8-15-2017

Mindset Theory: Pre-service Teachers' Beliefs About Intelligence and Corresponding Pedagogical Decisions

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Pre-service teachers' beliefs about intelligence and corresponding pedagogical decisions

by

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School of Education, George Fox University
In partial fulfillment of the requirements for the degree of
Doctor of Education

August 15, 2017

GEORGE FOX UNIVERSITY

COLLEGE OF EDUCATION

"MINDSET THEORY: PRE-SERVICE TEACHERS' BELIEFS ABOUT INTELLIGENCE AND CORRESPONDING PEDAGOGICAL DECISIONS," a Doctoral research project prepared by RACHEL CURTISS in partial fulfillment of the requirements for the Doctor of Education degree in Educational Leadership.

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ABSTRACT

This replication study explored the relationships between pre-service teachers' intelligence beliefs and their expectations for students' future success, inferences about student ability, and election of pedagogical practices in mathematics. After learning of one failing test score, participants self-reported how they might respond to a struggling male student. The quantitative study used a series of four individual surveys obtained during the participants' (N = 45) final semester of student teaching. Linear regression analyses were conducted to determine the relationship between theory of intelligence and teacher expectations, perceptions, and instructional elections. Results from this study indicate that pre-service teachers' entity beliefs are related to their pedagogical decisions. The findings of this study may support teacher education programs when making curricula decisions as addressing intelligence beliefs in conjunction with methods and philosophies of education may increase student motivation and continued engagement in the STEM fields.

Keywords: mindset theory, pre-service teachers, pedagogical decisions, mathematics, beliefs, expectations, future success, stereotypes, intelligence

ACKNOWLEDGMENTS

Completing this dissertation is evidence that God provides precious gifts for His children; I give thanks and praise to God for this miracle. Time and again, throughout the doctoral journey, I found myself amazed and in awe of His love and provision. He has been my rock and refuge and I would not be here without Him. He is my good, good Father.

Completing this dissertation is also evidence that I have a supportive, loving husband. Joshua, thank you for your continual encouragement and grace. You always believed in me and cheered me on. I think there may be an extra jewel in your crown embedded with the inscription, “bride’s dissertation.” Even though the late night conversations about the mindset theory will cease, I know we will continually sharpen and champion each other with new ideas and research. I am grateful for the call to teach and learn with you.

I am also thankful to my family for their time, energy, and patience while I journeyed. Mom and dad, thank you for flying across the country to care for me and Hudson while I spent several summers writing and re-writing my literature review. I know you sacrificed precious moments we could have spent together to provide me with the solitude I needed to create this narrative. I love you and am grateful for the numerous gifts you shared. To my mother-in-law Julie, thank you for spending time with me and Hudson so I could complete my research. I enjoyed our long conversations which provided a much-needed reprieve. I am blessed.

To my doctoral committee, I give thanks for each one of you. Dr. Patrick Allen, I could not have asked for a more encouraging and uplifting dissertation chair. I delighted in receiving your email check-ins and motivational directives. It has been a joy to learn from you. I would also like to thank Dr. Dane Joseph for his compassion and mathematical expertise. It was a pleasure talking with you about the data findings while having little people participate in our conversations. The degree of your dedication in helping me analyze the data is incalculable; thank you. A special thank you to Dr. Karen Buchanan for sharing your gift for constructing the written word. My writing is more articulate and eloquent because of your gracious prose.

There are others who supported me and offered encouragement, prayers, and a listening ear: Marlene, Mindy, Becky, Susan, Kathy, Rebecca, Derek, and Karl. Thank you for making me laugh and reminding me that I have what it takes. Finally, for my friend Leahanna; the summers would not have been the same without your friendship.

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CHAPTER 1

Introduction

Teachers of mathematics encounter many students who express a dislike or fear of the subject, and these negative predispositions can be problematic because they are likely to block or prevent student learning. I first observed this phenomenon when teaching middle level students, noticing their negative pre-dispositions to algebra.

Upon further reflection, it became clear that student responses resulted from multiple adverse experiences with the subject. Knowing that teaching involves the whole person (mind, body and spirit) I decided to use the observed visceral responses as a springboard, transforming a communal frustration into a mutual catalyst (Palmer, 1993). I sought to focus instruction on answering the following questions: What could be accomplished if past mathematical experiences did not determine one's future trajectory in the subject? What might happen if students persevered when challenges arose? The results were profound! Over the course of one semester, student attitudes changed and a community of mathematicians, who willingly engaged with and learned to value the subject, grew. Year after year, I continued focusing on the affective domain, addressing the beliefs students held about their abilities before beginning content instruction. Together we cultivated an environment where effort was encouraged as opposed to ability and performance. I began to wonder what might be the most effective ways to challenge student beliefs about their aptitude for learning mathematics?

The experience drew me toward research in the area of personal and epistemological beliefs. I uncovered that the phenomenon I witnessed, namely that acquiring knowledge about the malleability of the human mind alters students' motivation was gaining traction in the world of education (Blackwell et. al, 2007; Dweck, 2006; Boaler, 2016). In fact, a recent study by

Dweck and her colleagues indicated that beliefs about the nature of intelligence influence the pedagogical decisions of instructors (Rattan et al., 2012). After conducting a study with forty-one instructors of mathematics (or mathematics-related courses), Rattan and colleagues concluded that instructors who believed in the stability of intelligence were "more likely to opt to comfort students for their (presumed) low ability, and more likely to use teaching strategies that are less conducive to students' continued engagement with the field" (p. 734). However, this study was conducted with graduate students or teaching assistants – not teachers trained in educational theories or best practices. Would there be differences in the inferences about student ability and instructional decisions with those trained to educate children? Perhaps. This research study will seek to answer this question.

