self-efficacy, a dichotomous measure of GTA training is not significant (Prieto & Altmaier, 1994). When hours of GTA training is used with age as a covariate, GTA training is found to have a significant positive effect on GTA teaching self-efficacy (Prieto & Meyers, 1999).

All of the GTA training reported in the prior studies is measured in a basic way; hours of GTA training, GTA training or not, or in number of GTA training courses. However, this may not be the best way to measure GTA training since the quality varies widely (e.g. Bray & Howard, 1980; Davis & Kring, 2001; Hadre, 2003; Jones, 1993; Luft et al., 2004; Shannon et al., 1998). A measure of the quality of GTA

training has been developed and is also moderately (Cohen, 1988) correlated (r=.33) with GTA teaching self-efficacy (DeChenne & Enochs, 2010). Measuring the quality of teaching training in the K-12 teaching self-efficacy literature also indicates a positive perception of teaching training is correlated with teaching self-efficacy (Knobloch, 2006). Additionally, the number of hours spent in GTA training is correlated (r=.23) with the GTAs perception of their GTA training. Prieto and Scheel (2008) also find that the more time GTAs spend in GTA training the better their perception of training.

The hypothesized relationships between teaching GTA self-efficacy, GTA training, and the GTA's perception of their training are shown (Figure 4.1). The time that GTAs spend in training and their perception of that training should directly predict the teaching self-efficacy of the GTAs. GTA training should provide both vicarious experiences and verbal persuasion for development of the GTA's teaching self-efficacy. Additionally, the GTA's perception of their training should be affected by the time they have spent in training. GTAs should learn more about teaching when they have more hours of training, so perception of GTA training in this model is a partial mediator of the time spent in GTA training on GTA teaching self-efficacy (Figure 4.1).

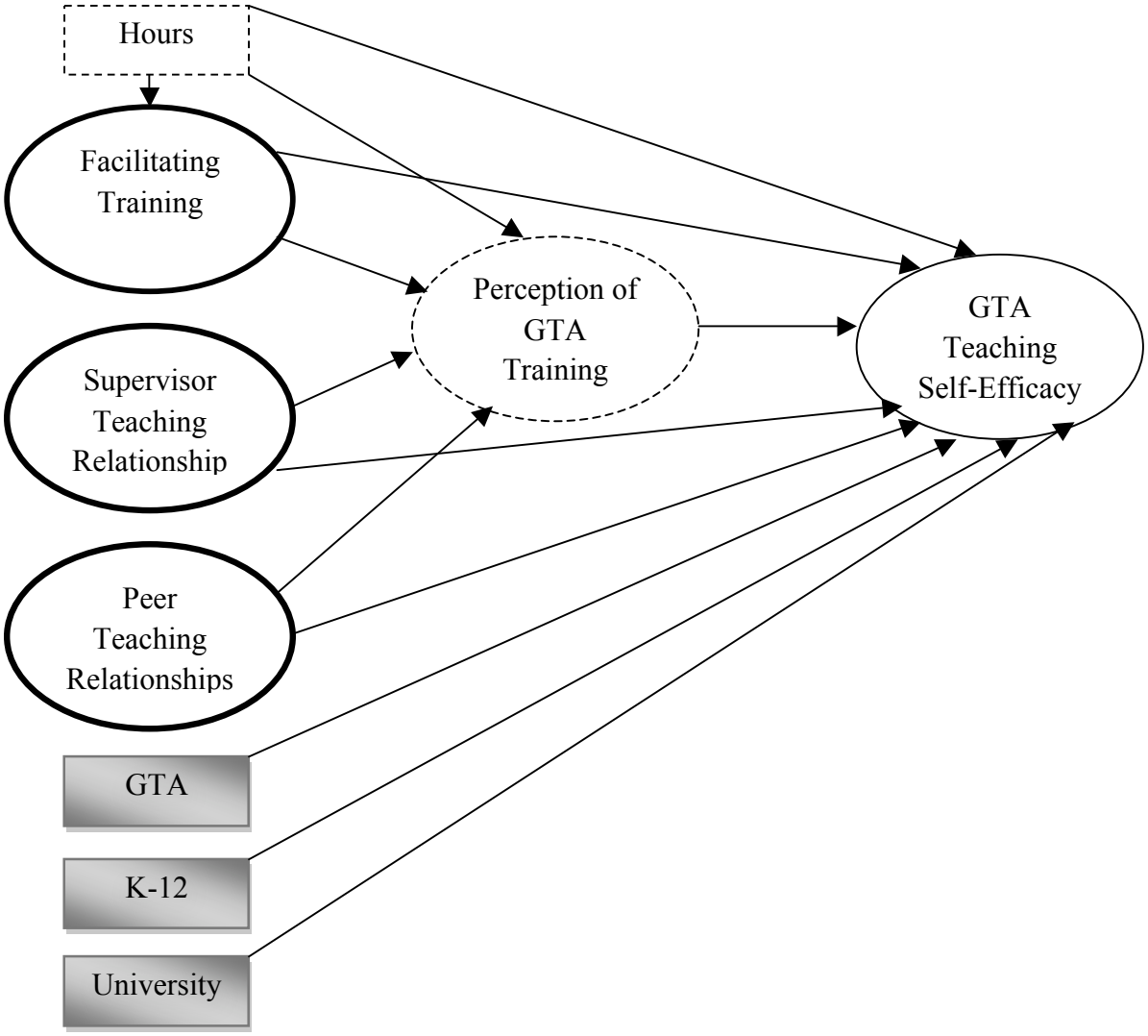

Figure 4.1: Proposed Model of Teaching Self-Efficacy for GTAs
The grey ovals and boxes are teaching experience. The dashed boxes and oval are GTA training. The heavy solid lines are departmental teaching climate factors.

Departmental Teaching Climate

GTA training can not affect the teaching self-efficacy of GTAs or greatly improve their teaching effectiveness unless there are factors in the department that facilitate the transfer of training to teaching in the classroom (Notarianni-Girad, 1999).

GTAs are most satisfied with their GTA training when those training methods relate directly to the practice of teaching (Prieto & Scheel, 2008). The GTAs also find the most support from the department when it provides support for new ideas, GTA training, and provides resources and time to support the GTA training. These department resources facilitate the transfer of the information learned in GTA training into the classroom (Notarianni-Girad, 1999). Although the effect of these facilitating GTA training factors in the department climate have not yet been linked to teaching self-efficacy for GTAs, similar items do predict teaching self-efficacy in K-12 teachers (Tobin, Muller, & Turner, 2006). In Figure 4.1 these relationships are indicated. The facilitating GTA training factors in the departmental teaching climate directly predicts the GTAs teaching self-efficacy. However, it is also a partial mediator of the hours of training the GTAs receive and is itself partially mediated by the GTAs perception of their training.

A departmental relationship that could affect the teaching self-efficacy of GTAs is that with their supervisor. Supervisors could provide verbal persuasions in the form of support and encouragement of the GTAs. Additionally, the feedback they provide on the GTAs' teaching should help the GTAs process their mastery experiences during teaching. Studies indicate that most GTAs have supervision, usually from faculty (Prieto, 1999; Prieto & Meyers, 1999; Prieto et al., 2007). There are also indications that the supervision varies highly in quality and helpfulness (Notarianni-Girad, 1999; Prieto, 1999). In a regression analysis of GTAs from across a university, a positive supervisor relationship is the most powerful predictor of an

academic career (Bomotti, 1994). So, the relationship that the GTA has with their supervisor can affect their interest in teaching. Using psychology GTAs who had classroom interactions with students, Prieto & Meyers find there is no effect for ongoing supervision on the teaching self-efficacy of GTAs. But, when looking at the teacher self-efficacy literature, there is support for the effect of supervision on self-efficacy (Sutton & Fall, 1995).

