Cognitive Test Anxiety, Self-Efficacy, and Performance on the Praxis Core Academic Skills for Educators Examination

Yang Zhao

Submitted to the graduate degree program in the Department of Educational Psychology and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Chairperson: Bruce Frey, Ph.D.

Neal Kingston, Ph.D.

Vicki Peyton, Ph.D.

David Hansen, Ph.D.

ChangHwan Kim, Ph.D.

Date Defended: December 4, 2019

The Dissertation Committee for Yang Zhao certifies that this is the approved version of the following dissertation:

Cognitive Test Anxiety, Self-Efficacy, and Performance on the Praxis Core Academic Skills for Educators Examination

Chairperson: Bruce Frey, Ph.D.

Date approved: December 4, 2019

Abstract

The Praxis Core Academic Skills for Educators exam is broadly used as a partial requirement of obtaining teacher licensure. The inferences made based on the Praxis Core Academic Skills for Educators exam results are of high stakes for teacher candidates, often determining if they are admitted into teacher education programs. The primary purpose of this dissertation was to investigate the levels of Cognitive Test Anxiety and Self-Efficacy among the Praxis Core Academic Skills for Educators exam takers and the correlations with exam performance. The data analyzed in this study were collected through a survey administered on Amazon Mechanical Turk (MTurk) to the Praxis Core Academic Skills for Educators exam takers who took the exam between 2014 and 2019 in the United States. The revised version of the Cognitive Test Anxiety Scale (Cassady & Johnson, 2002; Cassady & Johnson, 2014) and the English version of the General Self-Efficacy scale (Jerusalem & Schwarzer, 1981) were used to measure Cognitive Test Anxiety and Self-Efficacy. Results showed a negative correlation which was statistically significant between Cognitive Test Anxiety and the exam performance. Results also indicated a non-significant trend indicating chances of higher scores with higher levels of Self-Efficacy. In addition, it was found that the latent interaction between Cognitive Test Anxiety and Self-Efficacy, indicating positive moderation effect of Self-Efficacy on scores, was not statistically significant. Overall, for this study, it is concluded that the Praxis Core Academic Skills for Educators exam takers with higher levels of Cognitive Test Anxiety are more likely to receive lower scores.

Acknowledgements

I would first like to thank Dr. Bruce Frey for serving as an exceptional mentor. You provided tremendous support and helpful guidance on this dissertation. I am extremely grateful for your mentorship at a transitioning time. Thank you for your patience and positivity along the way.

I would also like to thank my other committee members. Dr. Neal Kingston, thank you for your insight and the opportunity to work at the Achievement & Assessment Institute for most of my doctoral career, where I gained invaluable research and operational experience. Dr. ChangHwan Kim, thank you for supporting me since my time at the Fraser Hall and for your encouragement these years. Dr. Vicki Peyton, thank you for your timely and detailed feedback on the dissertation drafts, which helped me strengthen this dissertation. Dr. David Hansen, thank you for your unique perspective and suggestions of future directions of my work.

I want to express my gratitude to Dr. William Skorupski and Dr. Jonathan Templin, for providing support during my graduate career. You both have taught me a wide range of measurement topics and pushed me to think critically. I would also like to thank Scott Bishop for your mentorship at the Achievement & Assessment Institute and especially for our friendship.

This dissertation would not be possible without the support and love from my family and friends. My greatest gratitude goes to my parents. Without your unconditional love, I would not have been where I am today. You both have always believed in me and encouraged me to go places. Thank you for making it so easy to be your child. My husband, Brandon Ross, it is not exaggerating to say that I could not have finished this journey without you. Thank you so much for always loving me and accepting my flaws. Meghan Fager, life has changed for the better

since you showed up. Thank you for all the laughs, tears, and most importantly becoming my family.

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

In a society where standardized tests are widely adopted to evaluate individuals for admission to higher education and access to labor markets, standardized test scores play an important role in individuals' lives. The stakes of testing can vary from low stakes to high stakes. When a test is labeled high stakes, it is usually indicated that the test scores are used to determine punishment or reward that of high importance to an individual. The reward can be, for example, getting admitted into a profession or getting accepted into universities. The punishment can be, for example, being denied of a professional licensure, or certification being revoked.

Among all tests, those that involve high stakes often have significant impact on test takers as the test results usually grant or deny advance in academics, career, etc. When individuals take a high-stakes test, they are often under tremendous pressure in fear of not achieving a high enough test score that meets or exceeds the passing score, also known as the standard in the testing world.

Every state requires that teaching candidates obtain formal approval to teach in public school classrooms, a process that is known as teacher certification or licensure. In many states, basic skills tests in Reading, Writing, and Mathematics are used as a requirement for entry into teacher education programs. High-stakes standardized scores are used in teacher certification. By 1999, 41 states required applicants to the teaching profession to pass standardized certification test such as the National Teachers Examination or Praxis examinations published by the Educational Testing Service (ETS).

Since 1998, the ETS National Teachers Examination, widely used to certify Education School graduates for work as teachers, has been known as the Praxis II, and is part of a series that includes Praxis I, also known as the Pre-Professional Skills test (PPST) which is used to screen applicants to Education Schools, and a series of classroom performance assessments known as Praxis III. Many states require both Praxis I and Praxis II (Angrist & Guryan, 2007). As of 2014, the Praxis Core Academic Skills for Educators exam replaced the Praxis I exam.

The Praxis Core Academic Skills for Educators examination measures academic competency in Reading, Writing, and Mathematics. The academic skills measured are deemed by teacher educators to be essential for all candidates preparing to be teachers, regardless of content area or grade-level they aspire to teach. The Praxis Core examination measures the skills and content knowledge of candidates entering teacher preparation programs. The tests are currently delivered on computer. Considering the high stakes involved in the Praxis Core tests, it is important to investigate factors that could affect examinees' test performance. With an understanding of factors in play, measures can be possibly taken to control negative impact.

Test anxiety has been receiving more attention in practical settings, especially with relevance for high-stakes testing, as it has become a universal experience in contemporary society (Lee, 2009; Stankov, 2010). Scholars have stated the significance of understanding the relationship between test anxiety and test performance (Cizek & Burg, 2006; van der Embse & Hasson, 2012; Weems et al., 2010).

Test anxiety refers to a situation-specific form of anxiety that accompanies concern about possible negative consequences or poor performance on an examination (Spielberger & Vagg, 1995; Zeidner & Matthews, 2005). Dusek (1980) defined test anxiety as "an unpleasant feeling or emotional state that has psychological and behavioral concomitants, and that is experienced in formal testing or other evaluative situations" (p.88). Sarason and Stoops (1978) described individuals with test anxiety as "persons for whom tests are noxious experiences" (p.107).

Although not all test takers associate test anxiety with negative consequences (Chamberlain, Daly, & Spalding, 2011), test anxiety in research typically refers to debilitating test anxiety rather than facilitating test anxiety.

Recent research has treated test anxiety as a multidimensional construct, generally focusing on two major components proposed by Liebert and Morris (1967): emotionality and worry (Bonaccio & Reeve, 2010; Pintrich, Smith, Garcia, & Mckeachie, 1993; Speilberger & Vagg, 1995). Worry, also known as the cognitive component of test anxiety, has been consistently shown to be the primary factor associated with declines in performance (Hembree, 1988).

Recognition of the importance of performing well can contribute to test anxiety (Seilkirk, Bouchey, Eccles, 2011). Test anxiety is likely to prevail when tests are used for evaluation with pass or fail decisions, rather than for formative or instructional purposes (Reeve, Bonaccio, & Charles, 2008; Hembree, 1988). Individuals are likely to experience severe test anxiety when they consider evaluative situations of high task value.

Another factor that could affect test performance on the Praxis Core Academic Skills for Educators tests is Self-Efficacy, which refers to individuals' beliefs that they have the ability to succeed at a specific task. Bandura (1988) stated that a major source of anxiety arousal was not the threatening event per se, but the lack of Self-Efficacy that is required in order to turn the anxiety arousal off. From his perspective, an event is construed as a threat if one has a low level of Self-Efficacy, but as a challenge if one has a high level of Self-Efficacy. Self-Efficacy beliefs have received increasing attention in education research primarily in studies of academic motivation and self-regulation (Pintrich & Schunk, 1995). Past scholarly findings suggested that efficacy beliefs mediate the effect of skills or other self-beliefs on subsequent performance attainments (See Bandura, 1977; Schunk, 1991).

Goals of Study

The purpose of the present study is two-fold. The first purpose is to investigate how Cognitive Test Anxiety and Self-Efficacy are correlated to test performance on the Praxis Core Academic Skills for Educators tests in Reading, Writing, and Mathematics, with the interaction between Cognitive Test Anxiety and Self-Efficacy considered at the same time. The second purpose is to expand the existing literature on Cognitive Test Anxiety, Self-Efficacy, and their potential impact on test performance in the context of high stakes testing.

Overview of Chapters

The remainder of this dissertation is organized as follows: Chapter 2 reviews relevant literature on the Praxis Core Academic Skills for Educators tests, test anxiety, and Self-Efficacy. The review on test anxiety focuses on the cognitive component – Cognitive Test Anxiety. Previous research on the relationship between test anxiety, Self-Efficacy, and test performance is also summarized. At the end of Chapter 2, research questions and hypotheses of the current study are introduced. Chapter 3 demonstrates the method of the current study, focusing on participants, instruments, and data analysis. Statistical models are introduced in the data analysis section. Chapter 4 presents the results of the study. Chapter 5 concludes the current study with the discussion of results, limitations, and directions for future research.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to review literature that serves as the foundation of this study. The chapter begins with an introduction of the Praxis Core Academic Skills for Educators tests. Following that, an overview of research in test anxiety, focusing on the cognitive component, is provided. Next, previous research on the relationship between Cognitive Test Anxiety and test performance is summarized, followed by a review of the impact of stakes of testing on Cognitive Test Anxiety. Studies in Self-Efficacy are then revisited and summarized. Literature on the relationship between Self-Efficacy and achievement is also reviewed. Lastly, an overview of studies on the relationship between Cognitive Test Anxiety and Self-Efficacy is presented.

Praxis Core Academic Skills for Educators Tests

In many states, basic skills tests in Reading, Writing, and Mathematics are used as a requirement for entry into teacher education programs. These tests include content designed to be aligned with outcome expectations for the mastery of basic skills that typically appear in standards for K-12 education (National Governors Association and Council of Chief State School Officers, 2010).

By 1999, 41 states required applicants to the teaching profession to pass standardized certification test such as the National Teachers Examination or Praxis examinations published by the Educational Testing Service (ETS). Since 1998, the ETS National Teachers Examination, widely used to certify Education School graduates for work as teachers, has been known as the Praxis II, and is part of a series that includes Praxis I, also known as the Pre-Professional Skills test (PPST) which is used to screen applicants to Education Schools, and a series of classroom performance assessments known as Praxis III. Many states require both Praxis I and Praxis II

(Angrist & Guryan, 2007). As of 2014, the Praxis Core Academic Skills for Educators exam replaced the Praxis I exam.

The Praxis Core Academic Skills for Educators tests are developed by ETS to measure academic competency in Reading, Writing, and Mathematics. The tests are delivered on computer. Many colleges, universities, and other institutions use the results of the Praxis Core tests as a way of evaluating test takers for entrance into teacher education programs. Many states also use the tests in conjunction with Praxis Subject Assessments as part of the teacher licensing process.

The standardized scaled scores in Reading, Writing and Mathematics for the Praxis Core Academic Skills for Educators tests can range from 100 to 200, with a score interval of 2. The average reliability across exam forms that were in use in Reading, Writing, and Mathematics, were 0.871, 0.820, and 0.874, respectively (Educational Testing Service [ETS], 2018). The median scores between 2014 and 2017 nationally were 156 for Mathematics, 172 for Reading, and 166 for Writing (ETS, 2018).

Test Anxiety

The literature on test anxiety has been well established since the early 1950's (Putwain, 2007). The concept of test anxiety itself was created in the 1950's when Mandler and Sarason developed the first widely used test anxiety questionnaire and found that low anxious students performed better than high anxious ones on intelligence tests (Hembree, 1988). During the 1960's, research on test anxiety was focused primarily on emotional aspect of test anxiety, and on building evidence for the debilitating effects of test anxiety. Research on test anxiety significantly increased in volume during the late 1960's, stimulated by test anxiety treatment research. During the 1970's, a large volume of research focused on the cognitive aspect of test anxiety, and interventions or treatment for individuals who suffer from test anxiety (Wine, 1980).

Nowadays, test anxiety is receiving more attention in practical settings, especially with relevance for high-stakes testing. It has become increasingly important to understand the relationship between test anxiety and test performance (Cizek & Burg, 2006; van der Embse & Hasson, 2012; Weems et al., 2010). Many theoretical models have been developed to investigate test anxiety and test performance, such as the drive model (Mandler & Sarason, 1952), cognitive-attentional models (Sarason, 1972; Wine, 1971), skills deficit models (Benjamin, Mckeachi, Lin, & Holinger, 1981; Culler & Holahan, 1980; Kirkland & Hollandsworth, 1980), the self-regulation model (Carver & Scheier, 1984), the self-worth model (Covington, 1992), and the transactional model (Spielberger & Vagg, 1995).

Research on test anxiety in the early days defined test anxiety as a construct with unidimensionality (Sarason, 1961). According to Sarason (1961), test anxiety can be described as a combination of "heightened physiological activity" and "self-deprecating ruminations" (pp. 201-202). Liebert and Morris (1967) theorized that test anxiety was composed of two separate components: worry and emotionality. The view that test anxiety is composed of these two dimensions has been widely accepted since the early 1970's. Recent research has treated test anxiety as a multidimensional construct and has generally focused on two major components proposed by Liebert and Morris (1967): *emotionality* and *worry* (Bonaccio & Reeve, 2010; Pintrich, Smith, Garcia, & Mckeachie, 1993; Speilberger & Vagg, 1995).

Emotionality refers to affective and physiological arousal of anxiety when one takes a test or receives evaluation (Pintrich et al., 1993). Physiological responses can include increased galvanic skin response and heart rate, dizziness, nausea, feelings, and feelings of panic

(Deffenbacher, 1980; Hembree, 1988; Morris, Davis, & Hutchings, 1981). *Worry*, also known as Cognitive Test Anxiety, refers to negative thoughts that disrupt performance. It is composed of cognitive reactions or internal dialogue to evaluative situations in the times prior to, during, or after evaluative tasks. Such common cognitive reactions include comparing self-performance to peers, considering the consequences of failure, showing low levels of confidence in performance, having excessive worry over evaluation, being afraid of causing sorrow for their families, feeling unprepared for tests, and experiencing low levels of self-worth (Deffenbacher, 1980; Depreeuw, 1984; Hembree, 1988; Morris, Davis, & Hutchings, 1981).

Treatment of test anxiety was a research topic that was highly sought after in the 1960's and 1970's. After reviewing 49 treatment studies of college students targeting test anxiety, Allen and colleagues (1980) found that only 18% of the treated groups for test anxiety experienced significant improvement in performance, with significant reduction in test anxiety after treatments. Similarly, Tryon (1980) reviewed 85 studies investigating test anxiety treatment. She found that treatment techniques focusing on the emotionality aspect of test anxiety had yielded minimal performance improvement. Cognitive modification, however, seemed to show better outcome.

Cognitive Test Anxiety and test performance.

The relationship between test anxiety and performance measures has been an ongoing interest of research on test anxiety. The cognitive component of test anxiety has been consistently shown to be the primary factor associated with declines in performance (Hembree, 1988). Many theoretical models have been developed to address the relationship between Cognitive Test Anxiety and test performance. The present study revisits three models: the skill deficit model, the cognitive interference model, and the information processing model.

Skill deficit model.

The skill deficit model suggests that high anxious students are simply lacking studying or test taking skills. These students experience anxiety in an evaluative situation or during a test when they realize they are inadequately prepared. Test anxiety in this model is considered a result, instead of a cause of poor academic performance. Desiderato and Koskinen (1969), Mitchell and Ng (1972), and Wittmaier (1972) found that anxious students had less effective study skills. Culler and Hollahan (1980) also reported that "high test-anxious students who have developed and exercise better study skills did better academically than those with poor study habits."

Cognitive interference model.

The interference model suggests that students become anxious due to the stressful nature of the test situation, and become preoccupied with worry, which interferes with their test performance. Researchers have found that individuals with high levels of test anxiety are more likely to worry about the outcome of the test, compare their abilities to others, or have lingering thoughts that they are not fully prepared for the test (Sarason, 1984; Schwarzer &Jerusalem, 1992). The cognitive interference model suggests that poor test performance can be a result of inability of suppressing competing thoughts caused by test anxiety during tests (Wine, 1971).

Information processing model.

The information processing model can be considered as an extension of the cognitive inference model with further examination of a full range of cognitive functions that may interfere with performance. Decremented performance can be associated with an inability to effectively process or retrieve exam-related information, or metacognitive awareness of a lack of preparation of ability that is strengthened by test anxiety (McKeachie, & Lin, 1987; Desiderato & Koskinen, 1969; Mckeachie, 1984; Navh-Benjamin, 1991).

Morris and Libert (1969) have stated that worry interferes with performance, but emotionality and performance are not related except for individuals who have low levels of worry. Deffenbacher (1980) stated that high levels of emotionality negatively influence test performance only under conditions where the individuals also experience high levels of worry, indicating that worry is the primary factor that impacts performance.

Wine (1971) contended that people with test anxiety tend to divide their attention between task-irrelevant activities and preoccupations with worry, self-criticism, and concerns. Therefore, performance of individuals with test anxiety is depressed, as a result of less attention available for task-relevant efforts. Dusek and colleagues found that the attention of test-anxious children appeared to be divided between task-relevant and task-irrelevant stimuli (Dusek, Mergler, & Kermis, 1976). Paulman and Kennelly (1984) investigated the effects of test anxiety and skill deficits on information processing deficits. They found that both high anxiety and low skill level were associated with a significantly higher number of task irrelevant thoughts. Their findings suggested that anxiety decreases student task performance by impacting the cognitive capacity through negative, self-deprecatory thoughts. For individuals with good learning skills, test anxiety causes problems primarily through interfering with the retrieval of information. For individuals with poor learning skills, test anxiety becomes present when they realize their deficits, and are further affected by test anxiety through the interference process.

Hunsley (1987) investigated the relationship between math anxiety, test anxiety, and Mathematics achievement, and concluded that test anxiety was predictive of lower achieved exam grades. In his 1988 meta-analysis of existing test anxiety research, Hembree (1988) analyzed the results of 73 studies that investigated the relationship between Cognitive Test Anxiety and student performance on IQ, aptitude, and achievement tests. He found that students with high test anxiety in general scored 6 points lower than students with low test anxiety on a 100-point test. Students with middle level of test anxiety scored in between high anxious and low anxious students. Similar results were found for grade point average (GPA) comparisons of students with low, middle, and high levels of test anxiety in many subjects (Reading, English, math, natural sciences, foreign language, psychology, mechanical knowledge, etc.). Using path analyses, William (1991) found that the path from Cognitive Test Anxiety to academic achievement was significant for adolescents. Bandalos and colleagues (1995) found that Cognitive Test Anxiety had a significantly impact on academic performance for postsecondary students. Schwarzer and Jerusalem (1992) showed that individuals with high levels of test anxiety were incapable of constraining competing thoughts in order to focus on the test. College students reporting high test anxiety were more susceptible to distraction during testing (Keogh, Bond, French, Ricahrds, & Davis, 2004). Ultimately, the test performance may not reflect individuals' true abilities due to the interference from negative thoughts associated with test anxiety. Kilmen (2015) suggested that test anxiety may arise from fear of failure, fear of being looked down upon, and feelings of insufficiency.

Task Importance, Cognitive Test Anxiety, and Stakes of Testing

Recognition of the importance of performing well can also contribute to test anxiety (Seilkirk, Bouchey, Eccles, 2011). Task importance has been described as an important type of antecedent to test anxiety (Wigfield & Meece, 1988; Zeidner, 1998; Zeidner & Matthews, 2005). Researchers have found that high levels of task importance are related to high levels of test anxiety. Emphasizing task importance, which is regarded as a way of motivating engaged behavior, may increase an individual's anxiety.

According to Lazarus and Folkman (1984), test anxiety is elevated as the perception of task importance increases. Pekrun (1984) highlighted that anxiety is determined in part by individuals' value systems. Power (1986) observed correlations in the range of −.35 and −.40 in a study of test anxiety and performance on the GRE. Cassady (2004) detected correlations around −.35 between test anxiety and SAT scores, and the anxiety-performance relationship was stronger for the SAT than for a low-stakes, non-evaluative assessment. Correlations of similar levels were found between Cognitive Test Anxiety and ACT performance (von der Embse & Witmer, 2014). Test anxiety is likely to prevail when tests are used to make references about examinees with pass and fail decisions, rather than for formative or instructional purposes (Reeve, Bonaccio, & Charles, 2008; Hembree, 1988). Individuals are likely to experience severe test anxiety when they consider evaluative situations of high task value.

In the task value literature, task importance is defined as an individual's perceived importance and usefulness of the task. The construct of task importance consists of three components: interest, importance, and usefulness (Eccles-Parsons et al., 1983). Recent studies separated interest (the intrinsic component) from importance and usefulness (the extrinsic components of task value) (Durik, Vida, & Eccles, 2006; Simpkins, Davis-Kean, & Eccles, 2006). Importance and usefulness have since been merged, and task importance has been used to refer to importance and usefulness combined.

The greater the subjective importance or value is attached to a task, the greater the potential is for anxiety. The perception of task importance can be treated as a threat if failure in the test indicates negative consequences that are significant to individuals. High-stakes tests are typically associated with significant task importance to test takers.

Self-Efficacy

Bandura (1977) developed the concept of Self-Efficacy as one component of social cognitive theory. He considered the role of Self-Efficacy beliefs in human functioning as "people's level of motivation, affective states, and actions are based more on what they believe than on what is objectively true" (p.2). He also suggested that people who attribute success to their own skill levels are more likely to develop positive Self-Efficacy beliefs, as compared to those who attribute success to luck or external circumstances.

Bandura (1986) later suggested that individuals possess a self-system that enables them to exercise a measure of control over their thoughts, feelings, motivation, and actions. The self-system provides reference mechanisms and a set of subfunctions for perceiving, regulating, and evaluating behavior, which results from the interplay between the system and environmental source of influence. Ultimately, the self-system serves a self-regulatory function by providing individuals with the capability to influence their own cognitive processes and actions and thus alter their environments.

People's behavior can be mediated by their beliefs about their capabilities and can often be better predicted by these beliefs than by the results of their previous performances. "Self-perceptions of capability help determine what individuals do with the knowledge and skills they have. More important, Self-Efficacy beliefs are critical determinants of how well knowledge and skills are acquired in the first place" (Bandura, 1986).

Bandura (1986) also suggested that constructs such as Self-Efficacy, anxiety and perceived usefulness are "common mechanisms" of personal agency that influence an outcome.

Lent et al. (1996) states that Self-Efficacy refers to “people’s judgement of their capabilities to organize and execute courses of action required attaining designated types of performance” (p.83). Self-Efficacy beliefs are sensitive to contextual factors, meaning that they are task and situation-specific and that individuals make use of judgments in reference to some type of goal (Bandura, 1986; Pintrich & Schunk, 1995). Bandura (2005) reiterated that “people are self-organizing, proactive, self-regulating, and self-reflecting. They are contributors to their life circumstances not just products of them” (p.3).

Self-Efficacy and achievement.

Self-Efficacy beliefs have received increasing attention in education research primarily in studies of academic motivation and self-regulation (Pintrich & Schunk, 1995). Researchers have typically assessed Self-Efficacy beliefs by asking individuals to report the level and strength of their confidence regarding completing a task or being successful in a situation (Bandura, 1989; Hackeet & Betz, 1989; Shell, Colvin, & Bruning, 1995).

Past scholarly findings provided evidence for Bandura’s (1986) contention that efficacy beliefs mediate the effect of skills or other self-beliefs on subsequent performance attainments (See Bandura, 1977; Schunk, 1991). Various studies supported the view that perceived Self-Efficacy in a certain field influences achievement. For example, Taylor, Locke, Lee, and Gist (1984) showed that perceived Self-Efficacy contributed to the scientific productivity of academic staff members. Similarly, Hill, Smith, and Mann (1987) and Gist, Schwoerer, and Rosen (1989) found that perceived Self-Efficacy greatly influenced computer performance and adequate use of computer programs. Multon, Brown, and Lent (1991) conducted meta-analysis of the relationship between Self-Efficacy beliefs and academic performance based on samples of predominantly elementary school children. The results of their study revealed a significantly positive relationship between Self-Efficacy and academic performance across a variety of experimental designs and assessment methods.

Self-Efficacy also influences the type of tasks individuals are inclined to. Locke and Latham (1990) found that individuals with high Self-Efficacy are likely to pursue challenging goals and persevere in difficult tasks. Tuckman and Sexton (1992) found that individuals with low Self-Efficacy were likely to undermine their focus when they were confronted with difficult tasks.

More recently, Robbins and colleagues (2004) investigated 109 studies on the relationship between Self-Efficacy and academic outcomes as reflected by college GPA. Although standardized test scores on the American College Test (ACT) and Scholastic Aptitude Test (SAT) tests as well as high school GPA were consistently the strongest predictors of college GPA, Self-Efficacy was proven significantly correlated with college GPA. With regression analyses used by most authors included in the meta-analysis, traditional predictors of college GPA such as socioeconomic status (SES), high school GPA, and standardized test scores better predicted college GPA, explaining approximately 22% of the variance in college GPA. Psychological variables were included in separate regression models, explaining 26% of the variance in college GPA. With all predictors included in one regression model, Self-Efficacy was shown to be the second strongest contributing factor to college GPA. Researchers have also explored the link between Self-Efficacy and college major and career choices, particularly in Mathematics and science (see Lent & Hackett, 1987, for a review). Ashton and Webb (1986) suggested that Self-Efficacy beliefs of teachers are related to their instructional practices and various student outcomes. Researchers have also studied how Self-Efficacy beliefs are correlated to other motivation constructs and with students' academic performances and achievement.

