Mitigating the Occurrences of Graduate Student Attrition: Making the Case for Standardized Noncognitive Assessments

by

Margaret Elizabeth Mastrogiovanni

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
August 7, 2021

Keywords: graduate student attrition, noncognitive factors, degree completion

Approved by

David M. Shannon, Chair, Humana-Germany-Sherman Distinguished Professor of Educational Foundations, Leadership, and Technology
Joni M. Lakin, Associate Professor at the University of Alabama
Jill D. Salisbury-Glennon, Associate Professor of Educational Foundations, Leadership, and Technology
Maria M. Witte, Associate Dean of the Graduate School and Professor of Educational Foundations, Leadership, and Technology

Abstract

The purpose of this dissertation study was twofold. First, this research study examined the role of noncognitive factors on degree completion, academic achievement, and persistence. Second, this research study examined the utility of the Personal Potential Index (PPI) as an avenue to reliably assess noncognitive factors of graduate students that avoids the drawbacks associated with self-assessment methods and unstandardized recommendation letters. The current study utilized a nonexperimental quantitative research design using de-identified, archival, PPI survey data of graduate student applicants (n = 362) obtained from Educational Testing Service (ETS). The PPI requires raters to evaluate applicants on six noncognitive attributes including: knowledge and creativity, communication skills, teamwork, resilience, planning and organization, and ethics and integrity (Kyllonen, 2008). The enrolled graduate applicant sample (n = 112) was used to determine if noncognitive scores predicted degree completion status, graduate GPA, and time-to-degree completion. The researcher also examined group differences and the presence of floor and ceiling effects for the PPI scales.

Results indicated that the PPI scales alone were not significant predictors of degree completion, graduate GPA, and time-to-degree. To explore the data further, hierarchical multiple logistic regression analyses and hierarchical multiple regression analyses were conducted to determine if the PPI scales predicted graduate school success outcomes above and beyond common admissions data (GRE scores, undergraduate GPA, degree level, and degree program). For degree completion, when the six PPI scale scores were added to the model, the planning and organization PPI scale was a significant predictor. For graduate GPA, of the admissions data, degree program was a significant predictor of graduate GPA. When the six PPI scales were added to the model, degree program and GRE Analytical Writing scores were significant

predictors of graduate GPA. For time-to-degree completion, of the admissions data, degree level was a significant predictor of time-to-degree completion and remained the only significant predictor when the PPI scale scores were added to the model.

The researcher was also interested in determining if there were significant differences in undergraduate GPA, GRE scores, the six PPI scale scores, and graduate GPA based on the interaction among degree completion status (graduated vs dropped out), classification/level (master's vs doctoral), and program (STEM vs NON). Results indicated a significant two-way interaction was present for degree completion and degree program. Simple effects analysis determined that students enrolled in STEM programs who graduated had significantly higher graduate GPAs than those who withdrew from their programs. When graduate GPA was taken out of the model, a significant two-way interaction was present for degree completion and degree level. Simple effects analyses determined that doctoral students who graduated had significantly lower GRE quantitative scores than those who withdrew from their programs. Finally, to determine how well the PPI scales performed in terms of creating enough variability among graduate applicants, ceiling and floor effects were examined. Results indicated that a ceiling effect was present for the ethics and integrity scale.

Acknowledgments

> It is not the critic who counts . . . The credit belongs to the man who is actually in the arena, . . . who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcomings; but who does actually strive to do the deeds; . . . who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.
>
> —Theodore Roosevelt, "Citizenship in a Republic" speech

During my doctoral studies, many people have shaped me, supported me, and believed in me. As graduate students, we are faced with unique challenges and obstacles. But with the support of great professors, friends, and my wonderful family, I am accomplishing things I never dreamed I could. Thank you all for inspiring me every day to be brave and enter the arena.

First, I wish to thank and am indebted to the incredible faculty members who have served on my dissertation committee. I would like to express my heartfelt gratitude and deepest appreciation to my major advisor and dissertation chair, Dr. David Shannon. I'll forever be grateful for your endless supply of invaluable advice and professional wisdom that supported me from the start to the finish of my doctoral studies. Your consistent support and belief in me motivated me to persist. You inspire me daily to pay forward the lessons you have given to me to others. To Dr. Joni Lakin, beyond being a phenomenal professor, it has been an honor to work with you and learn from you for the past two years as your graduate research assistant. Not only have you provided me countless opportunities that advanced my skillset, but your wittiness and constant encouragement made this entire "doctoral journey" less scary/intimidating which, in turn, increased my confidence in myself as a researcher. Thank you for challenging me and

pushing me to dig deeper, work harder, and to put my best foot forward. But most importantly, thank you for believing in me. Dr. Jill Salisbury-Glennon, from the moment I stepped into your classroom my first semester, your enthusiasm and excitement for education and "your man, V" immediately ignited my interest in learning theories. I am grateful for your guidance through the construction of my literature review, your passionate support of my research interests, and your consistently warm and welcoming demeanor. I would also like to express my sincere appreciation to Dr. Maria Witte for her assistance, insightful comments and suggestions, as well as her enthusiasm for my research project. Last, I would like to thank Dr. Megan Good for serving as my university outside reader.

I would additionally like to acknowledge some very important people who have influenced me professionally and personally throughout this journey. It is with sincere appreciation that I extend a special thank you to Dr. David Marshall for his mentorship and invaluable feedback that dramatically advanced my skillset as a quantitative researcher. I am grateful to have been given the opportunity to work with someone who shares my love for statistics and for the many doors you opened for me professionally. To my fellow graduate colleagues and "Ed-Psychos," Wilson Lester, Payton Hoover, Dwayne Clark, and Jessica Weise, I am indebted to each of you for your unwavering support, assistance, laughs, and encouragement throughout these years. Finally, I want to thank my parents, Thomas and Dena Mastrogiovanni, without whom this would not have been possible. Thank you for your unconditional love and for always reminding me "not to let your circumstances keep you from reaching your goals". Thank you for teaching me that the discomfort of new and challenging situations is temporary, yet necessary.

Disclaimer

Data Source: Derived from data provided by Educational Testing Service Copyright © 2020 ETS. www.ets.org

The opinions set forth in this dissertation are those of the author and not ETS.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

GRE	Graduate Record Examination
ETS	Educational Testing Service
GPA	Grade Point Average

CHAPTER I: INTRODUCTION

Background

Attendance in higher education institutions in the United States can be dated as far back as the 1600s (Berger, Ramirez, & Lyon, 2012; Demetriou & Schmitz-Sciborski, 2011). The 1800s saw the drastic expansion of higher education in America with the rise of private denominational colleges and rapidly soaring college enrollment (Berger et al., 2012). With this increase in enrollment numbers, colleges expanded curricula options and campus life experiences for participating students. These expansions naturally led to increases in degree attainment rates for participating college students (Berger et al., 2012). Higher education continued its dramatic growth into the mid-19th century with the establishment of women's colleges, the Morrill Land Grant Act of 1862, as well as the expansion of urban life and societal changes leading to the necessity of postsecondary degrees. During the mid-20th century, with the availability of financial support provided by the GI bill and the subsequent Higher Education Act of 1958, greater access to postsecondary education to various populations became possible (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011).

With enrollment numbers continuing to rise and different types of higher education institutions emerging during the 20th century, trends of student degree completion and attrition became more prevalent. In light of this growth, college student retention and attrition became a subject of importance and interest to institutions.

The first undergraduate retention research study was conducted in the 1930s by John McNeely with the United States Department of the Interior and the Office of Education (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011). This study explored demographic and institutional characteristics, student social engagements, and reasons for student departure in

order to examine patterns of student attrition. By the 1970s, student retention theories began to appear. Spady's (1970) sociological model of student dropout in higher education was the first model of retention that synthesized previous research findings into a conceptual framework. This model suggested that the interaction between student attributes and their environment influenced their academic and social integration. Ultimately, this integration influenced whether or not a student persisted or departed the institution (Alijohani, 2016). Shortly after, Tinto's (1975) foundational model of student departure emerged. Built upon Spady's model, Tinto's model suggested that student characteristics before entering college influence their commitment and goals. Thereafter, student experiences and integration continues to shape their commitment to their institution and graduation (Alijohani, 2016; Demetriou & Schmitz-Sciborski, 2011). Considered to be the foundational work on educational persistence, Tinto's work prompted increases in systematic research examining student retention.

Student enrollment numbers became stagnant by the end of the 1970s, prompting the emergence of additional retention research and theories in an effort to discover innovative ways to attract and retain students. Bean's (1980) model suggested student attrition was similar to employee turnover. Specifically, he highlighted the importance of background characteristics, satisfaction, and organizational structure as determinants of student departure (Alijohani, 2016; Demetriou & Schmitz-Sciborski, 2011). Additionally, with a focus on student transformation, Astin's model of student involvement proposed that the amount of energy, both physically and psychologically, students invests toward their learning and development influences and was influenced by their involvement at the institution (Astin, 1999). Ultimately, Astin proposed that the greater a student is involved at their institution, the greater they learn and develop, and ultimately the greater their likelihood of persistence (Alijohani, 2016; Astin, 1999).

As student populations became more diversified during the 1990s, the focus of retention research shifted to underrepresented students and students from disadvantaged backgrounds. (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011). Continuing to revise his theoretical model, Tinto (1993) suggested that different student groups have unique experiences. He proposed that these groups need interventions and policies tailored to their individual needs (Demetriou & Schmitz-Sciborski, 2011). As a result, institutions increased their attention to support services and first year experience programs (Demetriou & Schmitz-Sciborski, 2011).

Presently, retention remains a significant issue for higher education institutions where policy makers, researchers, and practitioners come together to learn how to better serve their student populations (Berger et al., 2012). Today, the retention literature concentrates on cross-institutional collaboration and responsibility for student retention by offering easily accessible support services/programs for students (Demetriou & Schmitz-Sciborski, 2011). As the landscape of higher education continues to change, including more diverse student populations and the emergence of distance learning, understanding the complexities of student retention remains a significant priority.

While most of the literature and theories on student retention and persistence focus primarily on undergraduate students, very little research in this area has focused on graduate student progression. Baird (1993) synthesized what little theoretical models exist regarding graduate student progress and categorized them into four types: psychological, sociological, process, and integrated models. Ultimately, the integrated model encapsulates and synthesizes Katz's (1976) psychological model, Tinto's (1991) sociological model, and Berkenkotter, Huckins, and Ackerman's (1991) process model. Baird's integrated model emphasized what the previous models claimed as important factors of graduate student progress: faculty and peers.

Faculty members in graduate programs set the standards of performance and attainment. Peers help students develop coping strategies and provide support to meet the faculty standards. According to Baird's model, graduate student attrition can be attributed to poor social and academic integration with faculty and peers, insufficient mastery of reasoning skills, and lack of support from groups (Baird, 1993).

Those who have received graduate degrees often occupy esteemed academic and research positions, administrative positions, as well as business and industry positions (Bair & Haworth, 1999). In fact, the number of students completing master's and doctoral degrees increased from 25% to 32% from 2006–2007 to 2016–2017 academic years (Snyder, de Brey, & Dillow, 2019). Despite the prestige associated with having a graduate degree, research indicates that 40% to 60% of graduate students do not persist to degree completion (Bair & Haworth, 1999; Council of Graduate Schools [CGS], 2008). Moreover, completion rates vary drastically by degree fields. Specifically, degree completion rates are highest for business, education, and health professions at the master's degree level (Snyder et al., 2019; Okahana & Zhou, 2019), whereas the highest completion rates at the doctoral level are seen in health professions, legal professions, education, engineering, biological sciences, psychology, and physical science fields (CGS, 2008; Most, 2008; Nerad & Miller, 1996; Snyder et al., 2019). Additionally, time-to-degree completion rates tend to vary by degree field. STEM fields including chemistry, chemical engineering, and biochemistry often report the fastest degree completion rates on average, where fields including music, art history, French, and history have the slowest average degree completion duration (Baird, 1990; Bok, 2013). Unfortunately, as time-to-degree increases, graduate students are more likely to leave their degree programs (Baird, 1990; Bok, 2013; Nerad & Miller, 1996). This is because students make various sacrifices including financial, time, and opportunity costs.

Ultimately, failure to complete a graduate degree remains one of the most difficult and significant problems within the graduate education system. When this occurs, students leave without any credential for their time spent at the institution and can result in debt. Additionally, the economic impact of a more educated workforce is influenced by graduate student attrition.

Over the past 30 years, previous research has examined and exhaustively outlined a variety of factors associated with graduate student persistence and attrition. For example, researchers have repeatedly indicated graduate student persistence and attrition are associated with departmental and programmatic factors including student interactions with faculty members, clarity of programmatic expectations, experiences of peer socialization, and receiving financial funding (Bair & Haworth, 1999; Bowen & Rudenstine, 1992; Council of Graduate Schools [CGS], 2009; De Clerq et al., 2019; Devos et al., 2016; Golde, 2005; Kelly & Salisbury-Glennon, 2016; Kerlin, 1995; Rockinson-Szapkiw et al., 2014; Rockinson-Szapkiw et al., 2016; Tinto, 1975; Wollast et al., 2018). Additionally, student factors, including outside employment duties, university and employment changes during graduate studies, and student demographic characteristics, have been demonstrated to contribute to and be associated with explaining graduate student persistence and attrition (Attiyeh, 1999; Bair & Haworth, 1999; Bowen & Rudenstine, 1992; Faghihi & Ethington, 1996; Gittings et al., 2018; Kerlin, 1995; Wollast et al., 2018). Overall, it is clear that not one single factor is responsible for explaining graduate student persistence, degree completion, and performance.

In addition to the factors associated with persistence pertaining to students in the process of pursuing their graduate education, the graduate admissions application process also serves as a catalyst in strengthening and improving higher education and completion of degree programs. In contrast to undergraduate admissions, graduate admissions practices are typically decentralized

(Kent & McCarthy, 2016; Michel et al., 2019). Often, graduate school admission professionals confirm the completion status of application materials for students and admissions decisions are made by departmental or programmatic committees (Michel et al., 2019). Typically, graduate schools require applicants to submit information providing a comprehensive overview of the students' academic performance/preparedness, social and emotional skills, previous experiences, and their interest in the program (Michel et al., 2019). Normally, these materials include undergraduate transcripts, standardized test scores, and letters of recommendation (Kent & McCarthy, 2016; Michel et al., 2019). Although, the weight that programs/departments place on these pieces of evidence is not universally known, many researchers suspect that traditional standardized test scores of cognitive ability are weighted significantly heavier than the other materials and dominate the decision-making practices (Enright & Gitomer, 1989; Kent & McCarthy, 2016; Lovitts, 2008; Walpole, Burton, Kanyi, & Jackenthal, 2002). Unfortunately, as graduate education admissions continue to primarily focus on cognitive abilities scores, this practice has historically put underrepresented and non-traditional student groups at a disadvantage and perpetuates group differences (Kent & McCarthy, 2016; Oliveri & Ezzo, 2014; Sedlacek, 2004). In fact, differences between gender and racial groups were most notable for cognitive measures of ability at the undergraduate level (ACT/SAT composite scores and GPA) (Schmitt et al., 2011). This gap occurs because cognitive achievement tests used in educational contexts reflect a number of variables, skills, and factors that invariably are not intended to be measured by these assessments (Messick, 1984)**.** Ultimately, as graduate admissions practices place higher values and weights on cognitive ability scores when making admissions decisions, these practices ultimately reinforce issues of educational access, wage inequality, and the

reduction of diversity as they do not assess all student equally, especially nontraditional students (Kent & McCarthy, 2016; Oliveri & Ezzo, 2014; Sedlacek, 2004).

In light of the aforementioned challenges, there is growing interest in incorporating noncognitive attribute assessments in admissions practices to predict graduate student success (Kent & McCarthy, 2016). Graduate faculty members often mention how noncognitive skills, which are often not assessed by traditional measures of student ability, strongly contribute to and are determinants of graduate student success, persistence, performance, and degree completion (Enright & Gitomer, 1989; Kent & McCarthy, 2016; Lovitts, 2008; Walpole, Burton, Kanyi, & Jackenthal, 2002). Research conducted by Kent and McCarthy (2016) highlighted the importance of incorporating noncognitive attributes in admissions practices for two reasons. First, there is ongoing debate surrounding whether these cognitive ability measures in fact predict graduate student success. On one side, researchers have argued and found that this information does not predict student success outcomes including graduate student persistence and degree completion (Bair & Haworth, 1999; Barry & Mathies, 2011; Bok, 2013; Kuncel et al., 2001; Kuncel & Hezlett, 2010; Lovitts, 1996). In contrast, other researchers have conducted validity studies documenting that the GRE does, in fact, predict first year graduate GPA, overall graduate GPA, and faculty ratings (Attiyeh, 1999; Burton & Wang, 2005; Kuncel & Hezlett, 2010; Kuncel et al., 2001, 2010). Second, since institutions are embracing a data-driven culture to determine decision-making, it is beneficial for all parties to use the best, most predictive assessments of student success (Kent & McCarthy, 2016). Overall, despite the debates concerning the appropriateness and utility of standardized test scores, what remains certain is the need for graduate programs to use information that provides reliable and valid information about their graduate student applicants. Although current cognitive ability measures strongly predict

important educational outcomes in graduate school, the significant issue of graduate student attrition remains a present concern. Ultimately, there is a need to improve the validity of graduate student selection practices (Kuncel et al., 2001). Because admissions practices are intended to select students who are the most likely to succeed in their programs, the inclusion of additional predictors can help improve and inform these admissions decisions.

While there is agreement that noncognitive skills are important in higher education and should be considered in graduate admissions, there isn't consensus on which noncognitive attributes are most important factors for predicting success (Kyllonen, Walters, & Kaufman, 2011). Many researchers have embraced the distinction between cognitive skills as facets of intellectual ability, analytical intelligence, informational processing, and subject matter knowledge and noncognitive skills as attitudes, motivation, and interest. However, Messick (1979) states these factors as a "relative balance between intellective and other personality determinants of individual differences" (Messick, 1979, p. 282). Therefore, meaningfully assess graduate student performance, competence, and ability level, educational measurement should focus on not only the acquisition of knowledge but also the cognitive processes and structuring of such knowledge systematically (Messick, 1979). Ultimately, the inclusion of noncognitive attribute assessments in combination with cognitive ability measures to better predict graduate student performance may present promising implications to graduate admissions practices and institutions of higher education.

Although the inclusion of such assessments demonstrates promising and beneficial outcomes for applicants, degree programs, and institutions, there are challenges associated with these suggestions. Specifically changing long-standing admissions practices can take an extensive amount of time and would add a layer of complexity to admission decision-making

(Kent & McCarthy, 2016). From a measurement perspective, many researchers are skeptical about the ability to measure noncognitive variables reliably because the most comment methods used (self-assessment and letters of recommendation) are susceptible to faking and are often unstandardized and subjective (Enright & Gitomer, 1989; Duckworth & Yeager, 2015; Kent & McCarthy, 2016; Kyllonen, 2005; Kyllonen et al., 2005; Oliveri & Ezzo, 2014).

One mechanism that can be used to combat the reliability limitations of common noncognitive assessment methods is the use of others' ratings or third-party evaluation (TPE) systems (Kyllonen, 2005, 2012). For this assessment method, outside raters (e.g., professors, advisors, or supervisors) evaluate applicants. Although TPE systems combat faking and coachability challenges, from a measurement perspective they still contain unique limitations. For instance, these limitations include biases held by individual instructors, low reliability comparing instructors' ratings (possibly from subjective judgments), and halo effects (Oliveri & Ezzo, 2014; Oliveri, McCaffrey, et al., 2017). One way to address these limitations is to standardize the process and use it as a supplement in the admissions process. This can potentially result in fairer applicant selections (Liu et al., 2009). To this end, the Personal Potential Index (PPI), formally known as the Standardized Letter of Recommendation (SLR), was developed by ETS as a standardized rating system to evaluate graduate school student applicants on their noncognitive attributes (Kyllonen, 2008).

Overall, despite the limitations, incorporating noncognitive measures at the graduate admissions level suggests promising outcomes for a variety of stakeholders. Noncognitive measures have the potential to help enhance accessibility to postsecondary education while having minimal impacts on institutional academic GPA and student quality (Oliveri & Ezzo, 2014; Schmitt et al., 2011). Although inferences can be made from associations between

noncognitive variables and educational outcomes, a systematic evaluation of the inclusion of noncognitive attribute assessments in combination with cognitive ability measures to better predict graduate student performance has not been widely documented in the literature.

Statement of the Problem

Previous research has outlined a variety of variables associated with graduate student persistence, performance, and degree completion. Much of the literature primarily focuses on institutional, departmental/programmatic, and student demographic factors. Further, although there is a growing body of literature that has examined the association of noncognitive factors with important educational outcomes, a systematic and quantifiable investigation of the role of noncognitive factors in graduate student degree completion and performance is lacking.

Admissions practices at all educational levels are intended to select students who are the most likely to succeed. Unfortunately, even with these intentions, research continues to indicate that graduate student attrition rates can range anywhere between 40% to 60% depending heavily on degree field (Bair & Haworth, 1999; CGS, 2008; Schramm-Possinger & Powers, 2015). Current admissions practices often rely heavily on cognitive ability, which is typically measured by traditional standardized test scores and GPA (Kent & McCarthy, 2016). The reliance on test scores and GPA has remained a subject of intense debate. Regardless of which side of the debate one identifies with, the vast amount of contradictory research findings over the years seriously puts into question the validity of these indicators. Additionally, these findings should cause decision-makers to reevaluate how heavily admissions decisions should depend on and value these cognitive ability indicators as predictors of graduate student degree completion and success. Ultimately, what remains certain is the need for graduate programs to use tools that provide reliable and valid information about the capabilities of graduate applicants. Therefore, as

student populations continue to diversify, the focus should move from “How can these cognitive measures improve?” to “What other information can we add to what we already use in order to improve and better inform admissions decisions?”.

As research continues to suggest that personal qualities not measured by traditional cognitive assessments serve as strong determinants of graduate student success, the inclusion of noncognitive assessments with current cognitive ability measurements can potentially enhance the quality of information obtained from these assessments, as well as improve admissions decisions made from such information (Sedlacek, 2010). Additionally, although reliably measuring noncognitive factors contains a variety of challenges, standardized TPE systems have the capability to combat many of the inherent limitations associated with common noncognitive assessment methods. Currently, the examination of the role of noncognitive factors on graduate student performance and degree completion using a standardized TPE system designs is lacking in the literature. Therefore, this dissertation addresses this gap. The present study can positively inform graduate student admissions practices.

Purpose of the Study

The purpose of this study was twofold. First, it examined the role of noncognitive factors on graduate student persistence and degree completion. The second purpose was to examine the utility of the Personal Potential Index (PPI) as an avenue to reliably assess noncognitive factors of graduate students that avoids the drawbacks associated with self-assessment methods and unstandardized recommendation letters (Kyllonen, 2008; McCaffrey et al., 2018). To accomplish this investigation, the researcher conducted a nonexperimental quantitative research design using archival TPE survey data. Specifically, the researcher used de-identified, archival, Personal Potential Index (PPI) scores to determine if these six noncognitive attributes predicted graduate

degree completion and time-to-degree completion. Additionally, the researcher used these scores to determine if graduate student degree completion, graduate GPA, and time-to-degree was related to PPI subscale scores as well as degree classification/level (master's vs doctoral students), graduate student degree program (STEM vs non-STEM programs) undergraduate GPA, and GRE scores (analytical writing, verbal, and quantitative).

For this study, graduate degree completion, graduate GPA, and time-to-degree completion served as the primary dependent variables. The primary independent variables in this study included the six PPI subscale scores (knowledge and creativity, communication skills, teamwork, resilience, planning and organization, and ethics and integrity), graduate student degree classification (master's vs doctoral students), graduate student degree program (STEM and non-STEM), undergraduate GPA, and GRE scores (analytical writing, verbal, and quantitative).

Research Questions

To address the problem of this study, the researcher raised the following research questions:

1. What are the predictive relationships among the six PPI scale scores…
    a. on graduate student degree completion status?
    b. on graduate grade point average?
    c. on graduate student time-to-degree completion?
2. What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores…
    a. On graduate student degree completion status?

b. On graduate grade point average?

c. On graduate student time-to-degree completion?

3. Are there group differences based on the interaction of degree completion status, degree level, and degree program among …

    a. the six PPI scale scores, GRE scores, graduate GPA, and undergraduate GPA?

    b. the six PPI scale scores, GRE scores, and undergraduate GPA?

4. How do the six PPI scales perform in terms of creating variability between applicants?

Significance of the Study

Although previous research has demonstrated the relationship between a variety of noncognitive factors and significant educational outcomes, a systematic and quantifiable investigation of the impact of noncognitive factors on graduate student degree completion and performance using standardized third-party evaluation design data has not been explored. Results from this study could meaningfully inform faculty members, graduate program coordinators, and graduate admissions officers how noncognitive factors contribute to graduate student performance and success. Specifically, this study can demonstrate the impacts of incorporating noncognitive assessments in admissions practices on the admissions decisions for graduate applicants. As a result, this study can provide implications and suggestions to decision-makers with mechanisms to better predict student ability and select the most capable students from more diverse backgrounds (Kent & McCarthy, 2016). At the degree program level, evaluating and monitoring students on their noncognitive skills yearly can provide insight into their skill development, progression, as well as help identify areas that students can improve. Ultimately, this study could provide suggestions and implications to departments and programs for

resources/interventions to help students who are already currently enrolled progress, develop, and persist in their programs.

Additionally, results from this study could demonstrate the promising features of standardized TPE designs and assessments. Specifically, traditional assessment methods used to measure noncognitive skills contain limitations that undoubtably put into question the reliability and validity of obtained scores and score interpretations. The use of others' ratings or TPE designs can provide researchers an avenue to reliably assess noncognitive factors that is not subjected to the limitations of faking, coachability, and subjectivity present in population assessment methods (Enright & Gitomer, 1989; Kyllonen, 2005; Sedlacek, 2004). Ultimately, the use of noncognitive standardized TPE designs can serve as a mechanism to engage in better, fairer, more equitable, and more holistic admissions selection practices (Liu et al., 2009).

Terms and Definitions

The following are significant terms used throughout this research study:

Attrition: refers to a student's decision to not re-enroll at their institution for the following semester.

Cognitive Abilities: refers to "mental learning and thinking abilities, such as language, reading, writing, and math skills. As defined, applied skills may be underpinned by cognitive abilities" (Casner-Lotto & Barrington, 2006, p. 15).

Cognitive Ability Tests: refers to tests examining "a combination of reasoning, verbal, and quantitative skills or discipline-specific knowledge, which are correlated and fit into a hierarchical structure with a single overarching general ability" (Kuncel & Hezlett, 2010, p. 339).

Communication Skills: refers to one's ability to speak and write in a clear, organized, interesting, and logical manner (Kyllonen, 2008).