In a study of effects of supervision and GTA training on teaching self-efficacy, Prieto et al. (2007) find complex effects and interactions with GTA training on GTA teaching self-efficacy. In a group of GTAs from across a university, Prieto et al. find that there is a difference in the teaching self-efficacy by level of responsibility and that influences what affects teaching self-efficacy. For the group of students without main responsibility for a class (graders and assistants) supervision and GTA training had no effect on teaching self-efficacy. However, with the group of GTAs primarily responsible for teaching a class, there are significant interaction effects for GTA training and supervision on teaching self-efficacy. When looking at those interactions, it is apparent that either GTA training or supervision alone produces higher teaching self-efficacy than having both. However, having neither is associated with the lowest levels of teaching self-efficacy. This might be because of contradictory messages being received about teaching from supervisors versus GTA training or it might simply be information overload. Using these studies it is probable that supervisor teaching relationships could affect the GTA's teaching self-efficacy (Figure 4.1). It is

also likely, given the results from Prieto et al., that the supervisor relationship on teaching self-efficacy could be mediated by their GTAs' perception of their training.

Another group that makes up the department's teaching climate is the other GTAs, the peer group that the GTA interacts with. Although in the GTA literature the effect of the peer group on teaching self-efficacy has not been studied, there is evidence from the teacher literature that it does. Research into factors that evoke teaching self-efficacy is just beginning in the teaching literature, but Tschannen-Moran and Hoy (2007) investigate antecedents to teaching self-efficacy in novice and experienced K-12 teachers. They find support of colleagues among the significant predictors for teaching self-efficacy in novice teachers, which they defined as three or less years of teaching experience. GTAs are like novice teachers in that they do not have extensive teaching mastery experiences to draw upon to form their teaching self-efficacy and are more likely to be affected by other sources of teaching self-efficacy such as verbal persuasions (from their peers or supervisors).

There is also evidence that strong peer support is a component in improving the teaching of GTAs (and thus should affect their teaching self-efficacy). GTA training programs with a large peer mentoring component are effective at producing effective GTAs (Davis & Kring, 2001; K. S. Smith & Simpson, 1993). These relationships are shown in Figure 4.1. The possible effect of peer teaching relationships on GTA teaching self-efficacy is given. Additionally, the effect of peers could easily be mediated through the GTAs perceptions of their training since they take that training with their peers.

Teaching Experience

Prior teaching experience generally has a positive effect on GTA's teaching self-efficacy. Tollerud (1990) finds that the teaching self-efficacy of the psychology GTA's significantly differ by the number of semesters that the GTAs have taught. Those with five or more semesters of teaching experience have a significantly higher teaching self-efficacy than those with no or one to two semesters of experience. However, prior professional teaching experience did not significantly affect the teaching self-efficacy of the GTAs.

GTA teaching experience has also been shown to be correlated to GTA teaching self-efficacy. In a study of psychology students from across the US, Prieto and Meyers (1999) find that there is a small correlation between teaching self-efficacy and GTA teaching experience (r=.18). With GTAs from across a university, the correlation between teaching self-efficacy and GTA teaching experience is .25 (Prieto & Altmaier, 1994). In a regression analysis of these GTAs, teaching experience is the only significant variable, accounting for 5% of the variance with a beta coefficient of .25. GTA training, gender, career plans, and race are not significant. However, one study, using a different measure of GTA teaching self-efficacy, did not find a correlation between teaching self-efficacy and GTA teaching experience (DeChenne & Enochs, 2010).

There are interesting effects of teaching experience and teaching self-efficacy related to the level of responsibility the GTA has in the classroom. Prieto et al. (2007) find that among GTAs from across a university there is an overall correlation between

GTA teaching experience and teaching self-efficacy (r=.26). However, when the GTAs are divided into two groups by their level of responsibility in the classroom, the effects of teaching experience differ. In the group of GTAs that have primary responsibility for a course there is no significant effect for GTA teaching experience. However, in the group of GTAs that have grading or assistant instructor duties, there is a significant positive effect of GTA teaching experience on their teaching self-efficacy. The authors speculate that the current experiences of being completely responsible for a course are affecting their teaching self-efficacy more than their past teaching experience as a GTA.

Social cognitive theory indicates that enactive mastery experiences (i.e., teaching experience in this context) will affect self-efficacy. Positive teaching experiences with good feedback from both the students and supervisors should provide an increase in the teaching self-efficacy of the GTAs. If the GTAs students are academically achieving that should increase the teaching self-efficacy of the GTAs. However, the converse is also true. Therefore, it is expected that GTA teaching experience will affect the GTA teaching self-efficacy (Figure 4.1). Despite the lack of correlation in Tollerud's (1990) original study, theory indicates that having prior professional experience, as either a K-12 or college/university teacher, should provide similar enactive mastery experiences and affect GTA teaching self-efficacy, so those are also included in the model (Figure 4.1).

Methods

To test the hypothesized relationships in the model (Figure 4.1), we used the participants, administration, measures, and data analysis procedures described below.

Participants

The participants for this study were 129 STEM GTAs at a Pacific Northwest university with a Carnegie basic classification of RU/VH (Research Universities with Very High research activity). The participants were recruited from four engineering departments, four science departments, and the mathematics department. The engineering departments included Chemical, Biological, and Environmental; Civil and Construction; Electrical and Computer Science; and Mechanical, Industrial, and Manufacturing. The science departments were Chemistry, Geosciences, Microbiology, and Physics. The GTAs were 28% female and 41% international students. Forty-eight percent of the GTAs were in engineering, 12% mathematics, and 40% in the sciences.

Administration

The GTAs were administered the items in a single survey once, near the end of the quarter. In addition to the questions asked above, demographic data including department, gender, primary teaching responsibility (grader, laboratory instructor, recitation/study section instructor, lecturer, course instructor), and degree were collected. Data was collected from Fall 2008 through Fall 2009. One of two administration techniques was used depending on department. The survey was distributed to the GTAs through the department mail system, collected in a sealed

container in the departmental office, and picked up directly by a researcher. Alternatively, the survey was administered during a GTA training class and collected by one of the researchers at that time. There was a reasonable response rate; 186 GTA surveys were returned (57% of GTAs surveyed), eight surveys were not usable and an additional 49 GTAs who had primarily administrative duties such as grading and did not teach in the classroom were not included in the analysis. Mastery experiences were theorized to be important in developing teaching self-efficacy and these GTAs had no classroom experiences to influence their teaching self-efficacy so they were removed. Additionally, prior research supported differential teaching self-efficacy for different levels of responsibility of the GTAs (Prieto & Meyers, 1999; Prieto et al., 2007).

Measures

Factors and variables in this study included GTA training, teaching experience, departmental teaching climate factors (facilitating GTA training factor, supervisor teaching relationship, peer teaching relationships), and teaching self-efficacy. All items were measured on five point scales.

GTA training. There were two measures of GTA training – hours of training in teaching and GTA perception of their teaching training. Participants were asked to indicate how many hours they had in university-wide and departmental GTA training. Additionally, they were asked how many hours of college coursework in teaching they had taken. These three were summed to compute the total hours of teaching training.

The GTAs' perceptions of their teaching training was measured with a 17 items that described each GTAs perception of how well they had learned various teaching skills (DeChenne & Enochs, 2010). Fifteen items were scored on a 5 point scale from "never learned" to "learned very well" and included items such as: facilitating group discussions, motivating students, managing disruptive students, and grading. Two items asked about overall effectiveness of TA training in teaching and "preparing them to work with students." These items were scored on a 5 point scale from "not effective" to "very effective." In a prior study, of which these GTAs were a subset, confirmatory factor analysis indicated that these items were one factor[1] with a reliability of .96 (DeChenne & Enochs, 2010). Reliability of GTA perception of teaching training with these participants was .95 with corrected item total-item correlation ranging from .63 to .81.

Teaching Experience. There were three measures of teaching experience in this study – GTA teaching, K-12 teaching, and college or university teaching. GTAs were asked how many quarters and semesters they had of GTA teaching experience. Since many GTAs had taught at more one than one institution, both types of experience were measured. Semester experience was multiplied by 1.5 and added to the quarters of experience to achieve the quarters of GTA teaching experience. GTAs were also asked how many years of experience they had teaching at the K-12 level and as a community college, college, or university instructor (not including their GTA experience). Few GTAs had other teaching experience; 9.4% of the GTA population had experience at the K-12 level and 12.6% had taught outside their roles as a GTA at

the college level. Both of these variables were recoded as dichotomous, yes/no, variables.