Constructs that are correlated with Self-Efficacy include attributions, goal setting, modeling, self-regulation and test anxiety.

Cognitive Test Anxiety, Self-Efficacy, and Test Performance

Researchers have studied the relationship between Self-Efficacy and test anxiety in academic achievement or evaluative situations. Efficacy beliefs influence the amount of stress and anxiety individuals experience as they engage in a task. Empirically, Self-Efficacy has been consistently found to be negatively associated with test anxiety in learning context (Bandalos et al., 1995; Betz & Hackett, 1983; Bonaccio & Reeve, 2010; Meece et al., 1990; Pintrich & de Groot, 1990; Wingfield & Meece, 1988; Zohar, 1998). For example, Wigfield and Meece (1988) found an overall correlation of −.10 between perceived ability and Cognitive Test Anxiety in a sample of Grade 6 to Grade 12 students. After analyzing 58 studies relating test anxiety to various measures of self-concept, Hembree (1988) stated that: “a strong inverse relationship appeared between self-esteem and test anxiety. High test anxiety students were inclined to an external locus of control and were prone to feel unprotected” (p.56). Using an additive model, Zohar (1998) found that Self-Efficacy was related to test anxiety. Meece et al. (1990) found negative correlations between math ability perceptions and math anxiety, ranging from −.11 to −.41, among Grade 7 to Grade 9 students.

Perceived Self-Efficacy to exercise control over stressors plays a central role in anxiety arousal. People who believe they can exercise control over threats do not conjure up disturbing thought patterns. In contrast, individuals who do not believe they can manage threats experience high anxiety arousal. “They dwell on their coping deficiencies. They view many aspects of their environment as fraught with danger. They magnify the severity of possible threats and worry about things that rarely happen. Through such inefficacious thinking they distress themselves and impair their level of functioning” (Bandura, 1994). A high sense of Self-Efficacy allows people to take on taxing and threatening activities without being disturbed with worries or negative thoughts that are not directly relevant to the task. A low sense of Self-Efficacy to exercise control often produces depression as well as anxiety.

Cooper and Robinson (1991) reported a low but significant correlation between math Self-Efficacy and performance on the Missouri Mathematics Placement Test. However, when they applied a regression model including Self-Efficacy, math anxiety, the quantitative score on the ACT, and prior math experience, the results revealed that Self-Efficacy did not account for a significant portion of the variance in math performance.

Dykeman (1994) investigated the effects of Self-Efficacy on test anxiety in graduate students and found that task-oriented, high Self-Efficacy students showed the least amount of test anxiety. Pajares and Kranzler (1994, 1995a, 1995b) constructed path models that included math Self-Efficacy, general mental ability, math self-concept, math anxiety, Self-Efficacy for self-regulation, previous grades in Mathematics, and sex. They found that the direct effect of Self-Efficacy on performance was as strong as was the effect of general mental ability. The other findings include non-significant effect of anxiety, reduce effect of self-concept on performance, as well as influence of Self-Efficacy on anxiety and self-concept.

Pajares (1996b) examined the interplay between Self-Efficacy judgements and the mathematical problem-solving of middle school students in algebra classes. He reported a significant impact of Self-Efficacy on the problem-solving performance of students after the effect of math anxiety was controlled for.

The Current Study

Previous subsections discussed existing literature and empirical results concerning Cognitive Test Anxiety, Self-Efficacy, test performance, and stakes of testing. It has been shown that Cognitive Test Anxiety and Self-Efficacy are associated with test performance, more so in the context of high stakes testing than formative testing. It is also shown based on existing literature that Cognitive Test Anxiety and Self-Efficacy are negatively correlated.

Few studies, if any, have investigated the correlation between test anxiety, Self-Efficacy, and the Praxis Core Academic Skills for Educators test performance. Most of the studies that explored the effect of test anxiety and Self-Efficacy on test performance applied correlational analysis, and/or regression models. Few studies in the literature, however, have applied models that treated Cognitive Test Anxiety and Self-Efficacy as latent variables. Additionally, fewer studies have included the latent interaction between Cognitive Test Anxiety and Self-Efficacy in the models to examine the impact of the interaction on test performance.

It is important to treat Cognitive Test Anxiety and Self-Efficacy as latent variables, as neither construct can be directly measured. Both latent variables can be referenced by manifest variables such as survey items. Existing literature has established a relationship between Cognitive Test Anxiety and Self-Efficacy. Therefore, it is of valid concern to examine the interaction between the two variables in terms of their correlation with test performance. It is important to treat the interaction between Cognitive Test Anxiety and Self-Efficacy as latent because the two variables are latent of nature per se.

Research Questions and Hypotheses

The research questions and hypotheses of the present study are herein presented.

Research Question 1: What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in Reading?

- Hypothesis 1a: Cognitive Test Anxiety is *negatively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Reading
- Hypothesis 1b: Self-Efficacy is *positively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Reading
- Hypothesis 1c: Self-Efficacy *moderates* the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Reading

Research Question 2: What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics?

- Hypothesis 2a: Cognitive Test Anxiety is *negatively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics
- Hypothesis 2b: Self-Efficacy is *positively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics
- Hypothesis 2c: Self-Efficacy *moderates* the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics

Research Question 3: What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in Writing?

- Hypothesis 3a: Cognitive Test Anxiety is *negatively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Writing
- Hypothesis 3b: Self-Efficacy is *positively* correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Writing
- Hypothesis 3c: Self-Efficacy *moderates* the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Writing

CHAPTER 3

METHODOLOGY

The purpose of this chapter is to describe the methods that were used to conduct this study. This chapter begins with a description of the participants and recruitment. Instruments used to collect data are then introduced. Finally, the specific analyses that were performed to address each of the three research questions are described.

Participants

The sample was drawn from the population who took the Praxis Core exam between 2014 and 2019 in the United States. Participants were recruited through Amazon Mechanical Turk (MTurk). Institutional Review Board approval was obtained from the Human Research Ethics Committee at the University of Kansas. Data collection was confidential and anonymous. Participants were told that the purpose of the study was to learn about Cognitive Test Anxiety and Self-Efficacy among the Praxis Core exam takers, and the relationship between Cognitive Test Anxiety, Self-Efficacy, and exam performance. All participants were required to provide consent prior to accessing the survey. At the end of the survey, participants were asked to enter the survey code that was randomly generated by Qualtrics. Upon completion of the survey, participants received a payment of $0.50, distributed through MTurk.

Instruments

A survey was assembled to measure participants' Cognitive Test Anxiety and Self-Efficacy. The survey included 17 items from the revised version of Cognitive Test Anxiety Scale, 10 items from the General Self-Efficacy Scale, three questions regarding the participants' Praxis Core scores in each of the three subjects, one question about self-reported college grade point average (GPA), and one question regarding participants' gender. Prescreening questions were embedded in the survey. Participants who did not provide satisfactory answers to the prescreening questions were forced to exit the survey. For example, one of the prescreening questions was "What subjects did you take the Praxis Core Academic Skills for Educators exam in?" Four response options were provided: a) Reading; b) Mathematics; c) Writing; and d) All of the above. Only participants who selected "All of the above" were able to proceed with the survey. Attention checks were also included in the survey. One question asked participants to provide answers to "What is 11 + 8?" Participants who provided wrong answers were forced out of the survey. Participants were asked to enter a randomly assigned 5-digit survey code before exiting the survey. Complete responses were kept if the survey code entered matched the records in the system. Further detail regarding the questionnaire is provided in Appendices A-C.

The Cognitive Test Anxiety Scale.

The original version of the Cognitive Test Anxiety Scale (CTAS) is an instrument created to measure the cognitive component of test anxiety in both the test preparation and test performance phases of the learning cycle (Cassady & Johnson, 2002; Cassady & Johnson, 2010). The CTAS was found to have high internal consistency, with a Cronbach's alpha coefficient of 0.86 (Cassady, 2002). Since its creation, the CTAS has been validated and used as a self-report instrument in various settings around the world (Cassady, 2004a, 2004b; Cassady & Johnson, 2002; Daly, Chamberlain, & Spalding, 2010; Chen, 2007).

Subsequent analyses of the CTAS, however, demonstrated that the use of reverse-coding in the original version produced two factors: Cognitive Test Anxiety and Test Confidence. The revised version of the Cognitive Test Anxiety Scale (CTAR), which was used in this study, is a shortened version of the original CTAS by excluding the 10 reverse-coded items (Cassey and

Finch, 2014). It was demonstrated that a reduced length version of the CTAS without the reverse-coded items provided a conceptually preferable and more parsimonious measure of Cognitive Test Anxiety than the original full-length version. Previous work demonstrated that the CTAR was able to validly assess Cognitive Test Anxiety within a variety of cultural contexts (Boz-kurt et al., 2016).

The CTAR (see Appendix A) can be described as a 17-item, 4-point, Likert-type instrument. Participants were required to read the statements (such as "I worry more about doing well on tests than I should" and "When I first get my copy of a test, it takes me a while to calm down to the point where I can begin to think straight"), and check the one single scaled response option that best described themselves. The four Likert-type response options are: 1 – "Not at all typical of me," 2 – "Somewhat typical of me," 3 – "Quite typical of me," and 4 – "Very typical of me."

The General Self-Efficacy Scale.

The General Self-Efficacy Scale (GSE) was originally developed in German to assess a general sense of perceived Self-Efficacy (Jerusalem & Schwarzer, 1981). The original scale has been translated into many other languages and used in studies across countries. In samples from 23 countries, Cronbach's alphas ranged from .76 to .90 (Jerusalem & Schwarzer, 1992; Zhang, J. X., & Schwarzer, R, 1995; Bäßler, J., & Schwarzer, R, 1996; Scholz, U., Gutiérrez-Doña, B., Sud, S., & Schwarzer, R, 2001). The full version of the GSE is provided in Appendix B.

This study adopted the English version of the GSE (Schwarzer & Jerusalem, 1995). Participants were asked to respond to 10 Likert-type items formatted as statements (for example, "I am confident that I can deal efficiently with unexpected events"), choosing one single best response from: 1 – “Not at all true,” 2 – “Hardly true,” 3 – “Moderately true,” and 4 – “Exactly true.”

Praxis Core Academic Skills for Educators Test Scores.

Participants were asked to provide their Praxis Core Test scores in Mathematics, Reading, and Writing. ETS reports the Praxis Core exam scores on a 100-200 standardized score scale, with high scores indicating better exam performance.

Self-Reported College grade point average (GPA).

Participants were also asked to provide information on their GPAs at the time of taking the Praxis Core test by answering “What was your college GPA on a 4.0 scale at the time you took the Praxis Core Academic Skills for Educator exam?” It was noted below the question that “an estimated GPA that is as accurate as possible is acceptable,” and that “refer to your GPA at your first attempt of the exam if you took the exam more than once.”

Data Analysis

Measurement model.

Measurement model specification.

The responses to the CTAR Scale and the GSE Scale were polytomous on an ordinal scale. Item responses were bounded between values of 1 and 4. Responses predicted by a confirmatory factor analysis (CFA) model may extend beyond the possible response options for possible factor levels. Compared to CFA models which assume continuous and normally distributed item responses, graded response models (GRMs) assume categorical responses that follow a binomial or multinomial distribution. Hence, for this study, psychometric assessment of the dimensionality of the CTAR and GSE scales was conducted using the graded response polytomous item factor analysis-item response theory (IFA-IRT) models in Mplus v 8.1 (Muthén and Muthén, 1998–2017). GRM uses a cumulative link function and a conditional multinomial response distribution, in which the four-category (1-4) outcomes are predicting using 3 binary submodels:

$$Logit\ (y_{is} > 1) = -\tau_{i1} + \lambda_i F_s \tag{4}$$

$$Logit\ (y_{is} > 2) = -\tau_{i2} + \lambda_i F_s \tag{5}$$

$$Logit\ (y_{is} > 3) = -\tau_{i2} + \lambda_i F_s. \tag{6}$$

In each model, $-\tau_i$ is the negative of an item-specific and category-specific threshold that gives the link-transformed probability of response (for item *i* and subject *s*) at a latent trait score F for subject s of 0, and λ is a factor loading for the expected change in the link-transformed probability of response for a one-unit change in F_s. No separate item-specific residual variances can be estimated given these items' multinomial response options.

GRM was first introduced by Samejima (1969) to handle ordered polytomous responses to attitudinal statements (such as a Likert Scale). The model can be expressed as

$$P_{ik}^{*}\ (\Theta_j) = \frac{e^{a_i\,(\Theta_j - b_{ik})}}{1+e^{a_i\,(\Theta_j - b_{ik})}}, \tag{1}$$

where k is the ordered response option or score, $P_{ik}^{*}\ (\Theta_j)$ denotes the probability of responding to alternative *k* or above in item *i* with a trait level Θ_j, a_i denotes the discrimination parameters, b_{ik} represents the cut-off points in the cumulative probabilities scale and therefore their interpretation is not direct. This function is called the cumulative category response function (CCRF). Probability of each score category can be given by

$$P_{ik}\ (\Theta_j) = P_{ik}^{*}\ (\Theta_j) - P_{ik+1}^{*}\ (\Theta_j) \tag{2}$$

The score category response function (SCRF) of the GRM can be expressed as

$$P_{ik}\ (\Theta_j)\ = \frac{e^{[-a_i\left(\Theta_j - b_{ik+1}\right)]} - e^{[-a_i\left(\Theta_j - b_{ik}\right)]}}{[1+e^{[-a_i\left(\Theta_j - b_{ik}\right)]}][1+e^{[-a_i\left(\Theta_j - b_{ik+1}\right)]}]} \quad (3)$$

Under the GRM, an item is comprised of k ordered response options, and parameters are estimated for $k-1$ boundary response function. Each boundary response option function represents the cumulative probability of selecting any response options greater than the option of interest. The GRM fits a two-parameter logistic model to each of the events obtaining a score of k or higher, $P_{ik}\ (\Theta_j)$ (see Figure 1, boundary characteristic curves).

The functions for an item *i* are characterized by two types of parameters. They discrimination parameters a_i is a measure of the discriminating power of the item. It indicates the magnitude of change of probability of responding to the item in a particular direction as a function of trait level. It can be interpreted qualitatively with Baker's (1985) classification, using the following criteria under a normal model: $a_i < 0.2$, very low discrimination; $0.21 < a_i < 0.40$, low discrimination; $0.41 < a_i < 0.80$, moderate discrimination; $0.81 < a_i < 1$, high discrimination; $a_i = 1$, very high discrimination. The difficulty or location parameter β_i provides a measure of item difficulty, or the extremity of frequency of an attitude or state of mind in this study.

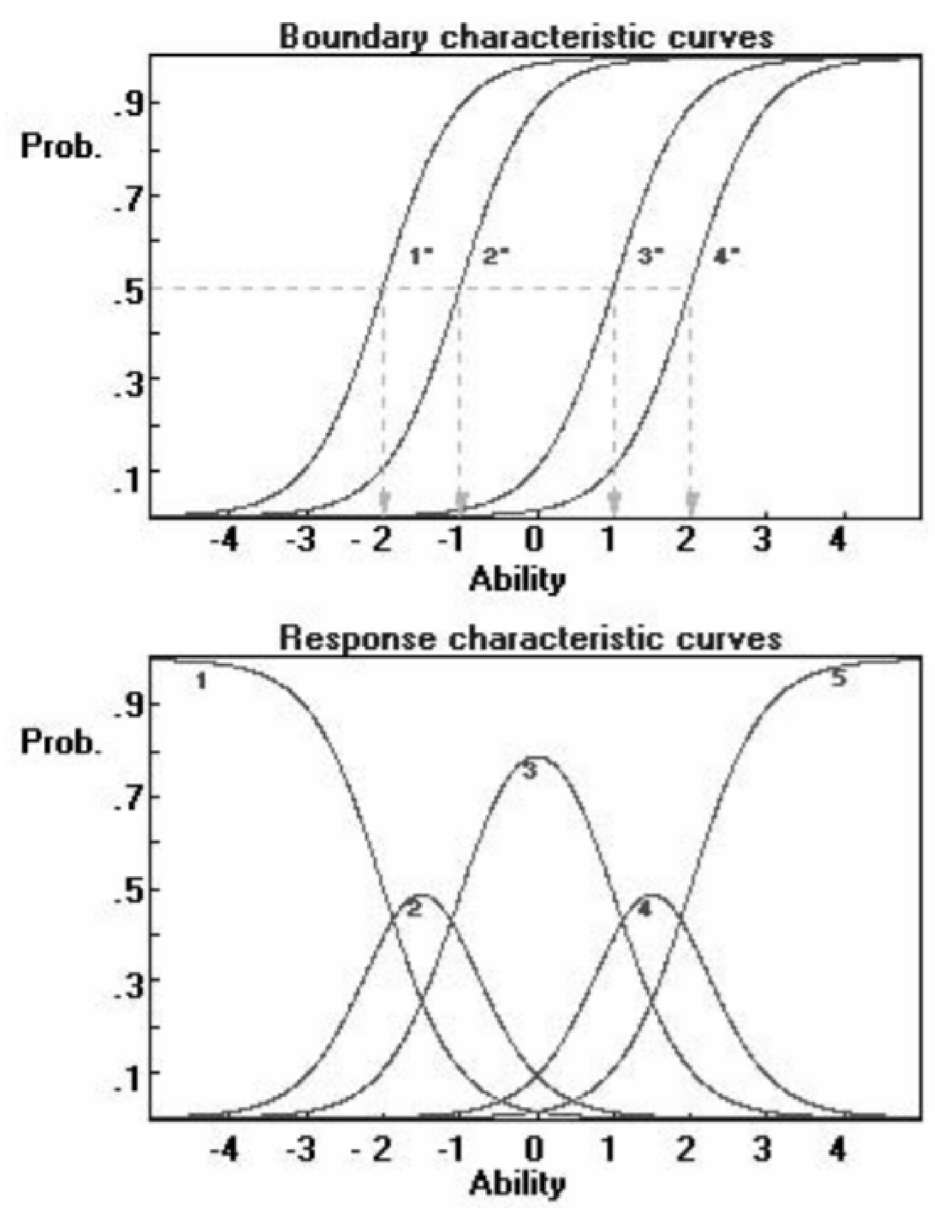

Figure 1. Example of boundary characteristic curves and response characteristic curves of the graded response model (α = 1.25, $b_1 = -2$, $b_2 = -1$, $b_3 = 1$, $b_4 = 2$)

Measurement model fit.

Measures of model fit when using ML involve the contingency table of all possible responses to all items. For the 17 items on the CTAR Scale, the full contingency table generates up to 4^{17} = 17,179,869,184 possible cells for the 17 items of the CTAR and up to 4^{10} = 1,048,576 possible cells for the 10 items of the GSE. Consequently, no measures of absolute fit would be valid for the current sample of 301 participants. Instead, assessment of model fit was conducted via a limited information diagonally weighted least squares estimator (WLSMV) using a mean and variance corrected X^2. The WLSMV is a robust estimator which does not assume normally distributed variables and provides the best option for modelling categorical or ordered data (Brown, 2006). In the WLSMV estimator, the item responses were first summarized into an estimated polychoric correlation matrix using the cross-tabulation of responses for each possible pair of items. The GRMs were then fitted to the estimated polychoric correlation matrix, such that traditional measures of global and local absolute fit can be computed by comparing the model-predicted and data-estimated polychoric correlation matrices.

The Chi-Square value (X^2) is a traditional measure for evaluating overall model fit. A good model fit would provide an insignificant result at .05 threshold (Barret, 2007). The Root Mean Square Error of Approximation (RMSEA), in recent years, has become regarded as "one of the most informative fit indices" (Diamantopoulos and Siguaw, 2000: 85) due to its sensitivity to the number of estimated parameters in the model. A cut-off value close to .06 (Hu and Bentler, 1999) or a stringent upper limit of .07 (Steiger, 2007) seems to be the general consensus in the field. Comparative Fit Index (CFI) is another fit index that accounts for sample sizes. A value of CFI ≥ .95 is presently recognized as indicative of good fit (Hu and Bentler, 1999). Tucker Lewis Index (TLI) is also used to evaluate model fit. A TLI value that is equal to or greater than .95

indicates good fit. Additionally, for model comparison, Mplus allows users to specify difference tests (DIFFTEST) and saves out information from the first model and compares it to the second model. Models that showed better fit to the response data were selected for further examination under the structural equation modeling framework.

Structural model.

Structural equation modeling with and without latent interaction.

As stated in the hypotheses in Chapter 2, the current study intends to answer three research questions regarding the correlation between Cognitive Test Anxiety and Praxis Core test performance, the correlation between Self-Efficacy and Praxis Core test performance, and how the interaction between Cognitive Test Anxiety and Self-Efficacy and Praxis Core test performance are correlated. To test the hypotheses proposed in Chapter 2, the current study employs structural equation modeling (SEM) to investigate the underlying relationship between Cognitive Test Anxiety, Self-Efficacy, and Praxis Core test performance in Reading, Mathematics, and Writing.

SEM is a multivariate method that allows one to investigate how the endogenous variables are related to or predicted by the exogenous latent variables, based on non-experimental survey data. With the SEM approach, relationships between unobservable, latent variables can be formulated in structural equations and errors of the observed/manifest indicator variables are incorporated in measurement models.

Endogenous and exogenous variables.

There were two latent exogenous variables in this study, Cognitive Test Anxiety and Self-Efficacy, and one observable exogenous variable, GPA. Cognitive Test Anxiety was treated as a latent variable manifested by responses to CTAR, and Self-Efficacy was treated as a latent variable manifested by answers to GSE. The three endogenous variables, Praxis Core Reading score, Praxis Core Mathematics score, and Praxis Core Writing score, were treated as observable.

Structural model specification.

Three sets of models, a total of six models, were fitted to the data. Each set included two models that were nested, with the larger model including an interaction term between the two latent exogenous variables, Cognitive Test Anxiety and Self-Efficacy. Each model included two selected GRMSs. One GRM related the latent factor, Cognitive Test Anxiety, to the 17 observed variables (i.e., 17 items on the CTAR scale). The other GRM related the latent factor, Self-Efficacy, to the 10 observed variables (i.e., 10 items on the general Self-Efficacy scale). GPA was included as a covariate in each model.

Model 1.1 and Model 1.2.

Model 1.1 and Model 1.2 investigated the exam performance in Reading only. Model 1.1 presented a linear SEM without the latent interaction between Cognitive Test Anxiety and Self-Efficacy, a simpler version of Model 1.2. Model 1.1 can be specified as

$$Praxis\ Reading\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}(\text{SE}) + \beta_{3i}(\text{GPA}) + \varepsilon_i \quad (7)$$

where Praxis Reading score was the score for person *i*, β_{0i} was the mean Praxis Core Reading score across the entire sample when predictors were zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy, β_{3i} was the coefficient for GPA, and ε_i was the error term for person *i*. By adding the latent interaction between Cognitive Test Anxiety and Self-Efficacy to Model 1.1, Model 1.2 also estimated the interaction effect on exam performance in Reading. Model 1.2 can be expressed as

$$Praxis\ Reading\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}\ (\text{SE}) + \beta_{3i}(\text{GPA}) + \beta_{4i}(\text{CTA} * \text{SE}) + \varepsilon_i \quad (8)$$

where Praxis Reading score was the score for person i, β_{0i} was the mean Praxis Core Reading score across the entire sample when predictors were zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy, β_{3i} was the coefficient for GPA, β_{4i} was the coefficient for the interaction between Cognitive Test Anxiety and Self-Efficacy, and ε_i was the error term for person *i*. Figure 2 and 3 show Model 1.1 and 1.2, respectively.