Even the United States Department of Education has endorsed the value of learning about the mindset theory, offering two-million dollars in grants to support students in developing a growth mindset (U.S. Department of Education, 2015). Yet the theory is not new; researchers had been studying this phenomenon for the past forty-five years. Dweck (1975) led the charge, as she noticed patterns of thought and behavior students display when they are confronted with difficulty. Her research fostered the development of a theoretical construct involving two types of mindsets: fixed and growth. These two ends of a physiological spectrum have been quantified using a self-assessment survey and depict the core assumptions about ability. In research literature, the Mindsets are also referred to as *implicit* theories of intelligence because they are overtly implied and rarely recognized. While researchers note that we can hold implicit beliefs about any personal characteristic, implicit beliefs about intelligence are especially important in the world of education (Yeager & Dweck, 2012).

In a fixed mindset, or when adhering to an entity theory of intelligence, people believe their qualities and intelligence are permanent traits. When confronted with a difficult circumstance or experience, people with a fixed mindset have been found to give up because they feel deficient. By contrast, in a growth mindset or incremental theory of intelligence, people believe their basic qualities can be cultivated over time through dedication and hard work. When faced with a challenge (real or perceived), people with a growth mindset are exhilarated by the opportunity to learn and develop their skills.

In addition, with the adoption of the Common Core State Standards for Mathematics (CCSS-M), there is a call for mathematics educators to create environments where perseverance is encouraged as students tackle high-level cognitive tasks (National Governors Association, 2010). The CCSS-M rank student development of perseverance and problem solving as the first of eight mathematical practices to be implemented in the classroom. Even the National Council for Teachers of Mathematics (NCTM) endorses problem solving as one of their five process standards, further signifying the importance of this skill as it is used by the mathematically proficient to acquire and deepen their knowledge of the subject (National Council for Teachers of Mathematics, 2013). Yet students often give up when math solutions do not come easily, attributing their struggle to an inherent inability to succeed in mathematics. Boaler (2016b) elucidates, "Students believe that the goal of math class is to answer questions correctly, not experience growth, creativity, or learning, and they often feel devastated when they struggle or fail" (para. 3). Clearly, these beliefs about one's aptitude have been found to "profoundly affect the way you lead your life" (Dweck, 2006, p. 6), and perhaps the way teachers and graduate students make instructional decisions.

However, a review of the research indicates that classroom teachers and graduate students are different. Teachers contemplate a variety of factors when considering student performance including: school, family, and personal characteristics such as intelligence (Patterson et al., 2016). Additionally, individuals training to teach grades K-12 as a career are exposed to an intense curriculum incorporating coursework in general education theory, content knowledge, and pedagogical knowledge. They spend hours observing classroom instructors and end their college training as co-instructor with a seasoned teacher, taking on the full responsibility of a classroom, all of which occurs before obtaining a teaching degree (Harris and Sass, 2007).

Graduate students have a unique skillset, which includes knowledge of research techniques, data entry into statistical software, and interpersonal relationships to help with joint authorship of publications (Brown-Wright, Dubick, & Newman, 1997). Graduate students receive “on-the-job” training (Prieto & Altmaier, 1994) and learning instructional practices are obtained through experience. As a result, awareness of pedagogy and student learning needs occurs gradually (Post, 2011). Even though graduate students have highly specialized knowledge of their content, researchers Harris and Sass purport that knowledge of instruction is essential and “colleges of education might improve the performance of their graduates, and schools might improve the productivity of existing teachers, by placing somewhat greater emphasis on content knowledge, including that which is pedagogically oriented” (2007, p. 29). College faculty may agree, with 55% of them believing instruction in teaching practices and techniques are the number one need of graduate teacher instructors. Formal training early-on may increase the self-efficacy of graduate instructors ***before*** they take on the responsibility of teaching (Prieto & Altmaier, 1994). In addition, Shulman (1987) believes that pedagogical content knowledge, or the understanding of content and how to adapt that content to a variety of learners, separates those that specialize in content from “the pedagogue” (p. 8).

These findings suggest that graduate student instructors and pre-service teachers (even those who hold an entity theory of intelligence) may respond to failing students differently. This researcher is hopeful, considering that teachers’ pedagogical moves make their beliefs clear to students (Stipek et al., 2001) and inadvertently send messages which affect students’ self-perceptions of ability. Furthermore, teacher beliefs have been shown to influence the goal-orientations promoted in the classroom toward either learning or performance (Bohlmann & Weinstein, 2013). When students perceive the goal of a mathematics classroom to be focused on learning, students are more likely to pursue a career in a mathematics field (Lazarides & Watt, 2015, p. 57). On the contrary, educators in the United States are cautioned that emphasizing performance in academic areas “could encourage children to equate school performance with intelligence, leading to lower beliefs in malleability, and less belief in the importance of effort in determining outcomes” (Kurtz-Costes et al., 2005, p.229). Moreover, researchers have proposed that focusing on a sole academic outcome (i.e. an assessment) may thwart student motivation for it sends the message that performing well is the focus, as opposed to developing ability (Madaus & Clarke, 2001).

While there exists a lacuna of research about the implications of holding a growth mindset, research discussing pre-service teacher’s beliefs about intelligence with their preparation to teach mathematics is in the initial phases. For example, researchers have begun to investigate the pedagogical decisions of instructors and the relationship to their views about student ability (Park et al., 2016). Research has also been designed to explore the mindset beliefs of pre-service teachers when responding to hypothetical student scenarios (Gutshall, 2014).

Taken together, a definitive conclusion regarding the way pre-service teachers will respond to students they perceive to struggle in mathematics still cannot be made.