Departmental Teaching Climate – Facilitating GTA Training Factor. This measure was developed from a study on whether departments utilize transfer of training principles when training their GTAs (Notarianni-Girad, 1999). In this study, facilitating variables affecting transfer of GTA training in the department were investigated; these were then adapted for the STEM GTA context. Five items were initially included in the measure. Reliability analysis of the five items was .63. However, corrected item-total item correlations indicated that dropping one item would improve the reliability. The final corrected item-total item correlations ranged from .37 to .49 and the reliability was .66. This indicated that the items were measuring the same concept and justified combining items into a single factor (Cortina, 1993). In an additional justification that these items measure one factor, a confirmatory factor analysis (CFA) of the four items had a good fit (NNFI=.925, CFI=.975, RMSEA=.075). The final four items were measured on 5 point scales from "strongly disagree" to "strongly agree". The items were:

1. The department is supportive of innovations that TAs wish to try in their teaching.
2. The department encourages TAs to experiment with newly learned teaching methods.
3. The department provides sufficient resources for me to be successful in carrying out my job (e.g., equipment, secretarial help, mentors, etc.).

4. The department provides sufficient time to use newly learned teaching skills.

Department Teaching Climate – Supervisor Teaching Relationship. This was measured using the Collegial Leadership dimension of the Organizational Climate

Table 4.1
Confirmatory Factor Analysis of Supervisor Teaching Relationship and Peer Teaching Relationships in the Departmental Teaching Climate

	Factor Loadings	
Items[1]	Supervisor Teaching Relationship Factor[2]	Peer Teaching Relationships Factor[3]
The supervisor is willing to make to make changes.[6]	,82	
The supervisor puts suggestions made by the GTAs into operation.	.80	
During meetings the supervisor explores all sides of a topic and admits that other options exist.	.69	
The supervisor treats all GTAs equitably.[5]	.69	
The supervisor is approachable and friendly.[5, 6]	.65	
The supervisor lets GTAs know what is expected of them.[4]	.63	
The supervisor maintains definite standards of performance for the GTA.[4]	.53	
GTAs in this school exercise professional judgement.		.75
GTAs respect the teaching competence of the other GTAs.		.69
GTAs "go the extra mile" with their students.		.69
GTAs accomplish their jobs with enthusiasm.[7]		.65
The interactions between the GTAs are cooperative.[8]		.63
GTAs provide strong social support for other TAs.[7, 8]		.62
GTAs help and support each other.		.38
Cronbach α	.88	.83

[1] Items coded on a 5 point scale of 1=rarely occurs to 5=very frequently occurs.
[2]All factor loadings are significant at $p<.05$. Model Fit indices are NNFI=.929, CFI=.963, RMSEA=.074.
[3]All factor loadings are significant at $p<.05$. Model Fit indices are NNFI=.955, CFI=.974, RMSEA=.054.
[4-8]Errors allowed to covary to achieve fit indices.

Index (Hoy, Smith, & Sweetland, 2002/2003); adapted for STEM GTAs by replacing principal with "supervisor" and "faculty" with "GTAs." The supervisor teaching

relationship was the degree that the supervisory style was open and collegial with clear expectations for performance of the GTAs (Table 4.1). Hoy et al. reported a reliability of .94 with a population of high school teachers. Given that this was a different population and context to the study reported here, and the items were slightly modified, a CFA was conducted on this population and the index demonstrated a good fit (NNFI=.929, CFI=.963, RMSEA=.074). Reliability of this measure with this population was .88 with corrected item total-item correlations ranging from .54 to .74. None of the items were dropped from this measure.

Department Teaching Climate – Peer Teaching Relationships. This was a measure from the Professional Teacher Behavior dimension of the Organizational Climate Index (Hoy et al., 2002/2003); adapted for STEM GTAs by replacing "teachers" with "GTAs." The peer teaching relationships were respectful, student supportive, and provided mutual cooperation and support among the GTAs (Table 4.1). Hoy et al. found a reliability of .88 with a population of high school teachers. Given that this was a different population and context to the study reported here, and the items were slightly modified; a CFA was done on this population and it demonstrated a good fit (NNFI=.955, CFI=.974, RMSEA=.054). Reliability of this measure with this population was .83 with corrected item total-item correlation ranging from .45 to .64. None of the items were dropped from this measure.

GTA Teaching Self-Efficacy. This was a measure from the teaching self-efficacy instrument for STEM GTAs (DeChenne & Enochs, 2010) that contained 15 items asking GTAs how confident they were in their abilities to do various teaching

tasks. Examples included "promote my students' confidence in themselves" and "appropriately grade my students' exams/assignments." The items were measured on a five point scales from "not at all confident" to "very confident." In the prior study, of which these GTAs are a subset, confirmatory factor analysis indicated that these items had a second-order factor structure and measured an overall concept of teaching self-efficacy[2] (DeChenne & Enochs, 2010). Reliability of teaching self-efficacy with these participants was .89 with corrected item total-item correlation ranging from .45 to .64. None of the items were dropped from this measure.

Data Analysis

As a first step in the analysis, all of the latent factors were created by computing mean composite indices for each factor (perception of GTA training, facilitating GTA training, supervisor teaching relationship, peer teaching relationships, and GTA teaching self-efficacy). Descriptive data was calculated and then correlational analysis was conducted on all latent factors and variables. Given the relatively small sample size (n=129), ordinary least squares regression path analysis was used instead of structural equation modeling to test the hypothesized paths in the model (Figure 4.1). Significant factors were retained in the path model and regressions were rerun to determine final adjusted R^2 and standardized regression coefficients (i.e. β). Fully mediated factors or variables were also regressed to predict teaching self-efficacy and were only kept in the path model if they predicted both the mediator and teaching self-efficacy.

Results

Descriptive Statistics and Correlations

All of the variables and factors measured in this study showed a range of values (Table 4.2). Consistent with the previous chapter, the teaching self-efficacy of STEM GTAs was high. The average of teaching training was 23 hours, but the median was 13 hours. The 23 hours includes 9% of the sample who had been K-12 teachers and had many more hours of training in teaching. GTAs felt they had learned the teaching skills taught in their training moderately well. It appeared that the departmental teaching climate was relatively collegial and did contain elements that facilitated the teaching training the GTAs received. Most of the GTAs had at least a year of teaching experience.

Table 4.2
Descriptive Statistics for Variables and Factors

Scales[1]	Mean	Median	St. Dev.	Minimum	Maximum
GTA Teaching Self-Efficacy	4.11	4.10	.53	2.47	5.00
Hours of GTA training	22.76	13.00	37.20	0	295[2]
Perception of GTA training	3.11	3.21	.99	1.00	5.00
Departmental Teaching Climate					
Facilitating GTA Training Factors	3.39	3.50	.74	1.75	5.00
Supervisor Teaching Relationship	3.89	4.00	.75	1.14	5.00
Peer Teaching Relationships	3.77	3.86	.72	1.00	5.00
Teaching Experience					
Quarters GTA	5.39	4.00	5.11	1.00	31.00
Years K-12	.09	0	.29	0	1.00
Years University	.13	0	.33	0	1.00

[1]All scales were rated on a scale of 1 to 5, with 5 being the best in each scale.
[2]Includes college coursework in teaching for a teaching license.