Creativity: refers to the ability to demonstrate originality and innovation, to communicate innovative ideas with others, and to integrate knowledge across domains (Casner-Lotto & Barrington, 2006).

Degree Completion Status: refers to whether a graduate student completed or did not complete their graduate degree.

Ethics: refers to one's ability to demonstrate integrity, responsibility, and ethical behavior for the larger community (Casner-Lotto & Barrington, 2006). Further, "ethics" refers to one's ability to behave according to their set of values.

Graduate Degree Classification/Level: refers to whether a graduate student is enrolled in a master's or a doctoral degree program.

Graduate Degree Program: refers to the academic college in which a graduate student's degree program resides. For the current study, degree program was differentiated from STEM and non-STEM.

Interpersonal skills: refers to communicating and working well with others, and awareness of social dynamics in situations and responding appropriately (Schmitt et al., 2011).

Knowledge: refers to one's mastery of content as well as ideas and theories, ability to integrate such knowledge in appropriate contexts, as well as one's perspective of a field of study (Kyllonen, 2008; Schmitt et al., 2011).

Noncognitive Factors: refers to attitudes, beliefs, values, motives, temperaments, and interests as well as their sociocultural environments and backgrounds (Messick, 1984).

Planning/Organization: refers to one's ability to make and stick with realistic goals, manage time, work effectively, and meet deadlines (Kyllonen, 2008).

Persistence: refers to a student's determination, desire, decision, and actions to remain at a higher education institution from admission though degree completion (Berger et al., 2012).

Resilience: refers to one's ability to accept feedback without becoming defensive, work well under stress, and overcome challenges (Kyllonen, 2008).

Teamwork/Collaboration: refers to one's ability to work with others in teams, negotiate, and effectively manage conflict (Casner-Lotto & Barrington, 2006).

Time-to-degree: refers to the number of years between graduate program entry to degree completion.

CHAPTER II: LITERATURE REVIEW

Introduction

Graduate student attrition has been estimated to occur at a rate of 40%–60% and represents a substantial challenge in graduate education (Bair & Haworth, 1999; Council of Graduate Schools [CGS], 2008). To understand and combat attrition in graduate education programs, it is essential to advance understanding of the various factors associated with graduate student persistence, performance, and degree completion. Specifically, the current literature has examined the association of various departmental/programmatic and student-related factors with graduate student persistence and degree completion. Additionally, exploring graduate education admissions processes and practices is important to understanding how these components contribute to and can reduce the occurrences of attrition. Graduate education admissions serve as a major catalyst in strengthening and improving higher education institutions and degree programs. Typically, graduate programs request that applicants submit materials including undergraduate transcripts, standardized test scores, and letters of recommendation (Kent & McCarthy, 2016; Michel et al., 2019). Although, the weight programs/departments place on these pieces of evidence to inform their decisions is not universally known, many researchers have suspected and some have discovered that traditional standardized test scores of cognitive ability are weighted significantly heavier than other materials and dominate decision-making practices (Enright & Gitomer, 1989; Kent & McCarthy, 2016; Lovitts, 2008; Walpole, Burton, Kanyi, & Jackenthal, 2002). Unfortunately, an ongoing debate has arisen surrounding whether these cognitive ability indicators, in fact, predict graduate student success outcomes (Kent & McCarthy, 2016). Despite traditional cognitive ability scores predicting some important educational outcomes in graduate school, graduate student attrition continues to remain a

pressing concern. Ultimately, to reduce the current rate of graduate student attrition, there remains room to improve the validity of graduate student selection systems and practices (Kuncel et al., 2001). Because the goal of admissions practices is to select students who are most likely to succeed in their specific programs, the inclusion of additional predictors, including noncognitive skills, can help improve and better inform admissions decisions.

This chapter provides an overview of the literature that has examined the landscape of higher education, seminal undergraduate retention theories as well as graduate education practices. Additionally, literature regarding various programmatic/departmental and student-related factors associated with graduate student persistence and degree completion was examined. Finally, a literature review addressing a variety of noncognitive factors associated with graduate student success, as well as the various mechanisms used to measure these skills.

Historical Overview of Higher Education and Student Retention Theories

Attendance at higher education institutions has been dated as far back as the 1600s (Berger, Ramirez, & Lyon, 2012; Demetriou & Schmitz-Sciborski, 2011). Students attending college were most often young men who studied to become ministers and pastors. It was not until the 1800s that institutions of higher education began to expand dramatically in America mainly due to the rise of private denominational colleges (Berger et al., 2012). Toward the middle and the end of the 19th century, colleges began expanding curricular options and campus life experiences. These expansions ultimately resulted higher degree attainment (Berger et al., 2012). Although undergraduate education was on the rise during this time, graduate education had not particularly advanced. It was not until 1861 that the first doctoral degree was awarded in the United States (Michel et al., 2019).

The signing of the Morrill Land Grant Act of 1862 changed the landscape of higher education in the United States. By predicating the grant of land to the states for colleges and universities on the condition that they offer agricultural and engineering programs, the number of learning institutions as well as students seeking access to higher education increased drastically (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011) The demand for increased access to colleges and universities at this time also grew as a result of societal changes occurring in the United States, leading to the necessity of postsecondary degrees. However, as more individuals sought access to higher education, colleges and universities implemented more selective criteria for their admissions practices (Berger et al., 2012). As a result, less selective colleges began to emerge to serve students and grant them access to educational opportunities.

As the number of students increased and the population diversified in higher education institutions, trends of student degree completion and attrition began to emerge. Ultimately, as the value of a college degree increased, the first undergraduate retention research study was conducted in the 1930s by John McNeely with the United States Department of the Interior and the Office of Education (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011). This study explored demographic characteristics, social engagements, and reasons for student departure from higher education institutions. Although the Great Depression reduced the nation's interest in higher education, enrollment boomed after World War II. With the launch of the GI bill and then the Higher Education Act of 1958, greater access to student populations became possible through the increased availability of financial support to attend college (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011). As student enrollment increased during this time, retention and attrition became a priority for colleges and universities. Additionally, graduate

education began to expand during this time due to an influx of federal research funds and the expansion of the middle class (Michel et al., 2019).

By the end of the 1960s, large scale studies examining student attrition and retention began to appear (Demetriou & Schmitz-Sciborski, 2011). By the 1970s, theories concerning student retention began to be developed. Spady's (1970) model of student dropout in higher education was the first model addressing retention. He suggested that the interaction between student characteristics and environmental factors influenced whether a student would be integrated in their institution and ultimately persist (Alijohani, 2016; Berger et al., 2012). Built upon Spady's model of student drop out, Tinto's (1975) foundational model of student departure emerged. Tinto suggested that student characteristics before entering college influence their commitment and goals. Thereafter, student experiences and integration into their institution continued to shape their commitment to their institution and their decisions to graduate. Ultimately, these experiences influenced their decisions to persist or depart (Alijohani, 2016; Demetriou & Schmitz-Sciborski, 2011).

As student enrollment numbers became more stagnant by the end of the 1970s, more retention research and theories began to emerge. Bean's (1980) model of student attrition suggested that student attrition was comparable to employee turnover. Specifically, he insisted that organizational structures determine student satisfaction and ultimately their persistence (Alijohani, 2016; Demetriou & Schmitz-Sciborski, 2011). Additionally, with a focus on student transformation, Astin's model of student involvement proposed that the amount of energy (both physically and psychologically) students invest toward their learning and development influences and also is influenced by their involvement at the institution (Astin, 1999). Ultimately, Astin

proposed that the greater a student is involved at their institution, the greater they learn and develop, and ultimately the greater their likelihood of persistence (Astin, 1999).

As student populations became more diverse during the 1990s, retention research focused on underrepresented student populations and students from disadvantaged backgrounds (Berger et al., 2012; Demetriou & Schmitz-Sciborski, 2011). Further, as he continued to revise his foundational theoretical model, Tinto (1993) suggested that different student groups have unique experiences that contribute to their persistence or attrition. He insisted that these groups require interventions and policies tailored to their individual needs (Demetriou & Schmitz-Sciborski, 2011). Toward the end of the 1990s and beginning of the 21st century, institutions increased their attention to support services and first-year experience programs as collaboration across campus departments and programs became a frequent occurrence (Demetriou & Schmitz-Sciborski, 2011). Additionally, financial aid began receiving more attention in retention studies (i.e., financial factors can impact student attrition) (Berger et al., 2012).

Today, the focus in retention research concentrates on cross-institutional collaboration by offering easily accessible support services and programs for students (Demetriou & Schmitz-Sciborski, 2011). In addition to the historical foundational persistence theories, the application of motivational theories and aspects to student retention has been under inspection, including attribution theory, expectancy-value theory, goal setting theory, self-efficacy beliefs, academic self-concept, and motivational orientations (Demetriou & Schmitz-Sciborski, 2011). Retention has remained a compelling issue for higher education institutions where policy makers, researchers, and practitioners come together to learn how to better serve their students (Berger et al., 2012). Overall, the nature of and focus on retention has evolved drastically within the last

100 years. As the landscape of higher education continues to change understanding the complexities of student retention remains a significant priority.

While most of the literature and theories on student retention and persistence has focused primarily on undergraduate students, very few have focused on graduate student progression. Baird (1993) synthesized the current theoretical models regarding graduate student progress and categorized them into four types: psychological, sociological, process, and integrated models. Ultimately, the integrated model encapsulated and synthesized Katz's (1976) psychological model, Tinto's (1991) sociological model, and Berkenkotter, Huckins, and Ackerman's (1991) process model. This integrated model emphasized the two factors all the previous models claimed as important in the graduate student progress: faculty and peers. Faculty members in graduate programs set the standards for performance and attainment. Peers assist students in developing coping strategies to ultimately meet the faculty standards. As a result, graduate student attrition in this integrated model could be attributed to poor social and academic integration with faculty and peers, insufficient mastery of reasoning skills, and lack of support from groups (Baird, 1993).

Graduate Student Attrition

Those who have received graduate degrees often occupy esteemed academic and research positions, administrative positions, as well as business and industry positions (Bair & Haworth, 1999). To that end, from "1997 to 2009, more than half of all Nobel Prize–winners in the sciences and economics received their graduate training in the United States" (Bok, 2013, p. 230). The number of students completing master's and doctoral degrees increased from 25% to 32% from 2006–2007 to 2016–2017 academic years (Snyder et al., 2019). Although there is a prestige associated with earning a graduate degree, research indicates that 40% to 60% of

graduate students do not persist to degree completion depending on the degree field (Bair & Haworth, 1999; Council of Graduate Schools [CGS], 2008; Kerlin, 1995). Degree completion rates have been the highest for the business, education, and health professional fields at the master's degree level (Okahana & Zhou, 2019; Snyder et al., 2019) At the doctoral degree level, the highest completion rates are in the health, legal, education, engineering, biological sciences, psychology, and physical science fields (CGS, 2008; Most, 2008; Nerad & Miller, 1996; Snyder et al., 2019). The Council of Graduate School's (2008) longitudinal Ph.D. completion project revealed that approximately 57% of doctoral students completed their degrees within 10 years. Completion rates were highest for engineering and life science fields (63%) and lowest for humanities (49%). Further, average time-to-degree completion rates vary by for these field. Results have indicated that STEM fields, including chemistry, chemical engineering, and biochemistry, on average, had the fastest rates regarding degree completion duration (5.9 – 6 years); whereas fields including music, art history, French, and history had the slowest and longest average degree completion duration (9.2 – 10 years) (Baird, 1990; Bok, 2013). As time-to-degree increases, graduate students have recognized that continuing their educational journey is an expensive endeavor, involving both their money and their time. Therefore, as time-to-degree increases, students have been more likely to depart from their programs (Baird, 1990; Bok, 2013; Nerad & Miller, 1996).

Failure to complete a graduate degree is one of the most problematic issues within the United States graduate education system. Many individuals have made substantial sacrifices to enroll in graduate programs, and higher education institutions have invested hundreds of thousands of dollars to support graduate students toward their graduate degrees (Council of Graduate Schools [CGS] & Educational Testing Service [ETS], 2010). Ultimately, not only have

there been direct costs and risks to the students and the university when graduate students have failed to complete their degree, but there have also been opportunity costs for the degree program and the student. When a student has failed to complete their degree, a space that may have been occupied by a student who could have completed their degree was unavailable (CGS & ETS, 2010). Additionally, students could have been working and making money during this time.

Factors Associated with Graduate Student Persistence

In light of the previous retention theories, researchers have outlined factors associated with graduate student persistence and attrition. For instance, Bair and Haworth (1999) synthesized 30 years of research investigating graduate student persistence and retention. In this meta-synthesis, graduate student attrition could be attributed to departmental/programmatic factors as well as student-related factors. Departmental and programmatic factors associated with graduate student persistence and attrition have included connection with faculty members, expectations of the program, peer socialization, and financial funding (Bair & Haworth, 1999; De Clerq et al., 2019; Devos et al., 2016; Golde, 2005; Kelly & Salisbury-Glennon, 2016; Kerlin, 1995; Rockinson-Szapkiw et al., 2014, 2016; Tinto, 1975; Wollast et al., 2018). Student factors including employment, changing universities, and student characteristics have also been shown to contribute to graduate student persistence and attrition (Bair & Haworth, 1999; Gittings et al., 2018; Kelly & Salisbury-Glennon, 2016; Kerlin, 1995; Rockinson-Szapkiw et al., 2014; Wollast et al., 2018).

Departmental Factors

According to theorists and researchers, a variety of factors have attributed to student retention including academic engagement, social engagement, and financial support (Demetriou & Schmitz-Sciborski, 2011). Examining the institutional and departmental characteristics and

culture can provide suggestions to better cultivate spaces that foster persistence for their graduate students.

The Faculty

The quality of the relationship between graduate students, faculty, and advisors has been shown to be a strong predictor of successful completion by students in a graduate program (Bair & Haworth, 1999; De Clerq et al., 2019; Golde, 2005; Holms et al., 2016; Kerlin, 1995; Rockinson-Szapkiw et al., 2016; Tinto, 1975). Students who are socially integrated with their advisor and other faculty members have reported having open communication with faculty members, receiving valuable feedback, and feeling supported. In turn, these benefits have been shown to directly impact their persistence toward degree completion (De Clerq et al., 2019; Rockinson-Szapkiw et al., 2016; Tinto, 1975). Feeling supported by faculty members has further been shown to predict positive emotions, perceived progression, and intention to persist for doctoral students in the beginning stages of their program (De Clerq et al., 2019). Counteractively, students who have experienced poor student-faculty interactions are often less likely to persist in their degree programs (Kerlin, 1995). Nonetheless, faculty members should express support to students in all stages of their graduate programs.

Student-faculty interaction has also been shown to be a strong contributor of persistence (Baird, 1997; Bok, 2013; Rockinson-Szapkiw et al., 2014; Tinto, 1997). Having contact with faculty members both inside and outside of the classroom has been shown to directly impact student development and persistence (Baird, 1997; Tinto, 1997). Additionally, interactions with faculty typically create a sense of collegiality for graduate students (Rockinson-Szapkiw et al., 2014). Students who have been asked by faculty members to assist them with research projects often reported feeling a sense of connection with those faculty members in addition to having

opportunities to improve research skills. Moreover, these opportunities influenced graduate students to persist towards degree completion because they could learn valuable tools through mentorship and guidance (CGS, 2009). As students have become more socially and academically involved with their faculty members and within their departments, they persisted at higher rates (Faghihi & Ethington, 1996). Further, the types of relationships and interactions between students and their academic community, specifically faculty members, has influenced their perceptions of program fit. Research conducted by Sweitzer (2009) revealed students perceiving adequate program fit reported a strong identity orientation which was similar to the prototypical professional identities in their programs. Additionally, these students identified strongly with colleagues who had similar goal and performance expectations. Ultimately students expressed these interactions were critical to their academic success in their graduate programs.

Evidence has suggested that one of the most important contributors to graduate student persistence is the student-advisor relationship (Bair & Haworth, 1999; Bok, 2013; CGS, 2009; Girves & Wemmerus, 1988; Golde, 1998, 2005; Litalien & Guay, 2015; Nerad & Miller, 1996; Rockinson-Szapkiw et al., 2016). Many graduate students have decided to leave their programs because of inadequate advising, mainly due to lack of interest or attention from the advisor, unavailability of the adviser, or even a negative with the advisor (Bair & Haworth, 1999; Bok, 2013; Golde, 1998, 2005; Nerad & Miller, 1996). The resultant lack of interaction, trust, and support due to a mismatch of the student and advisor markedly increased a student's likelihood towards attrition (Bair & Haworth, 1999; Golde, 2005).

The Degree Program

The degree program in which a graduate student enrolls can significantly influence whether they persist toward degree completion (Bair & Haworth, 1999). Students who attended

more selective graduate degree programs were often more likely to persist toward that goal (Attiyeh, 1999). However, the culture within a degree program has also contributed to students' experiences and thus their persistence in the program. The culture of the department has been shown to directly shape student involvement in academic activities, their satisfaction with the program, student-to-student interactions, and financial assistance available to students (Bair & Haworth, 1999; CGS & ETS, 2010; De Clerq et al., 2019; Devos et al., 2016; Girves & Wemmerus, 1988; Golde, 2005; Kerlin, 1995; Rockinson-Szapkiw et al., 2014; Rockinson-Szapkiw et al., 2016).

Tinto's (1975) model of student departure emphasized the importance of academic integration, specifically student satisfaction with the learning process, student academic performances, the academic assistance they receive through the program, and their academic match with the program. To succeed, it is critical that students be academically integrated into their department and degree program. Academic integration has regularly predicted whether candidates would persist in the dissertation phase of the program and persist toward degree completion (Rockinson-Szapkiw et al., 2016). In contrast, graduate students who reported dissatisfaction (and less academic integration) with their degree programs have often been less likely to persist in their programs (Kerlin, 1995). Overall, students who were more academically integrated into their programs were typically more involved in programmatic and departmental activities, which, in turn, influenced their persistence towards degree completion (Bair & Haworth, 1999; Rockinson-Szapkiw et al., 2016; Tinto, 1975).

Degree Program Quality. Perception of the quality of the degree program has also been shown to influence graduate student persistence or attrition (Bair & Haworth, 1999; Baird, 1990, 1997; CGS, 2009; Rockinson-Szapkiw et al., 2016). Specifically, those students who perceived

their degree program, curriculum, and instruction to be of high quality for dissertation research and future careers were more likely to persist. Further, if they perceived their program to be effective, they were more likely to complete their degree quickly (Baird, 1990). As a result, students benefitted from faculty members intentionally designing curricula that prepared students for the research stages they were expected to carry out in their dissertation. Intentionally designing degree programs that implement procedures to regularly evaluate student progress foster environments that can potentially increase the likelihood of their success (Baird, 1997).

Program Expectation. In addition to the perception of quality, having a clear understanding of the expectation of the degree program has significantly influenced graduate student persistence and attrition rates (Bair & Haworth, 1999; Baird, 1990; Bok, 2013; Golde, 2005; Nerad & Miller, 1996; Rockinson-Szapkiw et al., 2014). In particular, entering into a program with clear and realistic expectations about the amount of time, money, and the relational sacrifices that would be required impacts student satisfaction with their program (Bair & Haworth, 1999; Golde, 1998; Rockinson-Szapkiw et al., 2014). Ultimately, students with a clear and strong sense of familiarity with their programs were more likely to succeed (Baird, 1990). When there is a mismatch in expectations, this can significantly influence a student's decision to leave their programs (Bok, 2013; Golde, 1998, 2005; Nerad & Miller, 1996). Specifically, having a mismatch in the expectations of graduate school demands, the quick pace, and the nature of research practices has often influenced students towards attrition. Studies have shown that students who embarked on a graduate education without a clear understanding of the expectations of the program, as well as the time, money, and travel required, may have faced external barriers that ultimately restrict students from fully integrating academically and socially in their programs which may lead to attrition (Bok, 2013; Hwang et al., 2015). Likewise, some

graduate students may not have understood that the nature of graduate school consists of complex philosophical thinking, narrow professional training oriented towards being an academic, and a heavy workload (Golde, 1998, 2005; Nerad & Miller, 1996). For instance, students entering graduate programs may expect graduate school to be similar to their undergraduate experiences, which may cause students to become overwhelmed. Additionally, a mismatch in expectations concerning the reality of research practices often results in students experiencing isolation, having only a narrow focus of research, and feelings of unhappiness with the perceived irrelevancy of their work (Golde, 2005; Nerad & Miller, 1996). In turn, student isolation may be a result of the many roles students are assigned to, which can consequently keep these students from fulfilling their duties (Hwang et al., 2015). Overall, it is critical for degree programs and departments to clarify the experiences and expectations of graduate schooling to incoming students and to ensure that expectations are met.

Course Flexibility. Course time offerings, flexibility, and relevancy have been shown to influence persistence or attrition decisions for graduate students (CGS, 2009; Rockinson-Szapkiw et al., 2014). Many students have expressed that having flexible course options (for instance, online, weekend, or evening classes) has helped them persist towards degree completion. In fact, for many adult learners in graduate programs, flexible course offerings are the only way they can complete their degrees. In addition to flexibility, the nature and relevance of the courses offered impacts persistence and attrition. Students who perceived their courses as practical, where their learning was experiential and relevant often persisted towards degree completion (Rockinson-Szapkiw et al., 2014). Furthermore, students who perceived that their courses were structured toward building and preparing their research skills necessary for the

dissertation phase were often more satisfied with their programs and more likely to persist (Bair & Haworth, 1999; Rockinson-Szapkiw et al., 2014).

Phase of Graduate Studies. Previous research has indicated graduate student persistence and attrition can often be attributed to the phase of graduate studies and specific dissertation difficulties (Bair & Haworth, 1999; De Clerq et al., 2019; Devos et al., 2016; Golde, 2005). Tinto's (1988) research incorporating the stages of transition to college persistence highlighted the temporal nature of student departure from higher education. Doctoral candidates in the phase classified as "All But Dissertation" or ABD have not always been the students who consistently depart from their programs (De Clerq et al., 2019; Golde, 2005). In fact, students in different stages of their graduate program and stages of transition to higher education may have faced different barriers to their experiences and had other reasons to depart (Hwang et al., 2015; Tinto, 1988). Although it has been shown that more advanced students in their doctoral programs were more likely to persist, students typically chose to leave their programs right before specific candidacy requirements and hurdles, including comprehensive examinations (De Clerq et al., 2019; Golde, 2005). In fact, these programmatic requirements, often perceived as daunting hurdles where a doctoral student can fail, have often exacerbated attrition in doctoral programs, pushing students to leave before meeting candidacy requirements (Golde, 2005). Although this experience may be pushed and expected from some faculty members, it is critical that gradute applicants are cognizant of these experiences. Moreover, challenges in maintaining structure after completing comprehensive examinations have influenced student persistence in their graduate programs. Students who reported a lack of structure after completing their comprehensive exams may have been less likely to persist (Kerlin, 1995). Therefore, it has been

critical for students to implement structure in their independent studies in order to complete their degree requirements.

Graduate Assistantships. Graduate students holding teaching and/or research assistantships have experienced varying levels of professional development and growth, which have encouraged persistence (Ethington & Pisani, 1993; Strayhorn, 2010). Students who held research assistantships or holding both teaching and research assistantships reported more positive professional growth experiences, skill development, scholarly production, and were more likely to persist (Ethington & Pisani, 1993; Strayhorn, 2010). Students holding only teaching assistantships were less inclined to perceive their experiences as contributing to their graduate professional development (Ethington & Pisani, 1993). As a result, these students may have been less likely to persist as a result of their perceptions of inadequate development. In fact, research has indicated that teaching assistantships have not contributed to student persistence (Strayhorn, 2010). Furthermore, some research findings have indicated that assistantships may have prolonged graduate student time-to-degree completion (CGS, 2009). As a result, prolonged program duration resulting from a student holding a teaching assistantship may have had negative impacts on students' degree completion and persistence.

Peer Interaction and Isolation

Similar to a student's interaction with their advisors and departmental faculty, a student's connection with peers and experiences of peer interaction has been related to persistence towards degree completion for graduate students (Bair & Haworth, 1999; CGS, 2009; Golde, 2005; Holms et al., 2016; Kelly & Salisbury-Glennon, 2016; Litalien & Guay, 2015; Rockinson-Szapkiw et al., 2014; Rockinson-Szapkiw et al., 2016; Tinto, 1975). Tinto's (1975) concept of social integration included having open communication, feeling cared for, and developing trust

with peers. With this in mind, having a sense of community with and feeling supported by program peers has been linked as an important factor for persistence and degree completion (CGS, 2009; Holms et al., 2016; Kelly & Salisbury-Glennon, 2016; Litalien & Guay, 2015; Rockinson-Szapkiw et al., 2014). Conversely, social integration with peers has also been demonstrated to not be a prominent indicator or predictor of persistence in the literature (De Clerq et al., 2019; Devos et al., 2016). Therefore, the degree to which social integration predicts persistence towards degree completion has varied depending on the graduate student.

Although student integration may not be an indicator of persistence in some previous research findings, structural isolation has been documented as a factor of doctoral student attrition (Bair & Haworth, 1999; Golde, 2005). Appearing to be a programmatic feature in many graduate and doctoral programs, many students chose to leave their programs because they felt isolated from a departmental community. Because the nature of research practices has been demonstrated as isolating and lonely, isolation inherent in these practices often led individuals to experience an absence of supportive relationships in their programs (Golde, 2005).

Financial Support

The financial support offered by the institution and/or department to graduate students has often been related to the attrition and persistence of doctoral students (Bair & Haworth, 1999; Baird, 1997; CGS, 2009; CGS & ETS, 2010; Girves & Wemmerus, 1988; Kelly & Salisbury-Glennon, 2016; Kerlin, 1995; Litalien & Guay, 2015; Nerad & Miller, 1996; Rockinson-Szapkiw et al., 2016; Wollast et al., 2018). Students with more financial support have been more likely to persist (Attiyeh, 1999). Specifically, students who received funding through fellowships or graduate assistantships were more likely to persist toward their degree completion (Bair & Haworth, 1999; Baird; 1997; Kelly & Salisbury-Glennon, 2016; Litalien & Guay, 2015;

Wollast et al., 2018). Through some of these experiences, students gained the some of the necessary skills for the dissertation in addition to receiving funds that aided them throughout their doctoral program. Without necessary funding, graduate students have often been put in a position where they were forced to depart from their programs (Kerlin, 1995; Nerad & Miller, 1996).

In addition to assistantships and fellowships, other financial factors, including financial aid, has impacted graduate student persistence. For instance, expected family contribution, loan availability, and deferred educational loan payments have been shown to be financial aid factors that positively impact graduate student persistence (Stayhorn, 2010). Further, the historical impacts of increased access and availability of institutional grant programs, federal grants, and financial loans for students led to greater persistence (Gururaj, Heilig, & Somers, 2010). Ultimately, the less financial difficulty students have experienced, the more likely they will persist in their programs (Faghihi & Ethington, 1996). Overall, environmental factors related to the institution, degree program, faculty members, peers, and community all have had significant impacts on graduate student progression, success, persistence, and degree completion (Kyllonen et al., 2011; Lee & Shute, 2009; Sedlacek, 2010).