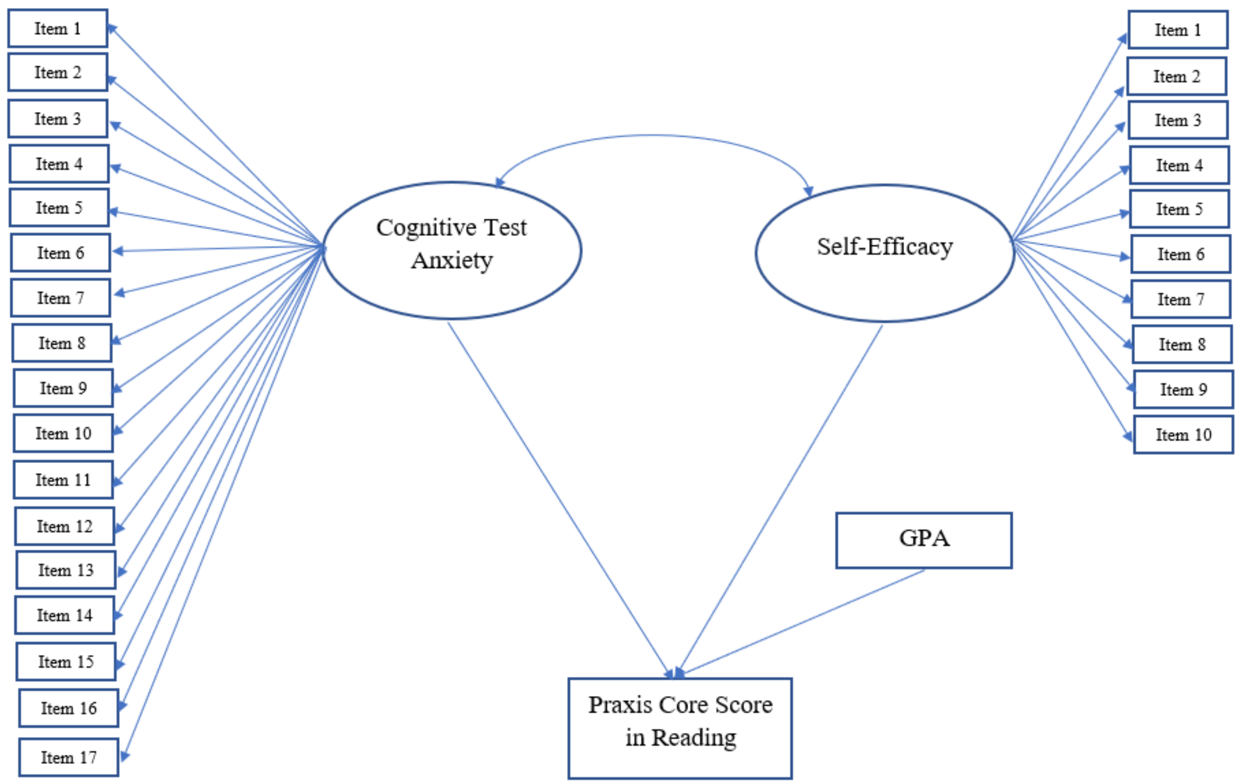

Figure 2. Model 1.1 for Praxis Core exam score in Reading: Measurement model and structural model without interaction between Cognitive Test Anxiety and Self-Efficacy

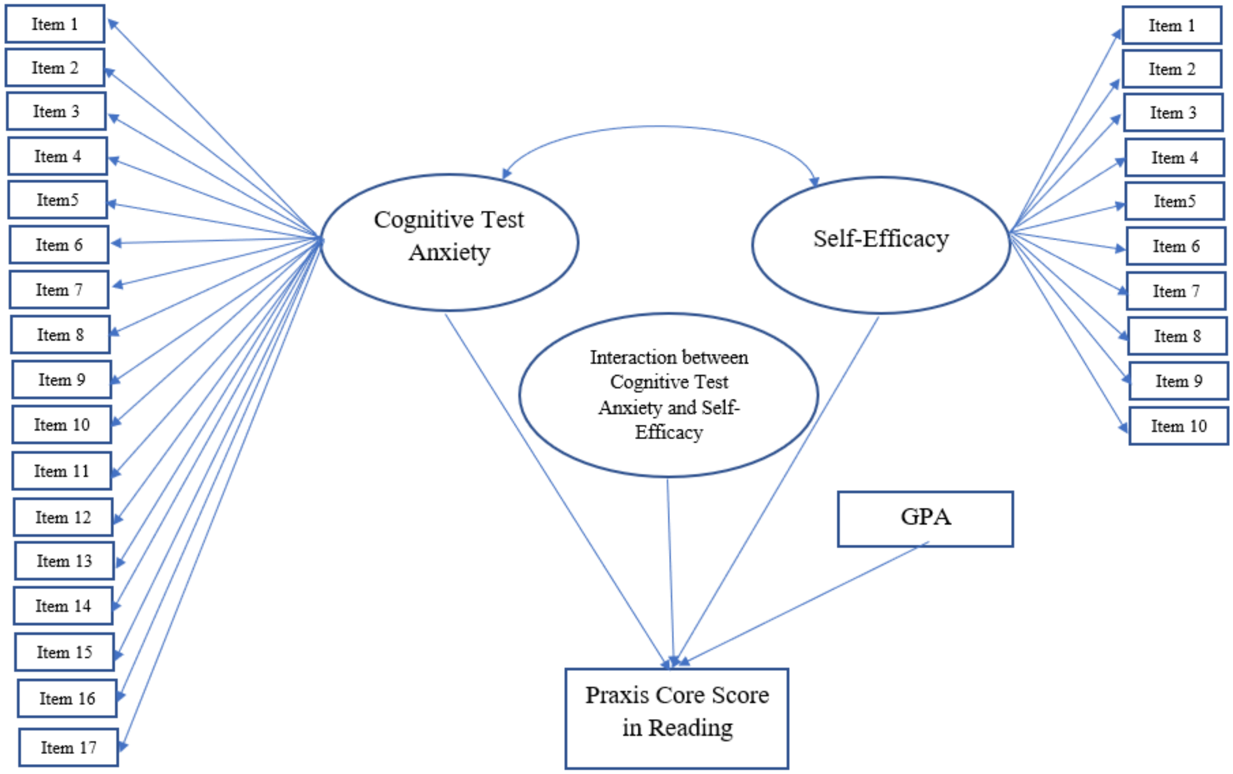

Figure 3. Model 1.2 for Praxis Core exam score in Reading: Measurement model and structural model with interaction between Cognitive Test Anxiety and Self-Efficacy

Model 2.1 and Model 2.2.

Model 2.1 and Model 2.2 focused on the exam performance in Mathematics only. Model 2.1 presented a linear SEM, and was a simpler version of Model 2.2, without including the latent interaction between Cognitive Test Anxiety and Self-Efficacy in the model. Model 2.1 can be specified as

$$Praxis\ Math\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}\ (\text{SE}) + \beta_{3i}(\text{GPA}) + \varepsilon_i \tag{9}$$

Where Praxis Math score was the score for person *i*, β_{0i} was the mean Praxis Core Math score across the entire sample when predictors were zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy, β_{3i} was the coefficient for GPA, and ε_i was the error term for person *i*. By adding the latent interaction between Cognitive Test Anxiety and

Self-Efficacy to Model 2.1, Model 2.2 also estimated the interaction effect on exam performance in Mathematics. Model 2.2 can be expressed as

$$Praxis\ Math\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}\ (\text{SE}) + \beta_{3i}(\text{GPA}) + \beta_{4i}(\text{CTA} * \text{SE}) + \varepsilon_i \qquad (10)$$

where Praxis Math score was the score for person *i*, β_{0i} was the mean Praxis Core Math score across the entire sample when predictors are zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy, β_{3i} was the coefficient for GPA, β_{4i} was the coefficient for the interaction between Cognitive Test Anxiety and Self-Efficacy, ε_i was the error term for person *i*. Figure 4 and 5 present Model 2.1 and 2.2.

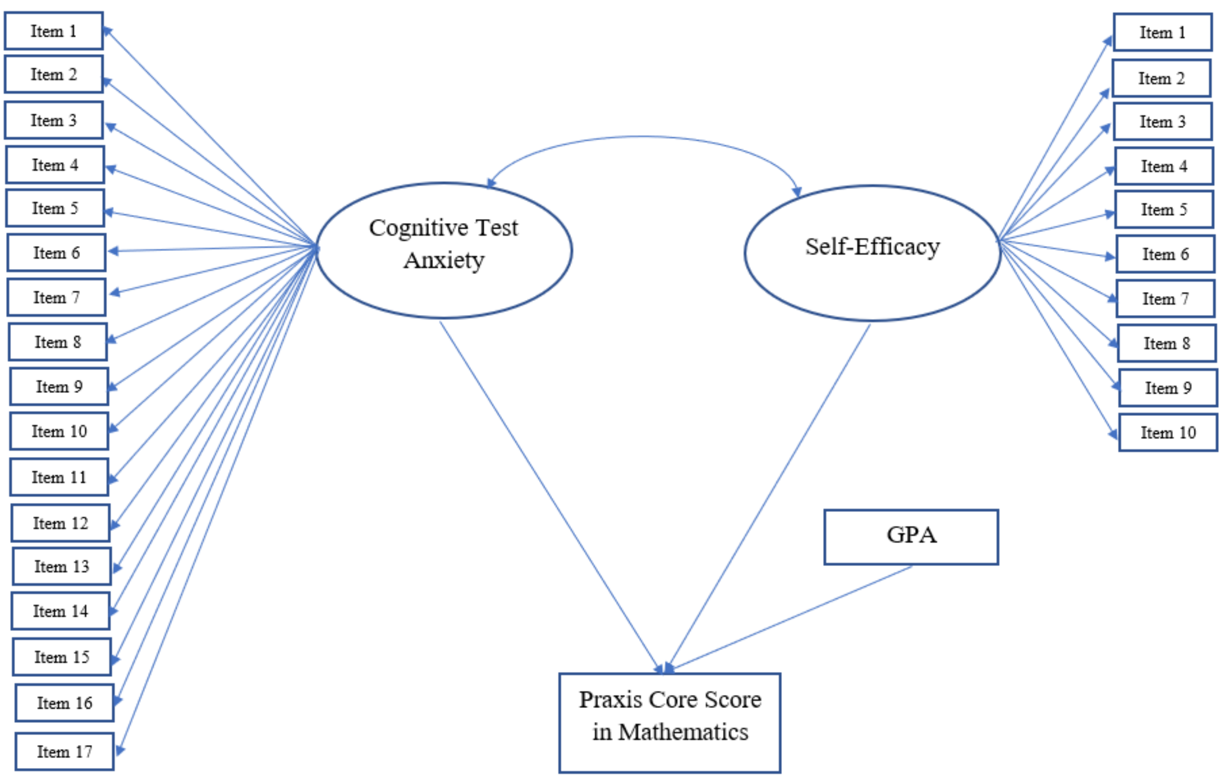

Figure 4. Model 2.1 for Praxis Core exam score in Mathematics: Measurement model and structural model without interaction between Cognitive Test Anxiety and Self-Efficacy

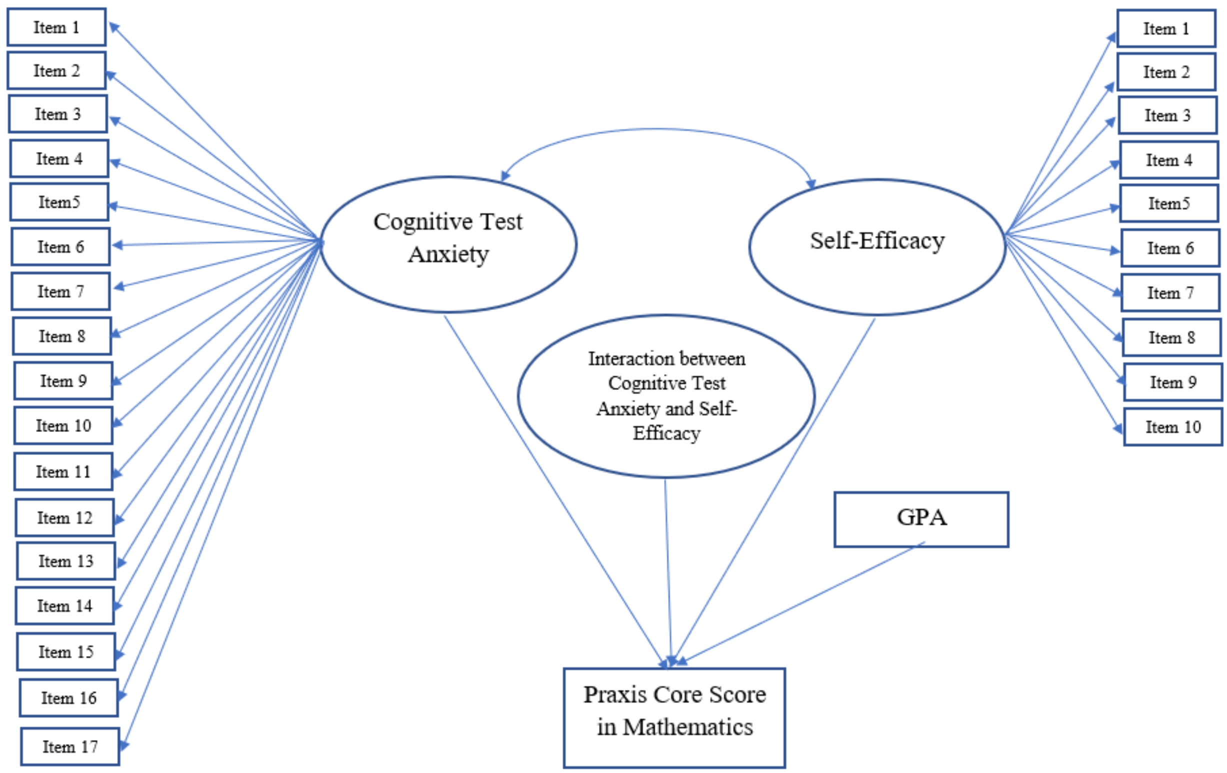

Figure 5. Model 2.2 for Praxis Core exam score in Mathematics: Measurement model and structural model with interaction between Cognitive Test Anxiety and Self-Efficacy

Model 3.1 and Model 3.2.

Model 3.1 and Model 3.2 investigated the exam performance in Writing. Model 3.1, which was a simpler version of Model 3.2, presented a linear SEM without including the latent interaction between Cognitive Test Anxiety and Self-Efficacy in the model. Model 3.1 can be specified as

$$Praxis\ Writing\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}\ (\text{SE}) + \beta_{3i}(\text{GPA}) + \varepsilon_i \quad (11)$$

where Praxis Writing score was the score for person *i*, β_{0i} was the mean Praxis Core Writing score across the entire sample when predictors were zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy, β_{3i} was the coefficient for GPA, and ε_i was the error term for person *i*. By adding the latent interaction between Cognitive Test Anxiety and Self-

Efficacy to Model 3.1, Model 3.2 also estimated the interaction effect on exam performance in Writing. Model 3.2 can be specified as

$$Praxis\ Writing\ Score_i = \beta_{0i} + \beta_{1i}(\text{CTA}) + \beta_{2i}\ (\text{SE}) + \beta_{3i}(\text{GPA}) + \beta_{4i}(\text{CTA * SE}) + \varepsilon_i \quad (12)$$

where Praxis Writing score was the score for person i, β_{0i} was the mean Praxis Core Writing score across the entire sample when predictors were zero, β_{1i} was the coefficient for Cognitive Test Anxiety, β_{2i} was the coefficient for Self-Efficacy β_{3i} was the coefficient for GPA, β_{4i} was the coefficient for the interaction between Cognitive Test Anxiety and Self-Efficacy, and ε_i was the error term for person *i.* Figure 6 and 7 present Model 3.1 and 3.2.

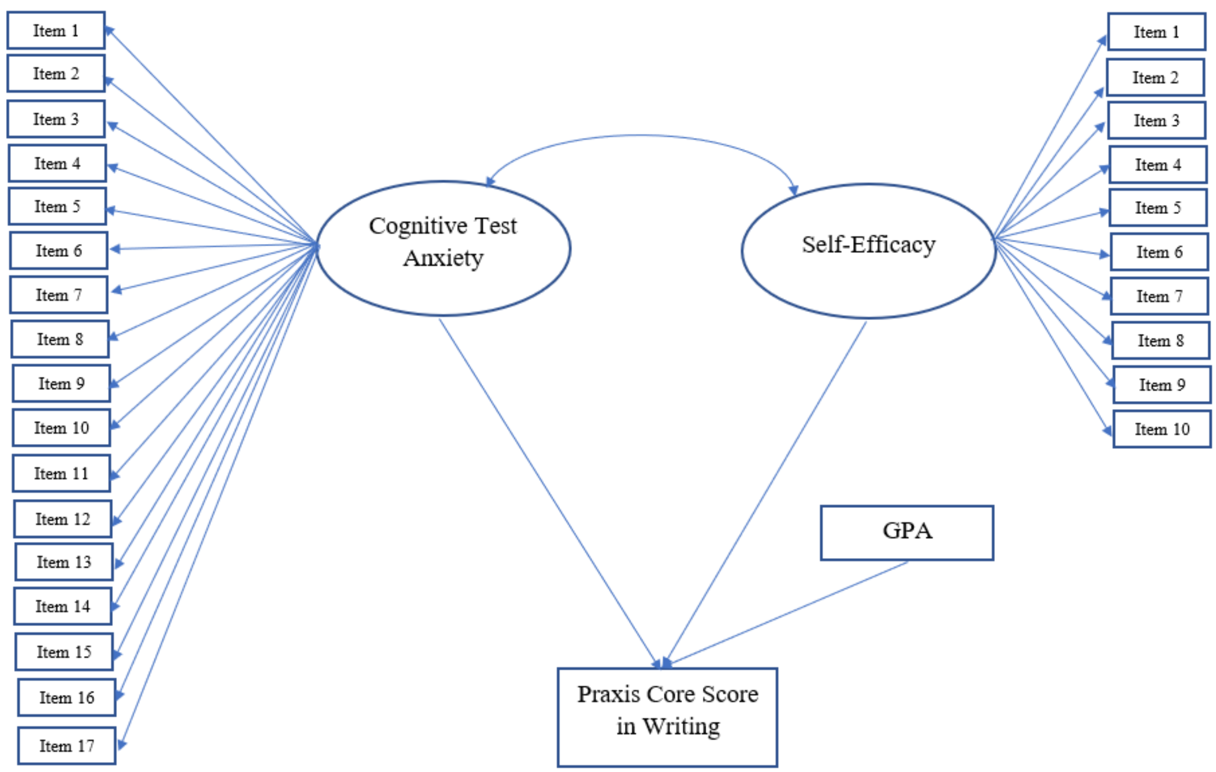

Figure 6. Model 3.1 for Praxis Core exam score in Writing: Measurement model and structural model without interaction between Cognitive Test Anxiety and Self-Efficacy

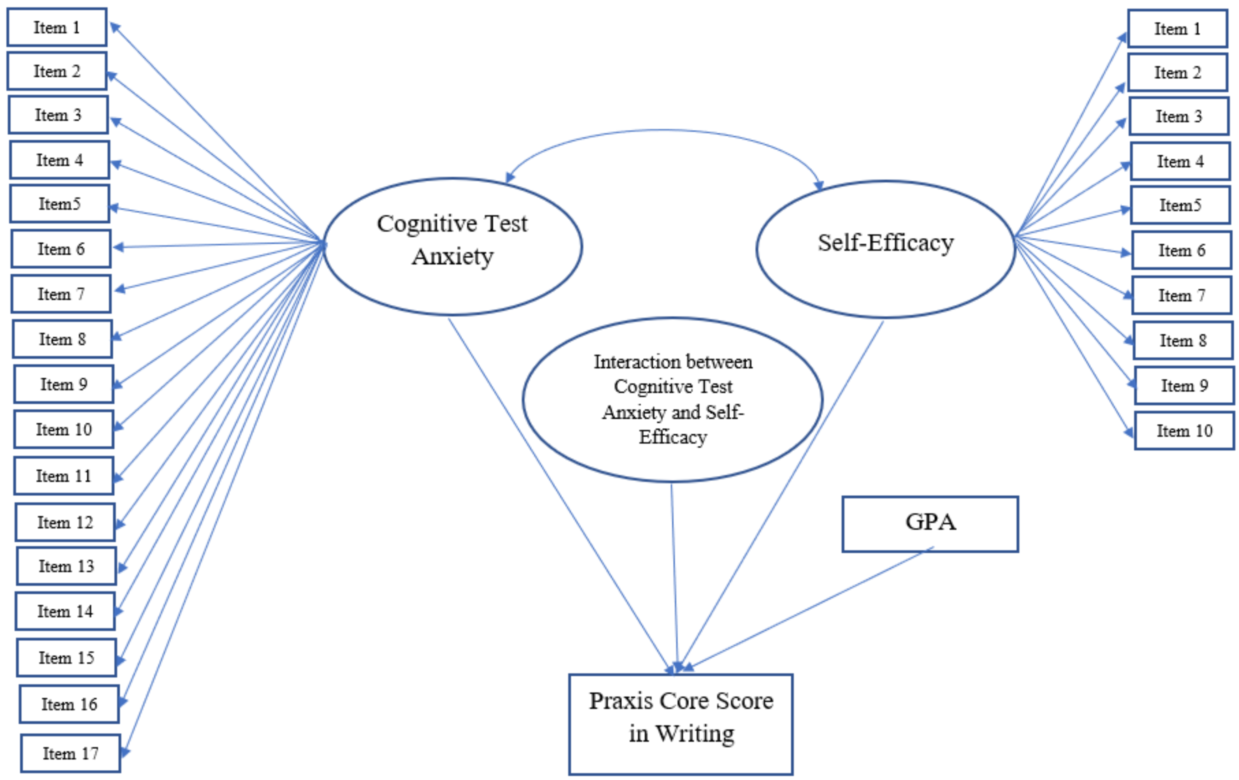

Figure 7. Model 3.2 for Praxis Core exam score in Writing: Measurement model and structural model with interaction between Cognitive Test Anxiety and Self-Efficacy

Structural model comparison.

Using a log-likelihood ratio test, the relative fit of the base model where the interaction was not estimated and the complex model where the interaction was estimated was compared. The log-likelihood ratios test was used to determine whether the more parsimonious model where the interaction was not estimated represented a significant loss in fit relative to the more complex model where the interaction was estimated (Satorra, 2000; Satorra & Bentler, 2010). If the log-likelihood test was significant, it can be concluded that the base model resulted in a significant loss of fit relative to the complex model. If the log-likelihood test was not significant, it can be concluded that the base model did not result in a significant loss of fit relative to the complex model. The test statistic of the log-likelihood test, often denoted as *D*, was calculated using the following equation

$D = -2$[(log−likelihood for base model) – (log-likelihood for complex model)].. (13)

The values of D are approximately distributed as x^2. The degrees of freedom (df) to determine the significance of D is calculated by subtracting the number of free parameters in the base model from the number of free parameters in the complex model. The difference in free parameters between the base model and the complex model is the latent interaction. Therefore, the D statistics calculated using the log-likelihoods from the base and the complex model can be compared to a x^2 distribution using $df = 1$.

Additionally, Akaike information criterion (AIC) and Bayesian information criterion (BIC) were considered for model comparison. AIC is a measure of the relative goodness of fit of models, offering a relative measure of the information lost. BIC remediates the overfitting problem by using a penalty term for the number of parameters in the model. AIC and BIC are defined as following:

$$\text{AIC} = 2k - 2\ln(L) \quad (14)$$

$$\text{BIC} = -2\ln(L) + kln(n) \quad (15)$$

where L is the maximized value of the likelihood function for the estimated model, n is the number of observations, k is the number of parameters in the model.

Statistical software.

Data management was performed in SAS. Substantive data analyses described above were performed in Mplus 7 (Muthén & Muthén, 1998–2012). Further detail of the Mplus syntax is provided in Appendices D-G.

CHAPTER 4

RESULTS

In this chapter, results of this study are presented. First, descriptive statistics are described for each of the measures. Second, the process and outcome of selecting the measurement models are presented. Third, results of the selected measurement models are presented by Cognitive Test Anxiety and Self-Efficacy, respectively. Lastly, results of the SEM models with and without the interaction term are presented.

Descriptive Statistics

Among a total of 3,302 survey entries received on MTurk, 301 entries were complete and validated based on the criteria described in Chapter 3, and therefore were included in the data analysis. Table 1 shows descriptive statistics of the Praxis Core scores by subject, self-reported college GPA, and participants' gender. The mean Praxis Core score in Reading was 164 (*SD* = 17.27). The mean Praxis Core score in Mathematics was 158 (*SD* = 18.06). The mean Praxis Core score in Writing was 166 (*SD* = 14.91). Participants' average self-reported college GPA at their first attempt of taking the Praxis Core examination was 3.51 (*SD* = 0.32) on a 4-point scale. Of the participants, 45% (*N* = 135) were male, and 55% were female (*N* = 166).

Table 1

Descriptive Statistics for Praxis Core Exam Scores, GPA, and Gender

Variable	N	Mean	SD	Min	Max
Praxis Core Scores					
Praxis Core Reading Score	301	164	17.27	100	200
Praxis Core Mathematics Score	301	158	18.06	100	200
Praxis Core Writing Score	301	166	14.91	110	200
GPA	301	3.51	0.32	2.00	4.00
Gender					
Female	166				
Male	135				

Tables 2 and 3 show descriptive statistics, including the number and percentage of responses for each response option, item mean response and standard deviation of responses by item for the 17 items on the Cognitive Test Anxiety Revised (CTAR) scale and the 10 items on the General Self-Efficacy (GSE) scale, respectively.

Table 2

Descriptive Statistics for the responses to the CTAR Scale

Item	Not at all typical of me (1)		Somewhat typical of me (2)		Quite typical of me (3)		Very typical of me (4)		Item Mean	Item SD
	N	%	N	%	N	%	N	%		
1. I lose sleep over worrying about examinations.	76	25%	77	26%	96	32%	52	17%	2.41	1.05
2. I worry more about doing well on tests than I should.	52	17%	90	30%	94	31%	65	22%	2.57	1.01
3. I get distracted from studying for tests by thoughts of failing.	93	31%	101	34%	71	24%	36	12%	2.20	1.08
4. I have difficulty remembering what I studied for tests.	98	33%	85	28%	78	26%	40	13%	2.17	1.00
5. While preparing for a test, I often think that I am likely to fail.	99	33%	91	30%	65	22%	46	15%	2.20	1.04
6. I am not good at taking tests.	88	29%	94	31%	82	27%	37	12%	2.19	1.06
7. When I first get my copy of a test, it takes me a while to calm down to the point where I can begin to think straight.	97	32%	107	36%	72	24%	25	8%	2.23	1.00
8. At the beginning of a test, I am so nervous that I often can't think straight.	76	25%	95	32%	89	30%	41	14%	2.08	0.94
9. When I take a test that is difficult, I feel defeated before I even start.	96	32%	80	27%	87	29%	38	13%	2.32	1.00
10. While taking an important examination, I find myself wondering whether the other students are doing better than I am.	98	33%	80	27%	86	29%	37	12%	2.22	1.03
11. I tend to freeze up on things like intelligence tests and final exams.	114	38%	65	22%	78	26%	44	15%	2.21	1.03

12. During tests, the thought frequently occurs to me that I may not be too bright.	96	32%	96	32%	81	27%	28	9%	2.17	1.09
13. During a course examination, I get so nervous that I forget facts I really know.	121	40%	94	31%	60	20%	26	9%	2.14	0.97
14. I do not perform well on tests.	81	27%	95	32%	79	26%	46	15%	1.97	0.97
15. During tests, I have the feeling that I am not doing well.	111	37%	83	28%	66	22%	41	14%	2.30	1.03
16. I am a poor test taker in the sense that my performance on a test does not show how much I really know about a topic.	48	16%	86	29%	108	36%	59	20%	2.12	1.06
17. After taking a test, I feel I should have done better than I did.	103	34%	81	27%	70	23%	47	16%	2.59	0.98

Note. The value of response options for each statement ranges from 1 (Not at all typical of me) to 4 (Very typical of me)

Table 3

Descriptive Statistics for the responses to the GSE Scale

Item	Not at all true (1)		Hardly true (2)		Moderately true (3)		Exactly true (4)		Item Mean	Item SD
	N	%	N	%	N	%	N	%		
1. I can always manage to solve difficult problems if I try hard enough.	10	3%	41	14%	185	61%	65	22%	3.01	0.70
2. If someone opposes me, I can find the means and ways to get what I what.	16	5%	89	30%	146	49%	50	17%	2.76	0.79
3. It is easy for me to stick to my aims and accomplish my goals.	12	4%	50	17%	168	56%	71	24%	2.99	0.75
4. I am confident that I can deal efficiently with unexpected events.	9	3%	45	15%	168	56%	79	26%	3.05	0.73
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.	6	2%	39	13%	164	54%	92	31%	3.14	0.71
6. I can solve most problems if I invest the necessary effort.	13	4%	36	12%	167	55%	85	28%	3.08	0.76
7. I can remain calm when facing difficulties because I can reply on my coping abilities.	9	3%	47	16%	168	56%	77	26%	3.04	0.73
8. When I am confronted with a problem, I can usually find several solutions.	9	3%	52	17%	157	52%	83	28%	3.04	0.75
9. If I am in trouble, I can usually find several solutions.	15	5%	54	18%	157	52%	75	25%	2.97	0.79
10. I can usually handle whatever comes my way.	6	2%	53	18%	163	54%	79	26%	3.05	0.72

Note. The value of response options for each statement ranges from 1 (Not at all true) to 4 (Exactly true)

Tables 4 and Table 5, respectively, show the inter-item correlation and the inter-item covariance for the items on the CTAR scale. The coefficient alpha for the CTAR items was 0.95, indicating that the scale has excellent internal consistency for the sample of the current study. Table 6 and Table 7, respectively, present the inter-item correlation and the inter-item covariance for items on the GSE scale. The coefficient alpha for these 10 items was 0.87, suggesting high reliability.