Not all of the correlations were consistent with the hypothesized relationships to GTA teaching self-efficacy (Table 4.3, Figure 4.1). The only teaching experience that was significantly positively correlated with teaching self-efficacy was K-12

teaching experience (r=.19, p<.05) neither GTA nor university teaching experience were significant. The remaining correlations were statistically significant and supported hypothesized relationships to GTA teaching self-efficacy. Both hours of

Table 4.3
Correlational Analysis of STEM GTAs Teaching Self-Efficacy, GTA Training, Teaching Experience, and Departmental Teaching Climate

Scales[1]	GTA TSE[2]	A	B	C	D	E	F	G
A. Hours of GTA training	.24**							
B. Perception of GTA training	.33**	.22*						
Departmental Teaching Climate								
C. Facilitating GTA Training Factors	.36**	.21*	.38**					
D. Supervisor Teaching Relationship	.27**	-.07	.33**	.46**				
E. Peer Teaching Relationships	.21**	.06	.25**	.40**	.71**			
Teaching Experience								
F. Quarters GTA	.12	.04	-.01	.09	.02	-.15		
G. Years K-12	.19*	.12	-.07	-.12	-.07	-.07	.01	
H. Years University	.11	-.04	.01	-.03	.02	.05	.18	.14

*p<.05 (2 tailed), **p<.01 (2-tailed)
[1]All scales were rated on a scale of 1 to 5, with 5 being the best in each scale.
[2]GTA Teaching Self-Efficacy

GTA training and the GTAs perception of their GTA training were positively correlated (r=.24 and r=.33, p<.01) to GTA teaching self-efficacy. All three of the department teaching climate factors were also significantly positively correlated to GTA teaching self-efficacy (p<.01) – facilitating GTA training factor (r=.36), supervisor teaching relationships (r=.27), and peer teaching relationships (r=.21). All of the hypothesized relationships with the GTAs perception of their GTA training were also positive and significant –hours training (r=.22, p<.05), facilitating GTA training factors (r=.38, p<.01), supervisor teaching relationship (r=.33, p<.01), and peer teaching relationships (r=.25, p<.01). The final hypothesized relationship, between hours of GTA training and the facilitating GTA training factor was also positive and significant (r=.21, p<.05).

Path Analysis

The hypothesized relationships (Figure 4.1) were tested with three regression equations. In the first regression equation, K-12 teaching experience, perceptions of GTA training, and the facilitating GTA training factor were significant predictors of GTA teaching self-efficacy (F=11.397, p<.001). In the second regression equation, hours of GTA training, supervisor teaching relationship, and the facilitating GTA training factor were significant predictors of perception of teaching training (F=11.801, p<.001). In the third regression equation, hours of training was a significant predictor of the facilitating GTA training factor (F=4.714, p=.032). Although the peer teaching relationships factor was correlated with GTA teaching self-efficacy, it was not a significant predictor in any of the regression equations.

The final model of factors influencing GTA teaching self-efficacy was summarized in Figure 4.2. All of the paths shown in the model were statistically significant at p<.05. With this population, GTA teaching self-efficacy was directly influenced by the GTA perception of training (β=.24, p=.008), K-12 teaching experience (β=.24, p=.005), and the facilitating GTA training factor (β=.30, p=.001). Taken together, these three factors collectively explained 23% of the variance GTA teaching self-efficacy. GTA perception of training significantly was predicted by hours of training (β=.19, p=.030), supervisory teaching relationship (β=.24, p=.014), and facilitating GTA training factor (β=.23, p=.020). These three factors explained 21% of the variance in GTA perception of training. Finally, hours of GTA training was related to the facilitating GTA training factor (β=.19, p=.032), explaining 4% of

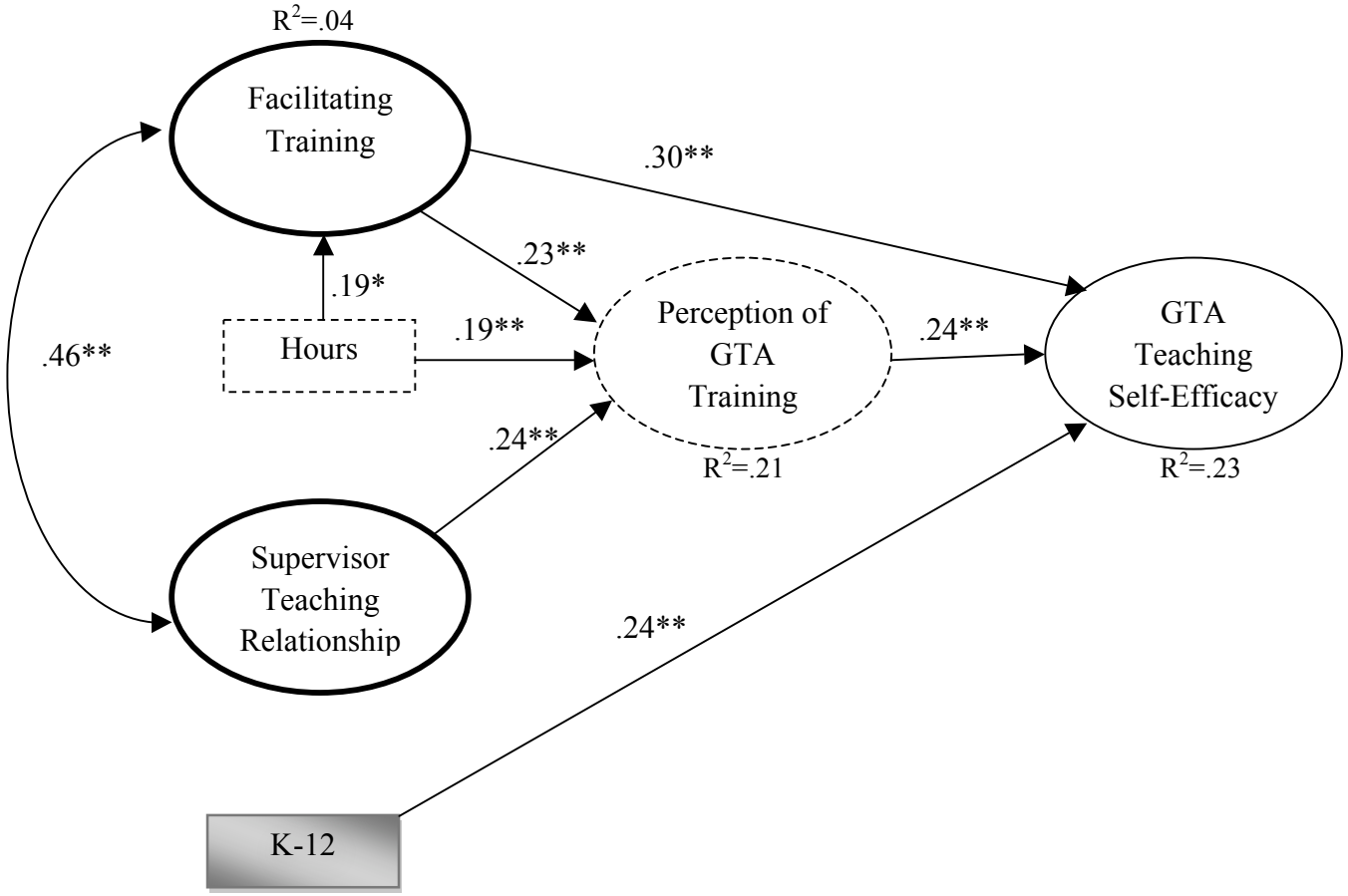

Figure 4.2: Model of Teaching Self-Efficacy in STEM GTAs *p<.05, **p<.01, Path coefficients are standardized regression coefficients. The grey ovals and boxes are teaching experience. The dashed boxes and oval are GTA training. The heavy solid lines are departmental teaching climate factors.

the variance in that factor. The facilitating GTA training factor and supervisor teaching relationship were also moderately correlated (r=.46, p<.01).

Conclusions

In this study of STEM GTAs, teaching self-efficacy appears to result from a number of factors within the climate the GTA works in and from prior experience in teaching. It is directly affected by facilitating factors in the department, the GTAs

perception of their training, and K-12 teaching. The GTAs perception of their GTA training, their feeling of how well they learned various teaching skills is a mediator of the department climate factors, facilitating GTA training factors, and supervisor teaching relationships, as well as the hours spent in GTA training. From a theoretical perspective, the more time spent in training or learning a skill the higher the self-efficacy for that skill. GTA training should provide verbal persuasion experiences and vicarious experiences both of which will enhance teaching self-efficacy. The facilitating GTA training factors provide support for the GTA to put their training into effect in the classroom. Similar support resources are shown to affect the teaching self-efficacy of K-12 teachers (Tobin et al., 2006; Tschannen-Moran & Hoy, 2007).