Student-Related Factors

In addition to various departmental and programmatic factors that have been associated with graduate student progress, performance, and degree completion, research has revealed various external and student factors associated with graduate student persistence and degree completion, including external employment, university changes, student characteristics, and student demographics.

External Employment and University Changes

Although many students receive funding from their institutions while completing their graduate degrees, some students choose to work full- or part-time to pay for their education (Bair & Haworth, 1999; Baird, 1997; Gittings et al., 2018; Wollast et al., 2018). Research has provided mixed results concerning the impacts of external employment on graduate student degree completion (Bair & Haworth, 1999). Many researchers have indicated that those who work full-time have often been less likely to persist and complete their degrees, compared to those whose education has been funded and/or who were working as research assistants (Bair & Haworth, 1999; Baird, 1997; Wollast et al., 2018). In fact, many who depart from their programs have reported that responsibilities associated with their full-time jobs often led them to leave their program (CGS & ETS, 2010). In addition to external employment and employment changes during graduate studies, students who changed degree programs or transferred to a different university during their studies were more likely to depart their graduate studies before completion (Bair & Haworth, 1999; Gittings et al., 2018; Wollast et al., 2018). As a result, circumstances involving changes in universities attended and employment seriously impacted some students' abilities to complete their degree.

Student Characteristics and Demographics

Although certain demographic variables have been previously investigated regarding their association with persistence, it is important to be cautious about these interpretations. Prior educational attainment has been associated with graduate student persistence and success. Students entering doctoral programs having already completed a master's degree were more likely to persist than students who did not (Attiyeh, 1999; Most, 2008). Regarding academic ability, students with higher grades and GRE quantitative and verbal scores were also more likely to persist and progress in their degree programs (Attiyeh, 1999; Girves & Wemmerus,

1988). Further, doctoral student performance on comprehensive and qualifying examinations has been demonstrated to relate to degree progress (Girves & Wemmerus, 1988). Potentially related, doctoral students who perceived themselves as competent were often more likely to persist in their degree programs (Litalien & Guay, 2015).

Researchers examining gender have indicated that gender has not been shown to be significantly related to graduate student attrition (Bair & Haworth, 1999; Bowen & Rudenstine, 1992) Additionally, results examining the association between a student's age and their likelihood to persist has been mixed. For instance, some research has indicated that older students demonstrated higher persistence rates (Attiyeh, 1999; Faghihi & Ethington, 1996); whereas others find that age did not significantly discriminate between those who completed and those who did not complete (Bair & Haworth, 1999). Further, students who were enrolled full-time were more likely to persist in their degree programs (Baird, 1997; Faghihi & Ethington, 1996; Girves & Wemmerus, 1988). However, other findings addressing full-time versus part-time enrollment have remained split (Bair & Haworth, 1999). Overall, experiential background factors including previous work experiences, educational history, demographic characteristics, and accomplishments of prior learning have played a role in individual differences in education. (Messick, 1979). Overall, the previous section have highlighted that institutional as well as student characteristics impact degree completion and persistence at the graduate level.

Graduate Education Admissions Practices

In addition to various departmental and student-related factors, exploration of the practices of graduate education admissions is critical to understand how these contexts and practices contributed to and could reduce the occurrences of attrition. Graduate education admissions serves as a major catalyst in strengthening and improving higher education

institutions and degree programs. Graduate admissions practices, in contrast to undergraduate admissions practices, have often been decentralized in nature (Kent & McCarthy, 2016; Michel et al., 2019). Specifically, graduate school admission professionals have often only determined the completion status of application materials for students, leaving the ultimate admissions decisions to be made by departmental or programmatic committees (Michel et al., 2019). As a result, the decentralized nature of admission practices could consequently impact whether the graduate schools' goals related to admission were met.

Graduate student applicants have historically been required to submit a variety of information providing a comprehensive overview of the student's academic performance/preparedness, social and emotional skills, previous experiences, and their interest in the program (Michel et al., 2019). Often, these materials have included undergraduate transcripts, standardized test scores, and letters of recommendation (Kent & McCarthy, 2016; Michel et al., 2019). Some programs have invited students to submit their personal statements, writing samples, interviews, and curricula vitae (Kent & McCarthy, 2016; Michel et al., 2019). What has not been universally known is the weight programs/departments place on these various pieces of information to inform admissions decisions. However, some have suspected, and some researchers have found, that traditional standardized test scores of cognitive ability have been weighted significantly heavier than other materials (Kent & McCarthy, 2016).

The most widely researched of these materials has been the utility and appropriateness of GRE scores and undergraduate GPA. The reliance on standardized test scores and undergraduate GPA has remained a subject of intense debate for a number of years. On one side of the argument, researchers have provided substantial evidence that GRE scores have, in fact, predicted outcomes, including graduate GPA, first year graduate GPA, faculty ratings,

comprehensive examination scores, research productivity, and work outcomes (Attiyeh, 1999; Burton & Wang, 2005; Kuncel & Hezlett, 2010; Kuncel et al., 2001, 2010). A meta-analysis that established the predictive validity of the GRE conducted by Kuncel et al. (2010) provided sufficient evidence that the GRE-V and GRE-Q scores were predictors of graduate GPA, first-year GPA, and faculty rating for both master's and doctoral students. Ultimately, these results indicate that the GRE is an effective admissions decision-making tool since it predicts a variety of important aspects of graduate student performance and success in their programs. Other researchers have argued and demonstrated that GRE scores and undergraduate GPA neither distinguish between graduate degree "completers" versus non-"completers" nor do they strongly predict other graduate success outcomes (Bair & Haworth, 1999; Barry & Mathies, 2011; Bok, 2013; Burton & Wang, 2005; Kuncel et al., 2001; Kuncel & Hezlett, 2010; Lovitts, 1996). In a predictive validity study of the GRE conducted by Burton and Wang (2005), results revealed that doctoral students who withdrew from their programs had similar GRE scores and undergraduate GPAs with those who advanced to candidacy and obtained their doctoral degrees. Further, there has been compelling evidence that these cognitive ability scores have consistently placed underrepresented students and non-traditional students at a disadvantage in achieving educational access and program acceptance (Kent & McCarthy, 2016; Oliveri & Ezzo, 2014; Sedlacek, 2004). Although group differences are not caused by these standardized tests themselves, the relationship between a student's socioeconomic status and their cognitive ability scores has remained a concern (Kuncel & Hezlett, 2010). In fact, ETS has explicitly advised against using cutoff scores for student admissions decisions because these practices disproportionately screen out students from ethnic backgrounds (Michel et al., 2019).

Despite the debates concerning the appropriateness and utility of standardized test scores and other cognitive ability measures, what has remained certain is the need for graduate programs to use tools that provide reliable and valid information about the capabilities of graduate applicants. It is true that current cognitive ability measures do strongly predict important educational outcomes in graduate school. However, to reduce the significant issue of graduate student attrition and degree completion, there remains room to improve the validity of graduate student selection systems and decisions (Kuncel et al., 2001). Because admissions practices are intended to select students who are most likely to succeed in their programs, the inclusion of additional predictors, and including better data combination methods, can help improve and better inform admissions decisions.

Noncognitive Skills

The landscape of higher education has drastically changed and become more diverse. Although the focus on cognitive ability has dominated conversations regarding graduate education admissions practices, graduate faculty members have often mentioned how noncognitive skills, which are often not assessed by traditional measures of student ability, strongly contribute to, and are determinants of, graduate student success, persistence, performance, and degree completion (Enright & Gitomer, 1989; Lovitts, 2008; Walpole, Burton, Kanyi, & Jackenthal, 2002). As mentioned previously, the heavy reliance on cognitive measures has historically put various student population groups at a disadvantage and perpetuated group differences and score gaps (Oliveri & Ezzo, 2014; Sedlacek, 2004). In fact, research conducted by Schmitt et al. (2011) revealed that at the undergraduate level, differences between gender and racial groups were most notable for cognitive ability assessments such as ACT/SAT composite scores and GPA. This occurred because research has historically demonstrated that cognitive

ability tests used in educational contexts reflect a number of variables, skills, and factors that invariably are not intended to be measured, such as student socioeconomic status (Messick, 1984). As admissions practices have heavily relied on cognitive ability assessment scores, this has ultimately reinforced issues of educational access, wage inequality, and institutional diversity as they have not assessed all students equally.

Incorporating noncognitive measurements has been shown to potentially help enhance accessibility to education and minimize group differences while having minimal impacts on academic GPA (Oliveri & Ezzo, 2014; Schmitt et al., 2011). This is because ethnic/racial minority student groups have often performed better on these noncognitive assessments. In fact, previous research has suggested that nontraditional students demonstrate their abilities through experiential and contextual intelligence assessments which are not evaluated by traditional standardized tests (Sedlacek, 2004). Therefore, incorporating noncognitive measures can possibly help combat the challenges of comparing international student scholastic backgrounds, minimize group differences, and enhance educational access.

While there has been agreement that noncognitive skills are important in higher education and should be considered in graduate admissions, a consensus on what the most important factors are appears to be lacking (Kyllonen, Walters, & Kaufman, 2011). Many researchers have embraced the distinction between cognitive skills as facets of intellectual ability, analytical intelligence, informational processing, and subject matter knowledge and noncognitive skills as attitudes, motivation, and interest. However, past consideration of "cognitive" and "noncognitive" skills as separate, categorical constructs has been inaccurate and misleading (Messick, 1984). Noncognitive skills including attitudes, beliefs, values, motives, temperaments, and interests as well as their sociocultural environments and backgrounds has influenced student

ability, academic achievement scores, and a variety of educational outcomes (Messick, 1984). To meaningfully assess student performance, competence, and ability level, educational measurement should focus not only on the acquisition of knowledge but also the cognitive processes and structures in which knowledge is acquired through systematic investigation. It is important to consider these factors as a "relative balance between intellective and other personality determinants of individual differences" (Messick, 1979, p. 282). Therefore, we must see them as intertwined.

Personality Factors and Temperament

Throughout time, there have been a variety of theories and models regarding temperament and personality. There has been agreement that the basic five-factor model of personality (extroversion, neuroticism, agreeableness, conscientiousness, and openness) as the foundation of personality (Kyllonen, Walters, & Kaufman, 2005). Proponents of incorporating personality factors, such as the "Big Five", in the conversation of evaluating graduate student performance, persistence, and degree completion have expressed that this model has shown to be generalizable across different cultures and language groups (Kyllonen et al., 2005).

Generally, temperament refers to one's disposition that impacts behavior (Messick, 1979). Extroversion, which denotes one's outgoingness and social ability, has been demonstrated to predict success in particular academic disciplines and job performance (Kyllonen et al., 2005). Neuroticism, which relates to one's emotional stability versus instability, is often exhibited by one's management of stress, adaptability, and taking all information into account when making decisions (Kyllonen et al., 2005). Neuroticism has been shown to be a strong predictor of job performances across contexts and graduate school outcomes across the board (Kyllonen et al., 2005). Conscientiousness, which refers to one's ability to organize, perform tasks, and follow

tasks, can be divided up into two factors: dependability and achievement striving (Kyllonen et al., 2005). Facets of the Big Five, including conscientiousness and openness to experience, including dependability, achievement striving, integrity, intellectual engagement, and need for cognition have been shown to play a prominent role in contributing to graduate student performance and outcomes (Kyllonen et al., 2005). Additionally, conscientiousness has continuously been documented as the strongest and most important predictor of job performance and academic success including achievement in early school years to graduate school as well as undergraduate GPA (Greham et al., 2011; Kyllonen et al., 2005, 2014; Noftle & Robins, 2007). Agreeableness, which refers to friendliness and likeability, often influences one's ability to be cooperative, tolerant, flexible, and courteous. This factor has been heavily associated with collaborative and teamworking activities that are prevalent in graduate school and the workforce (Kyllonen et al., 2005). Openness-to-experience, which refers to open-mindedness, creativity, knowledgeable, and curiosity, has often been associated with cognitive ability and academic outcomes (Kyllonen et al., 2005). Overall, research examining personality factors has widely demonstrated their associations and predictive relationships with important academic outcomes in higher education and graduate programs. In light of this, graduate admissions should consider evaluating facets of these personality factors in an effort to holistically assess graduate applicants. However, most admissions practices do not evaluate these facets through assessments because of the occurrence of faking.

Quasi-Cognitive Factors

Examining quasi-cognitive factors including creativity, cognitive styles, emotional intelligence, and metacognition has become an area of increased interest in higher education and graduate programs. Quasi-cognitive factors have been considered to be associated with both

cognitive and noncognitive attributes (Kyllonen et al., 2011). First, although creativity is difficult to define, it has been shown to be associated with personality factors including openness-to-experiences and extraversion as well as contributing greatly to graduate student performance (Enright & Gitomer, 1989; Kyllonen et al., 2011; Walpole et al., 2002). Creativity has been shown to predict persistence in difficult situations, coping strategies, and leadership abilities. Second, cognitive styles refer to information processing consistencies that demonstrates one's stable attitudes, preferences, strategies, problem solving, modes of perception, remembering, and thinking (Messick, 1979). Cognitive styles have been defined as field dependence-independence, pragmatic thinking, and narrative thinking (Kyllonen, et al., 2011). Further, cognitive styles can distinguish between accounting students, creative writing students versus journalism students, as well as individuals in mathematical versus humanitarian professions (Kyllonen et al., 2011). Therefore, it appears that differing cognitive styles play an important role in not only educational outcomes but also workforce outcomes. Emotional intelligence has been documented to tap into a variety of noncognitive skills, including assertiveness, independence, empathy, problem solving, happiness, and optimism (Kyllonen et al., 2011). Research has indicated that emotional intelligence is a strong determinant of leadership skills (Kyllonen et al., 2011). Fourth, metacognition denotes one's awareness or knowledge about their knowing, thinking, and problem-solving processes (Kyllonen et al., 2011). Predictors of metacognition include personality factors such as conscientiousness, attitudinal factors such as motivation, and environmental factors such as scaffolding methods to teach this skill. Ultimately, one's awareness of their own thinking and learning is heavily influenced by these quasi-cognitive factors that directly impact their academic outcomes in at all educational levels.

In a research study conducted by Lovitts (2008), focus groups conducted with faculty members revealed that doctoral students characterized as distinguished degree completers possess high levels of practical and creative intelligence, good informal and tactic knowledge, and engaged in a variety of knowledge acquisition behaviors. Many demonstrated strong curiosity, willingness, and the ability to seek help if needed. Undistinguished degree completers exhibited a high degree of analytic intelligence during coursework but lower levels of practical and creative intelligence. They encountered difficulty when making their own decisions, working hard, and solving practical problems independently. Additionally, many were not intrinsically interested in their research projects. Distinctions between undistinguished completers and non-completers were not addressed. However, most non-completers lacked analytical intelligence. While interviews may limit the generalizability of these results, these findings suggest that focusing on predictors of practical and creative, in addition to analytical, intelligence ability may be beneficial to graduate programs. Specifically, evaluating and monitoring current students through practical and creative intelligence assessments can provide an indication as to whether they will be distinguished in their programs.

Student Engagement Noncognitive factors

According to Lee & Shute (2009), student engagement "refers to students' behavioral, emotional, and cognitive involvement in and with their learning activities" (p. 5). The term engagement encompasses how students think, feel, behave, commit, and involve themselves (Lee & Shute, 2009). In their study, these student engagement factors were broken up into two groups: cognitive-motivational and emotional engagement factors.

Cognitive-Motivational Engagement Factors

Cognitive-motivation engagement factors highlight the efforts, thoughts, decisions, attitudes, and motivations of students while they have engaged in the learning process and pushing through challenges (Lee & Shute, 2009). Attitudes refer to an enduring disposition that remains consistent (Messick, 1979). In educational contexts, these could be demonstrated as orientations toward learning, schools, specific subject matter, and the self. Closely related were the constructs beliefs and locus of control. (Messick, 1979). Attitudinal factors, including self-concept, self-efficacy, attributes, interpersonal as well as intrapersonal behaviors, have often been demonstrated to be associated with academic outcomes such as achievement in graduate school and college (Crede & Kuncel, 2008; Kyllonen et al., 2011, 2014; Sedlacek, 2010). Self-concept, referring to the way people perceive themselves, has been shown to predict academic persistence and is associated with all five personality factors, college achievement and aspirations, retention, and postsecondary graduation (Kyllonen et al., 2011; Sedlacek, 2010). Self-efficacy, meaning the perception of one's abilities, has been demonstrated to strongly predict academic achievement, problem-solving and learning strategies, dissertation progress, persistence, and academic outcomes (Kyllonen et al., 2011). In fact, research has revealed that self-efficacy, particularly academic self-efficacy, is strongly associated with academic and workplace outcomes (Kyllonen, 2012a). Motives, which refer to the impulse, emotion, or desire that pushes individuals to take action, is the central tenant of motivation (Messick, 1979). Research examining a model of noncognitive factors on academic success and retention has indicated that academic mindset, including self-efficacy, belonging, and motivation, play a strong role in academic achievement, performance, and retention (Farruggia et al., 2018). Motivation can be broken up into two domains: intrinsic and extrinsic. Intrinsic motivation has been referred to as someone performing tasks out of enjoyment or for their own sake. Extrinsic

motivation has been characterized as someone performing a task for an external reward. Intrinsic motivation has been strongly associated with graduate student performance, task completion, and creativity, where extrinsic motivation was shown to negatively affect creativity in students (Enright & Gitomer, 1989; Kyllonen et al., 2011; Walpole et al., 2002). Further, attribution styles, which refer to the sources that individuals contribute their success to, have been demonstrated to relate to increased task efforts and academic persistence (Kyllonen et al., 2011). Values refer to beliefs that influence attitudes towards objects and situations or can be seen as standards that guide one's actions (Messick, 1979). An individual's values, therefore, can influence their motivation, attitudes, and ultimately their actions to succeed in graduate school.

Emotional Engagement Factors

Emotional engagement factors often refer to students' emotional and affective feelings toward learning. These may include students' interest, affect, and curiosity. Interest denotes one's patterns of likes and dislikes or to positive feelings experienced by activities done for one's own sake (Kyllonen et al., 2011; Messick, 1979). Interests are often demonstrated by one's stable patterns and the action/choice of seeking out those specific activities one enjoys. Research has shown that interest is also associated with environmental factors, including role models, interactions, and prior success, as well as personality factors including extraversion, openness, and conscientiousness. Additionally, interest has been documented as a predictor of academic outcomes, research productivity, and graduate school aspirations (Kyllonen et al., 2011). Affect pertains to conditions and characteristics of individuals, including feelings about school, learning, anxieties, and about the self (Messick, 1979). Curiosity refers to one's exploratory drive to experience something new to understand (Messick, 1979). A significant takeaway is that

these noncognitive factors have been shown to contribute greatly to educational outcomes and experiences of students across all educational levels (Kyllonen, 2005)

Learning Strategies

Exploring student engagement variables, in the context of persistence and attrition, has led researchers to emphasize the importance of discipline, self-regulated learning strategies, determination, organizational skills, and time management skills of graduate students (Bair & Haworth, 1999; Kelly & Salisbury-Glennon, 2016; Kerlin, 1995; Lee & Shute, 2009; Rockinson-Szapkiw et al., 2014). Graduate students must exhibit exceeding levels of discipline and motivation to work independently to succeed in their programs and graduate. Graduate students must be self-motivated and self-directed to complete their theses or dissertations to ultimately earn their degrees. Thus, setting goals and constantly regulating one's behavior, cognition, and motivation to support such goals is necessary (Kelly & Salisbury-Glennon, 2016; Kerlin, 1995). Self-regulated learning has been defined as a process where learners actively set learning goals and then "attempt[s] to monitor, regulate, and control their cognition, motivation, and behavior…" in an effort to meet those goals (Pintrich, 2000, p. 453). Engaging in self-regulated learning has been shown to significantly predict time elapsed from comprehensive exams to dissertation completion. According to Pintrich (2000), this process can be broken down into four activities: forethought, monitoring, controlling, and reflection (Kyllonen, Lipnevich, Burrus, & Roberts, 2014). During the forethought phase, individuals, for example, will usually engage setting a target goal, adopt a goal orientation, and exercise time/effort planning. During the monitoring phase, students, for example, will engage in metacognition to become aware and monitor their own thinking, thus becoming aware and monitor their motivation, and ultimately monitoring their actions, efforts, and time to complete their tasks. During the control phase,

students typically select, adapt, and manage their cognitive styles and motivational strategies which ultimately leads them to increase or decrease their efforts. During this phase, students often make the choice to either persist or give up (Pintrich, 2000). Finally, during the reflection phase, individuals will often engage in cognitive and motivational judgments as well as evaluate tasks and contexts in order to choose their behaviors. For graduate students, the utilization of self-regulated learning strategies is often tied to holding more intrinsic task value towards one's dissertation (Kelly & Salisbury-Glennon, 2016). When this type of discipline and motivation to work independently is lacking, graduate students may be at risk for degree program departure (Kerlin, 1995).

In addition to self-regulated learning strategies, engaging in time management strategies and help-seeking behaviors have been proven to positively impact achievement (Holms et al., 2016; Lee & Shute, 2009). Time management is often referred to as the behaviors that are directed towards the effective use of time for optimal productivity to meet goals. Time management typically includes components and processes of assessing, planning, and monitoring time and tasks at hand (Lee & Shute, 2009). For graduate students to be successful and balance the multiple roles they have, exercising time management skills has been shown to be imperative (Holms et al., 2016). In fact, some doctoral students have indicated that the inability to effectively manage their time was the reason for departing their graduate programs (Schramm-Possinger & Powers, 2015). Additionally, help-seeking behaviors, historically viewed as a sign of weakness, has become regarded as an indication of students exhibiting higher metacognitive awareness (Lee & Shute, 2009). Research conducted by Lovitts (2008) demonstrated how distinguished degree completers were not afraid to seek help from their advisors, if needed. Therefore, engaging in this type of learning strategy can be beneficial for graduate students and

put them in positions to succeed and advance in their programs (Holms et al., 2016). Overall, the development of discipline, time management, effort management, help seeking behaviors, and self-regulated learning strategies to work independently is necessary for students to complete their theses or dissertations, course-work, and ultimately their degree programs.

21st Century Skills

Employers, policy-makers, faculty members, researchers, and administrators of higher education have expressed the importance of 21st century skills for increasing economic success as well as combating income inequality (Kyllonen, 2012b). These skills have been organized into three components: cognitive skills (critical thinking, problem solving, creativity), interpersonal skills (communication skills, social skills, teamwork, cultural sensitivity, dealing with adversity), and intrapersonal skills (self-management, self-regulation, time management, self-development or lifelong learning, adaptability, executive functioning) (Kyllonen, 2012b; National Research Council [NRC], 2012; Oliveri & Markle, 2017). Although the research available is limited, the National Research Council (2012) reported that these cognitive competencies, intrapersonal and interpersonal skills are moderately correlated with success in adulthood, workplace, and academics. Additionally, graduate faculty members and employers that were interviewed consistently expressed how these skills contribute to success in graduate education (Enright & Gitomer, 1989; Walpole et al., 2001; Casner-Lotto & Barrington, 2006). In fact, many doctoral students have expressed that experiencing difficulty with their written and oral communication skills often resulted in their decisions to depart their degree programs (Schramm-Possinger & Powers, 2015). Conversely, students that displayed strong interpersonal competence, specifically leadership skills, often had the ability to organize and influence others that they work with (Holms et al., 2016; Sedlacek, 2010). Therefore, evaluating current and perspective graduate

students as well as new workforce entrants on these skills can be tremendously beneficial. For graduate programs, evaluating these skills in students can help improve admissions decisions when selecting the most successful students. Additionally, as degree programs evaluate students with respect to these skills on an ongoing basis, faculty members can gain a sense of whether the student is ready for the workforce.

Relatedly, previous research examined various skills that employers considered important for new workforce entrants, including professionalism/work ethic, oral and written communication skills, teamwork/collaboration, and critical thinking/problem solving skills (Casner-Lotto & Barrington, 2006; Holms et al., 2016; Oliveri & Markle, 2017; Walpole et al., 2002). Results indicated that many high school graduates as well as two-year and four-year college graduate workforce entrants demonstrated deficiencies in these critical skills. Specifically, both high school and college graduate demonstrated deficiencies in their written communications, and leadership skills (Casner-Lotto & Barrington, 2006). Although college graduates were better prepared than high school graduates for entry-level jobs, the number of deficiencies present for these graduates were considerable. Ultimately, employers rated these groups as either adequate (two-year/four-year college graduates) or falling short (high school graduates) in their overall preparation for entry level jobs (Casner-Lotto & Barrington, 2006). Overall, the skills graduate faculty and employers consider important overlap substantially. This further demonstrates the necessity to evaluate college students as well as graduate students on these sets of skills. Ultimately, these types of evaluations can help determine whether students will be ready for graduate programs as well as entry-level jobs.

Another important work habit, grit or perseverance, has been shown to be a strong predictor of academic and workforce success. A longitudinal study examining over 10,000 cadets

over a decade investigated the importance of personal attributes and cognitive abilities of cadets entering the United States Military Academy training (Duckworth et al., 2019). Results indicated that cadets who exhibited more grit were more likely to complete Beast Barracks tasks and continue on to their West Point training. Additionally, cognitive ability, as well as physical ability, were significant predictors of their corresponding GPAs while grit explained a smaller proportion of the variance in these outcomes (Duckworth et al., 2019). Further, grit and physical ability significantly predicted the likelihood of graduation better than cognitive ability. Overall, the noncognitive variable, grit, strongly predicted completion on Beast Barracks training, initial summer training (where attrition is at its peak), and graduation (Duckworth et al., 2019). Another research study examining a model of noncognitive factors on academic success indicated that more positive perseverance (grit) and academic mindset is associated with higher achievement, which, in turn, indicates a higher likelihood of the return to a second year of college (Farruggia et al., 2018; Walpole et al., 2002). Ultimately, these research studies revealed the importance of perseverance and grit in student persistence and achieving educational and workforce outcomes. These studies further demonstrated the need to evaluate incoming students on these skillsets.

Overall, previous research has clearly and consistently documented the relationship between noncognitive skills and educational outcomes at various educational levels, as well as the workforce. What was notable from this research was that various noncognitive skills were related to student persistence and degree attainment, which is particularly difficult to foresee and is often not predicted by traditional cognitive ability standardized tests (Kuncel & Hezlett, 2010; Kuncel, Kochevar, & Ones, 2014). Although current cognitive measures, including the GRE, have been shown to provide valuable information and to be a valid indicator of student performance in graduate programs, there is room for improvement in selection systems, as well

as graduate student progress evaluations (Kuncel, Hezlett, & Ones, 2001). Ultimately, the goal should not be to eliminate traditional cognitive ability measures but rather to supplement these measures with reliable assessments of noncognitive skills (Sedlacek, 2004). As the landscape of higher education becomes increasingly more data driven, it is imperative that selection systems utilize the most sophisticated and the most predictive tools of student ability. To that end, the incorporation of noncognitive indicators at the graduate admissions level has the potential to reduce graduate student attrition rates as well as to ensure that graduate programs are investing in the best and most qualified students that will be successful as well as to increase diversity amongst graduate students.