Significance of the Study

The benefits include an advancement of scientific knowledge as this replication study will provide a more robust understanding of how a different population of instructors would respond to struggling students.Past research indicates that graduate student instructors with an entity view of intelligence were more likely to comfort and demotivate students.

Findings from this study could be used to inform schools of education regarding the potential of Mindset beliefs to influence the decisions of pre-service teachers. In particular, the findings of this study will be used to support the creation and revision of a mathematics programs for elementary educators. The results may lead to incorporating a psychological element into the program with the hope that if we change the intelligence beliefs of future teachers, we can improve their pedagogical decisions in mathematics, and ultimately improve the mathematical instruction provided to the next generation of elementary students. In addition, the research may be used to help inform local school districts about the relationship between an instructor's intelligence beliefs and instructional practices. If there were significant differences in the pedagogical decisions of pre-service teachers with a growth mindset as opposed to a fixed, then there would be justification to consider adding opportunities to learn more about the intelligence theory into teacher education programs.

Statement of the Problem

The purpose of this study is to examine the intelligence beliefs of pre-service teachers at a university in Oregon. Specifically, the researcher will conduct a replication study to ascertain if beliefs about the malleability of intelligence would accompany inferences about student ability and preference for certain pedagogical practices in mathematics.

Research Questions

The overarching question to consider is: *Do pre-service teachers' beliefs about the malleability of intelligence affect their inferences about student ability and preference for certain pedagogical practices in mathematics?*

Additionally, the following questions will be examined:

1. What is the relationship between teacher attitude toward teaching and theory of intelligence for mathematics?
2. What is the relationship between teacher perceptions of a student's test score to depict math ability or effort and theory of intelligence for mathematics?
3. What is the relationship between teacher expectations about a student's future math performance and theory of intelligence for mathematics?
4. What is the relationship between teacher pedagogical decisions and theory of intelligence for mathematics?

Key Terms

- Fixed Mindset - A fixed, or entity mindset, is defined as the belief that intelligence, aptitudes, and traits are static and do not change with the passing of time. Entity theorists believe that innate ability produces success or failure. As a result, individuals with a fixed mindset feel deficient and have an aptitude to capitulate when confronted with a trial, believing that a struggle indicates a lack of ability. (Dweck, 2006).

- Growth Mindset - Incremental, or growth mindset, is defined as the belief that intelligence is malleable and can be cultivated over time. An incremental belief is distinguished by a desire to pursue understanding and an aptitude to persevere when faced with a challenge. Incremental theorists focus on developing intelligence via personal effort and see challenges as an opportunity for growth (Dweck, 2006).
- Mindset or Intelligence Theory - A construct consisting of two epistemological beliefs about the nature of human ability (Dweck, 2006). Originating with documentation of patterns in behavior (Diener & Dweck, 1978; 1980; Dweck, 1975; Dweck & Reppucci, 1973) to explain how humans respond to a challenge (either with avoidant or persistent actions). Further analysis led to a hypothesis that the type of goals individuals pursue may explain how individuals perceive a situation (Elliott & Dweck, 1988) and later, a theory to explain goal selection and patterns in individual's behavior. The resulting theory, known as the Mindset or Intelligence Theory, captures the resounding beliefs an individual holds about the nature of human ability (see Dweck and Leggett, 1988 for an evolution of Intelligence Theory).
- Pedagogical Decisions - Teaching choices that are based upon an understanding of content, needs of learners, classroom management, learning strategies, and aggregated wisdom (Shulman, 1987). The process involves sound thinking and reasoning and is predicated upon teacher beliefs about the nature of the subject and perceived ability of students (Shavelson & Stern, 1981; Saad et al., 2015).

Limitations and Delimitations

In this study there will exist a number of limitations and delimitations. One significant limitation is that the population will be limited to pre-service teachers at the graduate and undergraduate level. The findings may not be generalizable to the total population of future educators, especially pre-service teachers seeking endorsement in one academic domain. An additional limitation is the use of a convenience sample; having participants voluntarily enroll in the study may distort the findings because the data will not include the distinctive voices of the population who declined.

Using pre-service teachers' perceptions may present another limitation to the study. The dependent and independent variables will be measured by self-reports or perceptions as opposed to actual behaviors. In essence, the study does not address the actions or responses of participants when engaged in a teaching experience; rather, it describes the beliefs or values they ascribe to in the stated areas.

The selection of instruments will further limit the study. While Rattan and colleagues (2012) used several of the tools in previous research and indicated high reliability ratings, the population consisted of undergraduate and graduate students seeking mathematics degrees in a college setting. The instruments may have limitations in measuring what they purport with graduate and undergraduate pre-service teachers.

In addition to the above-mentioned limitations, several boundaries or delimitations will be imposed on the investigation. I chose one university to derive the sample of graduate and undergraduate pre-service teachers based upon size and convenience of data. To be specific, I selected students enrolled in full time student teaching. In addition, I chose to collect data during the spring semester of 2017. Students would have been exposed to similar coursework and, as a result, would provide a basis for determining if a difference exists in the variables of the study.

CHAPTER 2

Oliver Wendell Holmes, Sr. stated, “Man's mind, once stretched by a new idea, never regains its original dimension” (n.d.). Since Holmes’s claim in the eighteenth century, research has emerged surrounding the beliefs of cognitive factors that reveal the implicit power of the human mind, called “intelligence theory” (Dweck, 2006). Intelligence theory, also referred to as Mindsets, influences what people believe about themselves and others, even if they are unaware of these beliefs (Blackwell et al., 2007; Dweck, 2006). This concept is especially important in the educational arena because research has shown a direct correlation between the intelligence beliefs held by teachers and their conduct in the classroom (Czerniak & Schriver, 1994; Leroy, et al., 2007; Muijs & Reynolds, 2002).