Another interesting result is the lack of effect for GTA teaching experience on GTA teaching self-efficacy. Prior research with GTAs mostly shows that prior GTA teaching experience has a positive correlation with teaching self-efficacy (Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007; Tollerud, 1990). Results here, with GTA teaching self-efficacy, mirrors the finding of Shannon et al. (1998), that GTA teaching experience does not impact the teaching effectiveness of the GTAs, only college or K-12 teaching experience does. This is similar in this sample with STEM GTAs, where GTA teaching experience does not affect teaching self-efficacy but K-12 teaching experiences do. Presumably the K-12 experiences did provide some mastery experiences for the STEM GTA, as has been shown with both novice and experienced teachers (Tschannen-Moran & Hoy, 2007).

Most of the prior studies were done with psychology students or if they were done using GTAs from across the university, a large portion of the sample was from the liberal arts. The teaching styles and classroom experiences of the STEM GTAs are different from the liberal arts (DeChenne et al., 2009; Golde & Dore, 2004; Lindblom-Ylanne et al., 2006; Torvi, 1994; Verleger & Velasquez, 2007). In Prieto et al. (2007) the only group that does not exhibit a positive effect for GTA teaching experience is the group primarily responsible for a course, but in that same study the graders and assistant group's teaching self-efficacy is only predicted by GTA teaching experience. This second group would be more like the STEM GTAs, although the STEM GTAs are all in the classroom; only 5% of the sample indicated that they were completely responsible for a class. Instead, these STEM GTAs are leading recitation or discussion sections, teaching laboratories, or lecturing in a class under the control of a faculty member. It is possible that the STEM GTA teaching experiences of these graduate students are not providing the mastery experiences that social cognitive theory would predict. In a model of the cyclical nature of teaching self-efficacy, is important that the sources of efficacy need to go through cognitive processing (Tschannen-Moran et al., 1998). Although, the GTA teaching experience should be giving the GTAs a sense of their accomplishments as a teacher, it is possible that there is little or no feedback to the GTA about how well they are teaching. Therefore, there is little chance for the STEM GTA to process mastery experiences because the actual GTA teaching experience is not providing them. In this sample, for example, at least

38% of the GTAs had little or no feedback on their teaching. The department did not even have the students evaluate their GTAs.

The STEM GTA model (Figure 4.2) does help explain the complex interaction effects Prieto et al. (2007) sees between GTA training and supervision. They look at GTA training and supervision as dichotomous variables. When looking at the model it is evident that a STEM GTA's teaching self-efficacy is affected both by supervision and training, but both of those are mediated by the GTAs' perception of their training. Additionally, the hours of training is mediated by the facilitating GTA training factors in the department, which is correlated to the supervisor teaching relationship. Given this complex interaction between supervision and training, a simple test of each on GTA teaching self-efficacy holding the other constant (as is done in the Prieto et al. study) does not elucidate the relationship well. The supervisors are part of the faculty that set the departmental standards and provide the resources for GTA training and transfer of that training into the classroom. Therefore, the two factors are intimately intertwined in the development of a STEM GTA's teaching self-efficacy and ultimately their teaching effectiveness.

It is hypothesized that peer teaching relationships in the departmental teaching climate would also have an effect on STEM GTA teaching self-efficacy. There is a minimal (Cohen, 1988) correlational relationship (Table 4.3). However, peer teaching relationships are not significant in any of the hypothesized paths (Figures 4.1 & 4.2). This result is somewhat puzzling. There is some relationship between teaching self-efficacy and peer teaching relationships, but in this study it is not

predictive of teaching self-efficacy. Peer teaching relationships are above average (Table 4.2) and these positive behaviors (Table 4.1) would seem to occur with some frequency in the STEM environment. The items used to measure this factor would be most likely to provide verbal persuasions in the development of the STEM GTAs teaching self-efficacy. However, the amount of verbal persuasions available from the peer teaching relationships may not be enough to be a significant predictor of STEM GTA teaching self-efficacy with these GTAs.

Discussion

In this section the limitations of this research are discussed, as well as implications for the training of GTAs and directions for future research. There are several possible limitations in this study relating to nature of participant selection, sample size, lack of generalizability, and the use of a self-reporting instrument. All of the departments with large numbers of STEM GTAs in both colleges were invited to join the study. Nine of the ten departments joined the study. The amount of cooperation and support provided in data collection in each department varied greatly. Some departments made participation in the survey mandatory (although all GTAs were allowed to refuse to join the study) and were active in recruiting and collecting data, some strongly encouraged their GTAs and helped in data collection, and some simply asked their GTAs to participate and provided little help in data collection. No department had 100% of its GTAs participate, but there was higher participation in those departments that provided more support and thus the results may reflect a more supportive department teaching climate than is common.

The study had 129 STEM GTA from the nine departments participating in the study. This sample size limited the data analysis to regression path analysis instead of the use of structural equation modeling, which would be a more sensitive analysis approach. Additionally, this study was not designed to be generalizable to a population, because of the relatively small population of STEM GTAs teaching in a classroom even at a medium-sized research institution, a population survey was done. Therefore, these results may not represent STEM GTAs at a different type of institution. Finally, the survey that measured the factors and variables in this study was a self-reporting instrument. In this case, the participants may not be reading all the questions with the same meaning as the researcher intended.

Implications for Training GTAs

The results of this study and social cognitive theory provide some suggestions for improving the teaching and training of STEM GTAs. It is important for there to be consistent messages about teaching in the departmental climate; feedback on teaching is important, and the sources of self-efficacy should be considered when designing GTA training. With the interactions between the supervisor relationships, GTA training, and facilitating GTA training factors in the department, it is especially important that each one supports the efforts of the others. Faculty who are training the GTAs and faculty who are supervising the GTAs need to work together to provide consistent messages about the importance of teaching. They also need to coordinate efforts in providing feedback on teaching and consistent messages about how the best teaching occurs within their discipline. If all the faculty members involved with the

STEM GTAs are giving consistent messages about teaching to the GTAs then their teaching self-efficacy should be higher than if their trainers, teaching supervisors and even research supervisors are giving conflicting messages about teaching. Faculty in a department who work with GTAs should all know what are the departmental beliefs about good teaching and give consistent messages to the GTAs.

Mastery experiences are the most effective developers of self-efficacy. However, this process works through the cognitive processing of feedback on performance in the mastery experience. Therefore, STEM GTAs need consistent, thoughtful, and helpful feedback. Sources of feedback about their teaching can come during GTA training and supervision. Microteaching experiences with thoughtful feedback from the instructor provide the GTA with a way to evaluate what they are doing and where they can improve. Additionally, if the microteaching is performed in front of peers (other STEM GTAs) then the peers can also provide feedback. This also activates vicarious learning, (i.e. peer STEM GTAs watch someone else perform teaching skills). While the GTA is in a teaching experience, feedback from supervisors on their performance is crucial. This continues to provide the STEM GTA with the information they need to process their teaching experiences and allows the supervisor to use some well placed verbal persuasions. Student feedback, usually in the form of student evaluations, should also be provided for the STEM GTAs. Supervisors should go over the feedback with the STEM GTA, helping them understand how to interpret student feedback to gain the most use in improving their teaching. If there is a supportive departmental teaching climate, then when the STEM

GTA is having problems with students or in their teaching skills, they can go to their GTA training instructors, supervisor, or even their peers and resolve the problem, thus improving their teaching self-efficacy and their teaching effectiveness.

When designing GTA training programs, a thorough study of the sources of self-efficacy should be done and then incorporated into the program. The program should be designed with multiple mastery experiences such as microteaching and videotaping of teaching with constructive feedback. Social cognitive theory indicates that self-efficacy is improved the most when the experiences are at the edge of the person's capabilities. The microteaching and videotaping exercises should increase in difficulty throughout the GTA training.

Self-efficacy takes time to change and develop, therefore GTA training should not be compressed and condensed into a few days before the first term of teaching without any follow-up training. Instead, seminar training experiences that will allow the GTA to process what they are experiencing during their teaching in a supportive environment will provide the STEM GTA with verbal persuasions during critical periods. Some type of training experience should be included for at least the first semester if not the whole first year. Grouping GTAs teaching the same course within this training and then providing them with time and exercises related directly to the problems and content specific to that course would also provide plenty of vicarious experiences and verbal persuasions relating directly to the course the GTAs are teaching.