Methods for Measuring Noncognitive Factors

Although assessments in educational contexts primarily evaluate cognitive abilities, noncognitive factors play a significant role in graduate school educational and performance outcomes. Supporters of incorporating noncognitive assessments have claimed that these types of assessments can improve upon cognitive ability test's validity as well as reduce group differences (Kuncel et al., 2001). However, many researchers and policy makers have been skeptical about the capability to measure these noncognitive attributes reliably and validly (Enright & Gitomer, 1989; Duckworth & Yeager, 2015; Kyllonen, 2005; Kyllonen et al., 2005; Oliveri & Ezzo, 2014). One reason for this may be because current and popular noncognitive skill assessments have been primarily self-report assessments. Unfortunately, self-report assessments have inherent faking and coachability problems to assist an applicant in appearing more attractive to employers and admissions professionals (Kyllonen, 2005; 2008). Additionally, other methods used to gain insight into noncognitive factors, including letters of recommendation, undergraduate records, interviews, portfolios, and essays and other assessment

tools, have often been unstandardized, subjective, and have questionable reliability (Enright & Gitomer, 1989; Kuncel et al., 2014; Sedlacek, 2004).

A meta-analysis conducted by Kuncel et al. (2014) examined the predictive validity of letters of recommendation. Results of the meta-analysis demonstrated that correlations between letters or recommendation and academic outcomes ranged from low to high. Specifically, correlations were low for research productivity and standardized test scores, moderate for interview scores, personal statements, and prior grades, and high for undergraduate GPA. However, regression analyses indicated that the inclusion of letters of recommendation with standardized test scores and undergraduate GPA significantly increased the predictive power of academic outcomes and degree attainment (Kuncel et al., 2014). Overall, despite the limitations of letters of recommendation, they have been found to be predictors of student performance and are correlated with degree attainment in graduate school. This contribution remains meaningful as degree attainment has consistently remained difficult to predict (Kuncel et al., 2014). Unfortunately, the measurement limitations of letters of recommendation have reduced the overall value of these sources of evidence for decision-making committees (Walters, Kyllonen, & Plante, 2006). Ultimately, creating a structured system to collect information about specific abilities/qualities of applicants can be a potential solution to address, combat, and improve the measurement limitations of letters of recommendation, as well as improve the validity of the information provided by them (Kuncel et al., 2014).

In light of this, many researchers have devoted a considerable amount of time to develop fake-resistant assessments of noncognitive skills. These assessments have included reaction time, situational judgment tests (SJTs), verifiable biodata, and objective measures (Kyllonen, 2005; 2008; Kyllonen et al., 2005). SJTs present problems and have the examinee answer how to best

solve the problem (Kyllonen, 2008). SJTs have been used to examine a variety of noncognitive and cognitive factors and are commonly used in workforce (Kyllonen, 2008). However, these methods have been prone to coachability and testing effects. Verifiable biodata are similar to self-report assessments, but they have been usually accompanied by examinees providing verification of their answers. For instance, examinees may be asked questions regarding their leadership experiences followed by a list of such evidence (Kyllonen, 2008). Objective measures, including conditional reasoning tests and implicit association tests, have been found to be a popular assessment in social psychology. However, the results from these types of assessments have been difficult to replicate (Kyllonen, 2008).

The use of others' ratings or third-party evaluation (TPE) systems have been used as a mechanism to combat the limitations of popular assessment methods of noncognitive skills, including social desirability and faking (Kyllonen, 2005; 2008; 2012a). Others' ratings are assessments where outside evaluators rate applicants on a variety of skills. From a measurement perspective, although others' ratings, or TPE systems, combat faking and coachability challenges, they nevertheless contain unique limitations. These limitations include biases held by an individual evaluator, low reliability in comparing evaluators' ratings (possibly from subjective judgments), and halo effects (Oliveri & Ezzo, 2014; Oliveri, McCaffrey, et al., 2017). However, standardizing this process to supplement other admissions practices can potentially result in fairer applicant selections (Liu, Minsky, Ling, & Kyllonen, 2009). Additionally, rater effects can be monitored and adjusted regarding the raters' severity and validity (Kyllonen, 2008; Liu et al., 2009).

The Personal Potential Index

Educational Testing Services (ETS) has demonstrated a long history of interest in noncognitive factors (Kyllonen, 2005; 2008). The Personal Potential Index (PPI), formally known as the Standardized Letter of Recommendation (SLR), was developed by ETS as a rating system to evaluate graduate school student applicants on their noncognitive attributes (Kyllonen, 2008). The development of the SLR was informed by a variety of pieces of evidence. The first was previous research on noncognitive attributes in graduate schools that explored various skills that graduate faculty members believed to be strong determinants of graduate student success as well as the workforce (Casner-Lotto & Barrington, 2006; Enright & Gitomer, 1989; Kyllonen et al., 2005; Walpole et al., 2002). Next, the researchers conducted focus groups with faculty members across the United States that represented various institutional types to determine the format and function of the SLR (Walters et al., 2006). This ultimately led to the primary research initiative. This initiative was intended to gather feedback regarding the value, usefulness, and recommended improvements of the SLR, as well as evaluate the likelihood that the SLR could be adopted in admissions practices (Walters et al., 2006). Telephone surveys were conducted with 421 representatives, including graduate faculty, graduate school administrators, and HBCU faculty members. Overall, results from the telephone survey indicated that graduate faculty and admissions responded positively toward the SLR and most believed that it was a better tool than what was currently used at their institution (Walters et al., 2006). Additionally, most reported that the SLR provided useful and more reliable information about the applicant. However, many were split on whether graduate admissions would adopt the SLR in their practices. Ultimately, this research led to the SLR containing 28-items evaluating students on seven scales including: knowledge and skill, creativity, communication skills, teamwork, self-organization, motivation, and professionalism and maturity (Kim & Kyllonen, 2006).

Compared to other standardized reference letter systems, the SLR demonstrated distinct advantages. First, the SLR requested the evaluators to assess applicants on various items that target specific abilities and skills (Lui et al., 2009). Second, the SLR was developed through rigorous methodological research techniques. Last, the entire SLR evaluation process is conducted completely online. Therefore, this provided an advantage to evaluators regarding their time spent in this process (Lui et al., 2009).

Empirical studies examining the psychometric quality of the SLR based the analyses of graduate faculty ratings (Kyllonen & Kim, 2005; Kim & Kyllonen, 2006) as well as graduate students applying to the ETS internship program (Liu et al., 2009). First, research conducted by Kyllonen and Kim (2005) and Kim and Kyllonen (2006) analyzed 430 faculty members' PPI ratings of students. These faculty members were asked to complete ratings for students for whom they had previously completed a letter of recommendation. Overall, single-level factor analytic results indicated that faculty members did differentiate between cognitive (knowledge/skills and creativity) and noncognitive factors (communication skills, teamwork, motivation, and professionalism) of the SLR. Additionally, the findings indicated that the faculty members were able to distinguish students reliably across all the noncognitive qualities. However, regarding the cognitive qualities, faculty members did not differentiate between the knowledge and creativity scales (Kim & Kyllonen, 2006). Therefore, these attributes were later combined into one scale (Kyllonen, 2008). Further, the noncognitive qualities tended to result in higher ratings compared to the cognitive qualities.

Although both studies used the same data for their research studies, findings of the structure of the SLR were inconsistent (Kyllonen & Kim, 2005; Kim & Kyllonen, 2006; Lui et al., 2009). Findings from Kyllonen and Kim (2005) found that a six-factor model fit the data

better compared to a two-factor. Accordingly, these results provided implications to use ratings across all scales. However, findings from Kim and Kyllonen (2006) concluded that the items defined a single factor based on Rasch modeling analyses (Lui et al., 2009). Specifically, principal component analyses and exploratory factor analyses indicated the existence of a two-factor model (cognitive and noncognitive) with a correlation of r = .66. Ultimately, the results form this study suggested the use of a single composite score and two section scores (cognitive and noncognitive) could be more useful than seven scale scores (Kim & Kyllonen, 2006; Lui et al., 2009)

In addition to the psychometric analyses of the SLR, research conducted by Liu, Minsky, Ling, and Kyllonen (2009) examined the utility of the SLR for the ETS intern program under the seven-factor model. Data included SLR ratings of 51 selected summer interns from at least one faculty member and ETS mentor. First, results indicated that cognitive and noncognitive qualities correlated very highly with each other. However, the researchers argued to not combine these scales into a two-factor model due to exceptional reliability coefficients among the seven scales (Liu et al., 2009). Second, the cognitive scales demonstrated better predictive relationships in terms of intern selection than the noncognitive scales. Although ETS mentors may have focused on these scales more than the noncognitive scales (Liu et al., 2009). Third, when examining the prediction of outcome ratings and consistency, ETS mentors consistently rated the interns lower than faculty ratings (Liu et al., 2009). However, because the sample was small (n = 51), a larger sample may demonstrate the relationship between these two evaluation ratings better. Unfortunately, factor analytic results suggested that some of the items on the SLR may not effectively differentiate applicants. After consultation with experts, items and scales were revised and adjusted (Kyllonen, 2008). Ultimately, this led to the currently revised version and name

change to the Personal Potential Index. Currently, the PPI evaluates and rates applicants on six attributes: knowledge and creativity, communication skills, teamwork, resilience, planning and organization, and ethics and integrity which are scored separately (Kyllonen, 2008).

Current research examining the psychometric qualities as well as sources of variance demonstrates both the limitations and advantages of TPE systems and their meaningful interpretations (McCaffrey et al., 2018; Oliveri et al., 2017). Research conducted by Oliveri, McCaffrey, Ezzo, and Holtzman (2017) examined and analyzed the hypothesized structure and different sources of variance of the PPI using a multilevel factor analysis (MFA). These levels included variance due to raters and applicants as well as within- and between applicant levels (Oliveri, McCaffrey, et al., 2017). The researchers analyzed 12,693 PPI ratings of graduate applicants. First, MFA results indicated a two between-level factor structure of the PPI data. These MFA results differ significantly from previous findings that identified a six-factor structure (Kim & Kyllonen, 2006; Liu et al., 2009). Additionally, the MFA results provided evidence of a within-applicant structure, suggesting variability of in way the way evaluators rate applicants (Oliveri, McCaffrey, et al., 2017). One way to improve upon this approach would be to provide rater trainings and anchored rating scales to guide evaluators. Next, McCaffrey et al. (2018) examined the presence of different score variance in the same PPI data. The researchers conducted a generalizability theory analysis to identify different sources of variance as well as its magnitude. Additionally, they conducted a decision study to examine the impact of the different sources of variability. Similar to findings from Oliveri, McCaffrey, et al. (2017), results from this generalizability theory analysis indicated a low G-coefficient and that the largest source of variance was related to the evaluators. The low G-coefficient resulted from the large number of evaluators endorsing higher score categories across all of the items (McCaffrey et al., 2018).

Further, results from the decision study suggested that in order to obtain coefficients associated with high-stakes decision-making, applicants would need 10 or more evaluators (McCaffrey et al., 2018). Although these results indicated that with only a few evaluators, results may not be generalizable, the reality of using 10 raters is unrealistic for graduate applicants. However, including information about the relationship between the evaluator and the applicant could support and aid in the interpretation of evaluation scores (McCaffrey et al., 2018).

Summary

Overall, popular assessment methods evaluating noncognitive skills have contained a variety of limitations that caused skepticism concerning the reliability and validity of scores and their interpretations. Although there are challenges that remain with alternatives to self-report assessments, standardized others' ratings or TPE systems, like the PPI, can drastically reduce the occurrences of faking and coachability. Although previous research on the reliability of the PPI is not up to the standard of current admissions tools, practices including rater trainings, anchored items, and rater adjustments could improve the use of this instrument.. Noncognitive attributes clearly play a large role in and influence students' performance and success in graduate programs. They further influence students' abilities to succeed, persist, and ultimately attain their degrees. Therefore, evaluating prospective and current students systematically on important noncognitive skills benefits not only the students' progress, but also benefits faculty members, degree programs, and the institution. These evaluations can help ensure they are selecting and investing in students who will be the most successful. Ultimately, standardized TPE systems can provide a mechanism to better identify graduate students who are more likely to better perform, persist, and complete their degrees. Therefore, to reduce the attrition rate of graduate students in

higher education, incorporating noncognitive measures in addition to current cognitive measures can ultimately improve upon the quality of information needed to make admission decisions.

CHAPTER III: METHODOLOGY

Introduction

This chapter includes a description of the research methodology of the current study and the nonexperimental quantitative research design utilized to analyze the de-identified, archival Personal Potential Index (PPI) rating data of graduate students. First, this chapter includes a review of the problem statement and the purpose of the current study. Next, the chapter provides a description the research questions, research design, participants, instrumentation, data collection process, and data analyses techniques.

Problem Statement

Admissions practices at all education levels are intended to select students who are the most likely to succeed and attain their degrees. Despite these good intentions, graduate student attrition rates range between 40% to 60% depending on degree field or discipline (Bair & Haworth, 1999; CGS, 2008; Schramm-Possinger & Powers, 2015). Generally, graduate admissions assessments are limited to traditional cognitive ability measures such as the Graduate Record Examination (GRE) and undergraduate grade point average (GPA). Research continues to suggest that personal qualities, not measured by traditional cognitive assessments, serve as strong determinants of graduate student success. Therefore, the inclusion of noncognitive assessments with current cognitive ability measures can potentially enhance the quality of information obtained and ultimately improve decision making practices (Sedlacek, 2010). Additionally, standardized third-party evaluation (TPE) systems have the capability to combat the inherent limitations associated with common noncognitive assessment methods such as faking, subjectivity, and bias. However, the examination of the role of noncognitive factors on graduate student performance and degree completion using a standardized TPE systems is

lacking in the literature. Therefore, this dissertation research study addressed these gaps. Ultimately, these results can provide beneficial implications for higher education institutions, degree programs, and faculty members regarding their applicant selection practices. Specifically, findings from this study can aid and inform institutions and admissions practices with better tool to select graduate applicants that are more likely to succeed in their programs (Kent & McCarthy, 2016). Additionally, findings from this study can provide institutions a way to diversify their student populations without having significant drawbacks on institutional grade point averages and academic quality (Schmitt et al., 2011).

Purpose of Study

The purpose of this study was twofold. First, this study examined the association of noncognitive factors on graduate student performance and degree completion. Second, this study examined the measurement integrity and the utility of the Personal Potential Index (PPI) as an avenue to reliably assess noncognitive factors of graduate students that avoids the drawbacks associated with self-assessment methods and recommendation letters (Kyllonen, 2008; McCaffrey et al., 2018). To accomplish this investigation, the researcher conducted a nonexperimental quantitative research design using TPE survey data. Specifically, the researcher obtained and utilized de-identified, archival PPI scale scores to determine if these noncognitive scores predicted graduate degree completion, graduate GPA, and time-to-degree completion. The researcher also examined whether the PPI scale scores predicted graduate student degree completion, graduate GPA, and time-to-degree above and beyond degree classification/level (master's and doctoral students), graduate student degree program (STEM vs non-STEM) undergraduate GPA, and GRE scores (analytical writing, verbal, and quantitative). Additionally, the researcher examined group differences across the dependent variables and GRE scores.

Research Questions

To address the problem of this study, the researcher raised the following research questions:

1. What are the predictive relationships among the six PPI scale scores…
    a. on graduate student degree completion status?
    b. on graduate grade point average?
    c. on graduate student time-to-degree completion?
2. What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores…
    a. On graduate student degree completion status?
    b. On graduate grade point average?
    c. on graduate student time-to-degree completion?
3. Are there group differences based on the interaction of degree completion status, degree level, and degree program among …
    a. the six PPI scale scores, GRE scores, graduate GPA, and undergraduate GPA?
    b. the six PPI scale scores, GRE scores, and undergraduate GPA?
4. How do the six PPI scales perform in terms of creating variability between applicants?

Research Design

The current study utilized a nonexperimental quantitative research design using de-identified, archival, TPE survey data. A nonexperimental research design was appropriately selected for this research study for two reasons including: 1) the researcher did not manipulate

any of the independent variables or assign participants to a specific condition due to existing group differences (McMillian, 2015), and 2) the data for this research study were collected previously and derived from data provided by Educational Testing Service. Although nonexperimental research designs limit claims of cause-and-effect since random assignment is not implemented, these research designs permit researchers to examine predictive relationships and group differences among variables (McMillian, 2015).

Data Collection Procedures

In order to obtain the archival data and to adhere to the ethical considerations for conducting research, the researcher submitted a Not Human Subjects Research (NHSR) determination form to the institutional review board (IRB). See Appendix A for IRB approval. After IRB determined that this dissertation research project was not considered human subjects research, the researcher submitted a data request form to Educational Testing Service for the completed and de-identified Personal Potential Index (PPI) data files of Auburn University graduate students for secondary analyses as part of a PhD dissertation. See Appendix B for evidence of ETS data request approval.

Participants

The current study used archival data comprising of PPI ratings of 362 graduate student applicants. These students applied to a public research and land-grant university located in the southeast region of the United States. Each graduate student was rated using the PPI rating system by at least one evaluator. Of the 362 graduate applicants, 112 enrolled at the institution. See Table 1 for descriptive statistics of the enrolled samples' demographic characteristics. Overall, the currently enrolled sample consisted of student who were predominately master's students, enrolled in non-STEM degree programs, and who have graduated.

Table 1

Descriptive Statistics of Participant Demographic Characteristics (n = 112)

Demographic Category		*N*	%
Gender	Male	62	55.4
	Female	50	44.6
Ethnicity	Asian or Asian American	1	0.9
	Black or African American	11	9.8
	White (non-Hispanic)	65	58.0
	Hispanic/Latino	1	0.9
	Other	2	1.8
Graduate Major Field	STEM	50	44.6
	Social Sciences	5	4.5
	Humanities	10	8.9
	Education	39	34.8
	Business	2	1.8
	Other	6	5.4
Degree Program	STEM Program	50	44.6
	non-STEM Program	62	55.4
Degree Level	Master's	75	67.0
	Doctoral	27	24.1
	Other	10	8.9
Graduate Student Status	Dropped Out	19	17.0
	Enrolled	8	7.1
	Graduated	85	75.9
Total		112	100

Instrumentation

The Personal Potential Index (PPI) "is the first large-scale, standardized web-based evaluation system used to assess graduate school applicants' noncognitive attributes"

(McCaffrey et al., 2018, p. 2). Used to enhance the quality of information obtained from traditional data used in admissions decisions, the PPI was developed to evaluate student applicants' attributes that are associated with success in graduate programs (Kyllonen, 2008; McCaffrey et al., 2018; Walpole et al., 2002). Item and scale development was based on graduate dean and faculty survey responses collected by ETS as well as the previous research findings of important attributes associated with graduate student success (Casner-Lotto & Barrington, 2006; Enright & Gitomer, 1989; Kyllonen, 2008; Walpole et al., 2002).

The PPI evaluates applicants on six attributes including: knowledge and creativity, communication skills, teamwork, resilience, planning and organization, and ethics and integrity (Kyllonen, 2008). Subsumed under the openness trait on the five-factor personality model, the knowledge and creativity scale is intended to evaluate the evaluators' perception of the applicants' knowledge and perspective of the field as well as their ability to generate novel ideas (Kyllonen, 2008; McCaffrey et al., 2018). The communication skills scale is intended to evaluate the evaluators' perception of the applicants' ability to speak and write in a clear and organized manner (Kyllonen, 2008; McCaffrey et al., 2018). The teamwork scale is intended to evaluate the evaluators' perception of the applicants' ability to work well and effectively in a group setting as well as be supportive and contribute to a warm and friendly environment (Kyllonen, 2008; McCaffrey et al., 2018). The resilience scale is intended to evaluate the evaluators' perception of the applicants' commitment and persistence to work hard and overcome challenges (Kyllonen, 2008; McCaffrey et al., 2018). Subsumed under the conscientiousness trait on the five-factor personality model, the planning and organization scale is intended to evaluate the evaluators' perception of the applicants' ability to organize time effectively as well as set and meet realistic goals and deadlines (Kyllonen, 2008; McCaffrey et al., 2018). Finally, the ethics and integrity

scale is intended to evaluate the evaluators' perception of the applicants' trustworthiness and ethical standards (Kyllonen, 2008; McCaffrey et al., 2018). Each of the PPI subscales contains four items presented on a five-point Likert-type response scale ranging from 1 "below average" to 5 "truly exceptional". (Kyllonen, 2008; McCaffrey et al., 2018). See Appendix C for the PPI items.

Evaluators are requested to rate and compare the applicant relative to other students. Evaluators are asked to respond to each of the items presented on a five-point Likert-type response scale. A rating value of 1 indicates "below average", a 2 indicates "average", a 3 indicates "above average", a 4 indicates "outstanding" (top 5%), and a 5 indicates "truly exceptional" (top 1%). (Kyllonen, 2008; McCaffrey et al., 2018). Additionally, there is a sixth option, insufficient opportunity to evaluate, if an evaluator feels as if they do not know the applicant well enough to rate them on the particular item or attribute (Kyllonen, 2008; McCaffrey et al., 2018).

Regarding the PPI instrument reliability, one-way random intraclass correlations (ICC) were conducted for all six PPI scales to obtain inter-rater reliability estimates. A one-way random ICC was chosen because participants in this study were evaluated by different raters. ICC estimates were obtained to examine the inter-rater reliability across the first three raters. Out of the 112 enrolled participants in this study, 93 (83%) were evaluated by at least three raters. Additionally, ICC estimates were examined for the unenrolled student sample (n = 250) as well as the total sample (n = 362). See Table 2 for intraclass correlation estimates of each PPI subscale. Overall, intraclass correlations indicated that inter-rater reliability estimates across the three raters for the enrolled sample were classified as both poor and moderate for the enrolled sample, ranging from .433 to .574 (Koo & Li, 2016). For the total and unenrolled samples,

intraclass correlations indicated that the inter-rate reliability estimates were classified as moderate. This is undoubtably a limitation to this research study. However, a meta-analysis of letters of recommendation in graduate admissions conducted by Kuncel et al. (2014) suggests that standardizing letters of recommendation to focus on assessment of specific skills including conscientiousness is an improvement upon their current use and form.

Table 2

Intraclass Correlations for Inter-rater Reliability Estimates of the Personal Potential Index

PPI Scales	Enrolled Sample	Unenrolled Sample	Total Sample
Knowledge & Creativity	.457	.590	.550
Communication Skills	.578	.609	.600
Teamwork	.561	.533	.541
Resilience	.479	.522	.507
Planning & Organization	.433	.555	.519
Ethics & Integrity	.570	.542	.549

Data Analysis

All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) software, version 26. The researcher examined the data for missing values, outliers, and test assumptions. Descriptive statistics were conducted for all variables and are reported in the following chapter. In order to answer each of the research questions, a variety of statistical tests were conducted. All statistical tests were conducted at the significance level of .05. See Table 3 for the research question analysis table. Overall, multiple logistic regression, multiple regression and a three-way between-subjects MANOVA analyses were conducted to examine the predictive

relationships among the six PPI scale scores as well as group differences across the primary dependent variables. Last, the percentage of respondents achieving the lowest and/or highest possible scores was examined to investigate the presence of ceiling and floor effects. Specifically, the 15% ceiling and floor effect threshold for participants achieving the highest and lowest possible scale scores was adopted (Lim et al., 2015; Wang et al., 2008).

Table 3

Research Question Analysis Table

Research Questions		Statistical Test
1. What are the predictive relationships among the six PPI scale scores…	a. on degree completion status? b. on graduate GPA? c. on time-to-degree?	a. Multiple Logistic Regression b. Multiple Regression c. Multiple Regression
2. What are the predictive relationships among the six PPI scale scores above and beyond student degree classification, STEM vs non-STEM degree programs, undergraduate GPA, and GRE scores…	a. on degree completion status? b. on graduate GPA? c. on time-to-degree?	a. Hierarchical Multiple Logistic Regression b. Hierarchical Multiple Regression c. Hierarchical Multiple Regression
3. Are there group differences based on the interaction of degree completion status, degree level, and degree program among …	a. the six PPI scale scores, GRE scores, graduate GPA, and undergraduate GPA? b. the six PPI scale scores, GRE scores, and undergraduate GPA?	Three-way between- subjects MANOVA with canonical correlation analysis.
4. How do the six PPI scale scores perform in terms of creating variability between applicants		Percentage of respondents achieving the lowest and/or highest possible scores. Greater than 15% indicates the presence of a floor and ceiling effect.

Summary

In summary, this chapter provided a description of the research methodology used for this current study. Specifically, a nonexperimental quantitative research design using TPE survey

data was used to analyze the six PPI scales and their predictive relationship with degree completion, time-to-degree, and graduate GPA. Archival, de-identified TPE PPI survey data was used for secondary analysis for this study and was provided by Educational Testing Service. For data analyses, SPSS version 26 was used to perform preliminary data screening, conduct descriptive statistics as well as the primary data analyses to answer each of the research questions. Chapter 4 will present the results of the current study.

CHAPTER IV: RESULTS

Introduction

This chapter includes a description of the organization of the chapter, statistical analyses, and the statistical results of this dissertation study. First, this chapter includes a review of this dissertation study's problem statement, purpose of the study, and the research questions. Next, this chapter presents the preliminary data analyses results, descriptive statistics, and the primary data analyses results addressing each of the research questions. Last, this chapter summarized the statistical analyses and the research findings for this study.

Problem Statement

Admissions practices at all education levels are intended to select students who are the most likely to succeed and attain their degrees. However, despite these intentions, graduate student attrition rates range between 40% to 60% depending on one's degree field (Bair & Haworth, 1999; CGS, 2008; Schramm-Possinger & Powers, 2015). In addition to examining characteristics of the institution and the students enrolled in degree programs, exploring graduate admissions practices is important in order to understand how these practices contribute to and can hopefully combat the occurrences of attrition. Often, graduate admissions practices are limited to traditional cognitive ability measures such as the Graduate Record Examination (GRE) and undergraduate grade point average (GPA). Unfortunately, the utilization and the appropriateness of the GRE has remained the subject of intense debate. However, what remains certain is the need for graduate programs to use tools that provide the most reliable and valid information about an applicant's capabilities. Research suggests that noncognitive, personal qualities, not measured by traditional cognitive assessments, serve as strong determinants of graduate student success, performance, and completion. Therefore, the inclusion of noncognitive

assessments with current cognitive ability measures can potentially enhance the quality of information obtained about graduate student applicants and ultimately improve selection decisions (Sedlacek, 2010). Additionally, standardized third-party evaluation (TPE) systems have the potential to serve as an avenue to reliably assess noncognitive factors that is not subjected to the inherent limitations associated with common noncognitive assessment methods. Currently, the examination of the role of noncognitive factors on graduate student performance and degree completion using a standardized TPE system is lacking in the literature. Therefore, this dissertation research study addressed these gaps. Ultimately, these results can provide beneficial implications for higher education institutions, degree programs, and faculty members regarding their applicant selection practices as well as current graduate student evaluation practices.