One of the best-defined models of intelligence theory has evolved from Dweck’s (2006) research. Dweck describes her intelligence theory as a construct consisting of two mindsets: fixed and growth. Incremental theory, or growth mindset, is defined as the belief that intelligence is malleable and can be cultivated over time. An incremental belief is distinguished by a desire to pursue understanding and an aptitude to persevere when faced with a challenge. Incremental theorists focus on developing intelligence via personal effort. On the contrary, entity, or fixed mindset theorists believe that people have permanent intelligence in conjunction with feelings of deficiency and an aptitude to capitulate when confronted with a trial. Dweck points out that entity theorists focus on natural ability, creating competitive learning conditions.

According to Dweck (2006), beliefs concerning intelligence remain latent through times of success and surface when failure (real or perceived) presents itself. Teachers are consistently faced with challenges and individuals with a fixed mindset are more apt to give up instead of persevere. Educators may find this alarming considering the work of Jones et al. (2012) and

Gutshall (2014) that concluded at least twenty-five percent of pre-service teachers enter the education milieu with a fixed mindset.

Furthermore, education programs may also want to take note of teachers' intelligence beliefs because they impact teacher behaviors (Leroy, et al., 2007) and teacher behaviors directly impact the academic growth of students (Muijs & Reynolds, 2002). Researchers Leroy, Bressoux, Sarraxin, and Trouilloud (2007) found that teachers with a fixed mindset were more likely to create an environment of competition, emphasizing ability and decreasing student motivation. In contrast, the research of Jonsson and Beach (2012) suggest that teachers with a growth mindset would be more inclined to praise student effort and cultivate a climate of independence. It is perhaps in the best interest of schools of education to consider the influence teacher beliefs about intelligence have on instructional decisions; after all, Dweck (2006) identified effective teachers as those who hold a growth mindset.

Researchers Rattan, Good, and Dweck (2012) conducted one of the first investigations to explore how mindset beliefs could influence instructional selections in mathematics. Rattan and colleagues asked participants to take on the role of an instructor, meeting with a hypothetical student who received a failing test score. In a sequence of four different studies, researchers found that participants who adhered to a fixed mindset were more likely to attribute low performance *on one test* to a lack of mathematical intelligence. On the contrary, participants holding a growth mindset were more likely to attribute the low performance to a lack of hard work. Furthermore, participants endorsing a fixed mindset selected markedly different pedagogical practices such as assigning easier homework and calling on a student less during class; all strategies which could reduce student engagement in mathematics. Rattan and colleagues also looked into how the students would respond to the pedagogical decisions of their instructors. The results were compelling, as pedagogical practices of entity theorists conveyed a message of low ability and expectations to students.

The above-mentioned findings indicate that intelligence beliefs about mathematics may "play a causal role in the early diagnosis of ability and pedagogical practices that follow" (p. 733). While alarming, the results suggest that pedagogical decisions differ depending on the alignment with a fixed or growth mindset. However, it is important to note that none of the participants were elementary education majors; they were either undergraduate students or graduate teaching instructors (Rattan, Good, & Dweck, 2012). It leaves educator training programs to wonder how pre-service teachers would respond to struggling students and the type of pedagogical decisions they would make.

Gutshall (2014) recommended that future researchers explore how pre-service teachers apply their intelligence view when making such instructional choices. Given the potential of retaining a growth mindset, a review of the implications of holding an incremental view of intelligence may aid the efforts of teacher educators as they consider why and how they should attend to intelligence theory in their program design. This literature review will survey existing research on the incremental view of intelligence with respect to two domains: intelligence and pedagogical decisions. In particular, each variable will be defined, the implications for teaching will be presented, and the connection to intelligence beliefs identified.

General intelligence

Intelligence is a complex construct and, thus far, theorists have been unable to agree upon a definition (Furnham, 2001; Gottfredson, 1997; Neisser et al., 1996). Currently, psychologists confirm that individuals are complex, differing in their ability to interact with their environment, engage in multifaceted reasoning, and solve tasks using logic. An individual's aptitude can vary based upon the occasion of assessment and domain in reference. The concept of intelligence "attempts to clarify and organize this complex set of phenomena" (Neisser et al., 1996, p. 77).

Multiple approaches have influenced the discussion of intelligence. Foundational researchers in the field, like Alfred Binet, endeavored to quantify intelligence using psychometric tests (Neiser et al., 1996). In a similar vein, Spearman found a general factor of ability which he called "g" and claimed that it accounted for the variation in psychometric or IQ test scores (1927). Some psychologists still honor "g" as a base-line measure of one's intelligence. However, "g" is not the only measure of one's intelligence; a review of IQ psychometric tests revealed over seventy different abilities with "g" at the apex and a hierarchy of abilities below (Carroll, 1993). Additionally, some theorists assert the existence of intellect that cannot be measured by psychometric tests, such as Gardner's multiple intelligences (Neiser et al., 1996). Other researchers have suggested an inter-correlation between intelligence constructs, noting that Gardner's verbal, spatial, and mathematical intelligences have been found most closely related to "self-estimate of overall general intelligence" or "g" (Furnham, 2001, p. 1401).