The GTA training should include peer mentoring to give the STEM GTAs some models closely associated with themselves and provide increasing responsibilities for the peer mentors. Vicarious experiences have the best effects on teaching self-efficacy when the model most closely resembles you. Peer mentors could provide vicarious experiences by having the STEM GTAs watching them teach, they could also provide verbal persuasions by being available for the STEM GTAs to talk with when they are encountering a problem. Finally, increasing teaching responsibilities should be incorporated into the teaching experience. For teaching self-efficacy to continue to develop the GTAs need to be exposed to new teaching skills and more responsibility for the course in which they are assisting. Peer mentorship could also provide this need for increasing responsibility for some of the best of the trained and experienced GTAs. As they provide mentorship in teaching to inexperienced GTAs they themselves will be learning more about teaching, which should also increase their self-efficacy in teaching.

Future Research

Further research should be done on the effects and predictors of STEM GTAs teaching self-efficacy as well as designing better measures for the sources of teaching self-efficacy. The link between teaching effectiveness, student achievement, and teaching self-efficacy is well established in K-12 teaching. However, they are not yet established in GTAs. This is difficult to do, especially since STEM GTAs rarely are completely responsible for a course. Therefore, it can be difficult to determine what effect the GTAs teaching self-efficacy has on student achievement. However, studies

that link STEM GTA teaching self-efficacy to various positive teaching behaviors will strengthen the link in STEM GTAs between teaching self-efficacy and teaching effectiveness. Use of individual observation, such as the Reformed Teaching Observation Protocol (Swada et al., 2002) or OCEPT-Teacher Observation Protocol (Wainwright, Flick, & Morrell, 2003), combined with measuring the STEM GTAs teaching self-efficacy could tighten the link between teaching self-efficacy and teaching effectiveness.

Although some of the sources of teaching self-efficacy in STEM GTAs are known, there are many questions still needing to be answered. What is the relationship that peers have to STEM GTA teaching self-efficacy? What other factors in the GTAs' environment or within their person contribute to their teaching self-efficacy? How do prior teaching experiences, GTA or otherwise, effect STEM GTA teaching self-efficacy? Although it is possible to mine the K-12 teaching for some ideas about the factors that can affect teaching self-efficacy, it is important to remember that STEM GTAs are in a fundamentally different environment. They are teaching as part of their graduate student experience, not for a living. In fact, they may not want to teach for a living; 30% of the population in this study indicates no interest in academics as a career. Golde and Dore (2001) report that across disciplines 37% of doctoral students are not interested in an academic career. STEM GTAs particularly have many other opportunities outside of academics for employment; 57% of molecular biology and 67% of chemistry doctoral students are not interested in an

academic career (Golde & Dore, 2001). Therefore, how do personal motivations for teaching affect teaching self-efficacy?

In theory, mastery experiences contribute the most to self-efficacy, yet in this study GTA teaching experiences did not correlate with or predict STEM GTA teaching self-efficacy. Is there a better way to measure how well the GTA teaching experience is providing mastery experiences? Teaching experience has been used as a proxy for mastery experiences but it doesn't necessarily have to provide those experiences. A measure of the actual amount of feedback given to the STEM GTAs would probably be a better proxy for mastery experiences than a simple measure of time spent in GTA teaching. This measure needs to be developed. Additionally, are there other measures for the departmental climate? What about inhibiting factors within the department related to teaching? Is there a better measure of supervision and peer interactions?

As we continue to research STEM GTA teaching self-efficacy it is important to keep in mind the special environment in which the STEM GTA teaches. We need to be cognizant of the specific needs of the STEM GTAs. Finally, it is important to remember how important the faculty effects are on the teaching self-efficacy of STEM GTAs.

Endnotes

[1]With this subset of GTAs, CFA also indicated one factor from these 17 items (NNFI=.911, CFI=.923, RMSEA=.090, covarying the same error as in the prior research).

[2]With this subset GTAs, CFA also indicated one second-order factor from these 15 items (NNFI=.905, CFI=.920, RMSEA=.065, covarying the same errors as in the prior research).

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CHAPTER V

CONCLUSION

CONCLUSION

What have we learned about our two hypothetical chemistry GTAs from the first chapter? Given the previous chapters' information, we can now make some educated guesses about them. The first GTA, the young popular female GTA, is comfortable with her students and in her role as GTA, but has not learned how to teach. Likely, she has not received adequate preparation in teaching and is probably not receiving feedback from her supervisor about her instruction. Therefore, given that the students like her, she is most likely convinced that she is a good GTA. She doesn't get student complaints and does her job so she is considered a good GTA even by her supervisor. The male Chinese GTA may also be considered a good GTA. His students may complain, but he is a good student and appears to do his job well, so the student complaints are not considered a problem. The students are not as happy with the Chinese GTA and think it is because he doesn't speak English well, when actually they are reacting to a complete set of alternative cultural expectations of teaching and learning. In both cases, there is no one tracking their performance so there isn't even an understanding of the differences in their teaching and its effects on student learning. Both GTAs are immersed in the same departmental teaching climate and received a similar short, procedural, teaching training, but no in-depth learning about teaching or feedback about their teaching.

The information used to determine what might be happening with the two GTAs was contained in chapters two through four. The second chapter demonstrated

factors in the literature that affect teaching effectiveness; language and cultural proficiency, GTA training, teaching self-efficacy, and departmental teaching climate. From the second chapter, it was clear that language and cultural proficiency could have an effect on the teaching of STEM GTAs. There was contradictory information in the literature about whether being an ITA had an overall positive or negative effect on teaching and ultimately student achievement. Further testing of those relationships was beyond the scope of this dissertation.

GTA training had the largest amount of literature associated with it. However, much of that literature was descriptive of GTA training programs rather than measuring any effects of GTA training on teaching effectiveness. A problem identified with the GTA training literature that did measure GTA training is that it only measured the training in amount of time or presence/absence of training. When surveying across multiple programs, these types of measures gave no idea of the quality of the training encountered by the GTAs. In the third chapter of this dissertation, a measure of the quality of the GTA training was adapted from previous work by the author (DeChenne et al., 2009) and validated for STEM GTAs. This perception of how well the GTAs learned various teaching skills gave researchers a new measure of GTA training that could better reflect the quality and not just the quantity of the training.

GTA teaching self-efficacy had been previously studied; mostly in psychology GTAs although two studies looked at GTAs across university departments including some STEM GTAs. There were 10% STEM GTAs in the first study (Prieto &

Altmaier, 1994), but the sciences not separated from liberal arts in the second study, although there were 18% engineering GTAs (Prieto et al., 2007). Given that the teaching of STEM is different from the liberal arts and social sciences and that the duties of the STEM GTA are also substantially different a STEM GTA (Golde & Dore, 2001), a college teaching self-efficacy instrument was adapted for STEM GTAs and validated in the third chapter of this dissertation. Like some other measures of teaching self-efficacy (Tschannen-Moran & Hoy, 2001), this instrument had a multi-factor structure. There were two primary factors, self-efficacy for instructional strategies and self-efficacy for creating a positive learning environment. However, these individual factors were determined to have a higher order factor structure that measured STEM GTA teaching self-efficacy. In the fourth chapter, this higher order factor structure of teaching self-efficacy, rather than the individual self-efficacy factors, was used as the dependent measure in the regression modeling analysis. This added a specific measure for STEM GTA teaching self-efficacy for researchers to use in further work on the teaching of STEM GTAs.

The final factor found in the second chapter was the departmental teaching climate. This included the implicit and explicit messages about teaching that the GTA received from their department. The literature suggested that there would be features of the department that would inhibit or facilitate the transfer of the GTA training to the classroom. A measure from the items indicated in the one study of transfer of training (Notarianni-Girad, 1999) was developed for measuring the facilitating features of the department. The literature also indicated that supervision was important in the

teaching of GTAs and indicated the possibility of peers on GTA teaching. Much of the supervision work had been on the effects of supervision on teaching self-efficacy. Again the measure was a simply presence or absence of training. In the fourth chapter, a better measure of the quality of the supervision was adapted from the teacher education literature (Hoy et al., 2002/2003), as was a new measure for peer interaction around teaching from the same source.