Purpose of the Study

The purpose of this study was twofold. First, this study examined the association of noncognitive factors on graduate student performance and degree completion. Second, this study examined the measurement integrity and the utility of the Personal Potential Index (PPI) as an avenue to reliably assess noncognitive factors of graduate students that avoids the drawbacks associated with self-assessment methods and recommendation letters (Kyllonen, 2008; McCaffrey et al., 2018). To accomplish this investigation, the researcher conducted a nonexperimental, quantitative, research design using TPE survey data. Specifically, the researcher obtained and utilized de-identified, archival PPI data to determine if these noncognitive scores predicted degree completion, graduate GPA, and time-to-degree completion. The researcher also examined whether the PPI scale scores predicted graduate student degree completion, graduate GPA, and time-to-degree above and beyond degree classification/level

(master's and doctoral students), graduate student degree program (STEM and non-STEM programs), undergraduate GPA, and GRE scores (analytical writing, verbal, and quantitative). The researcher also examined group differences across the dependent variables and GRE scores. Lastly, the presence of floor and ceiling effects was examined for the PPI scales.

Research Questions

To address the problem of this study, the researcher raised the following research questions:

1. What are the predictive relationships among the six PPI scale scores…
    a. on graduate student degree completion status?
    b. on graduate grade point average?
    c. on graduate student time-to-degree completion?
2. What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores…
    a. On graduate student degree completion status?
    b. On graduate grade point average?
    c. on graduate student time-to-degree completion?
3. Are there group differences based on the interaction of degree completion status, degree level, and degree program among …
    a. the six PPI scale scores, GRE scores, graduate GPA, and undergraduate GPA?
    b. the six PPI scale scores, GRE scores, and undergraduate GPA?
4. How do the six PPI scales perform in terms of creating variability between applicants?

Organization of Chapter

Analyses for this research study were conducted using SPSS version 26. First, preliminary analyses examining missing values, outliers, and test assumptions were conducted. Additionally, means, standard deviations, frequencies, and percentages were computed for independent and dependent variables. For research question one and two, multiple logistic regression and multiple regressions were conducted to examine the predictive relationships among the independent variables on the outcome variables. For research question three, a one-way between-subjects MANOVA was conducted to examine group differences across the dependent variables. For the fourth and final research question, the percentage of participants achieving the highest/lowest possible scores were examined to determine ceiling and/or floor effects of the six PPI scales.

Preliminary Analyses

Statistical Assumptions

Prior to conducting the primary statistical analyses, the data were screened for missing values, outlier, and other statistical test assumptions. See Table 4 for a summary of the missing values in the dataset. Overall, missing values for the primary outcome variables varied from 1% – 7%. Time-to-degree resulted in a missing value rate of 24.10%. Potentially, this high missing value rate could have occurred due to losing data if a student switched institutions or the possibility that the student still attends the institution.

Table 4

Summary of Missing Values for the Sample (n = 112)

Variables	Missing Values Summary		Valid *N*	*M*	*SD*
	N	Percentage			
Undergraduate GPA	6	5.36	106	3.314	0.463
GRE-Verbal	6	5.36	106	151.92	6.811
GRE-Quantitative	6	5.36	106	151.87	8.920
GRE-Analytical Writing	7	6.25	105	3.633	0.624
Graduate GPA	2	1.80	110	3.764	0.456
Time-to-degree	27	24.10	85	2.146	1.343

In addition to examining missingness in the data, the assumption of normality was investigated. First, skewness and kurtosis estimates were examined. See Table 5 for means, standard deviations, skewness, and kurtosis values. Additionally, Figure 1, the histogram for graduate GPA, Figure 2, the histogram for time-to-degree, and Figure 3, the bar graph for degree completion status.

Table 5

Descriptive Statistics for Independent and Dependent Variables

Variables	*N*	*M*	*SD*	Skewness	*SE*	Kurtosis	*SE*
Knowledge & Creativity	112	4.083	0.442	-0.567	.228	0.425	.453
Communication Skills	112	3.951	0.508	-0.599	.228	0.182	.453
Teamwork	112	4.236	0.456	-0.663	.228	0.851	.453
Resilience	112	4.186	0.494	-0.947	.228	1.500	.453
Planning & Organization	112	4.067	0.519	-0.873	.228	0.945	.453
Ethics & Integrity	112	4.454	0.469	-0.909	.228	0.542	.453
GRE-Verbal	106	151.92	6.811	0.131	.235	-0.517	.465
GRE-Quantitative	106	151.87	8.920	0.352	.235	-0.839	.465
GRE-Analytical Writing	105	3.633	0.662	-0.202	.236	-0.011	.467
Undergraduate GPA	106	3.314	0.463	-0.503	.235	-0.508	.465
Graduate GPA	110	3.764	0.456	-4.405	.230	25.766	.457
Time-to-Degree	85	2.146	1.343	0.972	.261	0.672	.517

Overall, all skewness and kurtosis estimates for the variables in the dataset ranged between +/- 2 except for the graduate GPA variable. Specifically, graduate GPA exhibited a negative skew and leptokurtic distribution. This finding indicates that a large portion of the sample reported high performance in graduate school, which was similarly found in Wao et al. (2015). Specifically, with further exploration of the data, 40.2% (n = 45) of the enrolled sample reported a 4.00 graduate GPA. Further, Q-Q normality plots and P-P normality plots were generated for each of the continuous outcome variables to examine normality. Figure 4, the P-P

plot for graduate GPA, Figure 5, the Q-Q plot for graduate GPA, Figure 6, the P-P plot for time-to-degree, and Figure 7, the Q-Q plot for time-to-degree, all provide illustrations of normality for these continuous outcome variables.

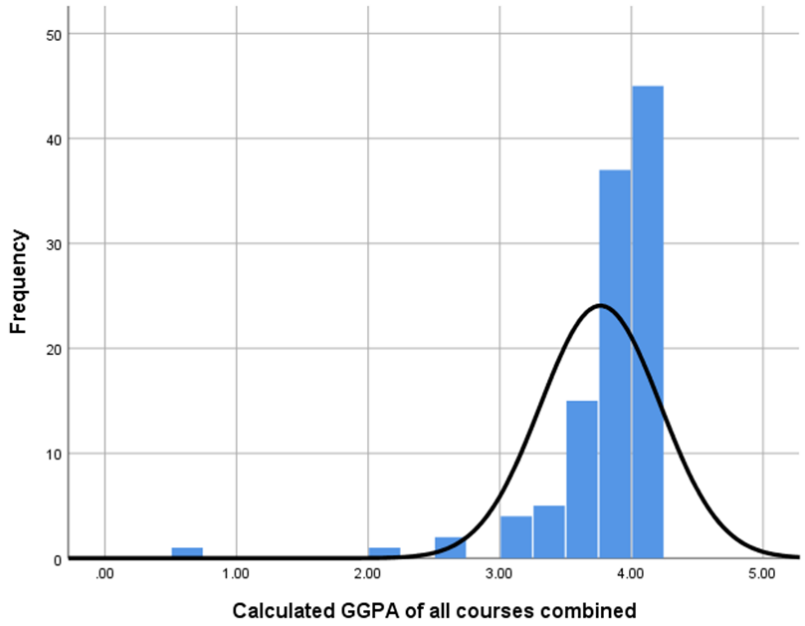


Figure 1. Histogram for Graduate GPA.

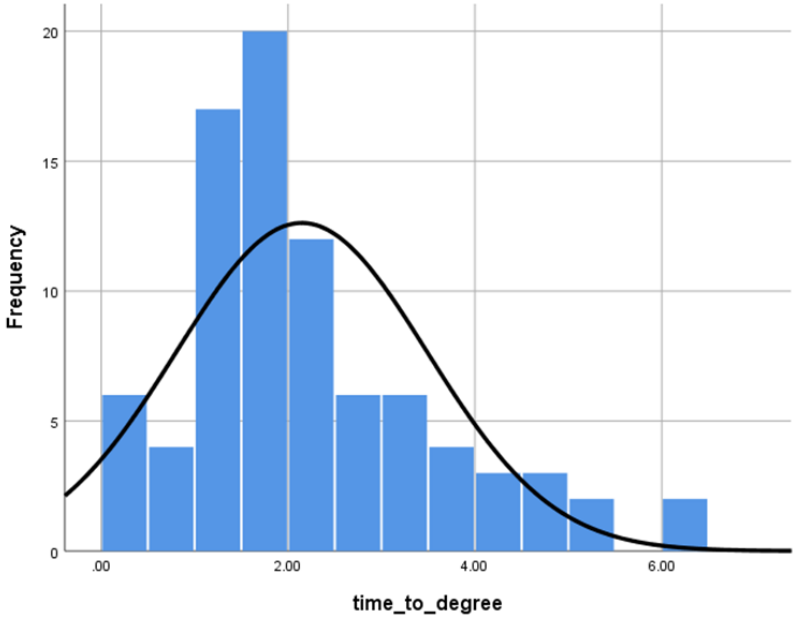


Figure 2. Histogram for Time-To-Degree Completion.

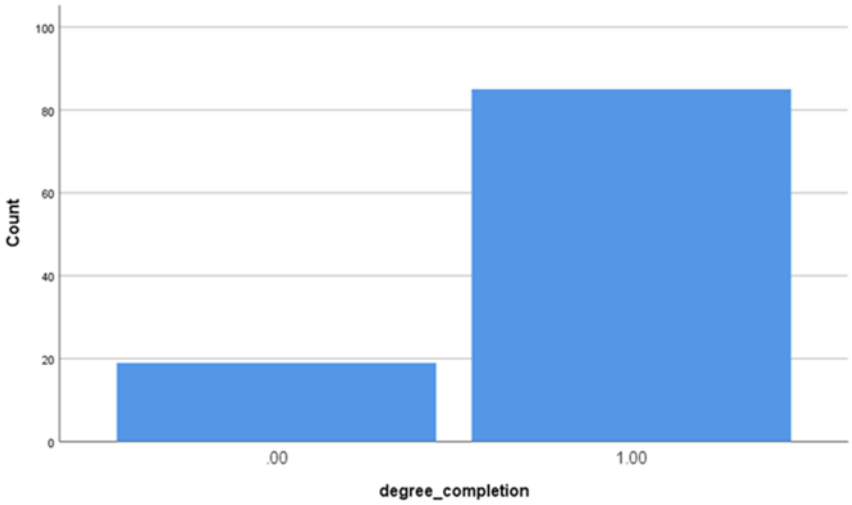


Figure 3. Bar graph for Degree Completion Status.

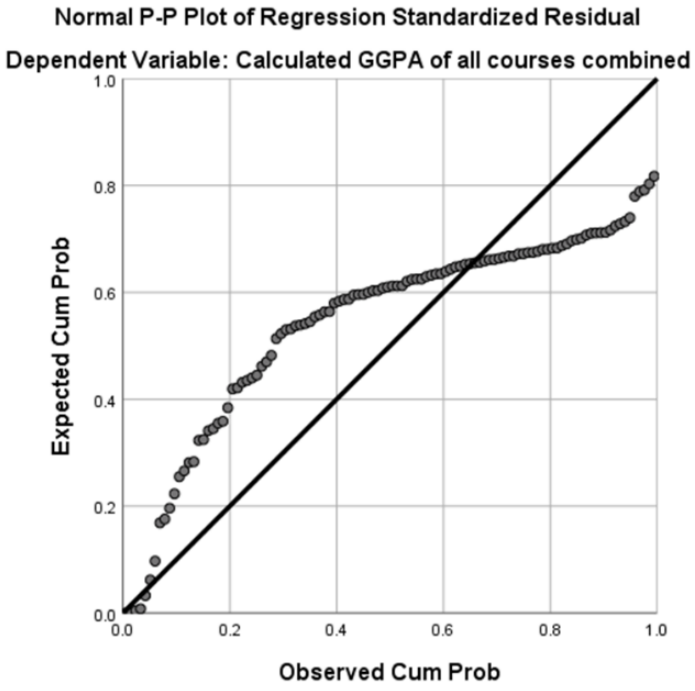


Figure 4. P-P Plot Testing Normality of Graduate GPA.

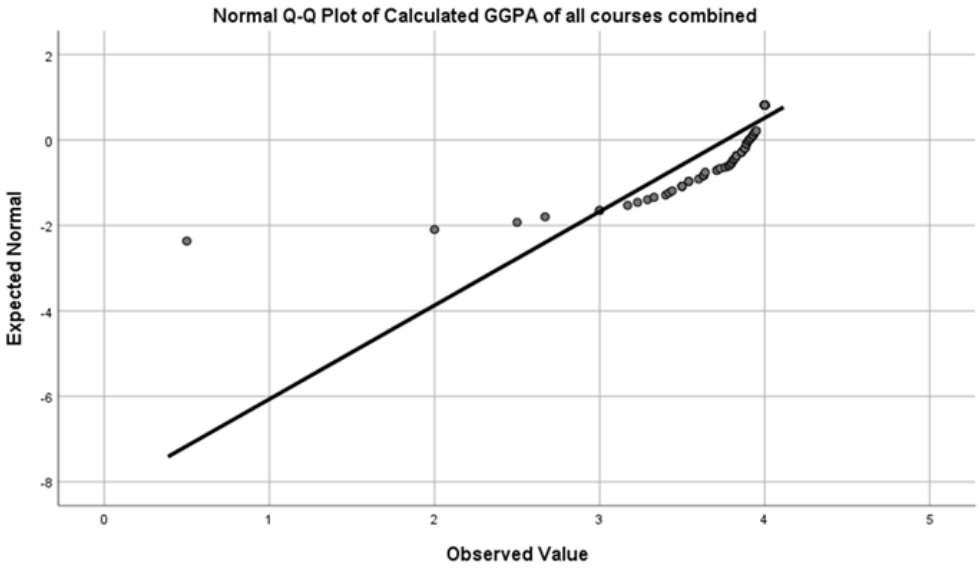


Figure 5. Q-Q Plot Testing Normality of Graduate GPA

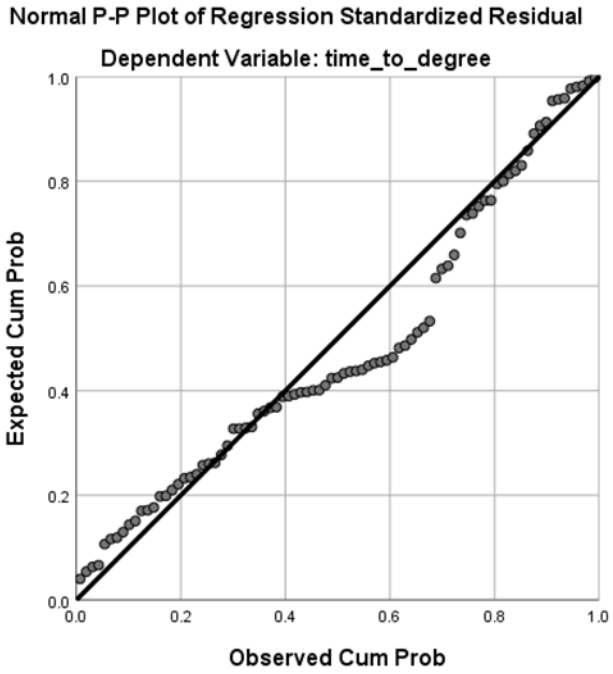


Figure 6. P-P Plot Testing Normality for time-to-degree completion.

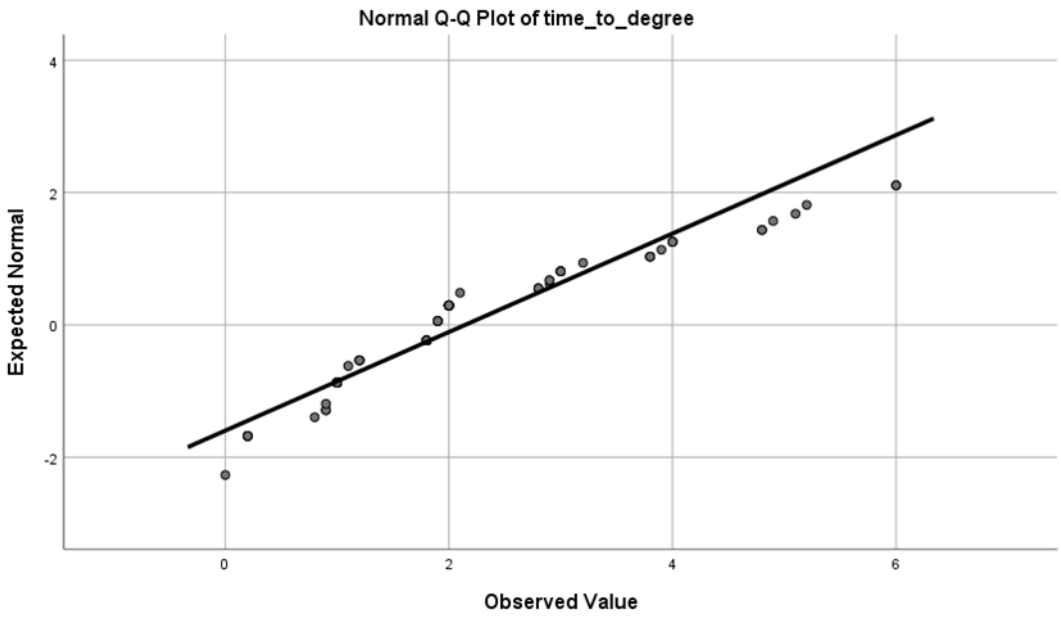


Figure 7. Q-Q Plot Testing Normality for time-to-degree completion.

Once again, the P-P normality plot and the Q-Q normality plot for graduate GPA illustrate that this distribution deviates strongly from the normality line. However, although the time-to-degree distribution line deviates slightly from the normality line on the P-P plot, the time-to-degree Q-Q plot illustrates that this distribution remains consistent with the normality line. Therefore, taking into consideration time-to-degree completion skewness, kurtosis, and the figures, normality can be assumed for the time-to-degree variable.

In order to address the violation of normality for the graduate GPA variable, a two-step transformation algorithm was conducted (Templeton, 2011). The two-step transformation algorithm was influenced by simulation research studies that "generate random probabilities (ranging from 0 to 1) that are then transformed using the inverse-normal CDF" (Templeton, 2011, p. 43). However, what differentiates this algorithm from random number generations is that the first step transforms the observed variables towards uniformity, where random number generation starts with no values (Templeton, 2011). For step one, the original graduate GPA

variable was transformed toward statistical uniformity by calculating the fractional rank of each score. The formula, which was gathered from Templeton (2011), is below:

$$Pr = 1 - [Rank(X_i)/n]$$

where,

Pr = Percentile rank or probability

$Rank(X_i)$ = Xi rank value

n = sample size

For step two, the uniform probabilities were transformed to normal using the inverse normal distribution function. The inverse normal distribution function, which was gathered from Templeton (2011), is shown below:

$$p = \mu + \sqrt{2}\,\sigma\,\mathrm{erf}^{-1}(-1 + 2\mathrm{Pr})$$

where,

p = standardize z – score from step 2

μ = mean of p or the standardized z-score (0)

σ = standard deviation of p or the standardized z-score (1)

erf^{-1} = inverse error function

Pr = probability from step 1

Through this transformation, graduate GPA variable resulted in normal skewness and kurtosis estimates between +/- 2. See Table 6 for descriptive statistics for transformed graduate GPA variable. Additionally, an updated Q-Q plot (Figure 8) and P-P plot (Figure 9) for graduate GPA was generated. These figures illustrate that the distribution for the transformed graduate GPA variable does not deviate from the normality line. Therefore, normality can now be assumed for graduate GPA.

Table 6

Descriptive Statistics for Transformed Graduate GPA Variable

Variables	*N*	*M*	*SD*	Skewness	*SE*	Kurtosis	*SE*
Normed GGPA	110	3.7507	0.39644	-0.569	.230	-0.687	.457

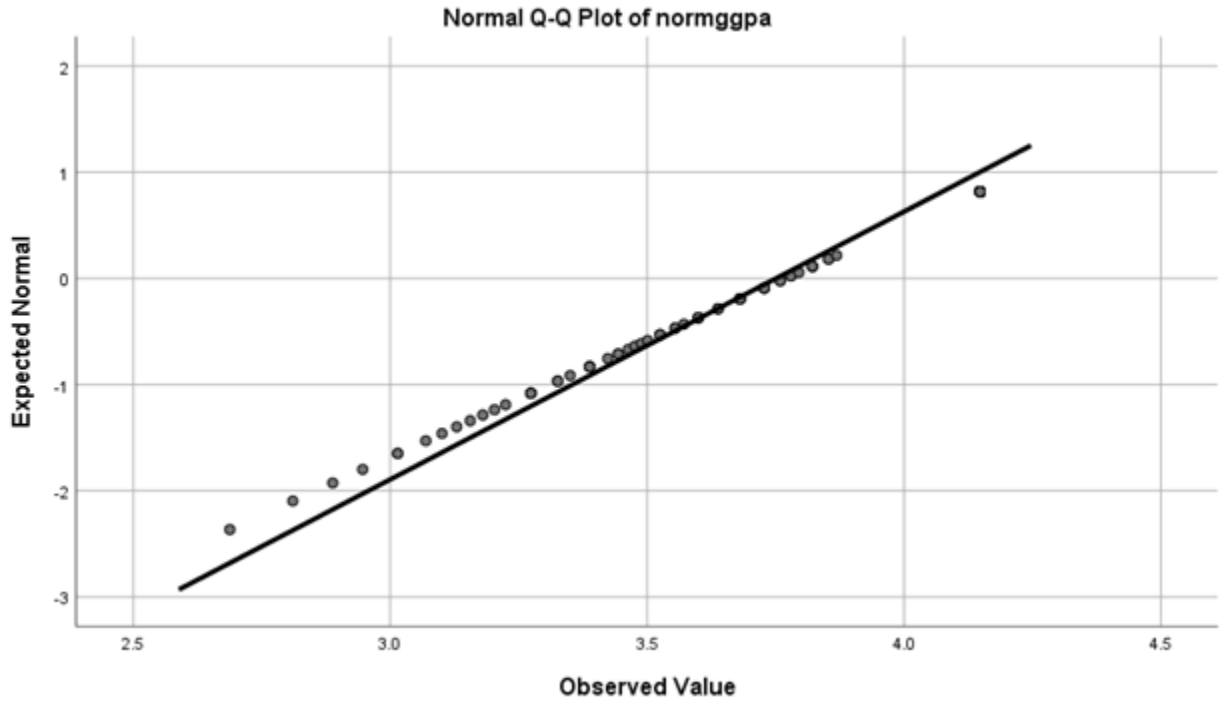


Figure 8. Updated Q-Q Plot Testing Normality for Transformed Graduate GPA Variable

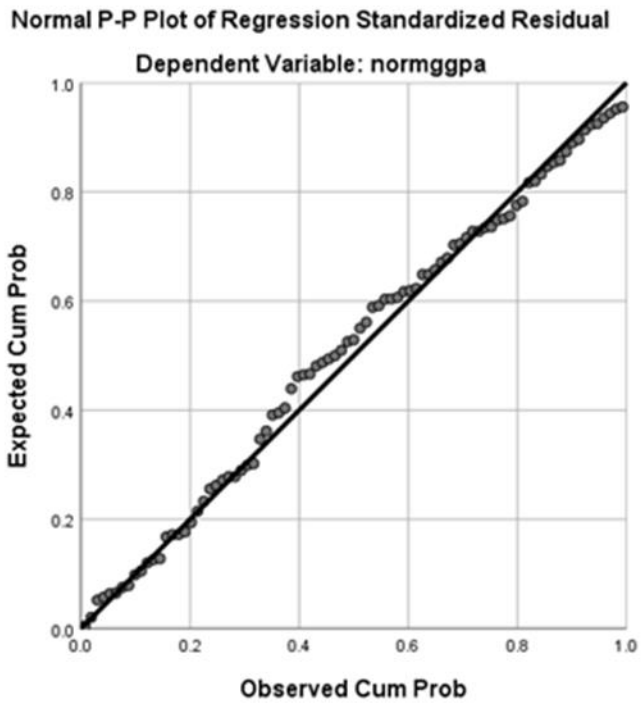


Figure 9. Updated P-P Plot Testing Normality for Transformed Graduate GPA Variable

The assumption of homoscedasticity was examined for the two continuous outcome variables. To check for this assumption, scatterplots of the standardized predicted by the standardized residual were conducted and examined. Figure 10 and Figure 11 provide illustrations of the homoscedasticity testing for these outcome variables. Results from these scatterplots indicate that the assumption for homoscedasticity is not met for graduate GPA. This is because this plot demonstrates an obvious pattern. Therefore, it can be assumed that error residuals are influenced by the increase of predicted values. However, the assumption for homoscedasticity can be assumed to be met for time-to-degree completion. This is because points are equally distributed across the X and Y axis.

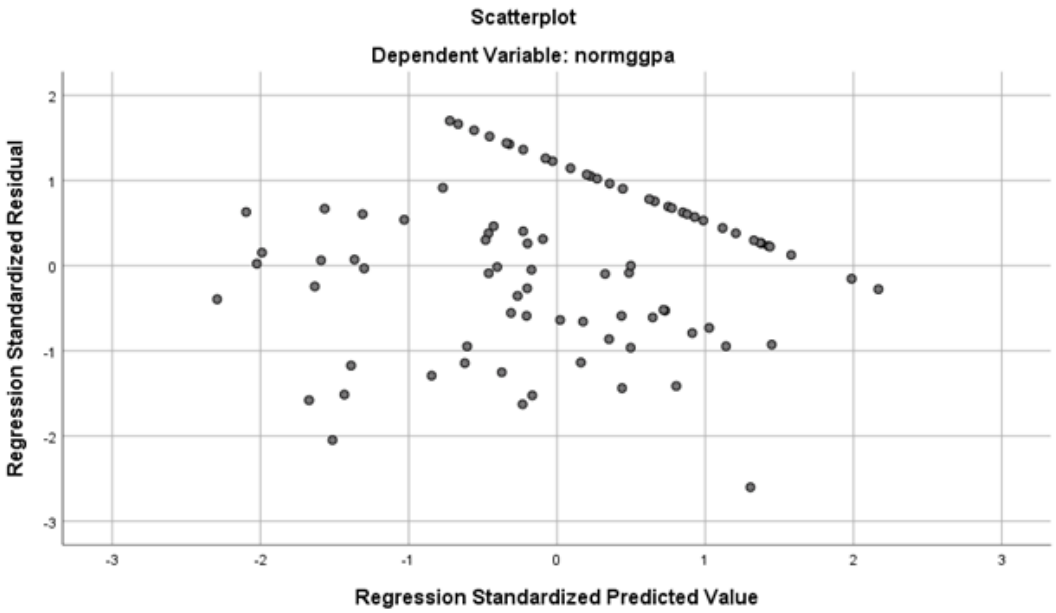


Figure 10. Scatterplot testing homoscedasticity of graduate GPA.