Table 4

Inter-Item Correlation Matrix - Cognitive Test Anxiety Scale-Revised.

Item	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17
Item 1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 2	0.65	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 3	0.5	0.4	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 4	0.56	0.51	0.64	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 5	0.44	0.39	0.5	0.54	1	–	–	–	–	–	–	–	–	–	–	–	–
Item 6	0.52	0.4	0.45	0.49	0.42	1	–	–	–	–	–	–	–	–	–	–	–
Item 7	0.51	0.5	0.6	0.63	0.49	0.59	1	–	–	–	–	–	–	–	–	–	–
Item 8	0.49	0.47	0.45	0.48	0.36	0.51	0.53	1	–	–	–	–	–	–	–	–	–
Item 9	0.51	0.39	0.57	0.53	0.52	0.61	0.61	0.49	1	–	–	–	–	–	–	–	–
Item 10	0.55	0.4	0.54	0.61	0.5	0.65	0.62	0.43	0.66	1	–	–	–	–	–	–	–
Item 11	0.46	0.41	0.56	0.61	0.5	0.49	0.65	0.52	0.62	0.65	1	–	–	–	–	–	–
Item 12	0.51	0.5	0.58	0.52	0.54	0.59	0.64	0.46	0.67	0.66	0.61	1	–	–	–	–	–
Item 13	0.41	0.35	0.49	0.46	0.67	0.44	0.53	0.36	0.57	0.55	0.51	0.65	1	–	–	–	–
Item 14	0.46	0.52	0.55	0.62	0.61	0.5	0.6	0.51	0.6	0.6	0.61	0.64	0.64	1	–	–	–
Item 15	0.49	0.4	0.54	0.51	0.63	0.49	0.56	0.38	0.6	0.58	0.51	0.64	0.65	0.68	1	–	–
Item 16	0.42	0.45	0.46	0.41	0.5	0.38	0.47	0.4	0.53	0.48	0.5	0.58	0.48	0.57	0.58	1	–
Item 17	0.59	0.5	0.65	0.65	0.56	0.52	0.58	0.5	0.53	0.54	0.55	0.58	0.54	0.6	0.5	0.43	1

Table 5

Inter-Item Covariance Matrix - Cognitive Test Anxiety Scale-Revised

Item	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17
Item 1	1.10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 2	0.69	1.03	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 3	0.52	0.40	1.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 4	0.60	0.53	0.67	1.08	–	–	–	–	–	–	–	–	–	–	–	–	–
Item 5	0.49	0.42	0.52	0.60	1.12	–	–	–	–	–	–	–	–	–	–	–	–
Item 6	0.55	0.40	0.46	0.51	0.44	1.01	–	–	–	–	–	–	–	–	–	–	–
Item 7	0.50	0.48	0.57	0.61	0.49	0.56	0.89	–	–	–	–	–	–	–	–	–	–
Item 8	0.51	0.48	0.45	0.49	0.38	0.51	0.50	1.00	–	–	–	–	–	–	–	–	–
Item 9	0.55	0.41	0.58	0.57	0.57	0.63	0.60	0.50	1.07	–	–	–	–	–	–	–	–
Item 10	0.60	0.42	0.55	0.65	0.55	0.67	0.60	0.44	0.70	1.06	–	–	–	–	–	–	–
Item 11	0.53	0.45	0.61	0.70	0.58	0.53	0.67	0.57	0.70	0.73	1.20	–	–	–	–	–	–
Item 12	0.52	0.49	0.57	0.52	0.56	0.57	0.58	0.45	0.67	0.66	0.65	0.94	–	–	–	–	–
Item 13	0.42	0.35	0.47	0.47	0.69	0.43	0.49	0.35	0.57	0.55	0.55	0.61	0.95	–	–	–	–
Item 14	0.50	0.54	0.56	0.66	0.67	0.52	0.59	0.52	0.64	0.63	0.68	0.64	0.64	1.06	–	–	–
Item 15	0.54	0.43	0.57	0.56	0.71	0.52	0.56	0.40	0.66	0.64	0.59	0.65	0.67	0.74	1.12	–	–
Item 16	0.43	0.45	0.44	0.42	0.51	0.38	0.44	0.39	0.53	0.49	0.53	0.55	0.46	0.57	0.60	0.96	–
Item 17	0.67	0.54	0.70	0.73	0.64	0.56	0.59	0.54	0.58	0.60	0.65	0.61	0.57	0.67	0.58	0.46	1.16

Table 6

Inter-Item Correlation Matrix - General Self-Efficacy Scale

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Item 1	1	–	–	–	–	–	–	–	–	–
Item 2	0.31	1	–	–	–	–	–	–	–	–
Item 3	0.42	0.30	1	–	–	–	–	–	–	–
Item 4	0.39	0.30	0.48	1	–	–	–	–	–	–
Item 5	0.46	0.33	0.42	0.42	1	–	–	–	–	–
Item 6	0.40	0.32	0.33	0.28	0.36	1	–	–	–	–
Item 7	0.48	0.35	0.38	0.42	0.48	0.49	1	–	–	–
Item 8	0.46	0.31	0.51	0.43	0.53	0.47	0.48	1	–	–
Item 9	0.37	0.32	0.40	0.41	0.37	0.35	0.43	0.47	1	–
Item 10	0.42	0.33	0.41	0.34	0.31	0.47	0.38	0.41	0.42	1

Table 7

Inter-Item Covariance Matrix - General Self-Efficacy Scale

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Item 1	0.49	–	–	–	–	–	–	–	–	–
Item 2	0.17	0.62	–	–	–	–	–	–	–	–
Item 3	0.22	0.17	0.56	–	–	–	–	–	–	–
Item 4	0.20	0.17	0.26	0.53	–	–	–	–	–	–
Item 5	0.22	0.19	0.22	0.22	0.50	–	–	–	–	–
Item 6	0.21	0.19	0.19	0.16	0.19	0.57	–	–	–	–
Item 7	0.24	0.20	0.21	0.22	0.24	0.27	0.53	–	–	–
Item 8	0.24	0.18	0.29	0.24	0.28	0.27	0.26	0.57	–	–
Item 9	0.21	0.20	0.24	0.23	0.20	0.21	0.25	0.28	0.63	–
Item 10	0.21	0.18	0.22	0.18	0.16	0.26	0.20	0.22	0.21	0.52

Measurement Model

Measurement models were first estimated for Cognitive Test Anxiety and Self-Efficacy, respectively, prior to estimating the structural model with the Praxis Core exam scores being the dependent variable. Unconstrained and constrained graded response models (GRMs) were applied to the response data for comparison. Unconstrained GRMs where factor loadings were estimated for each item were first applied to the response data of the CTAR and the GSE, respectively. Constrained GRMs were then applied to the response data where factor loadings were constrained to be equal across all items. The measurement model that showed better fit to the response data was retained for further examination.

Unconstrained Graded Response Models.

An unconstrained GRM with item factor loadings estimated per item was first applied to the CTAR and the GSE response data, respectively, using weighted least squares means and variance adjusted (WLSMV) estimator. The means and variances of the latent traits, Cognitive Test Anxiety and General Self-Efficacy, were fixed for identification to 0 and 1, respectively. Separate factor loadings were estimated for each item, and three item thresholds (equal to the number of response categories minus one) were estimated per item. Figures 8 and 9 show the unconstrained models for the CTAR and GSE response data. In Figure 8, all the factor loadings (shown as the first value on each of the arrows) were positive, indicating a positive relationship between the latent variable, Cognitive Test Anxiety, and the 17 items that were observed measures of Cognitive Test Anxiety. The values in the parentheses were the standard errors for the estimates of loadings. Similarly, in Figure 9, all the factor loadings were positive, indicating a positive relationship between the latent variable, Self-Efficacy, and the 10 items in the survey.

Evidence for model fit was mixed. The unconstrained GRM with factor loadings estimated for the CTAR response data exhibited acceptable fit according to the Comparative Fit Index (CFI) of 0.95. However, the model displayed unacceptable fit by the Model Chi-Square test of absolute fit, X^2 (119) = 529.337, p < 0.001, RMSEA = 0.107 [CI = 0.098 − 0.116, p < 0.001], and TLI = 0.943. The unconstrained model for the GSE response data exhibited acceptable fit by CFI = 0.95, RMSEA = 0.062 [CI = 0.043− 0.081, p = 0.138], and TLI = 0.975, but unacceptable fit by the X^2 test of absolute fit, (35) = 75.842, p < 0.001.

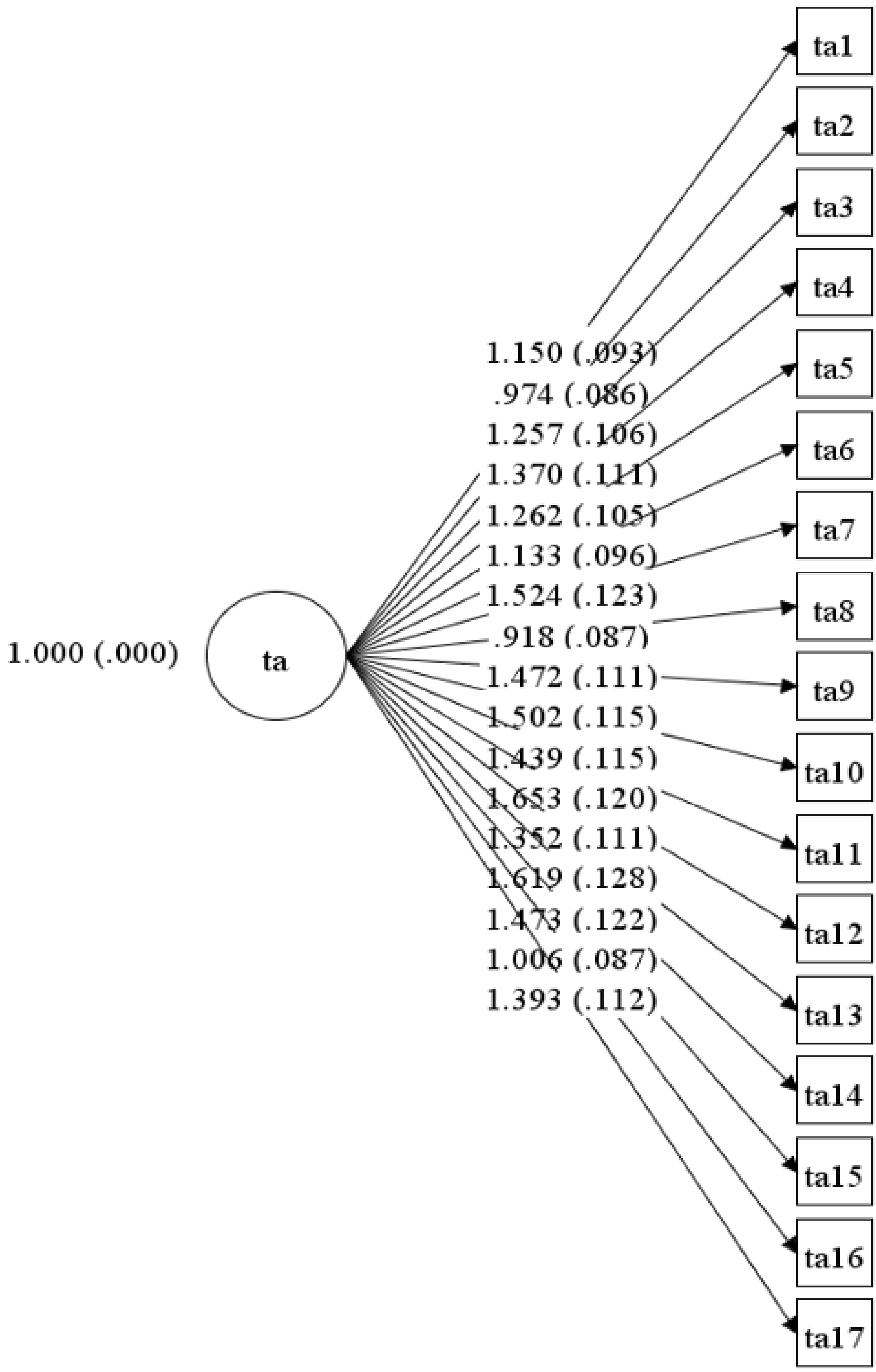

Figure 8. Measurement model: unconstrained Graded Response Model for the Cognitive Test Anxiety items

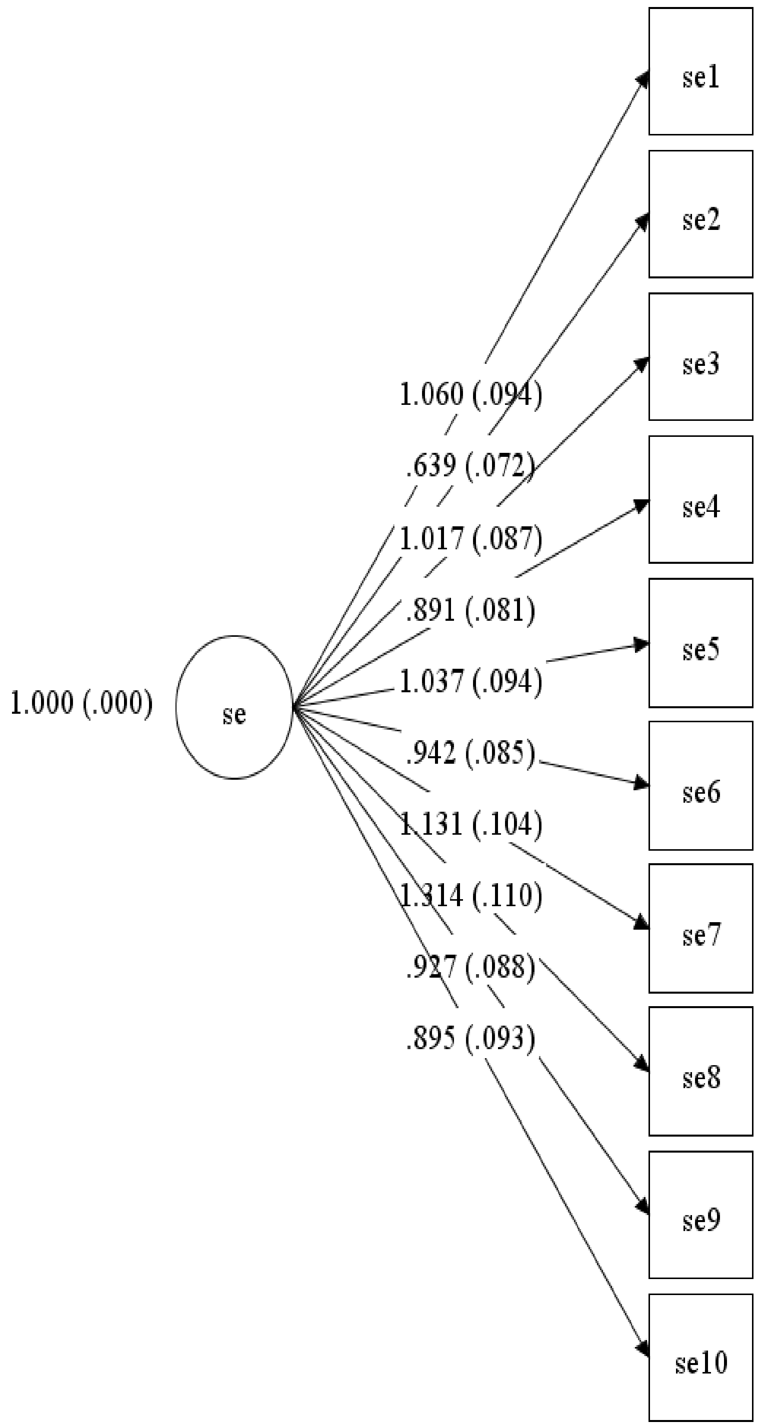

Figure 9. Measurement model: unconstrained Graded Response Model for the General Efficacy items

Constrained Graded Response Models.

Constrained GRMs that fix items to a common factor loading were then applied to the response data. Figure 10 and Figure 11 present the constrained models for the CTAR and GSE response data. In each model, factor loadings and factor variances were fixed to be equal across all items. In Figure 10, for example, all 17 items had equal factor loadings (1.317) and equal standard errors (0.066).

The fit indices used to evaluate model fit were inconsistent. The constrained GRM for the CTAR response data exhibited acceptable fit by the CFI and TLI, both of which were equal to 0.95, but unacceptable fit by X^2 (135) = 549.195, $p < 0.001$, as well as by RMSEA = 0.101 [CI = 0.092 − 0.110, $p < 0.001$]. A likelihood ratio test between the unconstrained and the constrained models for the CTAR response data indicated that the unconstrained GRM did not fit the data significantly better, DIFFTEST(16) = 19.858, $p = 0.227$. Thus, the constrained GRM was retained for further examination for the CTAR response data.

The model for the GSE response data had unacceptable fit as indicated by the X^2 (44) = 132.834, $p < 0.001$, and RMSEA = 0.082 [CI = 0.066 – 0.098, $p < 0.001$], despite an acceptable TLI value of 0.957. A likelihood ratio test between the unconstrained and the constrained models for the GSE response data indicated that the unconstrained model fit the data significantly better, DIFFTEST(9) = 56.992, $p < 0.001$, Therefore, the unconstrained model was retained for further examination for the GSE response data.

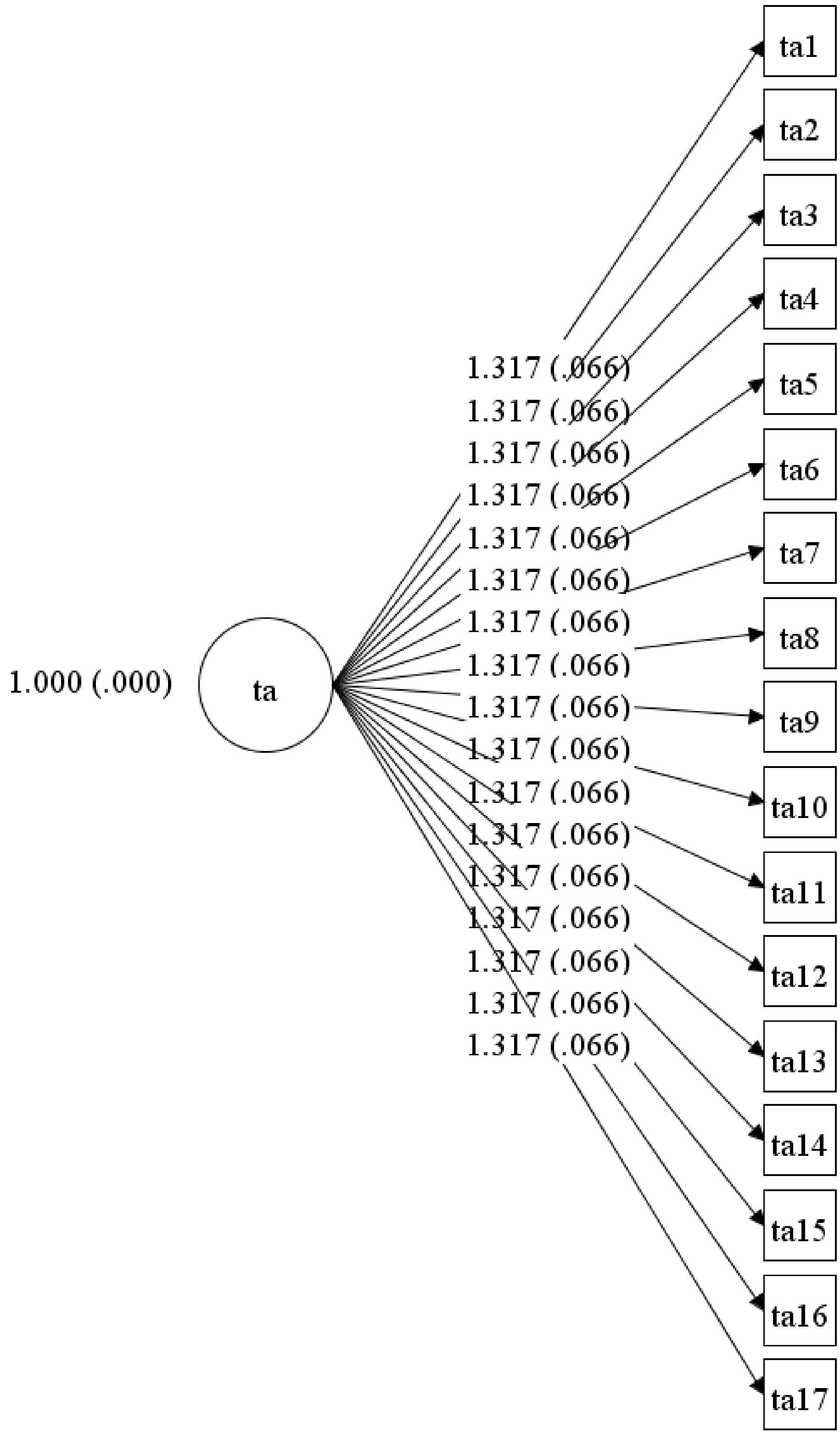

Figure 10. Measurement model: constrained Graded Response Model for the Cognitive Test Anxiety items

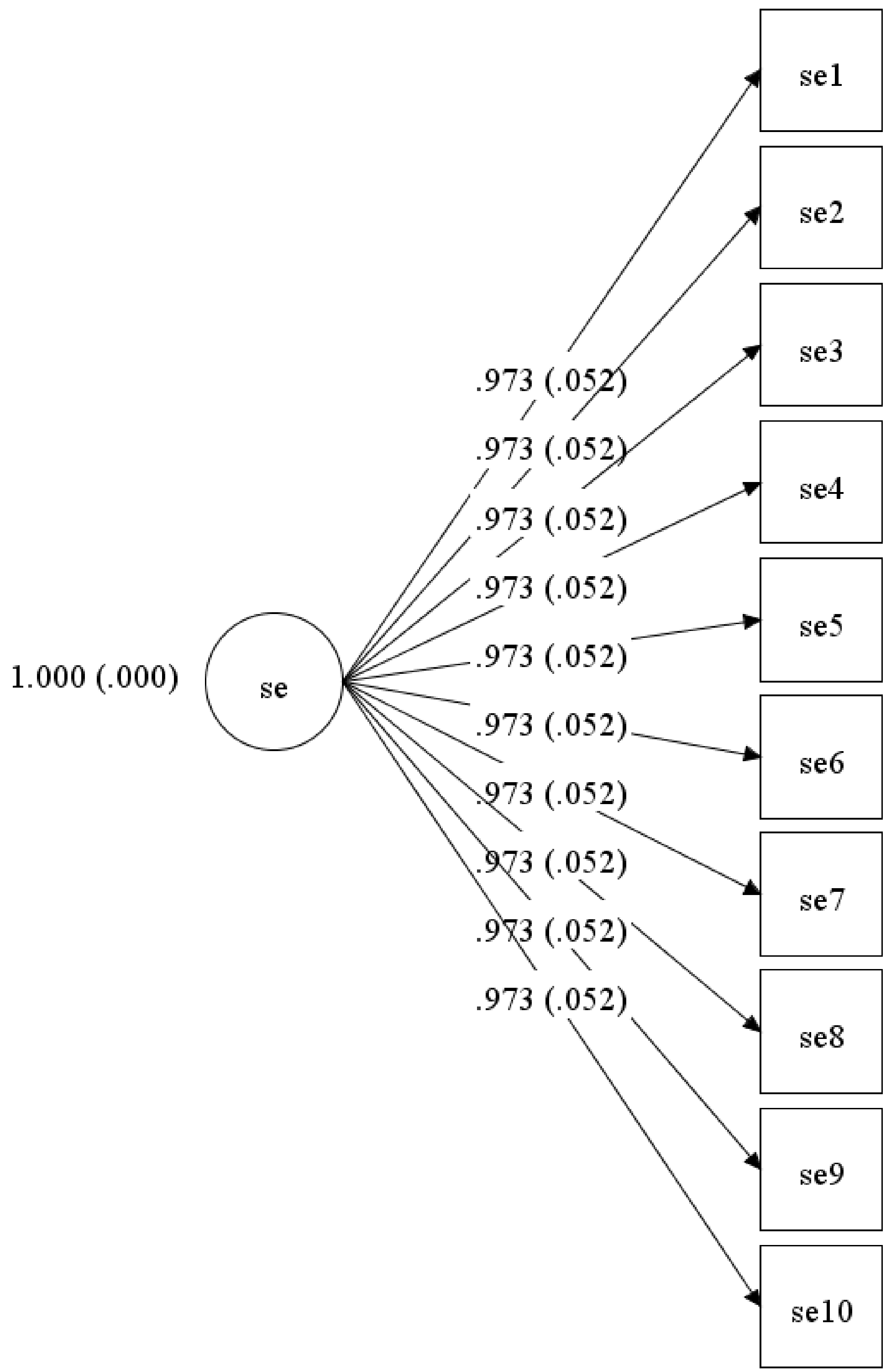

Figure 11. Measurement model: constrained Graded Response Model for the General Self-Efficacy items

Modeling Cognitive Test Anxiety response data.