All these measures were combined in the fourth chapter to test a part of the model developed in the second chapter, specifically a model of the sources of STEM GTA teaching self-efficacy. In this chapter, it was determined that a strong mediating factor in STEM GTA teaching self-efficacy was the STEM GTA's perception of GTA training. Both departmental facilitating factors and K-12 teaching experience also predicted STEM GTA teaching self-efficacy. STEM GTA's perception of training partially mediated the facilitating features of the department, and completely mediated the hours of GTA training and quality of supervision. This model added to the research on the sources of teaching self-efficacy in GTAs and also indicated possible areas for further research in the sources of K-12 teaching self-efficacy.

An important result of this dissertation was the important affect of the faculty on STEM GTA teaching. The literature search and model development indicated that faculty could be involved in multiple ways in GTA teaching. In the fourth chapter, the direct impact of facilitating factors in the department on STEM GTA teaching self-efficacy indicated faculty importance as did the mediated effect from supervision. Faculty usually provided the GTA training, supervision, and set departmental policies

around GTA teaching. Most of the rest of the literature on GTAs studied one faculty role in GTA teaching. This dissertation looked at complex interactions of faculty on STEM GTA teaching self-efficacy and showed multiple entry points for faculty effects on STEM GTAs.

Another important contribution of this dissertation was on measurement. Almost all of the measures used in the fourth chapter were new to the GTA literature. They contributed to a much richer picture of the sources of STEM GTA teaching self-efficacy than had been previously available. Interestingly, the one measure that was not changed, teaching experience – as a proxy for mastery experiences – did not correlate with STEM GTA teaching self-efficacy as would be expected from the literature (e.g. Prieto & Altmaier, 1994; Prieto & Meyers, 1999; Prieto et al., 2007; Tschannen-Moran & Hoy, 2007). This was probably because the GTA teaching experience was not a good mastery experience for these STEM GTAs. It was quite likely that these GTAs simply did not get enough feedback on their teaching for their teaching experience to have an effect on their teaching self-efficacy. Therefore, a better measure of mastery experiences should be developed, one that included a measure of feedback on teaching.

The practical significance of this dissertation was also important. Most GTA training literature was not grounded in theory. It was often based on empirical trial and error results. This dissertation indicated a theoretical background that could be used to ground GTA training. Social Cognitive Theory (Bandura, 1986) was about explaining why and how human behavior occurs. Teaching was a behavior that could

be explained using social cognitive theory. The theory was used as a basis for the research modeling and could also be used for a STEM GTA training program.

Social cognitive theory indicated that all behaviors were interacting with factors in the person and from the environment. STEM GTA training and the departmental teaching climate were environmental determinants that affected the personal determinant of teaching self-efficacy that was related to teaching behaviors. Since there was a theoretical foundation for the sources of self-efficacy, basing a STEM GTA training program in social cognitive theory would allow understanding of why specific training ideas work well and others don't. Then GTA trainers could weight training toward those experiences that would most positively impact teaching self-efficacy. A STEM GTA training program based in social cognitive theory would include: micro-teaching experiences including videotaping, occur concurrently with the GTA teaching experience, incorporate the GTA's experiences in the classroom including discussions of specific problems in those experiences, peer mentoring, peer feedback, GTA trainer feedback, and GTA supervisor feedback. Finally, this would occur over time (at least one semester), since it takes time to develop teaching self-efficacy and good teaching skills. Social cognitive theory indicated that all of these activities should provide the mastery experiences, verbal persuasions, and vicarious experiences that build self-efficacy.

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APPENDICES

INSTRUMENTS USED IN DISSERTATION

APPENDIX A

VALIDATING INSTRUMENTS FOR GTA TEACHING

A. On page one of the scantron, please enter the name of the department for which you are a teaching assistant (use the spaces labeled your name (last)). To fit in the space, common abbreviations are eng=engineering and dept=department. Where it asks for name (first) please indicate your university with the common abbreviation (eg. Oregon State University is OSU).

B. The questions on these three pages are about your relationship with your peers and your supervisor, teaching in your department, and your confidence in your teaching skills and abilities. Please fill in the corresponding bubble on page 2 of the scantron sheet for each question using a number 2 pencil. Your responses are completely anonymous and cannot be traced to you in any way.

Please rate the occurrence of the statements below on a scale from A to E: A=Rarely Occurs to E=Very Frequently Occurs. Fill in the letter on the scantron that best reflects the occurrence of the statement.

Supervisor refers to the person who is directly involved in supervising the teaching assistants.

GTA refers to graduate teaching assistant. A=Rarely Occurs to E=Very Frequently Occurs

1. GTAs help and support each other.
2. During meetings the supervisor explores all sides of a topic and admits that other opinions exist.
3. The supervisor treats all GTAs equitably.
4. GTAs respect the teaching competence of the other TAs.
5. The supervisor puts suggestions made by the GTAs into operation.
6. GTAs in this school exercise professional judgment.
7. GTAs accomplish their jobs with enthusiasm.
8. The supervisor is friendly and approachable.
9. The interactions between the GTAs are cooperative.
10. The supervisor is willing to make changes.
11. GTAs provide strong social support for other TAs.
12. The supervisor lets GTAs know what is expected of them.
13. The supervisor maintains definite standards of performance for the GTA.
14. GTAs “go the extra mile” with their students.

Please rate your agreement with the statements below on a scale from A to E: A=Strongly Disagree to E=Strongly Agree. Fill in the letter on the scantron that best reflects your agreement with the statement.

Supervisor refers to the person who is directly involved in supervising the teaching assistants.

Department refers to the department in which you are a TA.

A=Strongly Disagree to E = Strongly Agree

15. The department is supportive of innovations that TAs wish to try in their teaching. 16. In the department, when a TA suggests an idea/procedure to enhance teaching, they are discouraged from pursuing them.
17. The department encourages TAs to experiment with newly learned teaching methods. 18. The department provides sufficient resources for me to be successful in carrying out my job (eg. equipment, secretarial help, mentors, etc.)
19. Constantly changing teaching policies/procedures make it difficult for me to implement ideas learned in TA training. 20. In the department, TAs have freedom to conduct their teaching as they wish.
21. The department prefers that TAs use teaching strategies with which the department is familiar. 22. TA work in the department is often postponed until the last minute.
23. The department provides sufficient time to use newly learned teaching skills. 24. In the department, rules/administrative details make it difficult for new ideas of TAs to receive consideration.

For the following question, please select the best answer.

25. What is your most common/primary teaching role?	A=laboratory instructor B=recitation/study section instructor C=grader D=lecturer E=course instructor

Please indicate how confident you are in your ability to accomplish the stated activities, from A=no confidence to E=complete confidence. Fill in the letter on the scantron that best reflects your confidence level.

How confident am I in my ability to…

A=No Confidence to E=Complete Confidence

26. Specify the learning goals that I expect my students to attain?
27. Actively engage my students in the learning activities that are included the teaching plan/syllabus?
28. Create a positive classroom climate for learning?
29. Promote student participation in my classes?
30. Prepare the teaching materials I will use?
31. Promote a positive attitude towards learning in my students?
32. Evaluate accurately my students' academic capabilities?
33. Ensure that my students consider themselves capable of learning the material in the course?
34. Clearly identify the course objectives?
35. Maintain high academic expectations?
36. Appropriately grade my students' exams/assignments?
37. Think of my students as active learners, which is to say knowledge builders rather than information receivers?
38. Provide support/encouragement to students who are having difficulty learning?
39. Stay current in my knowledge of the subject I am teaching?
40. Provide my students with detailed feedback about their academic progress?
41. Calmly handle any problems that may arise in the classroom?
42. Develop my teaching skills using various means (attending conferences, reading about teaching/learning, talking to other teaching assistants…)?
43. Encourage my students to ask questions during class?
44. Make students aware that I have a personal investment in them and in their learning?
45. Evaluate the degree to which the course objectives have been met?
46. Let students take initiative for their own learning?
47. Show my students respect through my actions?
48. Be flexible in my teaching even if I must alter my plans?
49. Make students aware of the relevance of what they are learning?
50. Promote my students' confidence in themselves?
51. Spend the time necessary to plan my classes?
52. Select the appropriate materials for class activities?
53. Encourage the students to interact with each other?