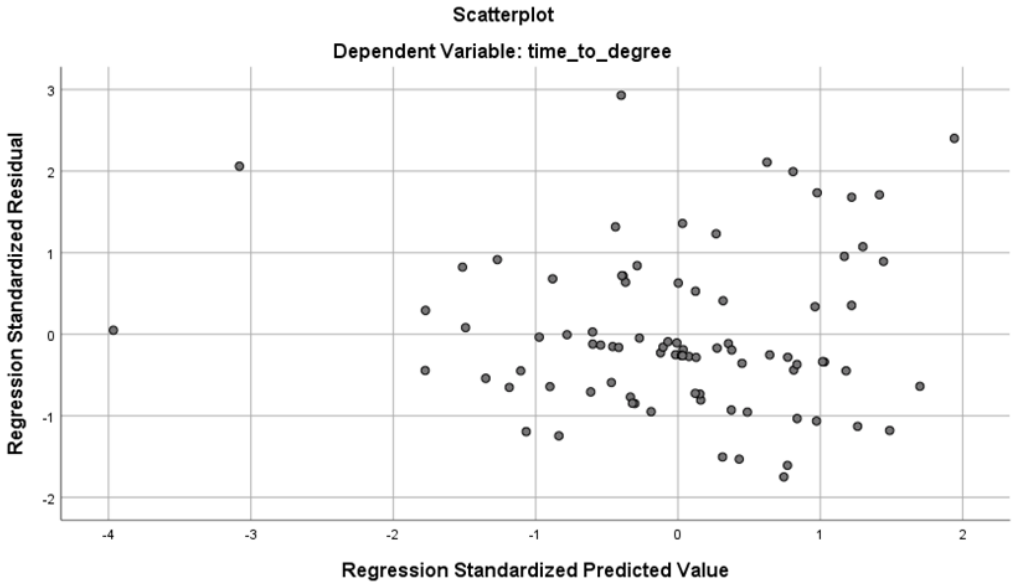


Figure 11. Scatterplot testing homoscedasticity of time-to-degree completion

Finally, the assumption of multicollinearity was evaluated by examining tolerance and VIF values. Results indicated that the absence of multicollinearity can be assumed for both graduate GPA and time to degree. This is because all VIF values were below 10. See Table 7 for collinearity statistics for time-to-degree completion and graduate GPA.

Table 7

Collinearity Statistics for graduate GPA and Time-to-Degree

Variables	Graduate GPA		Time-to-Degree	
	Tolerance	VIF	Tolerance	VIF
Knowledge & Creativity	.388	2.575	.320	3.126
Communication Skills	.399	2.509	.336	2.972
Teamwork	.241	4.153	.240	4.173
Resilience	.155	6.461	.164	6.110
Planning & Organization	.176	5.667	.196	5.099
Ethics & Integrity	.443	2.260	.321	3.116
GRE Verbal	.459	2.177	.509	1.964
GRE Quantitative	.417	2.399	.356	2.810
GRE Analytical Writing	.536	1.865	.644	1.554
Undergraduate GPA	.784	1.276	.731	1.367
Degree level	.870	1.149	.785	1.274
Degree program	.599	1.669	.535	1.869

Descriptive Statistics

Descriptive statistics were conducted to examine the means and standard deviations for outcomes variables by groups. Specifically, group means and standard deviations were estimated for graduate degree classification/level (master's and doctoral students), graduate degree program (STEM and non-STEM programs), and graduate student degree completion status (dropped out and graduated). Last, a correlation matrix was conducted for the PPI attributes. See

Tables 8 - 11 for these estimates. As seen in Table 11, the high correlations amongst the PPI scale scores suggest that these constructs may overlap or the presence of rater response bias in the data.

Table 8

Descriptive Statistics by Degree Level

Variables	Master's Level			Doctoral Level		
	N	*M*	*SD*	*N*	*M*	*SD*
Knowledge & Creativity	75	4.063	0.448	27	4.179	0.400
Communication Skills	75	3.970	0.470	27	3.981	0.575
Teamwork	75	4.209	0.468	27	4.323	0.404
Resilience	75	4.171	0.488	27	4.271	0.459
Planning & Organization	75	4.052	0.489	27	4.172	0.585
Ethics & Integrity	75	4.439	0.492	27	4.564	0.419
GRE-Verbal	70	152.94	6.980	26	150.42	6.288
GRE-Quantitative	70	152.03	8.499	26	152.08	10.763
GRE-Analytical Writing	70	3.643	0.660	25	3.660	0.732
Undergraduate GPA	70	3.332	0.441	26	3.333	0.517
Graduate GPA	74	3.722	0.424	26	3.825	0.305
Time-to-Degree	63	1.695	0.976	14	4.157	0.995

Table 9

Descriptive Statistics by Degree Programs

Variables	STEM Programs			Non-STEM Programs		
	N	*M*	*SD*	*N*	*M*	*SD*
Knowledge & Creativity	50	4.092	.453	62	4.075	.437
Communication Skills	50	3.910	.508	62	3.984	.511
Teamwork	50	4.168	.402	62	4.291	.491
Resilience	50	4.130	.535	62	4.231	.457
Planning & Organization	50	4.002	.537	62	4.119	.502
Ethics & Integrity	50	4.422	.454	62	4.479	.483
GRE-Verbal	49	152.47	6.532	57	151.46	7.066
GRE-Quantitative	49	157.67	8.217	57	146.88	6.039
GRE-Analytical Writing	49	3.469	.672	56	3.777	.625
Undergraduate GPA	45	3.378	.406	61	3.268	.499
Graduate GPA	49	3.570	0.413	61	3.896	0.317
Time-to-Degree	39	2.356	1.309	46	1.967	1.360

Table 10

Descriptive Statistics by Degree Completion Status

Variables	Dropped Out			Graduated		
	N	*M*	*SD*	*N*	*M*	*SD*
Knowledge & Creativity	19	4.239	0.346	85	4.039	0.455
Communication Skills	19	4.117	0.441	85	3.933	0.478
Teamwork	19	4.651	0.399	85	4.196	0.453
Resilience	19	4.277	0.573	85	4.159	0.463
Planning & Organization	19	4.121	0.544	85	4.046	0.492
Ethics & Integrity	19	4.594	0.317	85	4.399	0.493
GRE-Verbal	17	150.82	7.804	81	152.70	6.377
GRE-Quantitative	17	153.12	8.492	81	151.75	8.613
GRE-Analytical Writing	17	3.441	0.682	80	3.706	0.650
Undergraduate GPA	19	3.358	0.465	79	3.328	0.461
Graduate GPA	17	3.593	0.588	85	3.778	0.350
Time-to-Degree	-	-	-	85	2.146	1.343

Table 11

Correlation Coefficients for the Personal Potential Index Attributes

	K & C	CS	TW	RES	P & O	E & I
Knowledge & Creativity	-					
Communication Skills	.732**	-				
Teamwork	.652**	.641**	-			
Resilience	.669**	.618**	.841**	-		
Planning & Organization	.660**	.668**	.768**	.856**	-	
Ethics & Integrity	.535**	.515**	.699**	.653**	.619**	-

Note. ** $p < .01$

Data Analysis Results

Research Question One

RQ1a: What are the predictive relationships among the six PPI scale scores on degree completion status?

To examine the predictive relationships among the six PPI scale scores on degree completion, a binary multiple logistic regression analysis was conducted. Results of the Wald statistic indicated that the PPI scale scores were not significant predictors of degree completion. See Table 12 for the logistic regression table for degree completion. Further, results indicated that 10.3% of the variance in degree completion can be explained by the six PPI scale scores (Nagelkerke pseudo R^2 =.103). Additionally, Hosmer and Lemeshow Goodness of Fit test indicated the data did fit the model ($\chi^2_8 = 3.528$, $p = .897$). Further, the correct percentage rate was 82.7%, with 100% correct for students who graduated and 5.3% for students who dropped out.

Table 12

Logistic Regression Table for Degree Completion

Variables	*B*	*SE*	Wald	*p*	Exp(*B*)	95% CI for Exp(*B*)	
						Lower	Upper
Constant	8.550	3.533	5.856	.016	5165.320		
Knowledge & Creativity	-1.264	1.069	1.399	.237	0.282	.035	2.295
Communication Skills	-0.181	1.014	0.032	.858	0.835	.114	6.094
Teamwork	-0.728	1.265	0.331	.565	0.483	.040	5.770
Resilience	0.183	1.170	0.024	.876	1.200	.121	11.891
Planning & Organization	1.292	1.047	1.524	.217	3.642	.468	28.346
Ethics & Integrity	-0.893	0.909	0.965	.326	0.410	.069	2.432

RQ1b: What are the predictive relationships among the six PPI scale scores on graduate GPA?

To examine the predictive relationships among the six PPI scale scores on graduate GPA, a multiple linear regression analysis was conducted. The overall regression equation was not statistically significant ($F_{6,103} = 1.627$, $p = .147$). About 9% of the variance of graduate GPA was explained by the six PPI scale scores ($R^2 = .087$). Overall, the six PPI scale scores were not significant predictors of graduate GPA. See Table 13 for the regression table for graduate GPA.

Table 13

Multiple Regression Table for Graduate GPA

Variables	*B*	*SE*	β	*t*	*p*	95% CI for *B*	
						Lower	Upper
Constant	3.211	.406		7.915	.000	2.406	4.016
Knowledge & Creativity	-.063	.136	-.070	-.460	.647	-.333	.208
Communication Skills	.030	.117	.038	.253	.801	-.203	.262
Teamwork	-.034	.167	-.040	-.206	.838	-.366	.297
Resilience	.036	.178	.045	.203	.840	-.317	.389
Planning & Organization	.270	.148	.354	1.823	.071	-.024	.563
Ethics & Integrity	-.095	.113	-.113	-.839	.403	-.319	.129

RQ1c: What are the predictive relationships among the six PPI scale scores on time-to-degree?

To examine the predictive relationships among the six PPI scale scores on time-to-degree completion, a multiple linear regression was conducted. The overall regression equation was not statistically significant ($F_{6,78} = 0.712$, $p = .641$). About 5% of the variance of time-to-degree completion was explained by the six PPI scale scores ($R^2 = .052$). Overall, the six PPI scale scores were not significant predictors of time-to-degree completion. See Table 14 for the regression table for time-to-degree completion.

Table 14

Multiple Regression Table for Time-To-Degree Completion.

Variables	*B*	*SE*	β	*t*	*p*	95% CI for *B*	
						Lower	Upper
Constant	0.726	1.559	-	0.489	.626	-2.342	3.866
Knowledge & Creativity	0.083	0.552	0.028	0.150	.881	-1.016	1.181
Communication Skills	-0.140	0.527	-0.050	-0.265	.792	-1.188	.909
Teamwork	0.406	0.661	0.137	0.615	.540	-.909	1.722
Resilience	-0.686	0.735	-0.236	-0.933	.354	-2.149	.778
Planning & Organization	0.955	0.592	0.350	1.614	.110	-.223	2.134
Ethics & Integrity	-0.255	0.475	-0.093	-0.536	.593	-1.200	.691

Research Question Two

RQ2a: What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores on degree completion status?

A hierarchical, binary, multiple logistic regression analysis was used to determine if the six PPI scale scores would contribute to explaining degree completion over and above degree level, degree program, GRE scores, and undergraduate GPA. In step one, GRE scores (verbal, quantitative, and analytical writing), undergraduate GPA, degree level (master's and doctoral), and degree program (STEM and non-STEM) were entered as predictors. Results from step one indicated that about 10% of the variance in degree completion was explained (Nagelkerke pseudo R^2 =.099). Hosmer and Lemeshow Goodness of Fit test indicated the data fit the model

(χ^2_8 = 10.872, p = .209). Further, the correct percentage rate was 81.7%, with 98.5% correct for students who graduated and 12.5% for students who dropped out. Results of the Wald statistic indicated that the three GRE scores, degree level, undergraduate GPA, and degree program were not significant predictors of degree completion. See Table 15 for the logistic regression table for degree completion.

In step two, the previous predictors were retained and the six PPI scale scores were added as predictors. In step two, results indicated that about 30% of the variance in degree completion was explained (Nagelkerke pseudo R^2 =.296). Additionally, Hosmer and Lemeshow Goodness of Fit test indicated that the data fit the model (χ^2_8 = 7.103, p = .526). Further, the correct percentage rate was 82.9%, with 97.0% correct for students who graduated and 25% for students who dropped out. Results of the Wald statistic indicated that the planning and organization PPI scale was a significant predictor of degree completion. Under the condition that all the other variables in the model remain constant, the odds ratio indicates for every one-point increase in planning and organization scores, the likelihood of degree completion increases by approximately 33%. Overall, as a students' planning and organization score increases, their odds of graduating increase as well.

Table 15

Hierarchical Logistic Regression Coefficients for Degree Completion

Step	Variables	*B*	*SE*	Wald	*p*	Exp(*B*)	95% CI for Exp(*B*)	
							Lower	Upper
1	Constant	1.203	7.887	0.023	0.878	3.348		
	Undergraduate GPA	0.432	0.682	0.402	0.526	1.541	.405	5.865
	GRE-Verbal	0.017	0.056	0.094	0.760	1.017	.911	1.136
	GRE-Quantitative	-0.046	0.048	0.928	0.335	0.955	.870	1.049
	GRE-Analytical Writing	0.575	0.557	1.066	0.302	1.777	.596	5.297
	Degree Level	0.923	0.684	1.819	0.177	2.517	.658	9.625
	Degree Program	-0.682	0.764	0.796	0.372	1.977	.113	2.260
2	Constant	11.433	10.250	1.244	0.265	92336.889		
	Undergraduate GPA	-0.106	0.875	0.015	0.904	0.900	.162	5.002
	GRE-Verbal	0.064	0.064	1.000	0.317	1.066	.940	1.208
	GRE-Quantitative	-0.084	0.057	2.185	0.139	0.920	.823	1.028
	GRE-Analytical Writing	0.623	0.686	0.825	0.364	1.864	.486	7.151
	Degree Level	1.127	0.796	2.008	0.156	3.087	.649	14.681
	Degree Program	-1.226	0.881	1.936	0.164	3.409	.052	1.651
	Knowledge & Creativity	-1.940	1.457	1.772	0.183	0.144	.008	2.499
	Communication Skills	-0.153	1.390	0.012	0.912	0.858	.056	13.081
	Teamwork	-1.947	1.636	1.417	0.234	0.143	.006	3.523
	Resilience	-0.479	1.509	0.101	0.751	0.619	.032	11.915
	Planning & Organization	3.506	1.610	4.740	0.029	33.314	1.419	782.169
	Ethics & Integrity	-1.234	1.231	1.244	0.265	0.291	.026	3.254

RQ2b: What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores on graduate GPA?

A hierarchical multiple regression analysis was conducted to determine if the six PPI scale scores would contribute to explaining graduate GPA over and above degree level, degree program, GRE scores, and undergraduate GPA. In step one, GRE scores (verbal, quantitative, and analytical writing), undergraduate GPA, degree level (master's and doctoral), and degree program (STEM and non-STEM) were entered as predictors. The overall regression equation was statistically significant ($F_{6, 80} = 5.004$, $p < .001$). Together, the indicators explained about 27% of the variance in graduate GPA ($R^2 = .273$). Results indicated that degree program was a significant predictor of graduate GPA. Overall, under the condition that all the other variables in the model remain constant, when students enrolled in STEM degree programs, their GPA are more likely to be lower.

In step two, the previous predictors were retained and the six PPI scale scores were added as predictors. In step two, the regression equation remained statistically significant ($F_{12, 74} = 3.357$, $p = .001$), and explained about 35% of the variance in graduate GPA ($R^2 = .352$). The addition of the six PPI scale scores added about 8% to the explained variance ($\Delta R^2 = .080$), which was not a statistically significant increase in explained variance ($\Delta F_{6, 74} = 1.517$, $p = .185$). Results from step two indicated that degree program and GRE analytical writing scores were significant predictors of graduate GPA. Specifically, under the condition that all the other variables in the model remain constant while controlling for the other variables, as GRE analytical scores increased, graduate GPA increases as well. Additionally, under the condition that all the other variables in the model remain constant, as students enroll in STEM degree

programs, their GPA are more likely to be lower. The addition of the six PPI scale scores contributed to an incremental increase in the predictive influence of the GRE analytical scores. See Table 16 for the regression coefficients.

Table 16

Hierarchical Regression Coefficients for Graduate GPA

							95% CI for *B*	
Step	Variables	*B*	*SE*	β	*t*	*p*	*Lower*	*Upper*
1	Constant	1.738	.973		1.787	.078	-.198	3.675
	GRE-Verbal	.001	.007	.016	.116	.908	-.014	.016
	GRE-Quantitative	.008	.006	.189	1.374	.173	-.004	.020
	GRE-Analytical Writing	.131	.074	.223	1.760	.082	-.017	.278
	Undergraduate GPA	.089	.085	.103	1.045	.299	-.080	.257
	Degree Level	.097	.088	.109	1.100	.274	-.078	.272
	Degree Program	-.380	.095	-.486	-4.003	.000	-.569	-.191
2	Constant	.930	1.099		.846	.400	-1.260	3.120
	GRE-Verbal	.000	.008	-.008	-.058	.954	-.016	.015
	GRE-Quantitative	.012	.006	.266	1.839	.070	-.001	.024
	GRE-Analytical Writing	.150	.075	.255	1.997	.049	.000	.299
	Undergraduate GPA	.023	.091	.027	.254	.800	-.158	.204
	Degree Level	.060	.089	.068	.679	.499	-.116	.237
	Degree Program	-.375	.094	-.480	-3.973	.000	-.563	-.187
	Knowledge & Creativity	.066	.135	.073	.489	.626	-.203	.335
	Communication Skills	.000	.122	.000	.002	.998	-.243	.243
	Teamwork	-.085	.161	-.101	-.529	.598	-.407	.236
	Resilience	.019	.187	.024	.103	.918	-.353	.392
	Planning & Organization	.262	.168	.348	1.561	.123	-.072	.597
	Ethics & Integrity	-.090	.112	-.113	-.804	.424	-.314	.134

RQ2c: What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores on time-to-degree completion?

A hierarchical regression analysis was conducted to determine if the six PPI scale scores would contribute to explaining time-to-degree completion over and above degree level, degree program, GRE scores, and undergraduate GPA. In step one, GRE scores (verbal, quantitative, and analytical writing), undergraduate GPA, degree level (master's and doctoral), and degree program (STEM and non-STEM) were entered as predictors. The overall regression equation was statistically significant ($F_{6, 59} = 11.108$, $p < .001$). Together, the indicators explained about 53% of the variance in time-to-degree completion ($R^2 = .530$). Results indicated degree level was a significant predictor of time-to-degree completion. As expected, under the condition that all the other variables in the model remain constant, when students enrolled in doctoral programs, their expected time-to-degree completion increases.

In step two, the previous predictors were retained and the six PPI scale scores were added as predictors. The overall regression equation remained statistically significant ($F_{12, 53} = 5.852$, $p < .001$), and explained about 57% of the variance in time-to-degree completion ($R^2 = .570$). The addition of the six PPI scale scores added about 4% to the explained variance ($\Delta R^2 = .040$), which was not a statistically significant increase in explained variance ($\Delta F_{6, 53} = 0.810$, $p = .567$). Results from step two indicated that degree level remained a significant predictors of time-to-degree completion. See Table 17 for the regression coefficients.

Table 17

Hierarchical Regression Coefficients for Time-To-Degree Completion

Step	Variables	*B*	*SE*	β	*t*	*p*	95% CI for *B*	
							Lower	Upper
1	Constant	0.542	3.515		0.154	.878	-6.491	7.576
	Undergraduate GPA	0.370	0.308	0.114	1.200	.235	-.247	.987
	GRE-Verbal	0.008	0.025	0.038	0.322	.749	-.043	.059
	GRE-Quantitative	-0.009	0.022	-0.052	-0.393	.696	-.052	.035
	GRE-Analytical Writing	-0.075	0.238	-0.034	-0.314	.755	-.551	.402
	Degree Level	2.469	0.365	0.670	6.767	< .001	1.739	3.199
	Degree Program	0.473	0.330	0.167	1.434	.157	-.187	1.134
2	Constant	-0.920	4.121		-0.223	.824	-9.187	7.346
	Undergraduate GPA	0.113	0.342	0.035	0.329	.743	-.574	.800
	GRE-Verbal	0.020	0.027	0.095	0.753	.455	-.034	.075
	GRE-Quantitative	-0.004	0.025	-0.027	-0.178	.859	-.055	.046
	GRE-Analytical Writing	-0.122	0.244	-0.056	-0.499	.620	-.612	.368
	Degree Level	2.500	0.375	0.678	6.671	< .001	1.748	3.252
	Degree Program	0.415	0.350	0.146	1.186	.241	-.287	1.118
	Knowledge & Creativity	0.312	0.501	0.099	0.622	.536	-.692	1.315
	Communication Skills	-0.603	0.499	-0.188	-1.208	.233	-1.605	.399
	Teamwork	0.438	0.579	0.139	0.756	.453	-.724	1.600
	Resilience	-0.981	0.706	-0.310	-1.390	.170	-2.397	.435
	Planning & Organization	1.074	0.611	0.358	1.758	.084	-.151	2.300
	Ethics & Integrity	-0.217	0.441	-0.078	-0.491	.625	-1.101	.668

Research Question Three

RQ3a: Is there a statistically significant difference among the six PPI scale scores, GRE scores, undergraduate GPA, and graduate GPA based on the interaction among degree completion status, degree level, and degree program?

To determine if there are significant differences in undergraduate GPA, GRE scores, the six PPI scale scores, and graduate GPA based on the interaction among degree completion status (graduated vs dropped out), classification/level (master's vs doctoral), and program (STEM vs NON), a 2 x 2 x 2 MANOVA was conducted. Results indicated that the three-way interaction was not significant (Wilk's $\Lambda = .83309$, $F_{11,62} = 1.12921$, $p = .355$, $\eta^2 = .167$, eigenvalue = .20034). However, results indicated a significant two-way interaction was present for degree completion and degree program (Wilk's $\Lambda = .69584$, $F_{11,62} = 2.46369$, $p = .013$, $\eta^2 = .304$). Main effects tests indicated significant differences were present for graduate GPA. To follow up these significant findings, simple effects analysis were conducted. Among students enrolled in STEM programs, there was a significant difference in graduate GPAs between those who graduated and those who withdrew from their programs ($p < .001$). Specifically, those who graduated ($M = 3.695$, $SE = .067$) had significantly higher graduate GPAs than those who withdrew from their programs ($M = 3.147$, $SE = .131$). See Table 18 for follow up univariate test results. Further, see Table 19 for raw and standardized discriminant function coefficients and correlations between the dependent variables and the canonical variable.

Table 18

Main Effects Test Statistics for the Degree Completion and Degree Program Interaction

Dependent Variables	*df*	*F* Ratio	*p*	η^2
GRE-Verbal	1, 72	1.903	.172	.026
GRE-Quantitative	1, 72	.001	.975	.000
GRE-Analytical Writing	1, 72	.741	.392	.010
Knowledge & Creativity	1, 72	.341	.561	.005
Communication Skills	1, 72	.923	.340	.013
Teamwork	1, 72	1.142	.289	.016
Resilience	1, 72	2.836	.097	.038
Planning & Organization	1, 72	3.512	.065	.047
Ethics & Integrity	1, 72	1.691	.198	.023
Undergraduate GPA	1, 72	3.589	.062	.047
Graduate GPA	1, 72	11.215	.001	.135

Table 19

Discriminant Function Coefficients and Canonical Correlations for Degree Completion and Degree Program Interaction

Dependent Variables	Raw Discriminant Coefficients	Standardized Discriminant Coefficients	Canonical and DV Correlations
Undergraduate GPA	1.63372	.70330	.33769
GRE-Verbal	-.08230	-.56863	-.24588
GRE-Quantitative	.00497	.03398	.00571
GRE-Analytical Writing	.25311	.16481	-.15340
Graduate GPA	-2.31833	-.72811	-.59696
Knowledge & Creativity	1.18367	.53369	-.10409
Communication Skills	-.06893	-.03127	-.17122
Teamwork	.97520	.44185	-.19047
Resilience	.08346	.04037	-.30017
Planning & Organization	-2.04320	-.99879	-.33404
Ethics & Integrity	-.22179	-.11199	-.23181

To further explore how the data interacts to create group differences in the outcome variables, the weighted composites from the MANOVA were explored. Using the raw discriminant function coefficients as weights, a composite score was created for each dependent variable. This is similar to a canonical correlation and yields a weighted composite that maximizes the difference between the focal groups. Using this composite score, a two-way

ANOVA was conducted to examine if there were differences in composite scores based on the interaction between degree completion status, and degree program. This allowed the researcher to observe where the weighted composite has located group differences among all of the possible pairings of the outcome variables. Results indicated a significant two-way interaction was present ($F_{1,72} = 31.472$, $p < .001$, $\eta^2 = .304$). Based on the results presented in Table 19, the top weighted variables for the composite scores were present for graduate GPA, planning and organization skills, undergraduate GPA, and knowledge and creativity skills. To follow up the significant two-way interaction, a simple effects analysis was conducted. See Table 20 for composite score statistics by groups. Among students in non-STEM degree programs, there was a significant difference in composite scores between those who graduated and those who withdrew from their programs ($p = .004$). Specifically, those who graduated had significantly higher composite scores than those who dropped out. Additionally, among students in STEM degree programs, there was a significant difference in composite scores between those who graduated and those who withdrew from their programs ($p < .001$). Specifically, those who graduated had significantly lower composite scores than those who withdrew from their programs. In reviewing the composite scores presented earlier, it is clear that these group differences are predominately a function of graduate GPA, planning and organization skills, undergraduate GPA, and knowledge and creativity skills.

Table 20

Composite Score Statistics for Degree Program by Degree Completion

Groups					95% Confidence Interval	
		N	*M*	*SE*	*Lower*	*Upper*
Dropped Out	NON	7	-15.930	.418	-16.764	-15.096
	STEM	7	-11.882	.418	-12.716	-11.048
Graduated	NON	34	-14.477	.242	-14.960	-13.995
	STEM	32	-14.477	.214	-14.637	-13.784

RQ3b: Is there a statistically significant difference among the six PPI scale scores, GRE scores, and undergraduate GPA based on the interaction among degree completion status, degree level, and degree program?