Model parameters for Cognitive Test Anxiety obtained from using ML and a logit link are shown in this section, including the IFA item parameters (thresholds and loadings). IRT analogous parameters are also shown. IRT discrimination a_i was the same as the loading λ_i. IRT difficulty was computed as b_{ic} = τ_{ic}/λ_i. Table 8 summarizes estimated slope parameters from the constrained model. Factor loadings were fixed to be equal across all items in the constrained model. To translate the factor loadings in the context of IRT, the item discrimination parameters were fixed across all items.

Table 8

Estimated Slope Parameters for Cognitive Test Anxiety

	IFA Parameters		IRT Parameters	
	Loading		Discrimination	
Slope Parameters	Estimate	SE	Estimate	SE
Item 1	2.45	0.12	2.45	0.12
Item 2	2.45	0.12	2.45	0.12
Item 3	2.45	0.12	2.45	0.12
Item 4	2.45	0.12	2.45	0.12
Item 5	2.45	0.12	2.45	0.12
Item 6	2.45	0.12	2.45	0.12
Item 7	2.45	0.12	2.45	0.12
Item 8	2.45	0.12	2.45	0.12
Item 9	2.45	0.12	2.45	0.12
Item 10	2.45	0.12	2.45	0.12
Item 11	2.45	0.12	2.45	0.12
Item 12	2.45	0.12	2.45	0.12
Item 13	2.45	0.12	2.45	0.12
Item 14	2.45	0.12	2.45	0.12
Item 15	2.45	0.12	2.45	0.12
Item 16	2.45	0.12	2.45	0.12
Item 17	2.45	0.12	2.45	0.12

Table 9 shows the item-specific thresholds and difficulty for category 2, 3, and 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 9

Item-Specific Thresholds and Difficulty for Category 1 vs. Category 2, 3, and 4 for Cognitive Test Anxiety

	Threshold		Difficulty	
Location Parameters: $y > 1$	Estimate	SE	Estimate	SE
Item 1	-1.80	0.23	-0.74	0.10
Item 2	-2.61	0.26	-1.07	0.12
Item 3	-1.29	0.22	-0.53	0.09
Item 4	-1.16	0.22	-0.47	0.09
Item 5	-1.09	0.22	-0.44	0.09
Item 6	-1.40	0.22	-0.57	0.10
Item 7	-1.19	0.22	-0.49	0.09
Item 8	-1.72	0.23	-0.70	0.10
Item 9	-1.21	0.22	-0.49	0.09
Item 10	-1.20	0.22	-0.49	0.09
Item 11	-0.74	0.21	-0.30	0.09
Item 12	-1.27	0.22	-0.52	0.09
Item 13	-0.54	0.21	-0.22	0.09
Item 14	-1.69	0.23	-0.69	0.10
Item 15	-0.79	0.21	-0.32	0.09
Item 16	-2.84	0.26	-1.16	0.12
Item 17	-1.03	0.22	-0.42	0.09

Table 10 shows the item-specific thresholds and difficulty between category 1 and 2 vs. category 3 and 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 10

Item-Specific Thresholds and Difficulty for Category 1 and 2 vs. Category 3 and 4 for Cognitive Test Anxiety

	Threshold		Difficulty	
Location Parameters: $y > 2$	Estimate	SE	Estimate	SE
Item 1	0.25	0.21	0.10	0.08
Item 2	0.05	0.21	0.02	0.09
Item 3	1.14	0.21	0.47	0.09
Item 4	0.91	0.21	0.37	0.09
Item 5	1.07	0.21	0.44	0.09
Item 6	0.83	0.21	0.34	0.09
Item 7	1.36	0.21	0.55	0.09
Item 8	0.67	0.21	0.27	0.08
Item 9	0.76	0.21	0.31	0.09
Item 10	0.77	0.21	0.31	0.09
Item 11	0.79	0.20	0.32	0.08
Item 12	1.10	0.21	0.45	0.09
Item 13	1.68	0.21	0.69	0.09
Item 14	0.74	0.21	0.30	0.08
Item 15	1.21	0.21	0.50	0.09
Item 16	-0.22	0.21	-0.09	0.09
Item 17	0.94	0.21	0.38	0.09

Table 11 shows the item-specific thresholds and difficulty between category 1, 2 and 3 vs. category 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 11

Item-Specific Thresholds and Difficulty for Category 1, 2 and 3 vs. Category 4 for Cognitive Test Anxiety

	Threshold		Difficulty	
Location Parameters: $y > 3$	Estimate	SE	Estimate	SE
Item 1	2.66	0.24	1.09	0.11
Item 2	2.24	0.23	0.92	0.10
Item 3	3.38	0.27	1.38	0.12
Item 4	3.18	0.26	1.30	0.12
Item 5	2.88	0.25	1.18	0.11
Item 6	3.25	0.26	1.33	0.12
Item 7	4.01	0.30	1.64	0.14
Item 8	3.04	0.25	1.24	0.12
Item 9	3.28	0.26	1.34	0.12
Item 10	3.32	0.26	1.36	0.12
Item 11	2.98	0.25	1.22	0.11
Item 12	3.84	0.29	1.57	0.14
Item 13	3.88	0.29	1.59	0.14
Item 14	2.98	0.25	1.22	0.11
Item 15	3.18	0.25	1.30	0.12
Item 16	2.43	0.23	0.99	0.10
Item 17	2.91	0.24	1.19	0.11

The item difficulty parameter in the constrained model is equivalent to the latent trait, Cognitive Test Anxiety. Figure 12 shows the distribution of the latent trait under the constrained GRM.

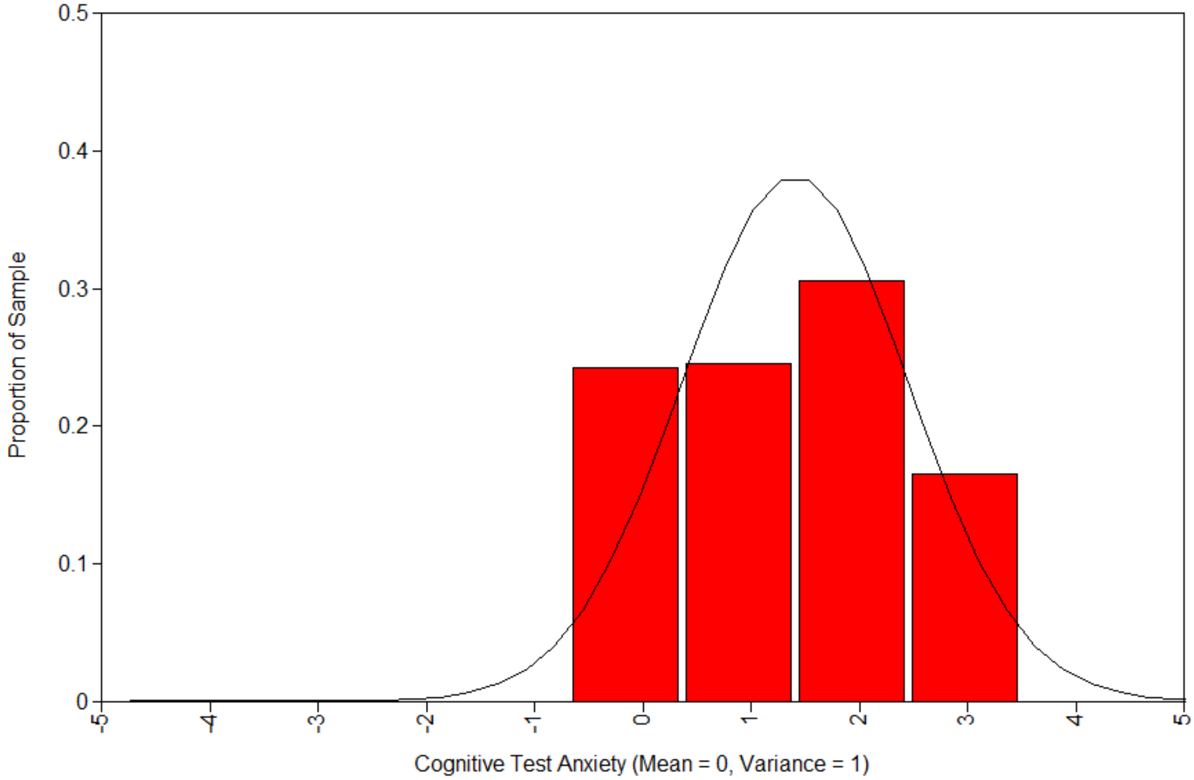

Figure 12. Distribution of Cognitive Test Anxiety

Figure 13 presents the reliability of the Cognitive Test Anxiety survey along the spectrum of the latent trait. Reliability is above 0.80 from about −1.6 standard deviation to 2.2 standard deviation from the mean. Outside of the range, reliability decreased significantly due to a lack of items with difficulty levels that are further away from the mean.

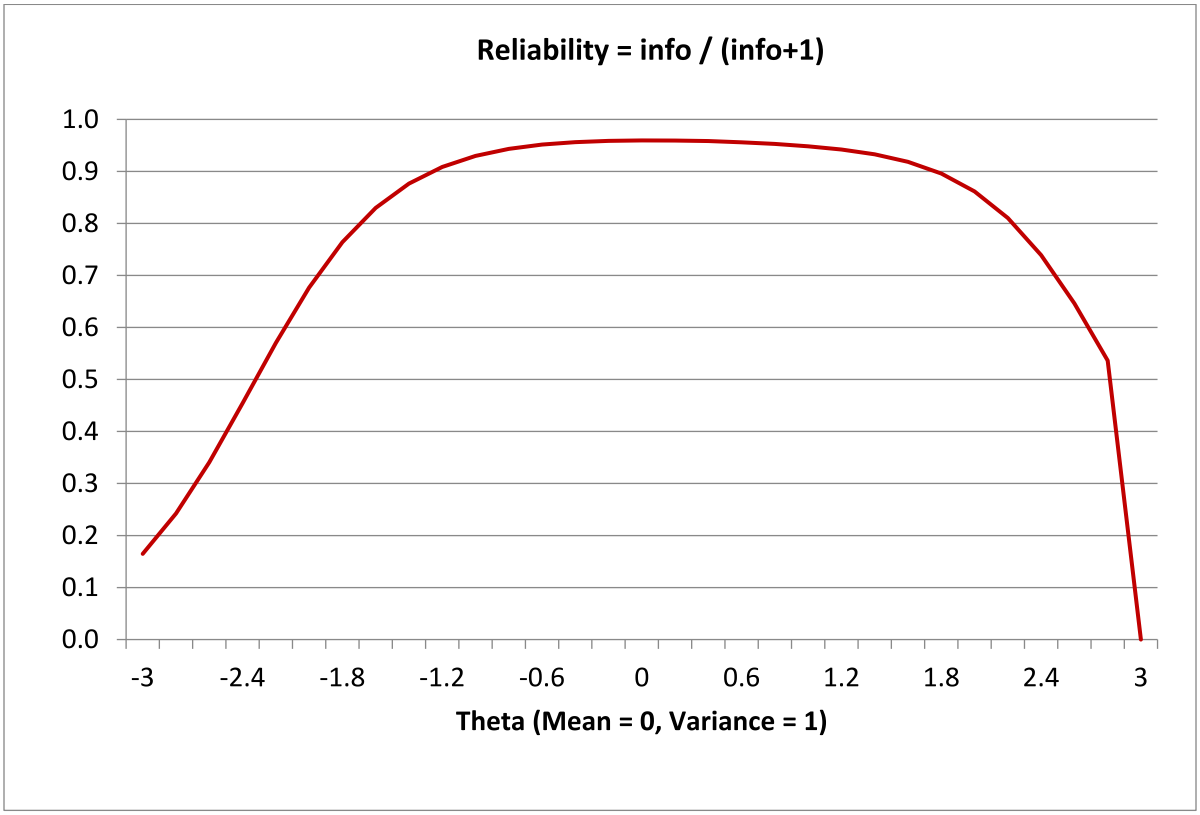

Figure 13. Reliability of the Cognitive Test Anxiety scale

Figure 14 shows item information for each of the 17 items on the CTAR scale. Items and people were placed on the same scale with a mean of 0 and a standard deviation of 1. It is presented in Figure 14 how precisely an item measures at each level of the latent trait, Cognitive Test Anxiety. Most of the items showed the highest precision of measurement around the mean of the latent trait.

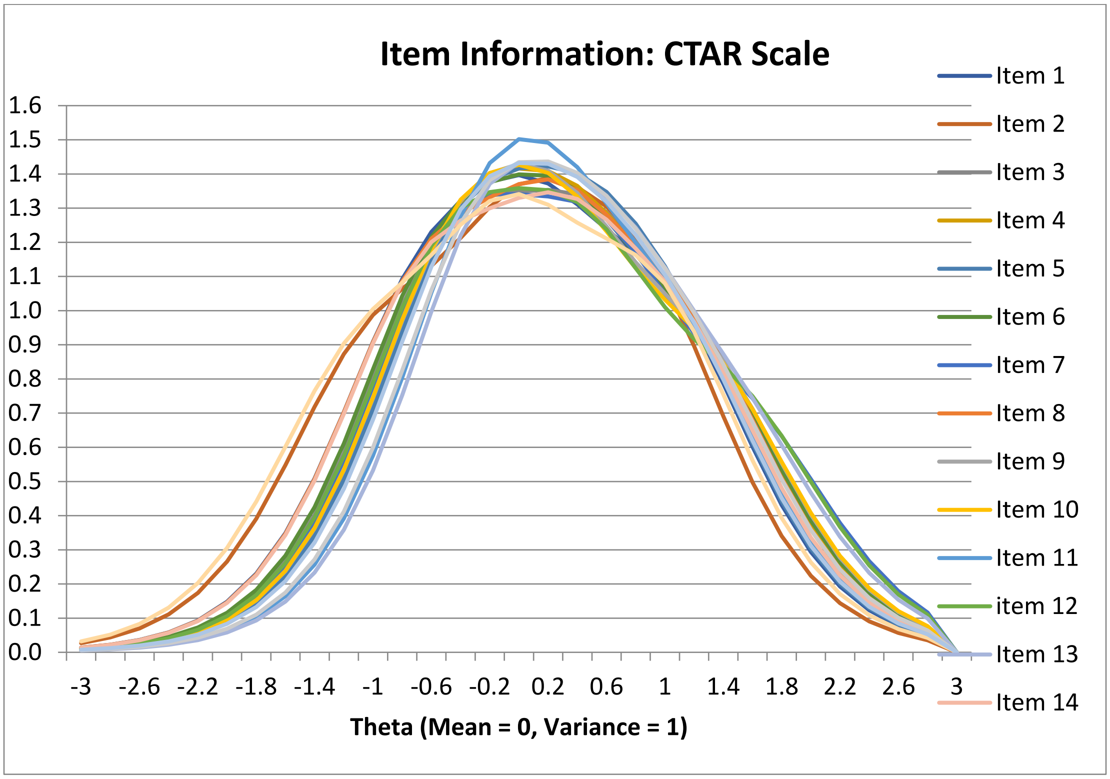

Figure 14. Item information for the Cognitive Test Anxiety items

Figure 15 shows the test information for the CTAR scale. Test information presents identical information as item information but on the level of the entire survey. It shows how precisely the scale measures each level of the latent trait, Cognitive Test Anxiety. Same as the conclusions based on item information, the scale showed the highest precision of measurement around the mean of the latent trait.

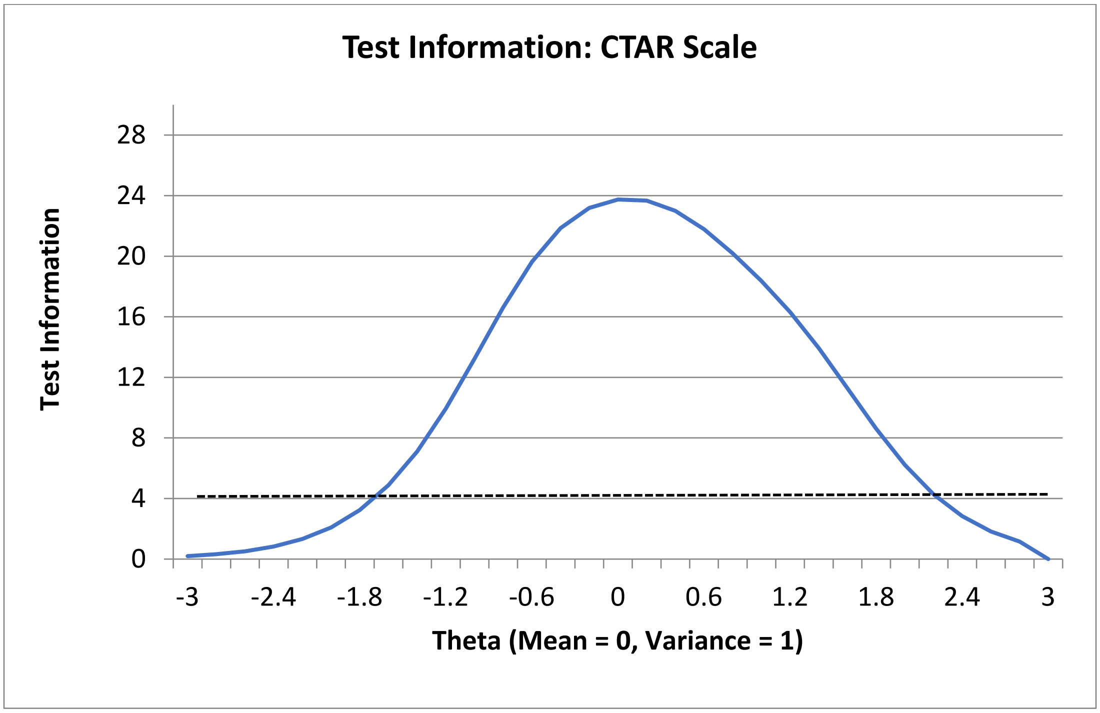

Figure 15. Test information for the Cognitive Test Anxiety scale

Modeling General Self-Efficacy response data.

Model parameters for general Self-Efficacy obtained from using ML and a logit link are shown in this section, including the IFA item parameters (thresholds and loadings). IRT analogous parameters are also shown. IRT discrimination a_i was the same as the loading λ_i. IRT difficulty was computed as b_{ic} = τ_{ic}/λ_i. Table 12 summarizes estimated slope parameters from the unconstrained model. Factor loadings were estimated in the unconstrained model. To translate the factor loadings in the context of IRT, the item discrimination parameters were estimated for all items.

Table 12

Estimated Slope Parameters for General Self-Efficacy

	IFA Parameters		IRT Parameters	
	Loading		Discrimination	
Slope Parameters	Estimate	SE	Estimate	SE
Item 1	2.06	0.25	2.06	0.25
Item 2	1.24	0.16	1.24	0.16
Item 3	1.90	0.23	1.90	0.23
Item 4	1.75	0.21	1.75	0.21
Item 5	2.00	0.24	2.00	0.24
Item 6	1.80	0.22	1.80	0.22
Item 7	2.15	0.25	2.15	0.25
Item 8	2.54	0.31	2.54	0.31
Item 9	1.90	0.22	1.90	0.22
Item 10	1.71	0.21	1.71	0.21

Table 13 shows the item-specific thresholds and difficulty for category 2, 3, and 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 13

Item-Specific Thresholds and Difficulty for Category 1 vs. Category 2, 3, and 4 for General Self-Efficacy

	Threshold		Difficulty	
Location Parameters: $y > 1$	Estimate	SE	Estimate	SE
Item 1	-4.87	0.46	-2.36	0.26
Item 2	-3.45	0.30	-2.78	0.36
Item 3	-4.40	0.40	-2.32	0.26
Item 4	-4.63	0.44	-2.64	0.31
Item 5	-5.45	0.56	-2.73	0.32
Item 6	-4.26	0.39	-2.36	0.26
Item 7	-5.13	0.49	-2.39	0.26
Item 8	-5.61	0.56	-2.21	0.23
Item 9	-4.16	0.37	-2.19	0.24
Item 10	-5.08	0.51	-2.97	0.37

Table 14 shows the item-specific thresholds and difficulty for category 3 and 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 14

Item-Specific Thresholds and Difficulty for Category 1 and 2 vs. Category 3 and 4 for General Self-Efficacy

	Threshold		Difficulty	
Location Parameters: $y > 2$	Estimate	SE	Estimate	SE
Item 1	-2.51	0.27	-1.22	0.13
Item 2	-0.84	0.16	-0.67	0.14
Item 3	-2.03	0.23	-1.07	0.13
Item 4	-2.13	0.23	-1.22	0.15
Item 5	-2.62	0.27	-1.31	0.14
Item 6	-2.38	0.24	-1.32	0.15
Item 7	-2.33	0.26	-1.08	0.12
Item 8	-2.48	0.29	-0.97	0.11
Item 9	-1.90	0.22	-1.00	0.12
Item 10	-2.00	0.22	-1.16	0.14

Table 15 shows the item-specific thresholds and difficulty for category 4 that give the link-transformed probability of response at a latent trait score *F* for subject *s* of 0.

Table 15

Item-Specific Thresholds and Difficulty for Category 1, 2, and 3 vs. Category 4 for General Self-Efficacy

	Threshold		Difficulty	
Location Parameters: $y > 3$	Estimate	SE	Estimate	SE
Item 1	2.04	0.25	0.99	0.13
Item 2	2.01	0.20	1.62	0.22
Item 3	1.77	0.22	0.93	0.13
Item 4	1.50	0.20	0.86	0.13
Item 5	1.25	0.21	0.62	0.11
Item 6	1.36	0.20	0.75	0.12
Item 7	1.72	0.23	0.80	0.12
Item 8	1.65	0.25	0.65	0.10
Item 9	1.62	0.21	0.85	0.12
Item 10	1.49	0.20	0.87	0.13

Figure 16 shows the distribution of the latent trait, general Self-Efficacy, under the unconstrained model.

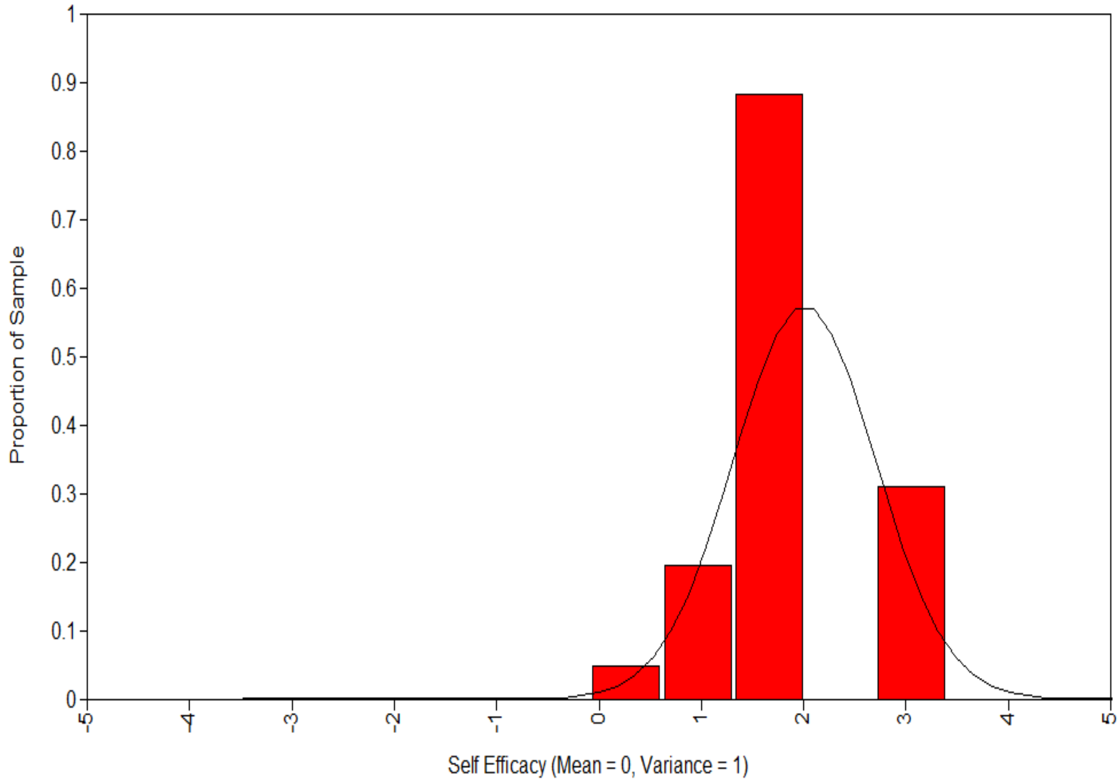

Figure 16. Distribution of General Self-Efficacy

Figure 17 presents the reliability of the GSE scale along the spectrum of the latent trait. Reliability is above 0.80 from about −2.2 standard deviation to 1.6 standard deviation from the mean. Reliability decreased steeply when the latent trait was 1.8 or more standard deviation from the mean, due to a lack of items with difficulty in that range.