While there may be many ways to be *intelligent*, conceptualizations of the construct that can be assessed with psychometric tests have been most thoroughly investigated. Research has indicated that several factors influence the ability or intelligence of an individual including one's culture, workplace, education, family of origin, genetics, nutrition, and exposure to toxins. Most interestingly, when comparing people from the same culture group, it is the life experiences of an individual mark which mark the greatest contributors of IQ differences (Neisser et al., 1996)

Fewer studies exist about intelligence and its constructs that do not lend themselves to psychometric tests such as "wisdom, creativity, practical knowledge, social skills" (Neisser et al., 1996, p. 95). As the components of laymen theories, the beliefs individuals hold about the nature of intelligence have been captured by asking questions such as, “What does it mean to be smart?” (Kurtz-Costes et al., 2005, p. 222). Such non-cognitive philosophies have been asked of children who believe, for instance that smart people jump higher and are nicer. Laymen’s theories shifted over time; for example, researchers studying children in the United States and Germany noted a reduction in these non-cognitive views of intelligence by fifth grade, perhaps due to the experiences of students in school (Kurtz-Costes et al., 2005). Regardless of the assessment used, a task team from the Board of Science Affairs of the American Psychological Association noted that academic success requires qualities such as persistence and motivation. After surveying the research landscape authors concluded that the current conception of intelligence is evolving and recommend that “We should be open to the possibility that our understanding of intelligence in the future will be rather different from what it is today” (Neisser et al., 1996, p. 80).

Intelligence beliefs and the role of effort & ability

According to Dweck, beliefs about intelligence fall in two distinct factions (2006). Theorists who endorse an entity view see intelligence as stable and performance indicative of high ability while failing indicates low ability. On the contrary, individuals who endorse an incremental view see intelligence as malleable and support the idea that effort is responsible for success (Dweck & Leggett, 1988; Dweck, 2006). Theorists from either camp value and interpret effort differently; incremental theorists see effort as a necessity for success while entity theorists see effort as an indicator of low ability or intelligence (Dweck & Leggett, 1988; Mueller & Dweck, 1998). From these two views, we get the components of any academic performance, effort (i.e. hard work) or innate ability (i.e. intelligence). Jonsson & Beach contend that intelligence beliefs and resulting praise demand attention because the logical response is to blame either student ability or effort when success or failure occur (2012).

The determinants of Dweck's Mindset Theory, effort and intelligence, have been found to affect the *perception* of academic performance in cross-cultural research. In fact, researchers have indicated two competing paradigms of achievement beliefs, noting that Eastern cultures emphasize *effort* and Western cultures focus upon *ability*. As an illustration, Stevenson and Lee surveyed 1,440 children and their mothers in Minneapolis, Taiwan and Japan (1990). The researchers found that participants from Asian cultures viewed effort as the primary component of success and those endorsing American culture favored innate skill. Stevenson and Lee also compared mathematics performance of students in all three countries and attributed the success of Taiwan and Japan's students to the *rejection* of the view that highly intelligent people do not need to exert effort while low ability individuals will not succeed regardless of the amount of effort employed. However, the researchers found that American students upheld the view, to the determinant of their success (1990). Such findings align with Blackwell et al.'s research in that holding an entity view of internal qualities can lead to a decline in mathematics performance (2007).

However, current studies surrounding the nature of intelligence and the role of effort have indicated varying sentiments among Eastern and Western societies. For instance, researchers Kurtz-Costes and colleagues came to a divergent finding after learning the intelligence views of 115 American & 100 German students in kindergarten through eighth grade (2005). They discovered that American children viewed intelligence as malleable when compared to German students, overall. American children were also more likely to associate *ability* with *effort*, considering hard work as a characteristic of an intelligent person. German students were more likely to believe that intelligent people did not work as hard; in fact, they believed only those low in ability needed to apply additional effort. German students were also more likely to support an inverse relationship between effort and ability when compared to American children. Kurtz-Costes et al. noted several limitations that could explain the contrary findings. First of all, German students were scheduled to attend a vocational or technical school and may have viewed additional effort as futile because their future work plans were pre-determined by grade five. On the contrary, students from the United States were part of an educational system that welcomed those of varying talents to obtain advanced degrees even after a history of academic failures. Secondly, researchers explained that American culture fosters a belief in the potential to increase intelligence via effort, even for those who are not born with innate talents (2005). Perhaps this paradigms shift is a result of the cultural message regarding hard work and effort, popularized by Dweck's research that has influenced mainstream America (2006).

Research also indicates a varying view about the role ability and effort play in different domains. Siegle et al. surveyed college honor students in the United States and asked if natural ability affected their performance in a variety of subjects. Students indicated a positive relationship between perceptions of high ability and success in academic subjects such as mathematics, indicating a belief that innate ability plays a role in performing well. Interestingly, the results showed a significant relationship between perceptions of high ability and effort in non-academic areas such as dance and music, indicating that *effort* contributes to success *only* in these domains. Researchers identified a possible limitation, mainly that participants were college freshman who had yet to exert effort in collegiate courses and, as honor students, they may not have experienced academic challenges in high school. Nevertheless, the findings indicate that effort may not be seen as valuable by those who are born with high levels of general intelligence

(2010). Regardless of the country of origin, the endorsement of intelligence as a fixed construct based upon ability or a malleable construct based upon hard work influences the perception of academic performance. In fact, the study this researcher is seeking to replicate by Rattan and colleagues included a measure to determine graduate student instructors' inferences about students' ability and effort after learning their performance on a single mathematics assessment (Rattan et al., 2012).