To determine if there are significant differences in the admission's dependent variables (GRE scores, undergraduate GPA, and the PPI scale scores) based on the interaction among degree completion status (graduated vs dropped out), level (master's vs doctoral), and program (STEM vs NON), a 2 x 2 x 2 MANOVA was conducted. For this model, graduate GPA was removed as a dependent variable. Results indicated that the three-way interaction was not significant (Wilk's $\Lambda = .83078$, $F_{10,65} = 1.32394$, $p = .237$, $\eta^2 = .169$). However, results indicated a significant two-way interaction was present for degree completion and degree level (Wilk's $\Lambda = .74800$, $F_{10,65} = 2.18984$, $p = .029$, $\eta^2 = .252$, eigenvalue = .302). Main effects tests indicated significant differences were present for GRE quantitative scores. To follow up these significant findings, simple effects analysis were conducted. Among doctoral students, there was a significant difference in GRE quantitative scores between those who graduated and those who withdrew from their programs ($p = .022$). Specifically, those who graduated ($M = 148.300$, $SE =$

2.004) had significantly lower GRE quantitative scores than those who withdrew from their programs (M = 157.000, SE = 3.125, d = 3.314). See Table 21 for follow up univariate test results. Further, see Table 22 for raw and standardized discriminant function coefficients and correlations between the dependent variables and the canonical variable.

Table 21

Main Effects Test for the Degree Completion and Degree Level Interaction

Dependent Variables	*F* ratio	*df*	*p*	η^2
Undergraduate GPA	3.236	1, 74	.076	.042
GRE-Verbal	2.767	1, 74	.100	.036
GRE-Quantitative	5.041	1, 74	.028	.064
GRE-Analytical Writing	0.066	1, 74	.798	.001
Knowledge & Creativity	0.245	1, 74	.622	.003
Communication Skills	1.919	1, 74	.170	.025
Teamwork	0.682	1, 74	.412	.009
Resilience	0.201	1, 74	.655	.003
Planning & Organization	0.000	1, 74	.983	.000
Ethics & Integrity	0.087	1, 74	.769	.001

Table 22

Discriminant Function Coefficients and Canonical Correlations for Degree Completion and Degree Level Interaction

Dependent Variables	Raw Discriminant Coefficients	Standardized Discriminant Coefficients	Canonical and DV Correlations
Undergraduate GPA	1.75340	.74802	.36030
GRE-Verbal	-.08587	-.58741	-.33316
GRE-Quantitative	-.07207	-.49340	-.44967
GRE-Analytical Writing	.28562	.18497	.05156
Knowledge & Creativity	.05066	.02262	.09906
Communication Skills	1.45842	.65324	.27742
Teamwork	1.38548	.62412	.16541
Resilience	-.43162	-.20611	-.08983
Planning & Organization	-1.99287	-.96729	-.00424
Ethics & Integrity	-.19982	-.10032	.05908

To further explore how these variables interacts to create group differences in the outcome variables, the weighted composites from the MANOVA were explored. Using the raw discriminant function coefficients as weights, a composite score was created for each dependent variable. Using this composite score, a two-way ANOVA was conducted to examine if there were differences in composite scores based on the interaction among degree completion status and degree level. Results indicated a significant interaction was present ($F_{1,74} = 23.991$, $p < .001$,

$\eta^2 = .245$). As shown in the Table 22, the top weighted variable composite scores are present for undergraduate GPA, planning and organization, communication skills, and teamwork. To follow up on the significant interaction, a simple effects analysis was conducted. See Table 23 for composite score statistics by groups. Among doctoral students, there was a significant difference in composite scores between those who graduated and those who dropped out ($p < .001$). Specifically, those who graduated had significantly higher composite scores than those who dropped out. Additionally, among master's students, there was a significant difference in composite scores between those who graduated and those who dropped out ($p = .001$). Specifically, those who graduated had significantly lower composite scores than those who dropped out. In reviewing the composite scores presented, it is clear that these group differences are predominately a function of undergraduate GPA, planning and organization, communication skills, and teamwork scores.

Table 23

Composite Scores for Degree Level by Degree Completion

Groups					*95% Confidence Interval*	
		N	*M*	*SE*	*Lower*	*Upper*
Dropped Out	Masters	11	-13.312	0.312	-13.935	-12.690
	Doctoral	5	-15.401	0.471	-16.339	-14.463
Graduated	Masters	54	-14.460	0.141	-14.740	-14.179
	Doctoral	12	-13.336	0.302	-13.937	-12.734

Research Question Four

RQ4: How do the six PPI scale scores perform in terms of creating variability between applicants?

To examine if ceiling and floor effects were present, frequencies and percentages of participants achieving the highest and lowest possible scores for each PPI scale were examined. Specifically, the 15% ceiling and floor effect threshold for participants achieving the highest and lowest possible scores was adopted (Lim et al., 2015; Wang et al., 2008). See Table 24 for floor and ceiling effect percentage estimates. Overall, results indicated the absence of floor effects for each of the PPI scales. This is because the frequency percentage of the lowest possible score obtained by applicants was less than 15%. However, results indicated that there was evidence of a ceiling effect for the Ethics and Integrity PPI scale. Specifically, 17% of the respondents achieved the highest possible score. Overall, due to the presence of a ceiling effect in the Ethics and Integrity scale, this presents a limitation of this instrument.

Table 24

PPI Scale Score Percentages

Variables			Lowest Value = 1		Highest Value = 5	
	M	*SD*	*N*	%	*N*	%
Knowledge & Creativity	4.083	0.442	0	0	1	0.9
Communication Skills	3.951	0.508	0	0	0	0
Teamwork	4.236	0.456	0	0	4	3.6
Resilience	4.186	0.494	0	0	2	1.8
Planning & Organization	4.067	0.519	0	0	1	0.9
Ethics & Integrity	4.454	0.469	0	0	19	17.0

Summary

This chapter provided a description of the statistical analyses used to evaluate each of the research questions of this study. Additionally, this chapter presented the results of this dissertation research study. Overall, the PPI scale scores alone were not significant predictors of graduate student degree completion status, graduate GPA, and time-to-degree completion (RQ 1). However, when the other admissions variables were included in the model (GRE scores, undergraduate GPA, degree level, and degree program), the planning and organization PPI scale significantly predicted graduate degree completion status and graduate GPA while holding the other variables in the model constant. Further, there was a statistically significant difference among the six PPI scale scores, GRE scores, undergraduate GPA, and graduate GPA based on the interaction among degree completion status, degree level, and degree program. Specifically, there was a significant three-way interaction. Based on this interaction and composite scores from the canonical correlation analysis, group differences are predominately a function of undergraduate GPA and graduate GPA. However, when graduate GPA was taken out of this model, the three-way interaction did not remain significant. However, a two-way interaction between degree completion status and degree level was significant. Ultimately, these group differences were predominately a function of GRE – quantitative scores. Last, when examining how the PPI scales create variability among the applicants, results indicated the presence of a ceiling effect for the Ethics & Integrity PPI scale in our data. Chapter 5 concludes this dissertation research study with a summary of the results, limitations of the research study, implications and future recommendations, and conclusions.

CHAPTER V: DISCUSSION

Introduction

Although admissions practices are intended to select students who are the most likely to succeed, graduate student attrition rates range between 40% to 60% depending on degree field or discipline (Bair & Haworth, 1999; CGS, 2008; Schramm-Possinger & Powers, 2015). Generally, graduate admissions assessments are limited to traditional cognitive ability measures such as the Graduate Record Examination (GRE) and undergraduate grade point average (GPA). However, research suggests that students' personal qualities, which are not measured by traditional cognitive assessments, serve as strong determinants of graduate student success. Therefore, the inclusion of noncognitive assessments with the current cognitive ability measures can enhance the quality of information obtained. And as a result, this can ultimately improve decision making practices and admissions decisions (Sedlacek, 2010).

The purpose of this study was twofold. First, this study examined the association of noncognitive factors with graduate student performance and degree completion. Second, this study examined the measurement integrity and the utility of the Personal Potential Index (PPI) as an avenue to reliably assess noncognitive factors of graduate students that avoids the drawbacks associated with self-assessment methods and recommendation letters (Kyllonen, 2008; McCaffrey et al., 2018).

The current study employed a nonexperimental quantitative research design using archival TPE survey data. Archival data from a sample of 362 graduate student applicants was obtained from Educational Testing Service. Of the 362 graduate applicants, 112 students enrolled at the university. The data from the enrolled student sample was therefore used to examine group differences and investigate the predictive relationships among the noncognitive factors (PPI scale

scores) and graduate school success outcomes (graduate GPA, degree completion, and time-to-degree).

Research Questions

The researcher raised the following research questions:

1. What are the predictive relationships among the six PPI scale scores…
    a. on graduate student degree completion status?
    b. on graduate grade point average?
    c. on graduate student time-to-degree completion?
2. What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores…
    a. on graduate student degree completion status?
    b. on graduate grade point average?
    c. on graduate student time-to-degree completion?
3. Are there group differences based on the interaction of degree completion status, degree level, and degree program among …
    a. the six PPI scale scores, GRE scores, graduate GPA, and undergraduate GPA?
    b. the six PPI scale scores, GRE scores, and undergraduate GPA?
4. How do the six PPI scales perform in terms of creating variability between applicants?

Summary

Research Question One

What are the predictive relationships among the six PPI scale scores on

A) degree completion status

B) graduate GPA

C) time-to-degree completion?

In order to examine the predictive relationships among the noncognitive factors and graduate school success outcomes, multiple logistic regression analyses as well as multiple regression analyses were conducted. Results indicated that the PPI scales alone were not significant predictors of degree completion, graduate GPA, and time-to-degree.

As previously stated, the planning and organization subscale is closely related to conscientiousness, one of the traits on the five-factor model of personality. Consistent with the results of this study, Greham et al. (2011) indicated that conscientiousness alone could not significantly predict graduate GPA. Additionally, Kuncel et al. (2014) indicated that letters of recommendation alone exhibit a positive yet low effect on academic performance. Therefore, it is clear that additional factors are needed in the model. However, results from this study are inconsistent with others. First, as previously stated, the knowledge and creativity scale is closely related to the openness trait on the five-factor model of personality. Additionally, research has shown that openness has been shown to be related to cognitive ability and academic outcomes (Kyllonen et al., 2005). Further, doctoral students have often attributed their difficulties in their degree program and their reasons for departure and persistence to their inadequate communication skills (Schramm-Possinger & Powers, 2015). Last, resilience and work ethic, teamwork, as well as ethics and integrity have all been deemed incredibly important to workforce employers, graduate faculty members, and are often indicative of task performance and one's ability to carry out their responsibilities (Casner-Lotto & Barrington, 2006; Kyllonen, 2012). With these previous findings in mind, inconsistencies of these results may have occurred

due to the nature in which the data were collected. As mentioned previously, common methods to measure noncognitive factors often occurred in the form of self-report assessments. This research study utilized a third-party evaluation system, where outside raters evaluated graduate applicants on a specific set of skills. Therefore, it is possible that inconsistencies are due to how the data were collected.

Research Question Two

What are the predictive relationship among the six PPI scale scores above and beyond student degree classification, student degree program, undergraduate GPA, and GRE scores on

A) degree completion status

B) graduate GPA

C) time-to-degree completion?

To build upon the first research question, hierarchical multiple logistic regression analyses as well as hierarchical multiple regression analyses were conducted. These analyses were used to determine if the PPI scales predicted graduate school success outcomes above and beyond common admissions data (GRE scores, undergraduate GPA, degree level, and degree program). For degree completion, the admissions data alone did not predict degree completion. When the six PPI scale scores were added to the model, the planning & organization scale was a significant predictor. Specifically, under the assumption that all of the other variables remain constant, a one-point increase was associated with the likelihood of degree completion increased by approximately 33%.

The ability to predict degree completion, a dichotomous variable, remains a significantly difficult task for researchers (Kuncel et al., 2014). Once again, planning and organization which is closely related to conscientiousness, has been previous documented as one of the strongest

predictors and contributors to academic success and achievement as well as job performance (Kyllonen et al., 2005). Therefore, findings from this study are consistent with previous research. Similar to the findings presented in this study, Kuncel et al. (2014) found that the addition of letters or recommendation (to undergraduate GPA, GRE scores, GGPA, and faculty ratings) increased improvement in prediction for degree attainment. Ultimately, the results presented in this study suggest that incorporating noncognitive factors, such as the PPI scales, with cognitive measures has the capability to contribute meaningfully to predicting difficult dichotomous outcomes including degree completion.

When predicting graduate GPA, of the admissions data, degree program was a significant predictor of graduate GPA. Specifically, when a student enrolls in a STEM degree program, their graduate GPAs are more likely to be lower than non-STEM degree programs. This findings is consistent with previous research, where STEM degrees are often associated with lower graduate GPAs (Floyd, 2019). When the six PPI scales were added to the model, degree program and GRE analytical writing scores were significant predictors of graduate GPA. The addition of the six PPI scale scores contributed to an incremental increase in the predictive influence of the GRE analytical writing scores. Inconsistent with the findings from this study, conscientiousness has been determined to be one of the strongest predictors of graduate student achievement (Kyllonen et al., 2005). Therefore, it was expected that planning and organization skills would have significantly predicted graduate GPA. Additionally, increases in GRE analytical scores, while holding the other variables constant, were associated with increases in graduate GPA. This finding is consistent with previous validity research of the GRE, specifically stating that GRE Analytical writing scores alone provide more value than undergraduate GPA (Klieger et al., 2014). However, it is unclear why GRE verbal and quantitative scores were not significant

predictors of graduate GPA, which has been found by several validity studies (Burton & Wang, 2005; Klieger et al., 2014; Kuncel, Hezlett, et al., 2001; Kuncel et al., 2010). This may be due to the nature of the sample in this research study as well as the normality violation of graduate GPA.

When predicting for time-to-degree completion, of the admissions data, degree level was a significant predictor of time-to-degree completion. Specifically, when a student enrolls in a doctoral degree level program, their time-to-degree completion increases. This is an expected finding because the time needed to complete a doctoral degree is much more extensive and lengthier than the time needed to complete a master's degree. When the six PPI scales were added to the model, degree level remained the only significant predictor. Inconsistent with the present study's findings, previous research has often indicated that degree program is significantly associated with one's time-to-degree completion (Baird, 1990; Bok, 2013). Specifically, previous research indicates that STEM fields on average typically have the fastest rates regarding degree completion duration, whereas non-STEM fields typically have the slowest and longest average degree completion duration. However, degree level being a significant predictor of time-to-degree completion was entirely expected.

Research Question Three

Is there a statistically significant difference among the six PPI scale scores, GRE scores, undergraduate GPA, and graduate GPA based on the interaction among degree completion status, degree level, and degree program?

In addition to examining the predictive relationships among the variables, the researcher was interested in examining which variables predominately contributed to group differences specifically for degree completion status (complete vs withdrew), degree level (masters vs

doctoral), and degree program (STEM vs non-STEM). When graduate GPA was included in the model, the three-way interaction was not significant. However, a two-way interaction for degree completion and degree program was significant. To interpret the significant interaction, the researcher examined main effects analyses which indicated that significant differences were present for graduate GPA. To further interpret these findings, simple effects analyses indicated that for students enrolled in STEM programs, those who graduated had significantly higher graduate GPAs than those who withdrew from their programs. This finding is consistent with Pyke and Sheridan's (1993) research that for master's students, higher graduate GPAs are associated with increased changes of degree completion. Additionally, research has shown that higher academic aptitude is associated with higher chances of persistence (Attiyeh, 1999). However, Bair and Haworth's (1999) seminal meta-synthesis conclude that traditional academic indicators are not reliable predictors or distinguishers of degree completion, with the exception of GRE section scores. This is also consistent with findings from Lovitts (1996), where academic indicators were not reliable distinguishers of doctoral students who graduated and those who withdrew from their programs.

Is there a statistically significant difference among the six PPI scale scores, GRE scores, and undergraduate GPA based on the interaction among degree completion status, degree level, and degree program?

In addition to this model, a second model that did not include graduate GPA was examined. This was done to examine significant differences in the admissions level data and the PPI level data based on the significant interaction among degree completion, level, and program. When graduate GPA was not included in the model, the three-way interaction was not significant. However, a significant two-way interaction was present for degree completion and

degree level. Main effects analyses indicated that significant differences were present for GRE quantitative scores. Simple effects analyses then demonstrated that among doctoral students, those who graduated had significantly lower GRE quantitative scores than those who withdrew from their programs. Interestingly, these results about doctoral students appear to be inconsistent with Burton & Wang's (2005) predictive validity study of the GRE. Specifically, for master's students, students who withdrew from their program often had lower GRE scores than those who completed their degrees. In contrast, doctoral students who withdrew from their degree program often had good, or even comparable GRE scores to those who graduated (Burton & Wang, 2005). Inconsistencies in these findings remain puzzling. However, these inconsistencies may have resulted due to the nature of our sample as well as possible differing standards and criteria degree programs uphold when admitting students.

Research Question Four

How do the six PPI scale scores perform in terms of creating variability between applicants?

Finally, to determine how well the PPI scales performed in terms of creating enough variability among graduate applicants, ceiling and floor effects were examined in the data. Results indicated that a ceiling effect was present for the ethics and integrity scale. These findings are not surprising. Specifically, in TPE systems, raters may demonstrate differing leniency levels in their evaluations based on their own standards and tendencies which can result in excess rater variance (Oliveri, McCaffrey, et al., 2017). Additionally, evaluators may positively appraise applicants due to the evaluator's desire to portray the applicant socially desirable to graduate programs. Unfortunately, these occurrences threaten the validity of the assessment and its interpretations.

Limitations

The present study is not without its limitations, which are critically discussed. First, the current study is based off of a small sample size. Although for the institution this is a positive occurrence, in the current sample, there was a disproportionately small number of students who withdrew from their programs (n = 19; 17%) compared to those who completed their degrees (n = 85; 75.9%). Additionally, there was a small number of doctoral students (n = 27; 24.1%) that was represented in the sample compared to master's students (n = 75, 67%). With these sample sizes in mind, it is difficult to certainly claim the magnitude of the predictive influence of these variables or to confidently claim group differences. Further, the data in this research study was based on data collected from one institution. Therefore, generalizability of these results is undoubtably restricted. Second, the normal assumption violation of the outcome variables, specifically graduate GPA was a significant issue in this research study, especially since this was a primary dependent variable. Although the graduate GPA variable was transformed normally, relationships and associations among variables were restricted and impacted. This may be the reason the other sections of the GRE or the planning and organization subscale were not significant predictors of this outcome. Third, results from this study were based on data that were previously collected from one single institution. Although there are many benefits of using archival data in research studies, the researcher however had limited ability to manipulate any of the independent variables or collect additional data on these students. Specifically, since this data were collected previously, some of the students' current status (e.g., enrollment status) and graduate GPA may not be up-to-date or difficult to update, especially since this data was de-identified. Therefore, due to these circumstances, data in this current research study may not capture a complete and accurate account of the associations among noncognitive factors and

degree completion status and academic achievement. Future research should consider having up-to-date student status data a priority in order to determine difference between degree completion statuses more accurately. Additionally, future research should collect data from graduate applicants from a variety of institutions and institutional types.

Fourth, regarding the instrument's reliability, intraclass correlation estimate classifications for the data ranged from poor to moderate for both the enrolled student sample (n = 93) as well as the entire student sample (n = 362). Unfortunately, poor interrater reliability estimates can be a reflection of not only a lack of agreement among raters, but also small sample sizes or a lack of variability among the participants (Koo & Li, 2016). This seems to be consistent with this sample in this study, since the sample was small and was from one institution. Since students in this research study were able to choose their own evaluators and were evaluated by at least one evaluator, rater bias may be present in the data (Koo & Li, 2016; Oliveri & Ezzo, 2014). Last, the presence of a ceiling effect in the Personal Potential index instrument serves as additional limitation for our results. Commonly, rating inflation may occur when a rater evaluates an applicant generously to provide a good impression to decision makers (Oliveri & Ezzo, 2014). Unfortunately, with this occurrence, it is difficult to objectively differentiate and compare the ability level of applicants and rank individuals. Additionally, ceiling effects can cause a variety of measurement issues and provide an inaccurate measure of central tendency and variance. However, one method to address this limitation is to use normative data for decision making practices and have an up-to-date understanding of the validity of the instrument. Although presently, the PPI does not currently have normative data, validity studies of the instrument are in progress and will be available in the future.

Implications and Future Directions

Results from this dissertation study have important implications for advancing our understanding of student ability and current admissions practices at the graduate education level. First, at the admissions level, the results from this study suggest that incorporating noncognitive assessments in addition to current cognitive assessments could improve the quality of information of graduate applicants' abilities and as a result, student selection. Specifically, through the inclusion of the PPI scales with current cognitive ability measures as well as student degree program information, degree completion, graduate GPA, and time-to-degree completion were both significantly predicted. It is notable that degree completion, an often-difficult dichotomous variable to predict, was significantly predicted by the planning and organizational skills. Although for graduate GPA and time-to-degree, the noncognitive factors were not specific significant predictors of these outcomes, their inclusion in the model contributed to the incremental increase in the predictive influence of the currently used admissions tools. Therefore, the inclusion of noncognitive factors in these contexts can aid in the predictive influence of admissions tools that are currently in use. Further, since cognitive ability measures tend to put underrepresented and nontraditional student populations at a disadvantage for educational access, incorporating noncognitive assessments can help combat existing issues of educational access, wage inequality, and institutional diversity (Kent & McCarthy, 2016; Oliveri & Ezzo, 2014; Sedlacek, 2004). However, with the limitations of this research study in mind, implications may be more helpful at the degree program level. At the degree program level, evaluating and monitoring students on their noncognitive skills yearly can provide insight of their skill development, progression, as well as help identify areas that students can improve. Specifically, degree programs can assess graduate students on their noncognitive traits when they begin their degree programs and monitor progress/developments. Ultimately, these results could

provide departments and programs suggestions for resources/interventions to help students who are currently enrolled to develop in areas imperative for success (mentoring programs, writing workshops, etc.) which could help combat student departure. Third, this study demonstrates the promising features of third-party evaluation systems to evaluate graduate applicant's noncognitive factors. As previously mentioned, many common assessments of noncognitive traits are subjected to measurement limitations. Results from this study demonstrate that, although there are some limitations present, this assessment method is an effective avenue to assess these skills. Because this method is standardized and structured in a way that collects data on a specific set of skills, this allows researchers and other uses to obtain information about an applicant's potential that is quantitative, structured, and more reliable than letters of recommendation.

Findings from the current dissertation study demonstrate that noncognitive factors have a unique contribution in explaining differences in graduate GPA, degree completion, and to a lesser extent, time-to-degree completion. However, the PPI noncognitive scales alone were not significant predictors of graduate success outcomes. Regarding future directions, it is critical that more research is conducted with this student population that examines these students longitudinally, with large sample sizes across varying institutions and institutional types. Not only is this work critical to determine quantitatively the relationship among noncognitive skills and graduate student success outcomes, but this work can ultimately improve admissions practices and help degree programs monitor, develop, and retain their students. Additionally, with large sample sizes, future research efforts should conduct a restriction of range corrections when normative data of the PPI scales become available. Through this analysis, researchers have the opportunity to see if these factors strongly relate to important graduate school outcomes.

Additionally, because noncognitive assessments are subjected to a variety of measurement limitations, it is critical to ensure that the instrument under evaluation has strong measurement integrity. Specifically, researchers should conduct a person separation statistical analysis. In addition to other common reliability estimates, this type of analysis is used to classify people and provides an estimates of the spread of the sample of individuals along a continuum of ability level in units of measurement error (Fisher, 1992). Through this analysis, researchers can determine if the instrument is sensitive enough to discriminate high and low performers. Last, incorporating an evaluator training for this assessment can potentially aid in the presence of excess rater bias and variance. As mentioned previously, these constructs have been shown to be difficult to measure, and in this present study the use of evaluator training on the instrument could have beneficially aided the measurement integrity of the instrument. Specifically, evaluator trainings could have possibly eliminated the presence of the ceiling effect and improved the inter-rater reliability estimates in the present study.

Conclusion

Those who have received graduate degrees often occupy prestigious academic and research positions, business, and industry positions, as well as administrative positions. Although there is prestige associated with obtaining a graduate degree, research illustrates that about 40% to 60% of graduate students fail to complete their graduate degrees depending on one's field (Bair & Haworth, 1999; CGS, 2008). Ultimately, student attrition remains a significant problem within the graduate education system.

Results from this research study demonstrate the association between noncognitive factors and important graduate success outcomes. Including the six PPI scale scores with currently used admissions and student data, resulted in significantly predicting student degree

completion status. Specifically, this incorporation provides decision-makers with information that pertains to a student's probability to complete their degrees. As a result, this can provide dramatic benefits and improvements in regard to graduate student degree completion rates, institutional ratings, institutional spending/funding for graduate students, and the overall occurrence of graduate student attrition.

Additionally, including noncognitive assessments has the potential to help enhance accessibility to education and minimize group differences. This is because cognitive ability measures have historically put various student population groups including nontraditional students, students from ethnic backgrounds, and underrepresented minority students at a disadvantage for educational acceptance and perpetuate group differences and score gaps (Oliveri & Ezzo, 2014; Sedlacek, 2004; Michel et al., 2019). Previous research suggests that nontraditional students demonstrate their abilities through noncognitive experiential and contextual assessments which are not evaluated by traditional standardized tests (Sedlacek, 2004). Therefore, incorporating noncognitive assessments in admissions practices can provide these students an additional avenue to demonstrate their skills and abilities to decision-makers. As a result, this incorporation can help combat existing issues of inequity in educational access and promote institutional diversity.

Overall, the present research study supports the usefulness of assessing graduate student's noncognitive traits, as done through Educational Testing Service's Personal Potential Index, in addition to cognitive ability measures. This study suggests that this incorporation can enhance decision-makers' ability to predict important graduate student success outcomes in an effort to combat the occurrences of graduate student attrition.

References

Alijohani, O. (2016). A comprehensive review of the major studies and theoretical models of student retention in higher education. *Higher Education Studies, 6*(2), 1-18. http://dx.doi.org/10.5539/hes.v6n2p1

Attiyeh, G. M. (1999). *Determinants of persistence of graduate students in Ph.D. programs*. (GRE Board Report No. 95-18R). Princeton, NJ: Educational Testing Service.

Astin, A.W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40*(5), 518-529.

Bair, C. R. & Haworth, J. G. (1999). *Doctoral student attrition and persistence: A meta-synthesis of research*. ASHE Annual Meeting Paper.

Baird, L. L. (1990). Disciplines and doctorates: The relationships between program characteristics and the duration of doctoral study. *Research in Higher Education, 31*(4), 369-385. https://doi.org/10.1007/BF00992273

Baird, L. L. (1993). Using research and theoretical models of graduate student progress. *New Directions for Institutional Research, 80*, 3-12. https://doi.org/10.1002/ir.37019938003

Baird, L. L. (1997). Completing the dissertation: Theory, research, and practice. *New Directions for Higher Education,* (99), 99-105. https://doi.org/10.1002/he.9909

Barry, M. & Mathies, C. (2011). *An examination of master's student retention and completion*. Paper presented at the Association of Institutional Research Annual Forum Toronto, Ontario

Bean, J. (1980). Dropouts and turnover: The synthesis and test of a causal model of student attrition. *Research in Higher Education, 12*(2), 155-87.