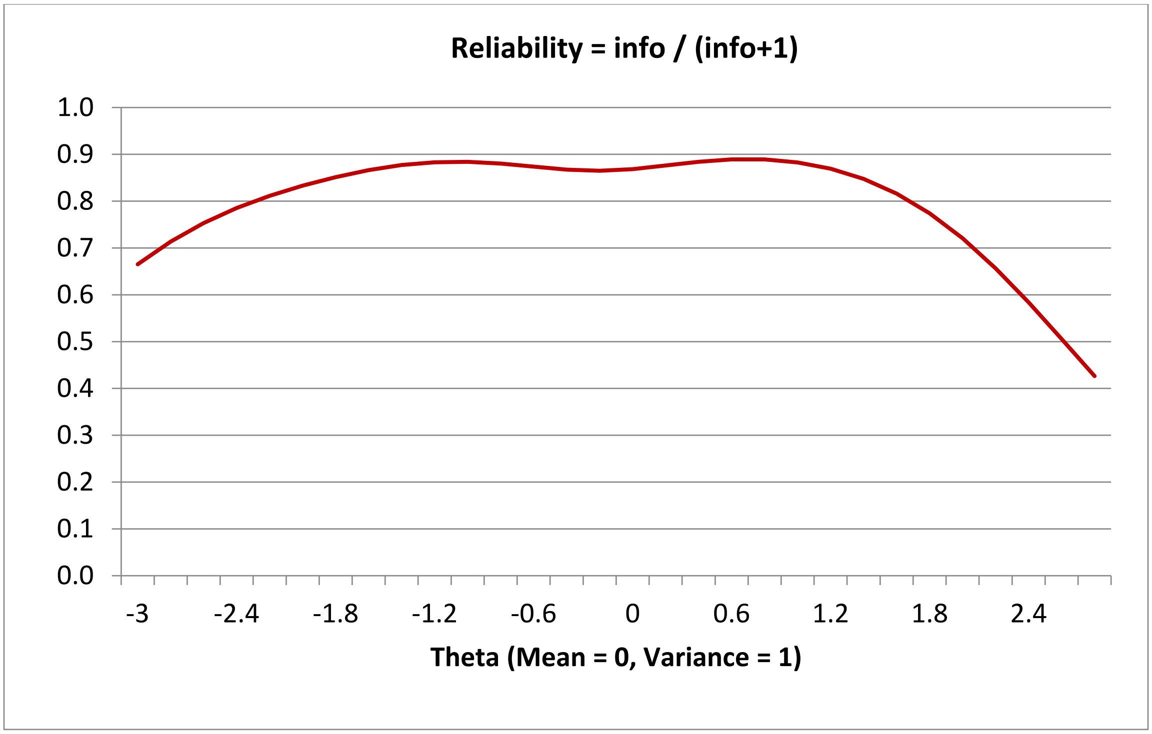

Figure 17. Reliability of the General Self-Efficacy scale

Figure 18 shows item information for each of the 10 items on the GSE scale. For the majority of the items, item information peaked at two data points along the spectrum of the latent trait.

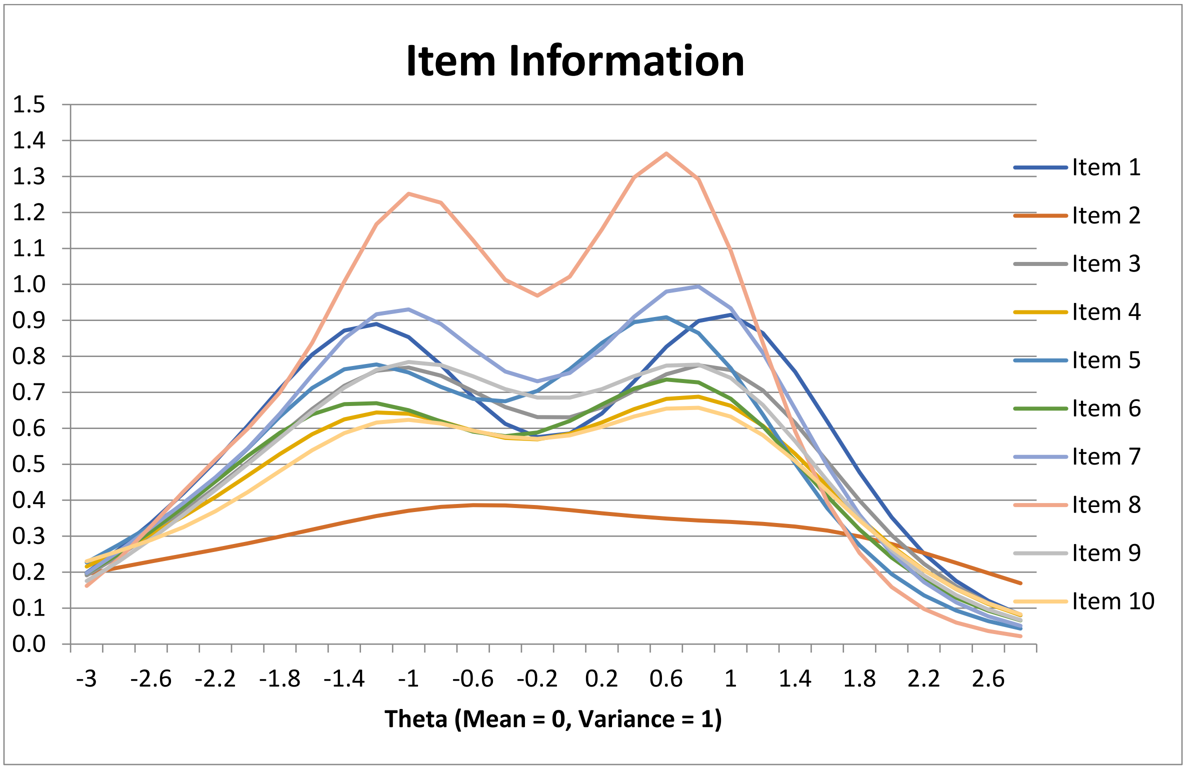

Figure 18.

Figure 18. Item information for the General Self-Efficacy items

Figure 19 shows the scale information for the GSE scale. Same as the conclusions based on item information, the scale showed the two peaks of precision of measurement along the spectrum of the latent trait, at −1 standard deviation from the mean and 0.8 standard deviation from the mean.

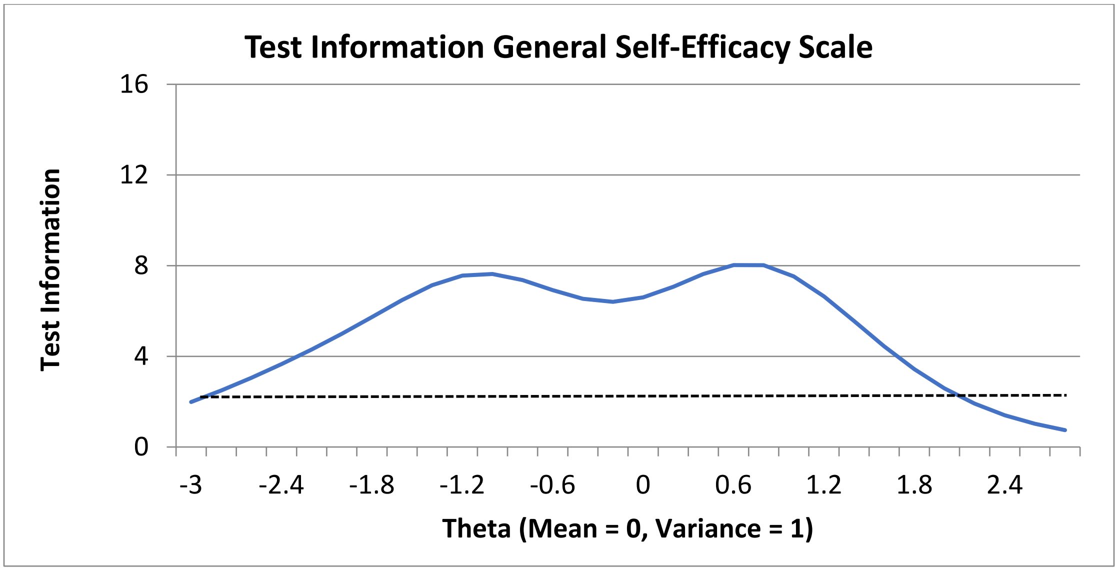

Figure 19. Test information for the General Self-Efficacy scale

Structural Models with Praxis Core Exam Scores as the Outcome

After ensuring the fit of the measurement models, structural models were estimated in two steps. The first step was to fit a structural model without the latent interaction term. The second step was to fit a structural model with the latent interaction. The two steps were conducted by the Praxis Core exam subjects respectively. To investigate the relationship between Praxis Core scores, Cognitive Test Anxiety, Self-Efficacy, and GPA, two structural equation models were fit to the data for each Praxis Core exam subject, Reading, Mathematics, and Writing. The first model of each set did not include the interaction between Cognitive Test Anxiety and Self-Efficacy. The second model of the set accounted for the interaction between Cognitive Test Anxiety and Self-Efficacy.

Models with Praxis Core Reading score as the outcome.

Table 16 shows parameter estimates for Model 1.1 and Model 1.2. The results of Model 1.1 suggested that the main effect of Cognitive Test Anxiety on Praxis Reading score was statistically significant. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Reading Scores ($\beta_1 = -2.381$). Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Reading ($\beta_3 = 9.104$). The main effect of Self-Efficacy on the Praxis Reading score, however, was not statistically significant.

Model 1.2 included the interaction between Cognitive Test Anxiety and Self-Efficacy. Cognitive Test Anxiety on Praxis Reading score was statistically significant. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Reading Scores ($\beta_1 = -2.523$). Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Reading ($\beta_3 = 9.121$). The main effect of Self-Efficacy on the

Praxis Reading score was not statistically significant. The interaction between Cognitive Test Anxiety and Self-Efficacy was not statistically significant in predicting the Praxis Core Reading scores.

Table 16

Parameter Estimates for the Model 1.1 and Model 1.2

	Model 1.1	Model 1.2
Model Parameter	Coefficient (SE)	Coefficient (SE)
Intercept (β_{0j})	131.352 (10.713***)	131.448 (10.711***)
Cognitive Test Anxiety (β_1)	−2.381 (1.054**)	−2.523 (1.083*)
Self-Efficacy (β_2)	1.181 (1.082)	1.503 (1.215)
GPA (β_3)	9.104 (3.041**)	9.121 (3.041**)
Interaction between Cognitive Test Anxiety and Self-Efficacy (β_4)		.0557 (0.941)

Note. *p < .05; **p < .01; ***p<.001

Figure 20 presents the results of Model 1.1. The top left part of the figure presents the measurement model for the CTAR response data, where the values on the arrows are factor loadings and standard errors (in parentheses) for the items. For example, for the first item on the CTAR scale, the factor loading is 2.464 with a standard error of 0.123. The bottom left part of the figure presents the measurement model for the GSE response data. Similarly, the values on the arrows are factor loadings and standard errors (in parentheses) for the items. For example, for the second item on the GSE scale, the factor loading is 1.237 with a standard error of 0.162. The right part of the figure shows the structural model where Reading scores were predicted by Cognitive Test Anxiety, Self-Efficacy, and GPA. The values on the arrows are the standardized coefficient estimates and standard errors (in parentheses) for the predictors. The two values by Reading are residual variance of Reading (276.699) and its standard error (22.601).

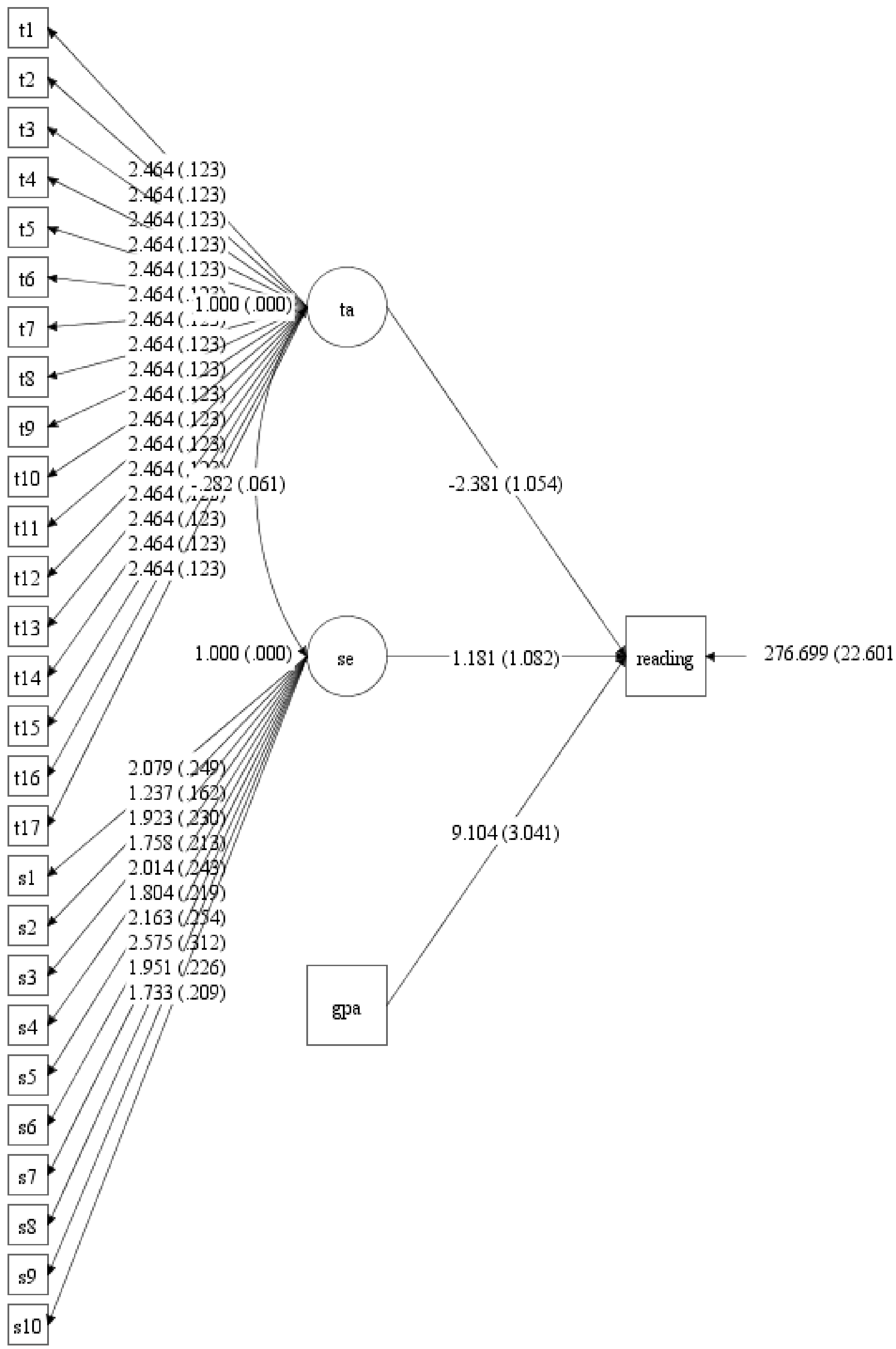

Figure 20. Results of Model 1.1

Figure 21 presents the results of Model 1.2.

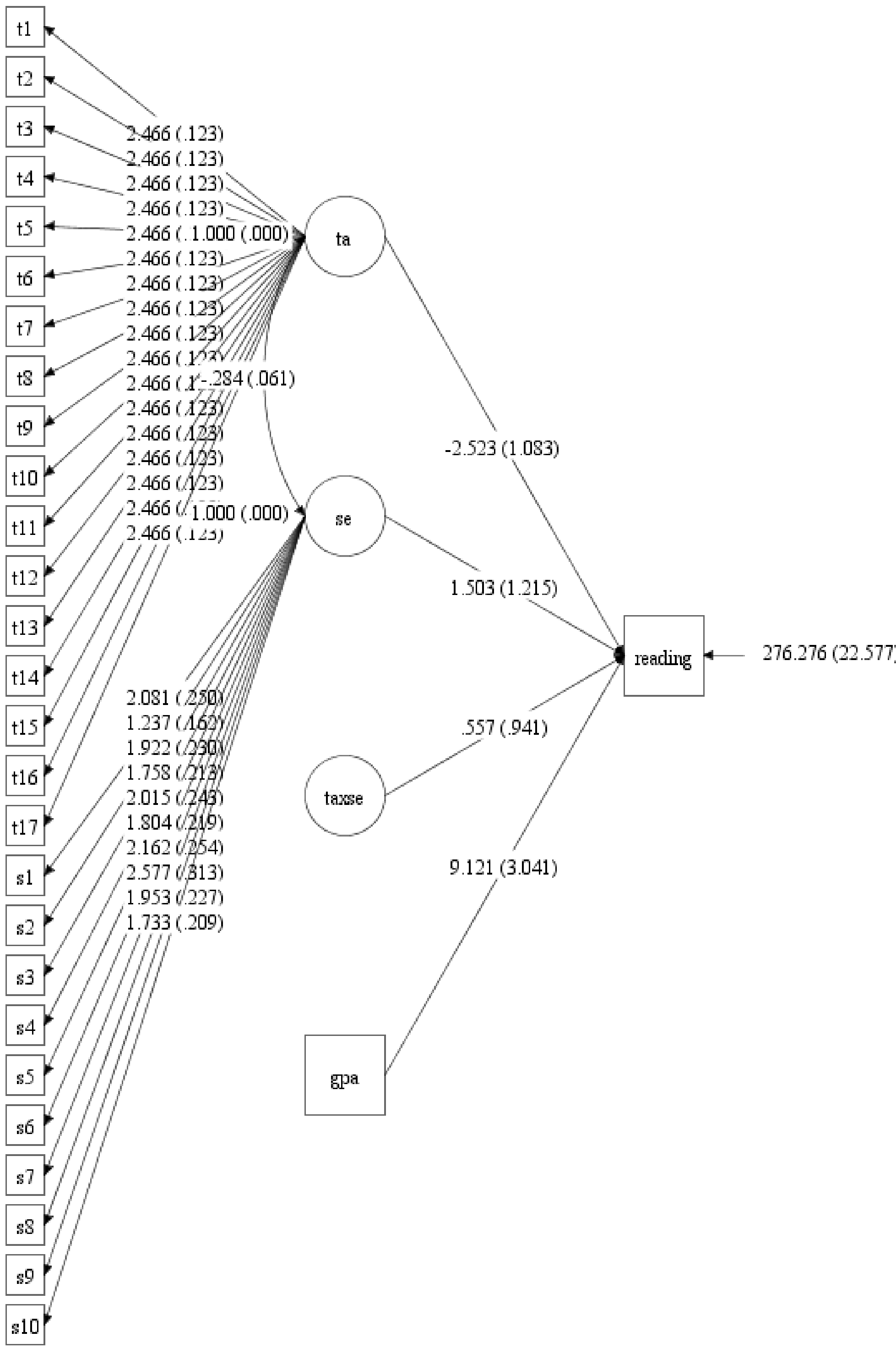

Figure 21. Results of Model 1.2

Table 17 summarizes the AIC and BIC information for Model 1.1 and Model 1.2. Model 1.1 had slightly smaller AIC and BIC than Model 1.2.

Table 17

Comparison of AIC and BIC between Model 1.1 and Model 1.2

	AIC	BIC
Model 1.1	18701.271	19064.568
Model 1.2	18702.919	19069.923

Table 18 presents the log-likelihood ratio and degree of freedom for Model 1.1 and Model 1.2. The log-likelihood ratio test comparing the log-likelihood of the two models yielded a log-likelihood difference value of *D* = 0.38. Using a x^2 distribution, this log-likelihood ratio test proved insignificant, indicating that Model 1.1 did not result in significant loss in fit relative to Model 1.2.

Table 18

Comparison of Log-likelihood between Model 1.1 and Model 1.2

	df	Log-likelihood
Model 1.1	98	−9252.635
Model 1.2	99	−9252.459

Models with Praxis Core Mathematics score as the outcome.

Table 19 shows parameter estimates for the Model 2.1 and Model 2.2. The results from Model 2.1 found a significant relationship between Cognitive Test Anxiety and Praxis Math scores. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Math Scores ($\beta_1 = -3.249$). Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Math (β_3 = 10.304). The main effect of Self-Efficacy on the Praxis Math score was not statistically significant.

Model 2.2 included the interaction between Cognitive Test Anxiety and Self-Efficacy. The relationship between Cognitive Test Anxiety and Praxis Math score was statistically significant. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Math Scores ($\beta_1 = -3.398$). Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Math (β_3 = 10.321). The main effect of Self-Efficacy on the Praxis Math score was not statistically significant. The interaction between Cognitive Test Anxiety and Self-Efficacy was not significantly related to Praxis Core Math score.

Table 19

Parameter Estimates for Model 2.1 and Model 2.2

	Model 2.1	Model 2.2
Model Parameter	Coefficient (SE)	Coefficient (SE)
Intercept (β_{0j})	122.496 (11.022 ***)	122.603 (11.022***)
Cognitive Test Anxiety (β_1)	−3.249 (1.087 **)	−3.398 (1.116**)
Self-Efficacy (β_2)	1.638 (1.113)	1.977 (1.248)
GPA (β_3)	10.304 (3.129 **)	10.321 (3.128 **)
Interaction between Cognitive Test Anxiety and Self-Efficacy (β_4)		0.589 (0.968)

Note. *p < .05; **p < .01; ***p<.001

Figure 22 presents the results of Model 2.1

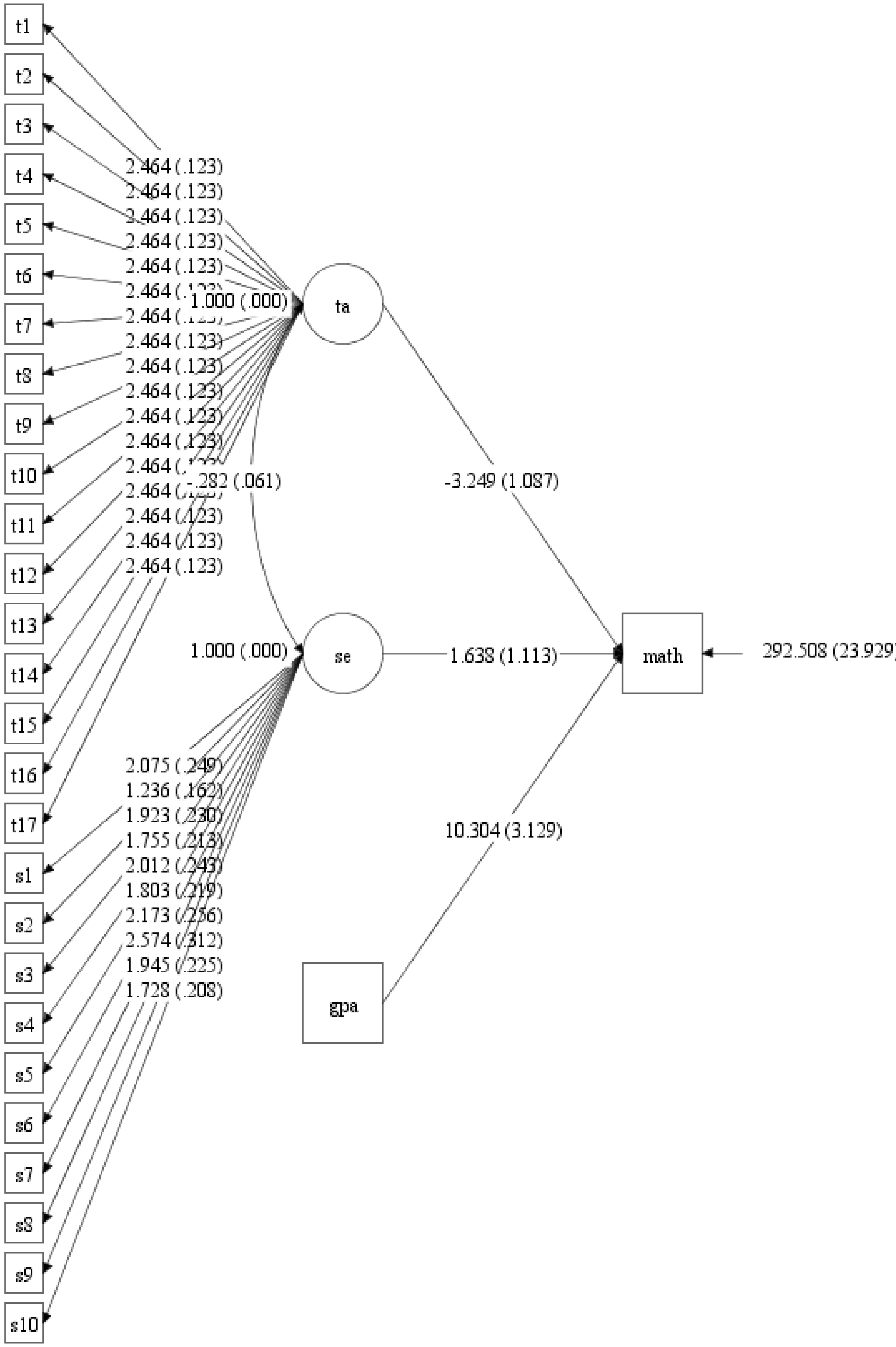

Figure 22. Results of Model 2.1

Figure 23 presents results of Model 2.2.