Mathematics intelligence & the role of effort and ability

To have mathematical ability, it is necessary to acquire proficiency within the domain itself. "Mathematical competence then means the ability to understand, judge, do, and use mathematics in a variety of intra-and extra-mathematical contexts and situations in which mathematics plays or could play a role" (Niss, 2003, pp. 6-7). The relationship between general intelligence and mathematics achievement has also been found in current research. Deary and colleagues (2007) studied over 70,000 students over a five-year span of time to uncover that an assessment of intelligence at age eleven explained over 50% of the variance in mathematics tests on a national level at age sixteen. The strong correlation indicates that general intelligence contributes to performance in mathematics. Furthermore, Cowan et al., (2011) found that to have mathematical competence, children call upon a variety of knowledge and acquired skills. After an analysis of 103 preschoolers, researchers Gray and Reeve would agree, as they found that a single marker of mathematical development did not exist, instead noting that mathematical ability of children varied (2016).

Steinmayr & Spinath (2009) offered a potential explanation for the variance, concluding that motivation variables (i.e. hope for success, fear of failure, need for achievement) contributed to predicted mathematics performance of German high school students over and above intelligence. The results were polemic, considering that success in mathematics is thought to be the outcome of high ability. Some may disregard the findings, dismissing the outcomes to cross-cultural differences. Yet the regression analyses clearly indicated that several motivational constructs contributed to the predicted grades of 342 university-bound learners. In light of Dweck, Chiu, and Hong's (1995) research regarding the importance of effort, this study contributes to a greater understanding of how motivation could affect student performance. Moreover, Steinmayr & Spinath propose that "when teachers aim at improving students' performance, enhancing their motivation might be as important as the conveyance of knowledge" (2009, p. 88).

The research of Murayama and colleagues communicated a similar message, that motivation (i.e. effort) affects student performance over and above intelligence (2013). In a study of over 3,530 German students in grades five through seven, researchers investigated students' development of mathematics achievement over time. They found that motivation and strategy predicted students' long-term growth, but intelligence did not. Murayama's work adds another facet to our understanding of how effort and motivation contribute to academic success. "Thus, an intriguing message from this study is that the critical determinant of growth in academic achievement is not how smart you are, but how motivated you are" (p. 1486). The results align with recommendations of NCTM, calling for teachers to encourage and value students' effort and promote their ability to persevere (National Council for Teachers of Mathematics, 2013).

Teacher views of students' intelligence

Educators also hold a view about the nature of intelligence and, as such, an opinion about the role of effort and ability. Using a mixed-methods approach, Jones et al. surveyed 270 pre-service teachers and 33 in-service teachers from the United States, asking them to self-report their beliefs about the constituents of students' intelligence. Researchers coded data to deduce a theory of teachers' intelligence beliefs (only three of the seven are relevant to our discussion and included here). Educators indicated that intelligence was comprised of student performance in academic endeavors, knowledge of a subject, and general cognitive ability. Interestingly, motivation was also included as a determinant but was not a key construct used by teachers' to define their view of students' ability. Said another way, educators in this study did not believe that effort contributed to students' intelligence (2012).

Teacher views of intelligence & experience

However, research indicated that teachers' views of intelligence varied depending on several factors, including age and experience (Jonsson et al., 2012; Georgiou, 2008; Jones et al., 2012). Jonsson and colleagues surveyed Swedish high school teachers and, using an ANOVA, found the population with the strongest preference for a fixed mindset included younger teachers with less-experience and older, seasoned educators (2012). As such, these teachers viewed innate ability as the main determinant of students' intelligence. In a similar vein, Georgiou analyzed the differences in intelligence beliefs of Greek pre-service and elementary teachers and, using a MANOVA, found that experienced teachers adhered to an entity view of intelligence, believing to a higher degree that intelligence and other biological determinates influenced student achievement. Seasoned educators assumed characteristics that were uncontrollable such as hereditary, intellect, gender, and family of origin (i.e. "you either have it or you do not") contributed to student success and that the construct of intelligence remained stable over time. Interestingly, a difference in the belief of effort as a determinant of student achievement was not identified (2008).

On the contrary, Jones et al. did not find a significant difference between intelligence beliefs of pre-service and in-service teachers in the United States (2012). Nor did they find a significant relationship between intelligence beliefs and experience (in years). Interestingly, the data indicated that 77.9% of educators (both pre-and in-) held an incremental view of intelligence. Researchers cautioned readers when interpreting their findings because the number in their sample was considerably low, consisting of a mere thirty-three in-service teachers (the quantity of pre-service teachers was 270).

Nevertheless, Jones and colleagues' work was recently confirmed by Patterson et al. with educators from the United States (2016). The intelligence beliefs of seventy-three pre-service and fifty-three in-service teachers were calculated using an ANOVA and the results indicated that a statistically significant difference between groups did not exist. In other words, both pre-service and in-service teachers did not hold different views about intelligence being either a fixed or malleable construct. In fact, the majority of Patterson's participants (M=2.79 on a six-point scale, with six indicating a strong alignment) also adhered to an incremental theory of intelligence. The research of Patterson and colleagues also brought to light another surprising statistic regarding the relationship between teachers' intelligence beliefs and student performance. They found a negative correlation between an entity belief of intelligence and sanctioning of factors that students could use to affect their academic performance. In other words, teachers with a fixed mindset did not believe that motivation and effort could alter student success (2016). In light of this replication study, these results indicate that educators with a fixed mindset may perceive academic performance to be the result of students' innate ability, much like the graduate student instructors in Rattan et al.'s study (2012). The outcome of such beliefs could negatively affect student performance.

Teacher views of intelligence & domain specificity

Research also indicated that educators hold capricious views of intelligence depending upon the academic domain being referenced (Jonsson et al., 2012; Beach, 2003). For instance, Jonsson et al. investigated over 200 high school teachers from Sweden and found that social science and practical discipline instructors preferred an incremental theory over an entity one. In fact, the results of the ANOVA indicated these instructors' preference for viewing intelligence as a malleable construct was significantly higher than their preference for a stable view of ability. However, math and science teachers did not differ in their preference of an intelligence view. The results signified that teachers from other disciplines favored an incremental theory of intelligence while math teachers do not. Said another way, mathematics instructors preferred to believe that intelligence was a fixed trait, dependent upon innate ability (2012).