APPENDIX B
MODELING GTA SURVEY INSTRUMENT

A. Please fill in your complete name on the first side of the scantron using a number 2 pencil. We will assigned you an identifying number to keep the information provided by you and your students linked together. No one but the researchers will have access to that information. Your responses are completely confidential.

B. The questions on these five pages are about your relationship with your peers and your supervisor, teaching in your department, your facility with American English and customs, your confidence in your teaching skills and abilities, your TA training, and your teaching experience. Please fill in the corresponding bubble on page 2 of the scantron sheet for each question using a number 2 pencil.

C. When you are done please return the scantron and the survey via campus mail to [insert office person, office number]. Please return by [date].

Please rate the occurrence of the statements below on a scale from A to E: A=Rarely Occurs to E=Very Frequently Occurs. Fill in the letter on the scantron that best reflects the occurrence of the statement.

Supervisor refers to the person who is directly involved in supervising the teaching assistants.

GTA refers to graduate teaching assistant.

TA refers to teaching assistant. (A=Rarely Occurs to E=Very Frequently Occurs)

1. GTAs help and support each other.
2. During meetings the supervisor explores all sides of a topic and admits that other opinions exist.
3. The supervisor treats all GTAs equitably.
4. GTAs respect the teaching competence of the other TAs.
5. The supervisor puts suggestions made by the GTAs into operation.
6. GTAs in this school exercise professional judgment.
7. GTAs accomplish their jobs with enthusiasm.
8. The supervisor is friendly and approachable.
9. The interactions between the GTAs are cooperative.
10. The supervisor is willing to make changes.
11. GTAs provide strong social support for other TAs.
12. The supervisor lets GTAs know what is expected of them.
13. The supervisor maintains definite standards of performance for the GTA.
14. GTAs “go the extra mile” with their students.

Please rate your agreement with the statements below on a scale from A to E: A=strongly disagree to E=strongly agree. Fill in the letter on the scantron that best reflects your agreement with the statement.

Supervisor refers to the person who is directly involved in supervising the teaching assistants.

Department refers to the department in which you are a TA. (A=Strongly Disagree to E=Strongly Agree)

15. The department is supportive of innovations that TAs wish to try in their teaching. 16. In the department, when a TA suggests an idea/procedure to enhance teaching, they are discouraged from pursuing them.
17. The department encourages TAs to experiment with newly learned teaching methods. 18. The department provides sufficient resources for me to be successful in carrying out my job (eg. equipment, secretarial help, mentors, etc.)
19. Constantly changing teaching policies/procedures make it difficult for me to implement ideas learned in TA training. 20. In the department, TAs have freedom to conduct their teaching as they wish.
21. The department prefers that TAs use teaching strategies with which the department is familiar. 22. TA work in the department is often postponed until the last minute.
23. The department provides sufficient time to use newly learned teaching skills. 24. In the department, rules/administrative details make it difficult for new ideas of TAs to receive consideration.

Please rate the truth of the statements below on a scale from A to E; A=False, B=Partly False, C=Equally True and False, D=Partly True to E=True. Fill in the letter on the scantron that best reflects the truth of the statement.

(A=False, B=Partly False, C=Equally True and False, D=Partly True, E= True)

25. I attend social functions with (Anglo) American people.
26. I speak English at home.
27. I know how to prepare (Anglo) American food.
28. I am familiar with important people in American history.
29. I think in English.
30. I speak English with my spouse or partner.
31. I feel totally comfortable with (Anglo) American people.
32. I understand English, but I'm not fluent in English.
33. I am informed about current affairs in the United States.
34. I like to eat American foods.
35. I regularly read an American newspaper.
36. I feel comfortable speaking English.
37. I feel at home in the United States.
38. I feel accepted by (Anglo) Americans.
39. I have many (Anglo) American acquaintances.

Please indicate how confident you are in your ability to accomplish the stated activities, from A=no confidence to E=complete confidence. Fill in the letter on the scantron that best reflects your confidence level.

How confident am I in my ability to…

(A=No Confidence to E=Complete Confidence)

40. Specify the learning goals that I expect my students to attain?
41. Actively engage my students in the learning activities that are included the teaching plan/syllabus?
42. Create a positive classroom climate for learning?

43. Promote student participation in my classes?
44. Prepare the teaching materials I will use? 45. Promote a positive attitude towards learning in my students? 46. Evaluate accurately my students' academic capabilities? 47. Ensure that my students consider themselves capable of learning the material in the course?
48. Clearly identify the course objectives? 49. Maintain high academic expectations? 50. Appropriately grade my students' exams/assignments? 51. Think of my students as active learners, which is to say knowledge builders rather than information receivers?
52. Provide support/encouragement to students who are having difficulty learning? 53. Stay current in my knowledge of the subject I am teaching? 54. Provide my students with detailed feedback about their academic progress? 55. Calmly handle any problems that may arise in the classroom?
56. Develop my teaching skills using various means (attending conferences, reading about teaching/learning, talking to other teaching assistants…)? 57. Encourage my students to ask questions during class? 58. Make students aware that I have a personal investment in them and in their learning? 59. Evaluate the degree to which the course objectives have been met?
60. Let students take initiative for their own learning? 61. Show my students respect through my actions? 62. Be flexible in my teaching even if I must alter my plans? 63. Make students aware of the relevance of what they are learning?
64. Promote my students' confidence in themselves? 65. Spend the time necessary to plan my classes? 66. Select the appropriate materials for class activities? 67. Encourage the students to interact with each other?

For following two questions please indicate how effective your TA training was from A to E; A=Not effective and E=Very Effective. Fill in the letter on the scantron that best reflects your answer.

68. Overall, how effective has the TA training you have received been in preparing you to teach?
69. Overall, how effective has the TA training you have received been in preparing you to work with students?

Of the following teaching topics and skills, please rate how well you have learned these in TA training from A to E; A=Never Learned to E=Learned Well. Fill in the letter on the scantron that best reflects your answer.

70. Grading
71. Presenting material to a large group of students
72. Motivating students

73. Interacting professionally one-on-one with your students
74. Assisting distressed students
75. Teaching students with different skill/knowledge levels

76. Power/authority relationships in the classroom
77. Communicating with course lead instructor
78. Managing disruptive students

79. Facilitating group discussions
80. Learning styles
81. Teaching culturally diverse students

82. Harassment
83. Teaching styles
84. Developing quizzes/exams

For questions 85 to 88 please fill in the letter on the scantron that best reflects your answer.

85. For the course in which you had the most responsibility as a TA, how much responsibility did you have?	Answer from A to E; A=No Responsibility to E =Complete Responsibility
86. Compared to other TAs in your department how much teaching experience do you have?	Answer from A to E; A=Less Experience to E=More Experience
87. How would you rate your own teaching experience?	Answer from A to E: A=Beginner to E = Expert
88. What is your most common/primary teaching role?	Choose the best response: A=laboratory instructor B=recitation/study section instructor C=grader D=lecturer E=course instructor

This page contains information that will be entered later. Circle the answer or fill in the blank as required on this sheet (not on the scantron.) Please fill in your full name again as indicated in question 88 so that this information can be linked to your scantron later.

89. What is your full name?_____

Please circle the appropriate answer.

90. Gender	Male	Female
91. What degree are you pursuing?	MS	PhD
92. Are you interested in an academic teaching career?	Yes	No

For questions 93 to 99 please fill in the blank on this sheet for each question. Please use 0 if you have never done what is asked in the question.

93. Including this quarter/semester, how many quarters/semesters have you been a TA at all institutions you have attended?
    _____10 week quarters
    _____15 week semesters

94. For how many different courses have you been a TA at all institutions you have attended?
    I have been a TA for _____ different courses.

95. How many years have you been a K-12 teacher?
    I have been a K-12 teacher for _____ years.

96. How many years have you been a college or community college instructor, other than as a TA?
    I have been a college/community college instructor for _____ years.

97. Please estimate the number of hours you have spent in the following types of TA training in all institutions you have attended.
    _____ Hours university-wide training
    _____ Hours departmental training
    _____ Hours in course(s) for college/university credit
    _____ Hours in other TA training (please specify)_____

98. What is your country of citizenship?_____

99. In which department are you pursuing your degree?_____