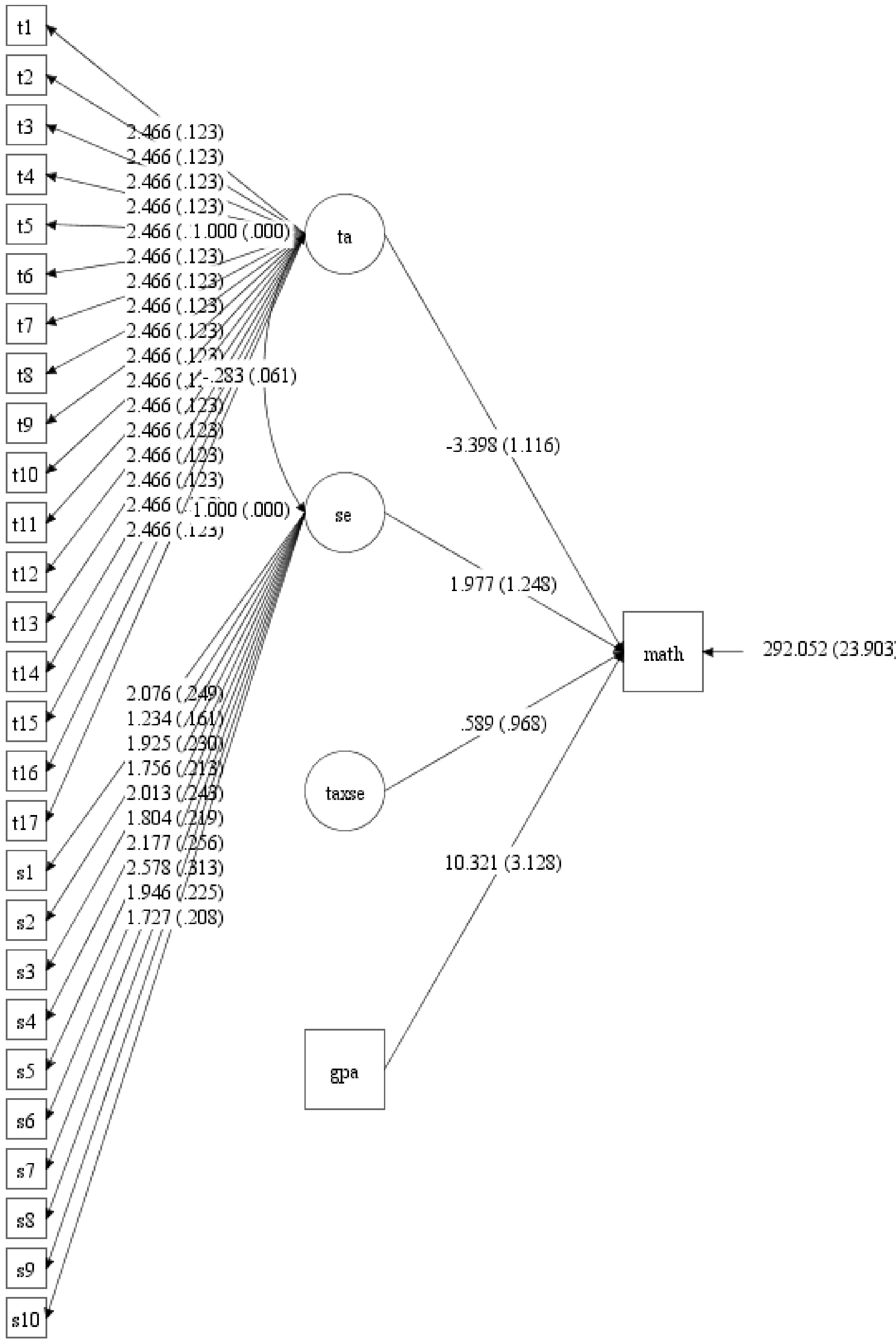

Figure 23. Results of Model 2.2

Table 20 shows the AIC and BIC information for Model 2.1 and Model 2.2. Mode 2.1 had slightly smaller AIC and BIC than Model 2.2.

Table 20

AIC and BIC Comparisons between Model 2.1 and Model 2.2

	AIC	BIC
Model 2.1	18718.434	19081.730
Model 2.2	18720.061	19087.065

Table 21 presents the log-likelihood ratio and degree of freedom for Model 2.1 and Model 2.2. The log-likelihood ratio test comparing the log-likelihood of the two models yielded a log-likelihood difference value of D = 0.37. Using a x^2 distribution, this log-likelihood ratio test proved insignificant, indicating that Model 2.1 did not result in significant loss in fit relative to Model 2.2.

Table 21

Comparison of Log-likelihood between Model 2.1 and Model 2.2

	df	Log-likelihood
Model 2.1	98	−9261.217
Model 2.2	99	−9261.031

Models with Praxis Core Writing score as the outcome.

Table 22 shows parameter estimates for the Model 3.1 and Model 3.2. The results from Model 3.1 showed a significant relationship between Cognitive Test Anxiety and Praxis Writing score. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Writing Scores ($\beta_1 = -2.140$). The main effect of Self-Efficacy on the Praxis Writing score was not statistically significant. Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Writing (β_3 = 7.081).

Model 3.2 included the interaction between Cognitive Test Anxiety and Self-Efficacy. The relationship between Cognitive Test Anxiety and Praxis Writing scores was statistically significant. Individuals with higher levels of Cognitive Test Anxiety had lower Praxis Core Writing Scores ($\beta_1 = -2.236$). The main effect of Self-Efficacy on the Praxis Writing score was not statistically significant. Self-reported GPA was also statistically significant. Individuals with higher self-reported GPA had higher scores in Praxis Core Writing (β_3 = 7.103). The interaction between Cognitive Test Anxiety and Self-Efficacy was not statistically significant in predicting the Praxis Core Writing scores.

Table 22

Parameter Estimates for Model 3.1 and Model 3.2

	Model 3.1	Model 3.2
Model Parameter	Coefficient (SE)	Coefficient (SE)
Intercept (β_{0j})	141.470 (9.353 ***)	141.502 (9.350***)
Cognitive Test Anxiety (β_1)	− 2.140 (0.925 *)	−2.236 (0.949*)
Self-Efficacy (β_2)	− 0.896 (0.949)	−0.680 (1.057)
GPA (β_3)	7.081 (2.656 **)	7.103 (2.655)
Interaction between Cognitive Test Anxiety and Self-Efficacy (β_4)		0.389 (0.844)

Note. *p < .05; **p < .01; ***p<.001

Figure 24 presents results from Model 3.1.

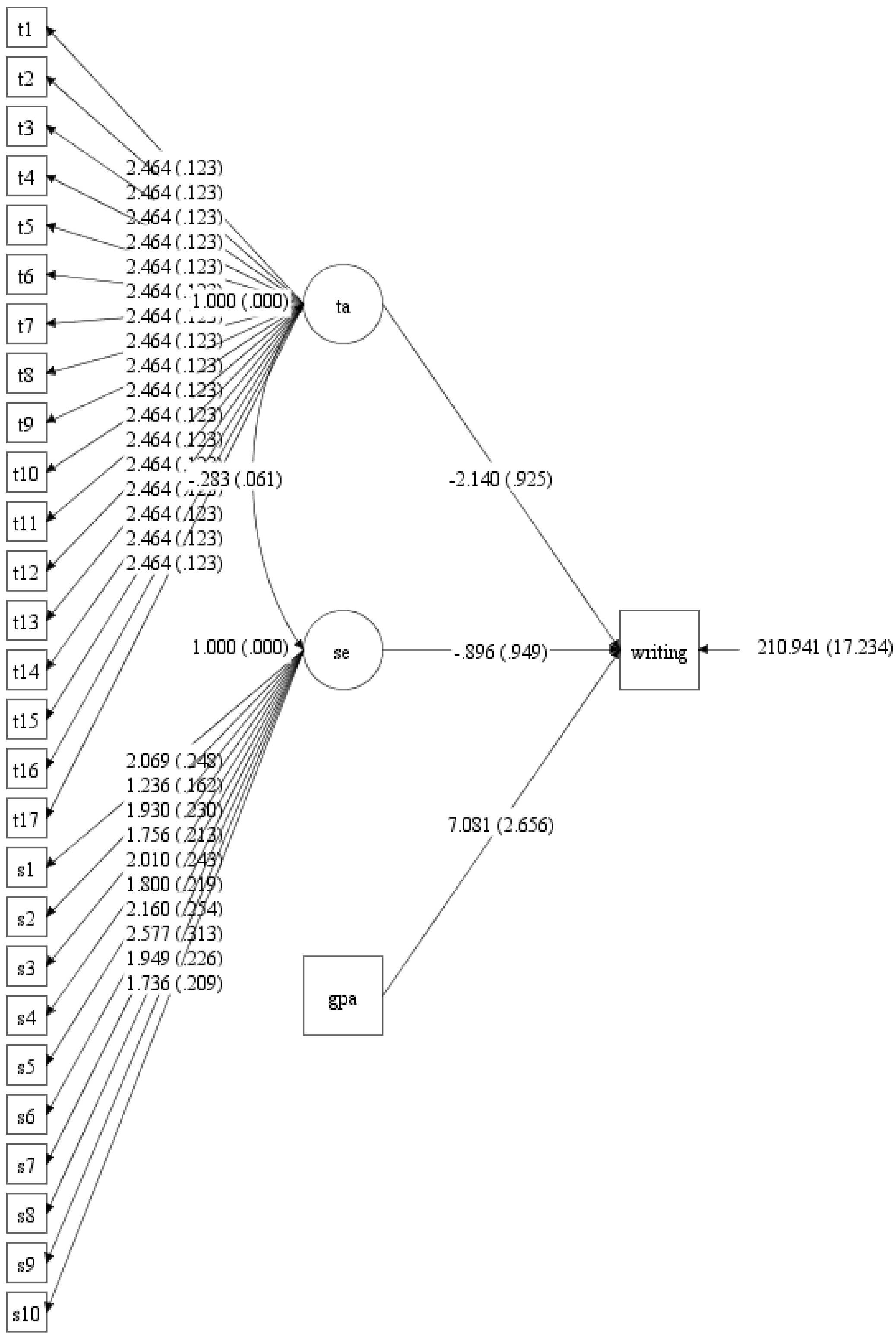

Figure 24. Results of Model 3.1

Figure 25 presents results from Model 3.2.

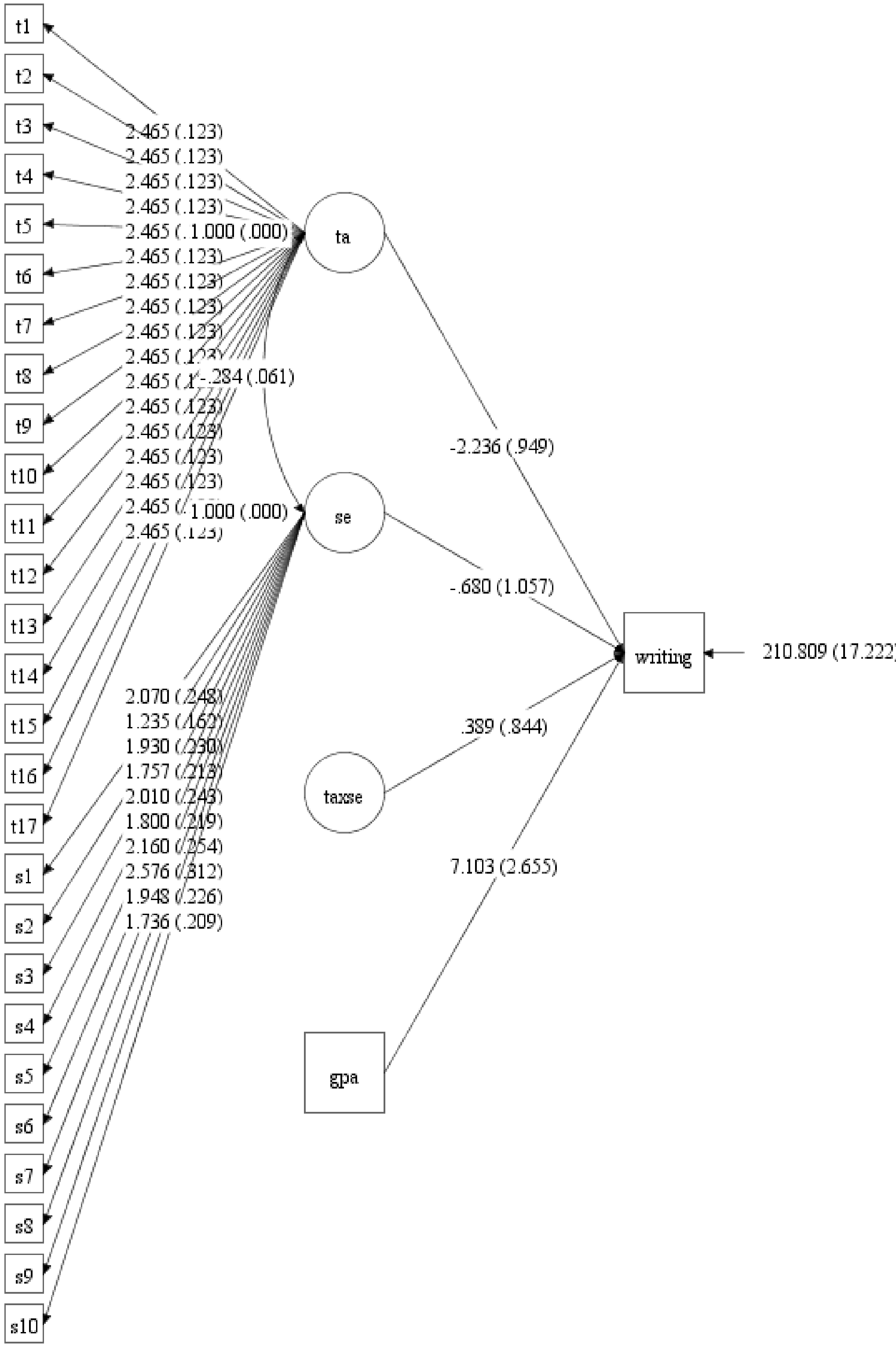

Figure 25. Results of Model 3.2

Table 23 shows the AIC and BIC information for Model 3.1 and Model 3.2. Model 3.1 had slightly smaller AIC and BIC than Model 3.2.

Table 23

AIC and BIC Comparisons between Model 3.1 and Model 3.2

	AIC	BIC
Model 3.1	18619.523	18982.820
Model 3.2	18621.313	18988.317

Table 24 presents the log-likelihood ratio and degree of freedom for Model 3.1 and Model 3.2. The log-likelihood ratio test comparing the log-likelihood of the two models yielded a log-likelihood difference value of D = 0.21. Using a x^2 distribution, this log-likelihood ratio test proved insignificant, indicating that Model 3.1 did not result in significant loss in fit relative to Model 3.2.

Table 24

Comparison of Log-likelihood between Model 3.1 and Model 3.2

	df	Log-likelihood
Model 3.1	98	−9211.762
Model 3.2	99	−9211.656

CHAPTER 5

DISCUSSION

Generally, the role of this chapter is to discuss the results of this study. To do this, I begin by reviewing the background and purposes of this dissertation. Then, I summarize the empirical results for each of the three research questions and address each of the three hypotheses under each research question. Following this, I discuss the primary limitations of this study. The chapter ends with ideas for future research.

Background and Purposes of this Dissertation

Many states use basic skill tests in Reading, Mathematics, and Writing as a threshold of entering teach education programs. Teaching candidates are usually required to take the Praxis Core Academic Skills for Educators exams developed by the ETS as partial fulfillment of teacher certification. Although the passing score of the Praxis Core Academic Skills for Educators exams can vary by state, high stakes are associated with a pass or fail result from the exam.

Cognitive Test Anxiety is likely to prevail when tests are utilized to make pass or fail decisions. It has been consistently shown to be the primary factor associated with declines in performance (Hembree, 1988). Recognition of the importance of performing well can contribute to Cognitive Test Anxiety. Cognitive Test Anxiety has becoming increasingly important in practice settings, especially with relevance for high-stakes testing. How people behave can be mediated by their beliefs about their capabilities. Another construct that has received more attention in education research is Self-Efficacy, which helps determine what individuals do with the knowledge and skills they have. Previous studies suggested that efficacy beliefs are positively associated with performance attainments.

Few studies have examined the Praxis Core exam performance while focusing on its relation to Cognitive Test Anxiety and Self-Efficacy. Additionally, many studies that investigated Cognitive Test Anxiety or Self-Efficacy used sum scores as indicators of the constructs. The current study sought to address the gap in the research by investigating how Cognitive Test Anxiety and Self-Efficacy are correlated with the Praxis Core exam performance. In addition, rather than using sum scores as indicators of Cognitive Test Anxiety and Self-Efficacy, both constructs were treated as latent variables using item-level responses. It was also within the scope of the current study to examine the latent interaction between Cognitive Test Anxiety and Self-Efficacy in the context of its relation to the Praxis Core exam performance.

Summary of Results by Research Question and Hypothesis

Research questions were posed around the Praxis Core exam subjects, Reading, Mathematics, and Writing. Three hypotheses were proposed under each research question. The results given in Chapter 4 can be interpreted in light of the research questions and hypotheses.

Research Question 1.

1. What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in *Reading*?

Hypothesis 1a. *Cognitive Test Anxiety is negatively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Reading*. It was found that Cognitive Test Anxiety was negatively correlated to Praxis Core exam scores in *Reading*. Examinees with higher levels of Cognitive Test Anxiety were likely to demonstrate lower performance on the exam in Reading.

Hypothesis 1b. *Self-Efficacy is positively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Reading.* Self-Efficacy was not significantly correlated to the Praxis Core exam score in *Reading*, after controlling for Cognitive Test Anxiety.

Hypothesis 1c. *Self-Efficacy moderates the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Reading.* The interaction between Cognitive Test Anxiety and Self-Efficacy was not found to be statistically significant in relation to the Praxis Core exam score in *Reading*, after controlling for Cognitive Test Anxiety and Self-Efficacy.

Research Question 2

- What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in *Mathematics*?

Hypothesis 2a. *Cognitive Test Anxiety is negatively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics*. It was found that Cognitive Test Anxiety was negatively correlated to Praxis Core exam scores in *Mathematics*. Examinees who were associated with higher levels of Cognitive Test Anxiety performed worse on the exam.

Hypothesis 2b. *Self-Efficacy is positively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics.* Self-Efficacy was not significantly correlated to the Praxis Core exam score in *Mathematics*, after controlling for Cognitive Test Anxiety.

Hypothesis 2c. *Self-Efficacy moderates the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Mathematics.* The interaction between Cognitive Test Anxiety and Self-Efficacy was not found to be statistically significant in relation to the Praxis Core exam score in *Mathematics*.

Research Question 3

- What are the roles that Cognitive Test Anxiety and Self-Efficacy may have played on exam performance on the Praxis Core Academic Skills for Educators examination in *Writing*?

Hypothesis 3a. *Cognitive Test Anxiety is negatively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Writing*. It was found that Cognitive Test Anxiety was negatively correlated to Praxis Core exam scores in *Writing*. Examinees with higher levels of Cognitive Test Anxiety were associated with lower scores on the exam.

Hypothesis 3b. *Self-Efficacy is positively correlated to exam performance on the Praxis Core Academic Skills for Educators examination in Writing.* Self-Efficacy was not significantly correlated to the Praxis Core exam score in Writing, after controlling for Cognitive Test Anxiety.

Hypothesis 3c. *Self-Efficacy moderates the correlation between Cognitive Test Anxiety and exam performance on the Praxis Core Academic Skills for Educators examination in Writing.* The interaction between Cognitive Test Anxiety and Self-Efficacy was not found to be statistically significant in relation to the Praxis Core exam score in *Writing*.

In summary, the current study indicates that examinees with higher levels of Cognitive Test Anxiety were likely to receive lower scores on the Praxis Core exams across three subjects. Exam performance is negatively impacted by the levels of Cognitive Test Anxiety. The statistical models did not suggest significant correlation between Self-Efficacy and Praxis Core exam scores, or significant interaction between Cognitive Test Anxiety and Self-Efficacy in relation to Praxis Core exam scores. Additionally, self-reported GPAs were found to be positively correlated with the Praxis Core exam scores, and the correlation was statistically significant. Examinees with higher GPAs at the time of the exam were more likely to receive higher scores on the exam.

Overall, these findings are aligned with what the literature on Cognitive Test Anxiety suggests. Cognitive Test Anxiety has the primary influence on exam performance. Individuals with high levels of Cognitive Test Anxiety are often associated with deteriorated exam performance. The findings of this study also suggest that Self-Efficacy moderates the impact of Cognitive Test Anxiety on exam performance to be less negative. In other words, individuals with high levels of Self-Efficacy are less likely to be negatively impacted by Cognitive Test Anxiety, or the negative impact is mediated to a lesser extent. The results of this study on Self-Efficacy support previous studies that detected non-significant effect of Self-Efficacy on exam performance after Cognitive Test Anxiety was accounted for.

This study sheds light on the factors that are associated with the performance on the Praxis Core Academic Skills for Educators exams. Using self-reported data, this study adds to the literature of Cognitive Test Anxiety, Self-Efficacy, and most importantly the relation to the Praxis Core exam performance. Additional factors such as gender and its correlation with exam performance may be investigated in future studies. This study may also be extended to further research on improving Praxis Core exam performance as measures can be possibly taken to reduce Cognitive Test Anxiety and increase Self-Efficacy.

Study Limitations

A few limitations of this study should be considered. The instruments used in the current study to measure Cognitive Test Anxiety and Self-Efficacy have been validated in previous research and shown with good reliability. However, Cognitive Test Anxiety and Self-Efficacy can be measured with different instruments that have been developed and validated. The results of the current study can be instrument-dependent.

Additionally, due to the unavailability of item-level response data of the Praxis Core Academic Skills for Educators tests, exam performance in this study was summarized into one single score for each of the exam subjects. The variance component estimates based on sum scores can be biased estimates of latent trait variance components. The exam performance may be treated as a latent variable if the item-level response data were available.

Future Directions

Considering the high stakes that many summative tests involve, future studies could further investigate the relationship between Cognitive Test Anxiety, Self-Efficacy, and exam performance. Ultimately, it is important to identify additional factors that are associated with exam performance. If circumstances permit, real-time surveys (that are administered at the end of tests) could be a better channel of gathering data. Similarly, future research might want to treat exam performance as a latent variable, should the item-level data become accessible

Appendix A: Cognitive Test Anxiety Scale - Revised (Cassady & Johnson, 2014)

1. I lose sleep over worrying about examinations
2. I worry more about doing well on tests than I should
3. I get distracted from studying for tests by thoughts of failing
4. I have difficulty remembering what I studied for tests
5. While preparing for a test, I often think that I am likely to fail
6. I am not good at taking tests
7. When I first get my copy of a test, it takes me a while to calm down to the point where I can begin to think straight
8. At the beginning of a test, I am so nervous that I often can't think straight
9. When I take a test that is difficult, I feel defeated before I even start
10. While taking an important examination, I find myself wondering whether the other students are doing better than I am
11. I tend to freeze up on things like intelligence tests and final tests
12. During tests, the thought frequently occurs to me that I may not be too bright
13. During a course examination, I get so nervous that I forget facts I really know
14. I do not perform well on tests
15. During tests, I have the feeling that I am not doing well
16. I am a poor test taker in the sense that my performance on a test does not show how much I really know about a topic
17. After taking a test, I feel I should have done better than I did

Appendix B: The General Self-Efficacy Scale (GSE) (Schwarzer & Jerusalem, 1995)

1. I can always manage to solve difficult problems if I try hard enough
2. If someone opposes me, I can find the means and ways to get what I want
3. It is easy for me to stick to my aims and accomplish my goals
4. I am confident that I can deal efficiently with unexpected events
5. Thanks to my resourcefulness, I know how to handle unforeseen situations
6. I can solve most problems if I invest the necessary effort
7. I can remain calm when facing difficulties because I can rely on my coping abilities
8. When I am confronted with a problem, I can usually find several solutions
9. If I am in trouble, I can usually think of a solution
10. I can usually handle whatever comes my way

Appendix C: Other Survey Questions

1. Did you take the Praxis Core Academic Skills for Educators exam between 2014 and 2019 in the United States?
   - Yes
   - No
2. What subjects did you take the Praxis Core Academic Skills for Educators exam in?
   - Reading
   - Mathematics
   - Writing
   - All of the above
3. What is 11 + 8? ___________
4. Did you take the Praxis Core Academic Skills for Educators exam in Reading?
   - Yes
   - No
5. Did you take the Praxis Core Academic Skills for Educators exam in Mathematics?
   - Yes
   - No
6. Did you take the Praxis Core Academic Skills for Educators exam in Writing?
   - Yes
   - No
7. What is your gender?
   - Female
   - Male

- I prefer to self-identify: ___________________

8. In your score report from ETS, what was your score on the Praxis Core Academic Skills for Educators exam in Reading? Report your score at your first attempt of the exam if you took it more than once.
9. In your score report from ETS, what was your score on the Praxis Core Academic Skills for Educators exam in Mathematics? Report your score at your first attempt of the exam if you took it more than once.
10. In your score report from ETS, what was your score on the Praxis Core Academic Skills for Educators exam in Writing? Report your score at your first attempt of the exam if you took it more than once.
11. What was your college GPA on a 4.0 scale at the time you took the Praxis Core Academic Skills for Educators exam? An estimated GPA that is as accurate as possible is acceptable. Refer to your GPA at your first attempt of the exam if you took the exam more than once