As mentioned above, Jonsson and colleagues' work has known validity concerns because the sample size was small and the population was not randomly selected. Researchers cautioned readers to avoid generalizing their findings and only use the results to discuss that an effect had been found in their sample (2012). Despite the cautions, other researchers have identified similar patterns. According to Beach's ethnography research, mathematics instructors made claims about the ability of all students, yet how they communicated actual outcomes signified innate ability was responsible for student performance. Instructors indicated that biological differences in students' intelligence contributed to the varying performance in mathematics (2003). The research of Myers, Nichols and White also suggested that the subject or discipline of a teacher affected their proclivities toward either a stable or malleable view of intelligence. Mathematics teachers may be more likely to believe in an entity theory when compared to other disciplines (2003). These findings may explain why Rattan and colleagues found that graduate student instructors who viewed intelligence as a stable construct believed that performance on a single mathematics test was the result of student ability (2012).

Educational implications of holding an incremental view of intelligence

Given the potential of retaining an incremental view of intelligence, it is essential to examine the outcomes of holding an incremental view of intelligence. As such, adherence to the belief in a malleability of intellect has been shown to influence teachers' expectations for learning, self-efficacy and academic achievement of students.

Incremental theorists have higher self-efficacy

Intelligence beliefs also have an impact on teachers' self-efficacy. With a large sample size of educators (n=336) and against the backdrop of a concise theoretical framework, Leroy and his colleagues concluded that the more teachers endorsed an incremental view of intelligence, the stronger their self-efficacy. In other words, teachers who believed intelligence was malleable and success is the result of effort were more apt to believe they could be successful when working with students (2007).

Self-efficacy beliefs may influence a teacher's dedication as well. A meta-analysis by Chesnut and Burley revealed a positive correlation between pre-service and in-service teachers' self-efficacy beliefs and their commitment to the profession. The higher a teachers' self-efficacy beliefs, the more likely they were to remain in the field. Self-efficacy beliefs were also found to predict longevity (2015). The research indicates that adherence to an incremental view may influence teacher commitment and confidence in the classroom.

Incremental theorists have higher expectations of students

Rogers (2009) investigated the relationship between an educators' intelligence beliefs and teaching practices. Using a population of fourth through eighth grade educators from California, Rogers found that entity theorists reported a statistically significant difference in the types of questions they would ask low-ability students. Thus, educators with an entity view were less likely to elicit high-level thinking of students perceived to have low ability. The pattern was not found with teachers who held an incremental view. On the contrary, instructors with an incremental view were more likely to incorporate high-level thinking into their lesson plans to reach all learners (Rogers, 2009). The findings indicate that instructors with an entity belief may not use demanding teaching practices that foster student achievement.

Furthermore, researchers Leroy and colleagues found that instructors with an entity view would be less supportive of attending to students' autonomy needs (2007). The results indicated a significant and negative effect of a teacher's entity beliefs with a motivating style that supports an autonomous climate. For instance, educators who adhered to an entity view indicated they would be less likely to encourage independence, empathize with learning needs, and encourage abilities. Such instructors would also place less emphasis on intrinsic motivation, favoring compliancy (Leroy et al., 2007). As such, instructors may be more willing to take control of the learning environment. When students were motivated to believe that their actions were the result of their own choices in an autonomous supporting environment, students were more likely to be self-directed in their interests and felt that they could determine the outcomes of their actions (Reeve & Jang, 2003).

Incremental theorists emphasize learning over performance

Researchers found a negative relationship between educators' endorsement of an entity view and preference for emphasizing student competence and achievement in their classrooms. On the contrary, researchers found a positive relationship between educators' beliefs that intelligence is malleable and self-reported emphasis on mastery. Mastery-orientations incorporate the development of concepts and attending to student learning, giving less attention to memorization (Park et al., 2016). The emphasis of incremental instructors aligns with the requirements of the CCSS-M standards which call for advancing conceptual understanding when teaching mathematics (National Governors Association, 2010).

Students in classrooms that emphasize mastery "feel" the expectations of their teachers. Researchers have found that teacher's preference for mastery, or making learning meaningful and valuing the power of mistakes, was positively and significantly related to students' identical perceptions of the learning foci of the classroom. As such, students in classrooms which they perceived to promote learning and enrichment, exhibited significantly less troublesome behaviors. The converse was also found to be true and significant, the relationship between students' disruptive behaviors was positively correlated with their perception of focus on achievement (Kaplan, et al., 2002). The research indicates that teachers with an incremental view of instruction may have classrooms with more attentive students.

Incremental theorists are less likely to stereotype students

Researchers Jonsson and Beach investigated pre-service teachers with incremental and entity views to discover their tolerance or acceptance of stereotypes. To determine stereotype tendencies, they gathered survey data regarding acceptance of unspoken group memberships, generalizations of people groups and agreement with critical judgments. The responses of 176 participants were analyzed using Pearson's correlations and step-wise multiple regressions. The analyses indicated that pre-service teachers who held an entity view in mathematics also accepted stereotypes; the correlation, while not strong r=.170, was statistically significant. On the other hand, a negative correlation was found between instructors who adhered to an incremental view of intelligence and their acceptance of stereotypes (2012) and negative stereotypes have been found to influence women's academic performance in mathematics (Good, Aronson, & Harder, 2008). Thankfully, educators with an incremental view may be more less likely than incremental theorists to classify and form judgments of students (Jonsson & Beach, 2012), even after the knowledge of one academic performance.