Berger, J. B., Blanco Ramírez, G. & Lyon, S. (2012). Past to present: A historical look at retention. In A. Seidman (Ed.), *College Student Retention: Formula for Student Success* (pp. 7-34). Lanham, MD: Rowman & Littlefield.

Bok, D. (2013). Graduate education. In D. Bok (Eds.) *Higher education in America* (pp. 225-246). Princeton University Press.

Bowen, W. G., & Rudenstine, N. L. (1992). *In pursuit of the PhD*. Princeton, NJ: Princeton University Press.

Burton, N. W. & Wang, M. (2005). *Predicting long-term success in graduate school: A collaborative validity study*. (GRE Board Report No. 99-14R; ETS Research Report No. RR-05-03). Princeton, NJ: Educational Testing Service.

Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work: Employers perspectives on the knowledge and applied skills of new entrants to the 21st century U.S. workforce.* The Conference Board, Inc., the Partnership for 21st Century Skills, Corporate Voices for Working Families, and the Society for Human Resource Management. Retrieved from http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=82&Itemid=40

Council of Graduate Schools. (2008). *Ph.D. completion and attrition: Analysis of baseline program data from the Ph.D. completion project.* Washington, DC: Author.

Council of Graduate Schools. (2009). *Ph.D. completion and attrition: Findings from exit surveys of Ph.D. completers*. Washington, DC: Author

Council of Graduate Schools & Educational Testing Service. (2010). *The path forward: The future of graduate education in the United States.* Report from the Commission on the

Future of Graduate Education in the United States. Princeton, NJ: Educational Testing Service.

Crede, M. & Kuncel, N. R. (2008). Study habits, skills, and attitudes: The third pillar supporting collegiate academic performance. *Perspectives on Psychological Science, 3*(6), 425-453. https://doi.org/10.1111/j.1745-6924.2008.00089.x

De Clercq, M., Devos, C., Azzi, A., Frenay, M., Klein, O., & Galand, B. (2019). I need somebody to lean on: The effect of peer, relative, and supervisor support on emotions, perceived progress, and persistence in different stages of doctoral advancement. *Swiss Journal of Psychology,* (2019), 1-13. http://doi.org/10.1024/1421-0185/a000224

Demetriou, C. & Schmitz-Sciborski, A. (2011). Integration, motivation, strengths and optimism: Retention theories past, present and future. In R. Hayes (Eds.) *Proceedings of the 7th National Symposium on Student Retention, 2011, Charleston* (pp. 300–312). Norman: The University of Oklahoma.

Devos, C., Boudrenghien, G., Van der Linden, N., Azzi, A., Frenay, M., Galand, B., & Klein, O. (2017). Doctoral students' experiences leading to completion or attrition: A matter of sense, progress and distress. *European Journal of Psychology of Education, 32*(1), 61–77. http://doi.org/10.1007/s10212-016-0290-0

Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher, 44*(4), 237–251. https://doi.org/10.3102/0013189X15584327

Duckworth, A. L., Quirk, A., Gallop, R., Hoyle, R. H., Kelly, D. R. & Matthews, M. D. (2019). Cognitive and noncognitive predictors of success. *Proceedings of the National Academy of Sciences, 116*(47), 1-6. https://doi.org/10.1073/pnas.1910510116

Enright, M. K., & Gitomer, D. (1989). *Toward a description of successful graduate students* (GRE Board Research Report No. 85-17R). Princeton, NJ: ETS. https://doi.org/10.1002/j.2330-8516.1989.tb00335.x

Ethington, C. A. & Pisani, A. (1993). The RA and TA experience: Impediments and benefits to graduate study. *Research in Higher Education, 34*(3), 343-354. https://doi.org/10.1007/BF00991848

Faghihi, F. & Ethington, C. A. (1996). *The effect of doctoral students' background, involvement, and perception of growth on their intention to persist*. ASHE Annual Meeting Paper

Farruggia, S. P., Han, C., Watson, L., Moss, T. P. & Bottoms, B. L. (2018). Noncognitive factors and college student success. *Journal of College Student Retention: Research, Theory & Practice, 20*(3), 308-327. https://doi.org/10.1177/1521025116666539

Fisher, W. P. (1992). Reliability, separation, strata statistic. *Rasch Measurement Transactions, 6*(3), 238. https://www.rasch.org/rmt/rmt63i.htm

Floyd, B. A. (2019). Studying the graduate record examinations' ability to predict student success as measured by graduate grade point averages. *MPA/MPP Capstone Projects.* 313. https://uknowledge.uky.edu/mpampp_etds/313

Girves J. E. & Wemmerus, V. (1988). Developing models of graduate student degree process. *The Journal of Higher Education, 59*(2), 169-189. https://doi.org/10.1080/00221546.1988.11778320

Gittings, G., Bergman, M., Shuck, B., & Rose, K. (2018). The Impact of student attributes and program characteristics on doctoral degree completion. *New Horizons in Adult Education & Human Resource Development, 30*(3), 3–22. https://doi.org/10.1002/nha3.20220

Golde, C. M. (1998). Beginning graduate school: Explaining first-year doctoral attrition. *New Directions for Higher Education*, (101), 55-64. https://doi.org/10.1002/he.10105

Golde, C. M. (2005) The role of the department and discipline in doctoral student attrition: Lessons from four departments, *The Journal of Higher Education, 76*(6), 669-700, https://doi.org/10.1080/00221546.2005.11772304

Grehan, P. M., Flanagan, R., & Malgady, R. G. (2011). Successful graduate students: The roles of personality traits and emotional intelligence. *Psychology in the Schools, 48*(4), 317–331. https://doi-org.spot.lib.auburn.edu/10.1002/pits.20556

Gururaj, S., Heilig, J. V. & Somers, P. (2010). Graduate student persistence: evidence from three decades. *Journal of Student Financial Aid, 40*(1), 31-46. https://ir.library.louisville.edu/jsfa/vol40/iss1/3

Hwang, E., Smith, R. N., Byers, V. T., Dickerson, S., McAlister-Shields, L. Onwuegbuzie, A. J. & Benge, C. (2015). Doctoral students' perceived barriers that slow the progress toward completing a doctoral dissertation: A mixed analysis. *Journal of Educational Issues, 1*(1), 165-190. https://doi.org/10.5296/jei.v1i1.7703

Holms, B., McAuley Brown, L. T., Parker, D. M., Mann, J., & Woods, E. (2016). Decoding persistence and engagement patterns of doctoral students who finish. *Education Doctorate Faculty Works, 11*. Retrieved from https://openriver.winona.edu/educationeddfacultyworks/11

Kelley, M. J. M. & Salisbury-Glennon, J.D. (2016). The role of self-regulation in doctoral students' status of all but dissertation (ABD). *Innovative Higher Education, 41*, 87 – 100. https://doi.org/10.1007/s10755-015-9336-5

Kent, J. D. & McCarthy, M. T. (2016). *Holistic review in graduate admissions: A report from the council of graduate schools*. Washington, DC: Council of Graduate Schools

Kerlin, S. P. (1995). Pursuit of the Ph.D.: "Survival of the fittest," or is it time for a new approach. *Education Policy Analysis Archives, 3*(16), 1-28. https://doi.org/10.14507/epaa.v3n16.1995

Kim, S., & Kyllonen, P. C. (2006). *Rasch rating scale modeling of data from the Standardized Letter of Recommendation*. (ETS Research Report RR-06-33). Princeton, NJ: ETS.

Klieger, D. M., Cline, F. A., Holtzman, S. L., Minsky, J. L., & Lorenz, F. (2014). *New Perspectives on the Validity of the "GRE"® General Test for Predicting Graduate School Grades.* ETS GRE® Board Research Report. ETS GRE®-14-03. ETS Research Report. RR-14-26. ETS Research Report Series.

Koo, T. K. & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155-63. https://doi.org/10.1016/j.jcm.2016.02.012

Kuncel, N. R. and Hezlett, S. A. (2010). Fact and fiction in cognitive ability testing for admissions and hiring decisions. *Current directions in psychological science, 19*(6), 339-345.

Kuncel, N. R., Hezlett, S. A., & Ones, D. S. (2001). A comprehensive meta-analysis of the predictive validity of the Graduate Record Examinations: Implications for graduate student selection and performance. *Psychological Bulletin, 127*(1), 162-181. https://doi.org/10.1037//Q033-2909.127.1.162

Kuncel, N. R., Kochevar, R. J., & Ones, D. S. (2014). A meta-analysis of letters of recommendation in college and graduate admissions: Reasons for hope. *International Journal of Selection and Assessment, 22,* 101–107. https://doi.org/10.1111/ijsa.12060

Kuncel, N. R., Wee, S., Serafin, K., & Hezlett, S. A. (2010). The validity of the graduate record examination for master's and doctoral programs: A meta-analytic investigation. *Educational and Psychological Measurement, 70*(2), 340-352. https://doi.org/10.1177/0013164409344508

Kyllonen, P. C. (2005). *The case for noncognitive assessments* (R&D Connection No. 4). Princeton, NJ: Educational Testing Service.

Kyllonen, P. C. (2008). *The research behind the ETS personal potential index*. Princeton, NJ: Educational Testing Service. Retrieved from http://www.ets.org/Media/Products/PPI/10411_PPI_bkgrd_report_RD4.pdf

Kyllonen, P. C. (2012a). The importance of higher education and the role of noncognitive attributes in college success. *Pensamiento Educativo, 49*(2), 84–100. https://doi-org.spot.lib.auburn.edu/10.7764/PEL.49.2.2012.7

Kyllonen, P. C. (2012b). *Measurement of 21st century skills within the common core state standards.* Paper presented at the Invitational Research Symposium on Technology Enhanced Assessments

Kyllonen, P. C., & Kim, S. (2005). *Personal qualities in higher education: Dimensionality of faculty ratings of students applying to graduate school.* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Kyllonen, P. C., Lipnevich, A. A., Burrus, J. & Roberts, R. D. (2014). *Personality, motivation, and college readiness: A prospectus for assessment and development*. (ETS Research Report No. RR-14-06). Princeton, NJ: ETS.

Kyllonen, P. C., Walters, A. M., & Kaufman, J. C. (2005). Noncognitive constructs and their assessment in graduate education: A review. *Educational Assessment, 10,* 153 – 184. https://doi.org/10.1207/s15326977ea1003_2

Kyllonen, P. C., Walters, A. M., & Kaufman, J. C. (2011). *The role of noncognitive constructs and other background variables in graduate education.* (GRE Board Report No. GREB-03-11). Princeton, NJ: Educational Testing Service. https://doi.org/10.1002/j.2333-8504.2011.tb02248.x

Lee, J. & Shute, V. J. (2009). *The influence of noncognitive domains on academic achievement in K-12*. (ETS Research Report No. RR-09-34). Princeton, NJ: Educational Testing Service.

Lim, C. R., Harris, K., Dawson, J., Beard, D. J., Fitzpatrick, R., & Price, A. J. (2015). Floor and ceiling effects in the OHS: An analysis of the NHS PROMs data set. *BMJ Open, 5*(7), 1-8. https://doi.org/10.1136/bmjopen-2015-007765

Litalien, D. & Guay, F. (2015). Dropout intentions in PhD studies: A comprehensive model based on interpersonal relationships and motivational resources. *Contemporary Educational Psychology, 41*, 218-231. http://dx.doi.org/10.1016/j.cedpsych.2015.03.004

Liu, O. L., Minsky, J., Ling, G. & Kyllonen, P. (2009). Using the standardized letter of recommendation in selection: Results from a multidimensional rasch model. *Educational and Psychological Measurement, 69*(2), 475-492. https://doi.org/10.1177/0013164408322031

Lovitts, B. E. (1996). *Who is responsible for graduate student attrition-the individual or the institution? Toward an explanation of the high and persistent rate of attrition.* AERA Annual Meeting Paper.

Lovitts, B. E. (2008). The transition to independent research: Who makes it, who doesn't, and why. *The Journal of Higher Education, 79*(3), 296-325. https://doi.org/10.1080/00221546.2008.11772100

McCaffrey, D. F., Oliveri, M. E. & Holtzman, S. (2018). *A generalizability theory study to examine sources of score variance in third-party evaluations used in decision-making for graduate school admissions.* (GRE Board Research Report No. 18-03; ETS Research Report No. RR-8-37). Princeton, NJ: ETS. https://doi.org/10.1002/ets2.12225

McMillan, J. H. (2015). *Educational research: Fundamentals for the consumer*. (7th ed.). Boston: Pearson Education.

Messick, S. (1979). Potential uses of noncognitive measurement in education. *Journal of Educational Psychology, 71*(3), 281-292. https://doi.org/10.1002/j.2333-8504.1978.tb01156.x

Michel, R. S., Belur, V., Naemi, B., & Kell, H. J. (2019). *Graduate admissions practices: A targeted review of the literature*. (ETS Research Report No. RR-19-33). Princeton, NJ: Educational Testing Service.

Most, D. E. (2008). Patterns of doctoral student degree completion: A longitudinal analysis. *Journal of College Student Retention, 10*(2), 171-190. https://doi.org/10.2190/CS.10.2.d

National Research Council (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. Washington, DC: The National Academies Press.

Nerad, M. & Miller, D. S. (1996). Increasing student retention in graduate and professional programs. *New Directions for Higher Education, 1996*(92), 61-76. https://doi.org/10.1002/ir.37019969207

Noftle, E. E. & Robins, R. W. (2007). Personality predictors of academic outcomes: Big Five correlates of GPA and SAT scores. *Journal of Personality and Social Psychology, 93*(1), 116-130. https://doi.org/10.1037/0022-3514.93.1.116

Okahana, H. & Zhou, E. (2019). *Graduate enrollment and degrees: 2008 to 2018*. Council of Graduate Schools, Graduate Record Examinations (GRE) Board. Retrieved from: https://cgsnet.org/ckfinder/userfiles/files/CGS_GED18_Report_web.pdf

Oliveri, M. E., & Ezzo, C. (2014). The role of noncognitive measures in higher education admissions. *The Journal of the World Universities Forum, 6*(4), 55–65.

Oliveri, M. E., & Markle, R. (2017). *Continuing a culture of evidence: Expanding skills in higher education*. (ETS Research Report No. RR-17-09). Princeton, NJ: Educational Testing Service. https://doi.org/10.1002/ets2.12137

Oliveri, M. E., McCaffrey, D., Ezzo, C., & Holtzman, S. (2017). A multilevel factor analysis of third-party evaluations of noncognitive constructs used in admissions decision-making. *Applied Measurement in Education, 30*(4), 297–313. https://doi.org/10.1080/08957347.2017.1353989

Pek, J., Wong, O., & Wong, A. C. (2018). How to address non-normality: A taxonomy of approaches, reviewed, and illustrated. *Frontiers in Psychology, 9*(2104). https://doi.org/10.3389/fpsyg.2018.02104

Pintrich, P. (2000). The role of goal orientation in self-regulated learning, In M. Boekerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp 451–529). San Diego, Academic Press

Pyke, S. W. & Sheridan, P. M. (1993). Logistic regression analysis of graduate student retention. Canadian Journal of Higher Education, 23(2), 44-64. https://doi.org/

Rockinson-Szapkiw, A. J., Spaulding, L. S., & Bade, B. (2014). Completion of educational doctorates: How universities can foster persistence. *International Journal of Doctoral Studies, 9*, 293–308. https://doi.org/10.28945/2072

Rockinson-Szapkiw, A. J., Spaulding, L. S., & Spaulding, M. T. (2016). Identifying significant integration and institutional factors that predict online doctoral persistence. *Internet & Higher Education*, *31*, 101–112. https://doi-org.spot.lib.auburn.edu/10.1016/j.iheduc.2016.07.003

Schmitt, N., Billington, A., Keeney, J., Reeder, M., Pleskac, T. J., Sinha, R., & Zorzi, M. (2011). *Development and validation of measures of noncognitive college student potential.* (College Board Research Report No. 2011-1).

Schramm-Possinger, M. E. & Powers, D. E. (2015). *The first year graduate study: Documenting challenges and informing ways to reduce attrition*. (ETS Research Report No. RM-15-02). Princeton, NJ: Educational Testing Service.

Sedlacek, W. E. (2004) Why we should use noncognitive variables with graduate and professional students. *The Advisor: The Journal of the National Association of Advisors for the Health Professions. 24* (2), 32-39.

Sedlacek, W. E. (2010). Noncognitive measures for higher education admissions. *In B. McGaw, E. Baker, & P. L. Peterson (Eds.).* International Encyclopedia of Education, Third Edition. Amsterdam, The Netherlands. Elsevier.

Snyder, T. D., de Brey, C., & Dillow, S.A. (2019). Digest of Education Statistics 2018. (NCES 2020-009). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Spady, W. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*, 64-85.

Strayhorn, T. L. (2010). Money matters: The influence of financial factors on graduate student persistence. *Journal of Student Financial Aid, 40*(3), 4-25. https://ir.library.louisville.edu/jsfa/vol40/iss3/1

Sweitzer, V. B. (2009). Towards a theory of doctoral student professional identity development: A development networks approach. *The Journal of Higher Education, 80*(1), 1-33. https://doi.org/10.1080/00221546.2009.11772128

Templeton, G. F. (2011). A two-step approach for transforming continuous variables to normal: Implications and recommendations for IS research. *Communications of the Association for Information Systems, 28*(4), 42-59. https://doi.org/10.17705/1CAIS.02804

Thorndike, R. L. (1949). *Personnel selection: test and measurement techniques*. New York: Wiley.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89-125, https://doi.org/10.3102/00346543045001089

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition.* (2nd ed.). Chicago: University of Chicago Press.

Tinto, V. (1997). Classrooms as communities. *The Journal of Higher Education, 68*(6), 599-623, https://doi.org/10.1080/00221546.1997.11779003

Wang, L., Zhang, Z., McArdle, J. J., & Salthouse, T. A. (2008). Investigating ceiling effects in longitudinal data analysis. *Multivariate Behavioral Research, 43*(3), 476-496. https://doi.org/10.1080/00273170802285941

Wollast, R., Boudrenghien, G., Van der Linden, N., Galand, B., Roland, N., Devos, C., De Clercq, M., Klein, O., Azzi, A., & Frenay, M. (2018). Who are the doctoral students who drop out? Factors associated with the rate of doctoral degree completion in universities. *International Journal of Higher Education, 7*(4), 143–156. https://doi.org/10.5430/ijhe.v7n4p143

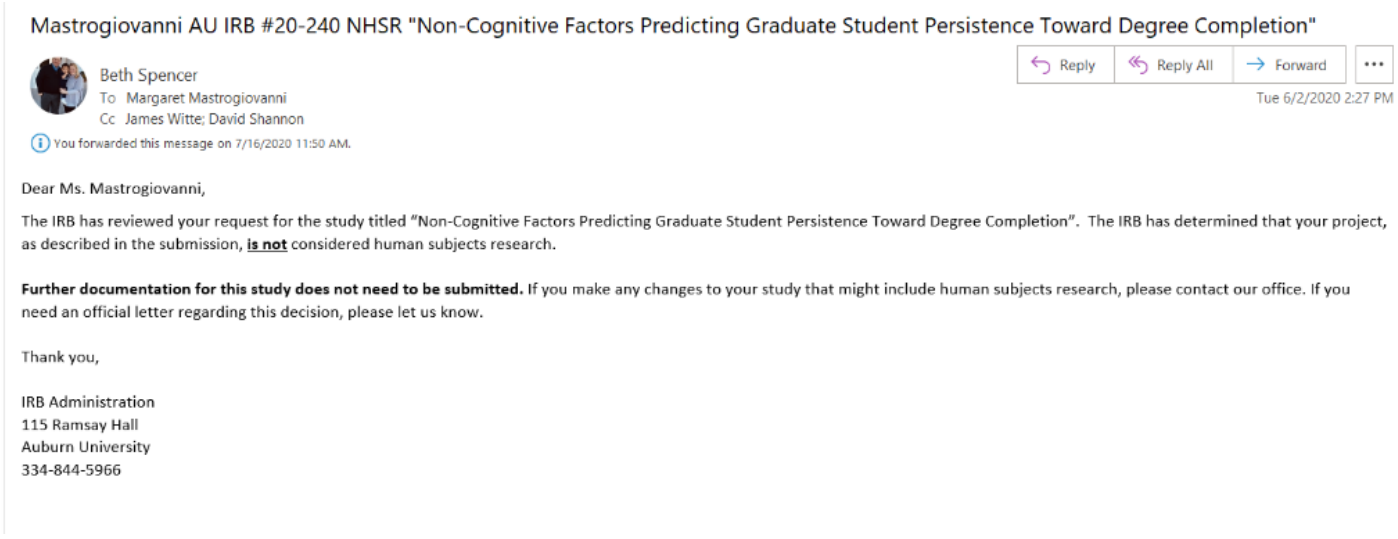
Walpole, M. B., Burton, N. W., Kanyi, K., & Jackenthal, A. (2002). *Selecting successful graduate students: In-depth interviews with GRE users.* (GRE Board Research Report No. GRE B-99-11R). Princeton, NJ: Educational Testing Service. https://doi.org/10.1002/j.23338504.2002.tb01875.x

Walters, A., Kyllonen, P. C., & Plante, J. (2006). Developing a standardized letter of recommendation. *The Journal of College Admission, 191*, 8–17.

Wao, J. O., Ries, R., Flood, I., Lavy, S., & Ozbek, M. E. (2015). Relationship between admissions GRE scores and graduation GPA scores of construction management graduate students. *International Journal of Construction Education and Research, 12*(1), 37-53. http://dx.doi.org/10.1080/15578771.2015.1050562

Appendix A

Auburn University Email Notification of IRB Exemption



Mastrogiovanni AU IRB #20-240 NHSR "Non-Cognitive Factors Predicting Graduate Student Persistence Toward Degree Completion"

Reply | Reply All | Forward | ...

Beth Spencer
To Margaret Mastrogiovanni
Cc James Witte; David Shannon

Tue 6/2/2020 2:27 PM

You forwarded this message on 7/16/2020 11:50 AM.

Dear Ms. Mastrogiovanni,

The IRB has reviewed your request for the study titled "Non-Cognitive Factors Predicting Graduate Student Persistence Toward Degree Completion". The IRB has determined that your project, as described in the submission, **is not** considered human subjects research.

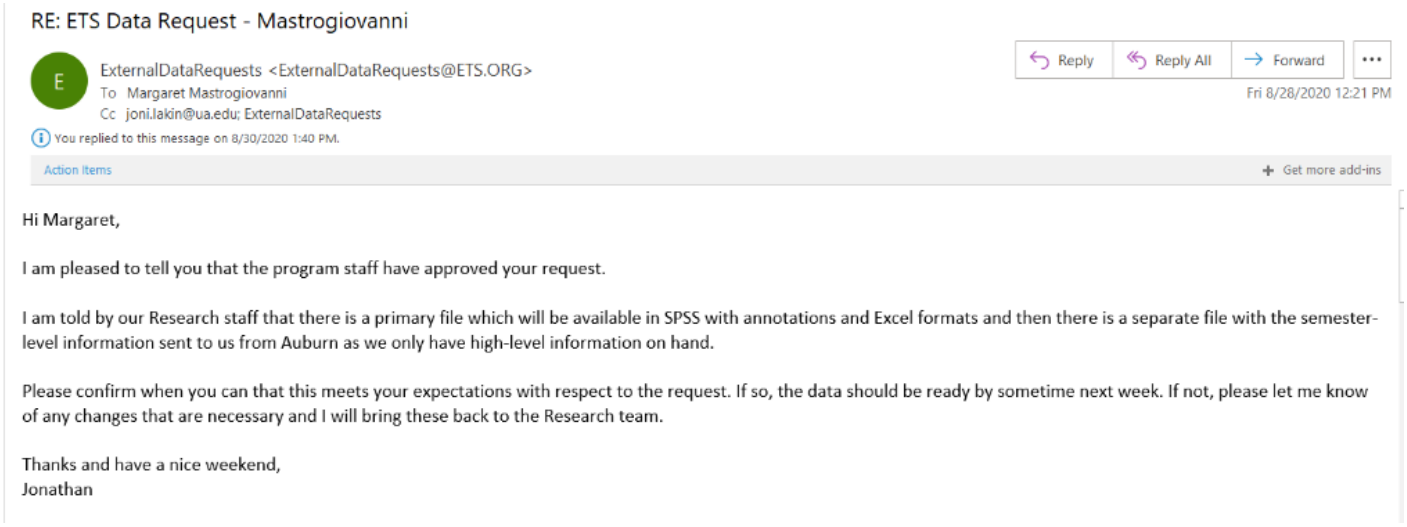
Further documentation for this study does not need to be submitted. If you make any changes to your study that might include human subjects research, please contact our office. If you need an official letter regarding this decision, please let us know.

Thank you,

IRB Administration
115 Ramsay Hall
Auburn University
334-844-5966

Appendix B

Educational Testing Service Data Request Approval



RE: ETS Data Request - Mastrogiovanni

E

ExternalDataRequests <ExternalDataRequests@ETS.ORG>
To Margaret Mastrogiovanni
Cc joni.lakin@ua.edu; ExternalDataRequests

Reply | Reply All | Forward | ...

Fri 8/28/2020 12:21 PM

You replied to this message on 8/30/2020 1:40 PM.

Action Items | Get more add-ins

Hi Margaret,

I am pleased to tell you that the program staff have approved your request.

I am told by our Research staff that there is a primary file which will be available in SPSS with annotations and Excel formats and then there is a separate file with the semester-level information sent to us from Auburn as we only have high-level information on hand.

Please confirm when you can that this meets your expectations with respect to the request. If so, the data should be ready by sometime next week. If not, please let me know of any changes that are necessary and I will bring these back to the Research team.

Thanks and have a nice weekend,
Jonathan

Appendix C

The Personal Potential Index Items (Kyllonen, 2008)

Table 3. PPI Scales and Items
Knowledge and Creativity
Has a broad perspective on the field
Is among the brightest persons I know
Produces novel ideas
Is intensely curious about the field
Communication Skills
Speaks in a clear, organized, and logical manner
Writes with precision and style
Speaks in a way that is interesting
Organizes writing well
Teamwork
Supports the efforts of others
Behaves in an open and friendly manner
Works well in group settings
Gives criticism/feedback to others in a helpful way
Resilience
Accepts feedback without getting defensive
Works well under stress
Can overcome challenges and setbacks
Works extremely hard
Planning and Organization
Sets realistic goals
Organizes work and time effectively
Meets deadlines
Makes plans and sticks to them
Ethics and Integrity
Is among the most honest persons I know
Maintains high ethical standards
Is worthy of trust from others
Demonstrates sincerity