Appendix D: Mplus syntax for unconstrained graded response model (Cognitive Test Anxiety as an example)

```
VARIABLE: NAMES ARE TA1-TA17;
                     CATEGORICAL ARE TA1-TA17;
                     USEVARIABLES ARE   TA1-TA17;
ANALYSIS:  ESTIMATOR IS WLSMV;
                     PARAMETERIZATION IS THETA;
OUTPUT: STDYX RESIDUAL;
SAVEDATA: DIFFTEST=2PLWLSMV.dat;
PLOT: TYPE IS PLOT1;
           TYPE IS PLOT2;
           TYPE IS PLOT3;
MODEL:
TA BY TA1-TA17* (L_I1-L_I17);
 [TA1$1-TA17$1*] (T1_I1-T1_I17);
[TA1$2-TA17$2*] (T2_I1-T2_I17);
[TA1$3-TA17$3*] (T3_I1-T3_I17);
 [TA*] (FactMean); TA* (FactVar);
MODEL CONSTRAINTS:
FactMean=0; FactVar=1;
```

Appendix E: Mplus syntax for constrained graded response model (Cognitive Test Anxiety as an example)

```
VARIABLE: NAMES ARE TA1-TA17;
                    CATEGORICAL ARE TA1-TA17;
                    USEVARIABLES ARE   TA1-TA17;
ANALYSIS:  ESTIMATOR IS WLSMV;
                    PARAMETERIZATION IS THETA;
                            DIFFTEST=2PLWLSMV.dat
OUTPUT: STDYX RESIDUAL;
SAVEDATA:
PLOT: TYPE IS PLOT1;
          TYPE IS PLOT2;
          TYPE IS PLOT3;
MODEL:
TA BY TA1-TA17* (L);
[TA1$1-TA17$1*] (T1_I1-T1_I17);
[TA1$2-TA17$2*] (T2_I1-T2_I17);
[TA1$3-TA17$3*] (T3_I1-T3_I17);
 [TA*] (FactMean); TA* (FactVar);
MODEL CONSTRAINTS:
FactMean=0; FactVar=1;
```

Appendix F: Mplus syntax for SEM without interaction (Reading as an example)

```
VARIABLE: NAMES ARE Reading math Writing gpa gender t1-t17 s1-s10;
          CATEGORICAL ARE t1-t17 s1-s10;
          USEVARIABLES ARE Reading gpa t1-t17 s1-s10;
ANALYSIS:  ESTIMATOR IS ML;
          LINK=LOGIT;
OUTPUT: STDYX;
         RESIDUAL TECH10;
PLOT: TYPE IS PLOT1;
      TYPE IS PLOT2;
      TYPE IS PLOT3;

MODEL:
TA BY t1-t17* (L);
[t1$1-t17$1*] (T1_I1-T1_I17);
[t1$2-t17$2*] (T2_I1-T2_I17);
[t1$3-t17$3*] (T3_I1-T3_I17);

 [TA*] (FactMean); TA* (FactVar);

MODEL CONSTRAINTS:
FactMean=0; FactVar=1;

NEW(A B1_I1-B1_I17 B2_I1-B2_I17 B3_I1-B3_I17);

A=L* SQRT(FactVar);
```

```
DO (1,17) B1_I# = (T1_I# - (L*FactMean)) / (L*SQRT(FactVar));
DO (1,17) B2_I# = (T2_I# - (L*FactMean)) / (L*SQRT(FactVar));
DO (1,17) B3_I# = (T3_I# - (L*FactMean)) / (L*SQRT(FactVar));

MODEL:
SE BY s1-s10* (L_I1-L_I10);

[s1$1-s10$1*] (S1_I1-S1_I10);
[s1$2-s10$2*] (S2_I1-S2_I10);
[s1$3-s10$3*] (S3_I1-S3_I10);

 [SE*] (SEFactMean); SE* (SEFactVar);

MODEL CONSTRAINTS:
SEFactMean=0; SEFactVar=1;

NEW(A_I1-A_I10 SB1_I1-SB1_I10 SB2_I1-SB2_I10 SB3_I1-SB3_I10);
DO(1,10) A_I#=L_I# * SQRT(SEFactVar);

DO (1,10) SB1_I# = (S1_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));
DO (1,10) SB2_I# = (S2_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));
DO (1,10) SB3_I# = (S3_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));

MODEL:
Reading on TA;
Reading on SE;
Reading on gpa;
```

Appendix G: Mplus syntax for SEM with interaction (Reading as an example)

```
VARIABLE: NAMES ARE Reading math Writing gpa gender t1-t17 s1-s10;
          CATEGORICAL ARE t1-t17 s1-s10;
          USEVARIABLES ARE Reading gpa t1-t17 s1-s10;

ANALYSIS:  ESTIMATOR IS ML;
          LINK=LOGIT;
          TYPE=RANDOM;

OUTPUT: STDYX;
         RESIDUAL TECH10;

PLOT: TYPE IS PLOT1;
       TYPE IS PLOT2;
       TYPE IS PLOT3;
MODEL:
TA BY t1-t17* (L);
 [t1$1-t17$1*] (T1_I1-T1_I17);
[t1$2-t17$2*] (T2_I1-T2_I17);
[t1$3-t17$3*] (T3_I1-T3_I17);

 [TA*] (FactMean); TA* (FactVar);

MODEL CONSTRAINTS:
FactMean=0; FactVar=1;
NEW(A B1_I1-B1_I17 B2_I1-B2_I17 B3_I1-B3_I17);
A=L* SQRT(FactVar);
```

```
DO (1,17) B1_I# = (T1_I# - (L*FactMean)) / (L*SQRT(FactVar));
DO (1,17) B2_I# = (T2_I# - (L*FactMean)) / (L*SQRT(FactVar));
DO (1,17) B3_I# = (T3_I# - (L*FactMean)) / (L*SQRT(FactVar));

MODEL:
SE BY s1-s10* (L_I1-L_I10);

 [s1$1-s10$1*] (S1_I1-S1_I10);
[s1$2-s10$2*] (S2_I1-S2_I10);
[s1$3-s10$3*] (S3_I1-S3_I10);

 [SE*] (SEFactMean); SE* (SEFactVar);

MODEL CONSTRAINTS:
SEFactMean=0; SEFactVar=1;

NEW(A_I1-A_I10 SB1_I1-SB1_I10 SB2_I1-SB2_I10 SB3_I1-SB3_I10);
DO(1,10) A_I#=L_I# * SQRT(SEFactVar);

DO (1,10) SB1_I# = (S1_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));
DO (1,10) SB2_I# = (S2_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));
DO (1,10) SB3_I# = (S3_I# - (L_I#*SEFactMean)) / (L_I#*SQRT(SEFactVar));

MODEL:
TAxSE| TA XWITH SE;

Reading on TA;
```

Reading on SE;

Reading on gpa;

Reading on TAxSE;

REFERENCES

Allen, G., Elias, M., & Zlotlow, S. (1980). Behavioral interventions for alleviating test anxiety: A methodological overview of current therapeutic practices. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and applications (pp. 155-185). Hillsdale, NJ: Erlbaum

Angrist, J. D., & Guryan, J. (2007). Does teacher testing raise teacher quality? Evidence from state certification requirements. *Economics of Education Review*, 27(5), 483-503.

Ashton, P. T., & Webb, R. B. (1986). Making a difference: Teachers' sense of efficacy and student achievement. New York: Longman.

Baker, F.B. (1985). The basics of item response theory. Portsmouth, NH: Heineman.

Bander, R. S., & Betz, N. E. (1981). The relationship of sex and sex role to trait and situationally specific anxiety types. *Journal of Research in Personality*, 15(3), 312-322.

Bandalos, Deborah & Yates, Kristin & Thorndike-Christ, Tracy. (1995). Effects of Math Self-Concept, Perceived Self-Efficacy, and Attributions for Failure and Success on Test Anxiety. *Journal of Educational Psychology*, 87. 611-623.

Bandalos, Deborah & Yates, Kristin & Thorndike-Christ, Tracy. (1995). Effects of Math Self-Concept, Perceived Self-Efficacy, and Attributions for Failure and Success on Test Anxiety. *Journal of Educational Psychology*, 87. 611-623.

Bandura, A. (1977). Self-Efficacy: Toward a unifying theory of behavioral

change. Psychological

Review, 84, 191-215.

Bandura, A. (1986). The social learning perspective: Mechanisms of aggression. In H. Toch (Ed.), Psychology of crime and criminal justice (pp. 198-236). Prospect Heights, IL: Waveland Press.

Bandura, A. (1988c). Self-Efficacy conception of anxiety. *Anxiety Research*, 1, 77-98.

Bandura, A. (1989). Self-regulation of motivation and action through internal standards and goal systems. In L. A. Pervin (Ed.), Goals concepts in personality and social psychology (pp. 19-85). Hillsdale, NJ: Erlbaum.

Bandura, A. (1994). Self-Efficacy. In V. S. Ramachaudran (Ed.), Encyclopedia of human behavior (Vol. 4, pp. 71-81). New York: Academic Press. (Reprinted in H. Friedman [Ed.], Encyclopedia of mental health. San Diego: Academic Press, 1998).

Bandura, A. (1997). Self-Efficacy: The exercise of control. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co.

Bandura, A. (2005). Evolution of social cognitive theory. In K. G. Smith & M. A. Hitt (Eds.), Great minds in management (pp. 9-35). Oxford: Oxford University Press.

Bäßler, J., & Schwarzer, R. (1996). Evaluación de la autoeficacia: Adaptación española de la escala de autoeficacia general [Measuring generalized self-beliefs: A Spanish adaptation of the General Self-Efficacy scale]. Ansiedad y Estrés, 2 (1), 1-8.

Bonaccio, Silvia & L. Reeve, Charlie. (2010). The nature and relative importance of students' perceptions of the sources of test anxiety. *Learning and Individual Differences*, 20. 617-625.

Bozkurt, S., Ekitli, G. B., Thomas, C. L., & Cassady, J. C. (2017). Validation of the Turkish Version of the Cognitive Test Anxiety Scale–Revised. SAGE Open.

Carver, C. S., & Scheier, M. F. (1984). Self-focused attention in test anxiety: A general theory applied to a specific phenomenon. In H. M. van der Ploeg, R. Schwarzer, & C. D. Spielberger (Eds.), Advances in test anxiety research (Vol. 3, pp. 3-20). Hillsdale, NJ: Erlbaum.

Cassady, J. C. (2004). The impact of Cognitive Test Anxiety on text comprehension and recall in the absence of external evaluative pressure. *Applied Cognitive Psychology*, 18: 311-325.

Cassady, J. C. (2004a). The impact of Cognitive Test Anxiety on text comprehension and recall in

the absence of salient evaluative pressure. *Applied Cognitive Psychology*, 18, 311-325.

Cassady, J. C. (2004b). The influence of Cognitive Test Anxiety across the learning-testing cycle.

Learning and Instruction, 14, 569-592.

Cassady, J. C. (2010). Test anxiety: Contemporary theories and implications for learning. In J. C.

Cassady (Ed.), Anxiety in schools: The causes, consequences, and solutions for academic anxieties (pp. 5-26). New York, NY: Peter Lang

Cassady, J. C., & Finch, W. H. (2014). Confirming the factor structure of the Cognitive Test Anxiety Scale: Comparing the utility of three solutions. *Educational Assessment Journal*, 19, 229-242.

Cassady, J. C., & Johnson, R. E. (2002). Cognitive Test Anxiety and academic performance. *Contemporary Educational Psychology*, *27*(2), 270-295.

Chen, M. L. (2007). Test anxiety, Reading anxiety, and Reading performance among university English as a second language learners (Masters' thesis). Ming Chuan University, Taipei, Taiwan.

Cizek, G. J. & Burg, S., G. J. & Burg, S. S. (2006). Addressing test anxiety in a high-stakes environment. Thousand Oaks, CA: Corwin Press.

Cooper, S. E., & Robinson, D. A. G. (1991). The relationship of Mathematics Self-Efficacy beliefs to Mathematics anxiety and performance. *Measurement and Evaluation in Counseling and Development*, 24(1), 4-11

Covington, M. V. (1992). Making the grade: A self-worth perspective on motivation and school reform. New York, NY, US: Cambridge University Press.

Culler, R. E., & Holahan, C. J. (1980). Test anxiety and academic performance: The effects of study-related behaviors. *Journal of Educational Psychology, 72*(1), 16-20.

Deffenbacher, J. L. (1980). Worry and emotionality in test anxiety. In I. G. Sarason (Ed.), Test anxiety: Theory, research and application. Hillsdale, New Jersey: Erlbaum.

Depreeuw, E. A. (1984), A profile of the test-anxious student1. *Applied Psychology*, 33: 221-232.

Desiderato, O., & Koskinen, P. (1969). Anxiety, study habits, and academic achievement. *Journal of Counseling Psychology, 16*(2, (1), 162-165.

Dodds, J.H. 1975. An attribution theory approach to the correlations of children's anxiety with IQ, sex and school achievement. Unpublished dissertation.

Drew H. Gitomer, Andrew S. Latham, and Robert Ziomek, The Academic Quality of Prospective Teachers: The Impact of Admissions and Licensure Testing, Teaching and Learning Research Report Series, Princeton, NJ: Educational Testing Service, 1999. (www.ets.org/Media/ Research/pdf/RR-03-35.pdf)

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task Values and Ability Beliefs as Predictors of High School Literacy Choices: A Developmental Analysis. Journal of Educational Psychology, 98, 382-393.

Dusek, J. B. (1980). The development of test anxiety in children. In Irwin, B.S (Ed.), Test

Anxiety: theory, research and applications. (p.88). Hillsdale, NJ: Lawrance Erlbaum Associates, Inc.

Dusek, J. B., Mergler, N. L., & Kermis, M. D. (1976). Attention, encoding, and information processing in low- and high-test-anxious children. *Child Development, 47*(1), 201-207.

Dykeman, B. F. (1994). The effects of motivational orientation, Self-Efficacy, and feedback condition on test anxiety. *Journal of Instructional Psychology*, *21*(2), 114-119.

Eccles J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), Achievement and achievement motivation (pp. 75–146). San Francisco, CA: W. H. Freeman.

Educational Testing Service, Technical manual for the Praxis tests and related assessments. Princeton, N.J., 2018

Gist, M. E., Schwoerer, C., & Rosen, B. (1989). Effects of alternative training methods on self-efficacy and performance in computer software training. *Journal of Applied Psychology, 74*(6), 884-891.

Hackett, G., & Betz, N. E. (1989). An exploration of the Mathematics Self-Efficacy/Mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*(3), 261-273.

Hembree, R. (1988). Correlates, Causes, Effects, and Treatment of Test Anxiety. *Review of Educational Research*, 58(1), 47–77.

Hill, T., Smith, N. D., & Mann, M. F. (1987). Role of efficacy expectations in predicting the decision to use advanced technologies: The case of computers. *Journal of Applied Psychology, 72*(2), 307-313.

Hunsley, J. (1987). Cognitive processes in Mathematics anxiety and test anxiety: The role of appraisals, internal dialogue, and attributions. *Journal of Educational Psychology, 79*(4), 388-392.

Jerusalem, M., & Schwarzer, R. (1992). Self-Efficacy as a resource factor in stress appraisal processes. In R. Schwarzer (Ed.), Self-Efficacy: Thought control of action (pp. 195-213). Washington, DC: Hemisphere.

Joreskog, K. G. & Yang, F. (1996). Nonlinear structural equation models: the Kenny–Judd ¨ model with interaction effects. In: G. A. Marcoulides & R. E. Schumacker, (eds.), Advanced Structural Equation Modeling. Mahwah, NJ: Lawrence Erlbaum, pp. 57–89

Kenny, D. A., & Judd, C. M. (1984). Estimating the nonlinear and interactive effects of latent variables. *Psychological Bulletin*, 96(1), 201-210.

Keogh, E., Bond, F. W., French, C. C., Richards, A., & Davis, R. E. (2004). Test anxiety, susceptibility to distraction and examination performance. *Anxiety Stress and Coping*, 17(3), 241-252.

Kilmen, S. (2015). Why do the tests make us anxious? *International Journal of Social Sciences and Education*, 5(4), 604-612.

King, N. J., Ollendick, T. H., & Gullone, E. (1990). School-Related Fears of Children and Adolescents. *Australian Journal of Education*, 34(1), 99–112.

Kirkland, K., & Hollandsworth, J. G. (1980). Effective test taking: Skills-acquisition versus anxiety-reduction techniques. *Journal of Consulting and Clinical Psychology, 48*(4), 431-439.

Klein, A. & Moosbrugger, H. *Psychometrika* (2000) 65: 457.

Klein, A. G., & Muthén, B. O. (2007). Quasi-maximum likelihood estimation of structural equation models with multiple interaction and quadratic effects. *Multivariate Behavioral Research, 42*(4), 647-673.

Lazarus, R., & Folkman, S. (1984). Stress, appraisal, and coping. New York: Springer Publishing Company.

Lent, R. W., & Hackett, G. (1987). Career Self-Efficacy: Empirical status and future directions. *Journal of Vocational Behavior, 30*(3), 347-382.

Lent, R. W., Brown, S. D., & Hackett, G. (1996). Career development from a social cognitive perspective. In D. Brown, L. Brooks, & Associates (Eds.), Career choice and development (3rd ed., pp. 373—421). San Francisco: Jossey-Bass.

Liebert, R. M., & Morris, L. W. (1967). Cognitive and Emotional Components of Test Anxiety: A Distinction and Some Initial Data. *Psychological Reports*, *20*(3), 975–978.

Locke, E. A., & Latham, G. P. (1990). A theory of goal setting & task performance. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Mandler, G., & Sarason, S. B. (1952). A study of anxiety and learning. *The Journal of Abnormal and Social Psychology*, *47*(2), 166-173.

Marsh, H. W., Wen, Z. and Hau, K. T. 2006. “Structural equation models of latent interaction and quadratic effects”. In *A second course in structural equation modeling*, Edited by: Hancock, G. and Mueller, R. 225–265. Greenwich, CT: Information Age.

Mitchell, K., & Ng, K. (1972). Effects of group counseling and behavior therapy on the academic achievement of test-anxious students. *Journal of Counseling Psychology*, 19, 491-497.

McKeachie, W. J. (1984), Does anxiety disrupt information processing or does poor information processing lead to anxiety? Applied Psychology, 33: 187-203.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its consequences for young adolescents-course enrollment intentions and performance in Mathematics. *Journal of Educational Psychology*, 82, 60-70.

Morris, L. W., & Liebert, R. M. (1969). The effects of anxiety on timed and untimed intelligence tests: Another look. *Journal of Consulting and Clinical Psychology*, 33, 240-244.

Morris, L. W., Davis, M. A., & Hutchings, C. H. (1981). Cognitive and emotional components of anxiety: Literature review and a revised worry–emotionality scale. *Journal of Educational Psychology, 73*(4), 541-555.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of Self-Efficacy beliefs to academic

outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*(1), 30-38.

Naveh-Benjamin, M. (1991). A comparison of training programs intended for different types of test-anxious students: Further support for an information-processing model. *Journal of Educational Psychology, 83*(1), 134-139.

Naveh-Benjamin, M., McKeachie, W. J., & Lin, Y.-g. (1987). Two types of test-anxious students: Support for an information processing model. *Journal of Educational Psychology, 79*(2), 131-136.

Naveh-Benjamin, M., McKeachie, W. J., Lin, Y.-g., & Holinger, D. P. (1981). Test anxiety: Deficits in information processing. *Journal of Educational Psychology, 73*(6), 816-824.

Pajares, F. (1996). Self-Efficacy Beliefs in Academic Settings. *Review of Educational Research, 66*(4), 543–578.

Pajares, F., & Kranzler, J. (1994). Self-Efficacy, self-concept, and general mental ability in mathematical problem-solving. *Florida Educational Research Council Research Bulletin*, 26, 8-32.

Pajares, F., & Kranzler, J. (1995a). Competence and confidence in Mathematics: The role of self-efficacy, self-concept, anxiety, and ability. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Pajares, F., & Kranzler, J. (1995b). Self-Efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology*, *20*(4), 426-443.

Paulman, R. G., & Kennelly, K. J. (1984). Test anxiety and ineffective test taking: Different names, same construct? *Journal of Educational Psychology*, *76*(2), 279-288.

Pekrun, R (1984). An expectancy-value model of anxiety. In H. M. van der Ploeg, R. Schwarzer & c. D. Spielberger (Eds.), Advances in test anxiety research (Vol. 3, pp. 5 3-72). Usse, The Netherlands: Swets & Zeitlinger.

Peter F. Halpin, Cibele da-Silva, Paul De Boeck. (2014) A Confirmatory Factor Analysis Approach to Test Anxiety. *Structural Equation Modeling: A Multidisciplinary Journal* 21:3, pages 455-467.

Pintrich, P. R., & de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-40.

Pintrich, P. R., & Schunk, D. H. (1995). Motivation in education: Theory, research, and applications. Englewood Cliffs, NJ: Prentice Hall.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & Mckeachie, W. J. (1993). Reliability and Predictive Validity of the Motivated Strategies for Learning Questionnaire (Mslq). *Educational and Psychological Measurement*, *53*(3), 801–813.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement*, 53, 801-813.

Powers, D. E. (1986), Test anxiety and the GRE general test. ETS Research Report Series, 1986: i-49.

Putwain, D. (2007), Researching academic stress and anxiety in students: some methodological considerations. *British Educational Research Journal*, 33: 207-219.

Reeve, Charlie & Bonaccio, Silvia & E. Charles, Jennifer. (2008). A policy-capturing study of the contextual antecedents of test anxiety. *Personality and Individual Differences*. 45.

Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do Psychosocial and Study Skill Factors Predict College Outcomes? A Meta-Analysis. *Psychological Bulletin, 130*(2), 261-288.

Samejima, F. (1969). Estimation of ability using a response pattern of graded scores. *Psychometrika Monograph*, No. 17.

Sarason, I. G. (1961). Test anxiety and the intellectual performance of college students. *Journal of Educational Psychology, 52*(4), 201-206.

Sarason, I. G. (1972). Test anxiety and the model who fails. *Journal of Personality and Social Psychology, 22*(3), 410-413.

Sarason, I. G., & Stoops, R. (1978). Test anxiety and the passage of time. *Journal of Consulting and Clinical Psychology, 46*(1), 102-109.

Scholz, U., Gutiérrez-Doña, B., Sud, S., & Schwarzer, R. (2001-submitted). Is perceived self-efficacy a universal construct? Psychometric findings from 25 countries.

Schunk, D. H. (1991). Self-Efficacy and academic motivation. Educational Psychologist, 26, 207-231.

Selkirk, L. C., Bouchey, H. A., & Eccles, J. S. (2011). Interactions among domain-specific expectancies, values, and gender: Predictors of test anxiety during early adolescence. *The Journal of Early Adolescence, 31*(3), 361-389.

Selkirk, L. C., Bouchey, H. A., & Eccles, J. S. (2011). Interactions among domain-specific expectancies, values, and gender: Predictors of test anxiety during early adolescence. *The Journal of Early Adolescence*, *31*(3), 361-389.

Sharma, A. (1998), Mode of entry and *ex-post* performance. Strat. Mgmt. J., 19: 879-900.

Shell, D. F., Colvin, C., & Bruning, R. H. (1995). Self-Efficacy, attribution, and outcome expectancy mechanisms in Reading and Writing achievement: Grade-level and achievement-level differences. *Journal of Educational Psychology, 87*(3), 386-398.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology*, *42*(1), 70-83.

Spielberger, C. D., & Vagg, P. R. (1995). Test anxiety. Theory, assessment, and treatment. Washington, DC: Taylor & Francis.

Suzanne Chamberlain, Anthony Leslie Daly & Victoria Spalding (2011) The fear factor: students' experiences of test anxiety when taking A-level examinations, *Pastoral Care in Education*, 29:3, 193-205.

Taylor, S.E., Locke E. A., Lee, C., & Gist, M. E. (1984). Type A behavior and faculty research productivity: What are the mechanisms? *Organizational Behavior and Human Decision Processes*, 34: 402-418.

Tryon, G. (1980). The measurement and treatment of test anxiety. *Review of Educational Research*, 50, 353-372.

Tuckman, B & Sexton, T. (1992). Self-believers are self-motivated; self-doubters are not. *Personality and Individual Differences*, 13. 425-428.

Von de Embse, N. & Hasson, R. (2012). Test Anxiety and High-Stakes Test Performance Between School Settings: Implications for Educators. Preventing School Failure: *Alternative Education for Children and Youth*, 56(3), 180-187.

Weems, Carl & Scott, Brandon & Taylor, Leslie & F. Cannon, Melinda & M. Romano, Dawn & M. Perry, Andre & Triplett, Vera. (2010). Test Anxiety Prevention and Intervention Programs in Schools: Program Development and Rationale. *School Mental Health*, 2. 62-71.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210-216.
Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210-216.
Williams, J. E. (1991). Modeling test anxiety, self-concept and high school students' academic achievement. Journal of Research and Development in Education, 25, 51-57.

Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin*, *76*(2), 92-104.

Wine, J. (1980). Cognitive-Attentional Theory of Test Anxiety. In I. G. Sarason (Ed.), Test Anxiety: Theory, Research and Applications (pp. 349-385). Hillsdale, NJ: Erlbaum.

Wittmaier, B. (1972). Test anxiety and study habits. Journal of Educational Research, 352-354.

Zeidner, M. (1998). *Perspectives on individual differences. Test anxiety: The state of the art.* New York, NY, US: Plenum Press.

Zeidner, M., & Matthews, G. (2005). Evaluation Anxiety: Current Theory and Research. In A. J.

Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 141-163). New York, NY, US: Guilford Publications.

Zeidner, M., & Matthews, G. (2005). Evaluation Anxiety: Current Theory and Research. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 141-163). New York, NY, US: Guilford Publications.

Zhang, J. X., & Schwarzer, R. (1995). Measuring optimistic self-beliefs: A Chinese adaptation of the General Self-Efficacy Scale. *Psychologia: An International Journal of Psychology in the Orient*, *38*(3), 174-181.

Zieky, M. J., Perie, M, & Livingston, S. A. (2008). Cutscores: A manual for setting standards of performance on educational and occupational tests. Princeton, NJ: Educational Testing Service.

Zohar, D. (1998). An additive model of test anxiety: Role of exam-specific expectations. *Journal of Educational Psychology, 90*(2), 330-340.