In addition, perceptions of an entity theory and stereotypes may explain the lack of female representation in the STEM fields. A recent study by Good et al. (2012) investigated how perceptions of an entity theory in a college mathematics classroom could affect students' sense of belonging and subsequent pursuit of mathematics endeavors. The third in a series of three studies involved college calculus students with robust math skills, scoring well above the national average on their SAT exams. Researchers assessed students' perceptions of their learning environment three times during the semester. The findings indicated that the more women perceived the classroom culture as supportive of the belief that intelligence was a static trait, coupled with gender stereotyping, the lower their sense of belonging. Importantly, sense of belonging was defined as, "one's personal belief that one is an accepted member of an academic community whose presence and contributions are valued" (p. 711). Women's sense of belonging also predicted their aspirations for further acquisition of mathematics knowledge. When women perceived the culture to esteem an incremental view of intelligence, they were more likely to feel they valued members of the community, regardless of the existing gender-stereotypes (2012). Taken together, these "findings highlight the importance of students' perceptions of their learning environment for their math achievement and career trajectories," (p. 713) and call attention to the need for educators with adherence to a growth mindset.

View of intelligence and pedagogical decisions

Definition

The term *pedagogical decisions* has been used to define the process of thinking and reasoning that comprise the choices educators make when selecting an instructional method (Saad et al., 2015). At multiple times throughout a given school day, teachers make rational judgments and select techniques to benefit their students (Shavelson, 1978; Shavelson & Stern, 1981). The process of making instructional choices that incite the attainment of knowledge is the central duty of an educator (Hunter, 1979; Shulman, 1987). Educators make instructional or teaching decisions about how to present topics and develop student understanding, adapting to the differing abilities of all learners (Shulman, 1987).

Math pedagogy

The NCTM and CCSS-M support the use of instructional pedagogy that is increasingly student centered, requiring problem solving and understanding of the connections between mathematical concepts (National Governors Association, 2010; National Council for Teachers of Mathematics, 2013). The reform initiatives were intended to increase student understanding of mathematics, as opposed to the traditional view with its focus on performance and memorization of procedures (Dossey, McCrone, & Halvorsen, 2016). In a report of mathematics education, presented at the thirteenth International Congress on Mathematical Education, Dossey et al. identified that even collegiate math instructors are expected to “stress conceptual understanding” and “foster active learning in the classroom,” to ensure students learn and can apply the content (2016, p. 35). In fact, attention to perseverance is one of the eight mathematical practices in the CCSS. Therefore, encouraging perseverance through word and action in the classroom would be a necessity. In addition, children need the ability to think creatively and flexibly, and have a desire to learn not just apply pre-learned knowledge. All of this requires an attention to learning goals, not performance ones. What might be the role of a teacher in such an environment? Stipek and colleagues (2001) recommend that educators support and guide students as they construct new knowledge.

Beliefs about the nature of mathematics & pedagogical decisions

Thankfully, over the last twenty years, educational researchers around the globe have begun to take interest in the ***beliefs*** that prompt the use of teachers' pedagogical choices (Beijaard & De Vries, 1997; Tatoo, 1998). While pedagogical content knowledge and content knowledge are also vital components for an educator acquire (Shulman, 1986) it is the beliefs of an educator that are at the core of instructional intentions. The shifting focus on beliefs took time, especially because personal epistemologies can be a formidable construct to investigate (Pajares, 1992). Pajares, a leading researcher in the study of educational beliefs, explained, "when specific beliefs are carefully operationalized, appropriate methodology chosen, and design thoughtfully constructed, their study becomes viable and rewarding" (1992, p. 308). Once researchers understood more about beliefs and began identifying specific types (i.e. self-efficacy, self-esteem, mindsets) their enquiries became increasingly useful to educators. Beliefs about several factors affect an educators' choices of instruction.

Beginning in 1990, Ball found that pre-service teachers had a tendency to believe that remembering rules and applying algorithms were central components of mathematics instruction. These beliefs about mathematics have been shown to affect how prospective teachers come to understand the subject and what they believe about mathematical ability. Believing that they know what good mathematics instruction look like, pre-service teachers might not be inclined to learn mathematics pedagogy and may instruct using direct teaching exactly as they had experienced during their K-20 education (Ball, 1990). Current researchers may agree, finding that even pre-service teachers' beliefs about mathematics tend to be inspired by memories of past experiences in the classroom (Swars et al., 2006; Sloan, 2010). As indicated in aforementioned research, pre-service teachers may have experienced math instruction from educators who believed that intelligence is fixed (Jonsson et al., 2012; Beach, 2003) and foster a culture that focused on performance (Bohlmann & Weinstein, 2013; Leroy, et al., 2007). As such, they may have the tendency to perpetuate these same beliefs when interacting with students of their own.

The research of Stipek and colleagues may further an understanding of how educators' beliefs about the nature of learning mathematics and instructing influence their pedagogical decisions. After studying the views of twenty-one teachers, a difference was found in the instructional practices of those who **endorsed traditional beliefs about the nature of mathematics** (consisting of operations and procedures) as opposed to the NCTM recommended **inquiry-view** (promoting problem-solving and active engagement of learners). In fact, traditional beliefs about teaching mathematics were negatively correlated with the pedagogical practice of promoting student effort. Said another way, the more classrooms endorsed a traditional view the greater the emphasis on student performances such as finding the right answer or high achievement. The converse was also true in these classrooms as less focus was placed on promoting student effort. Stipek's research indicates an association between teachers who emphasized performance and the belief that mathematics ability is static (2001).

Stuart and Thurlow also researched preservice teachers' understanding of how beliefs about mathematics affect their pedagogical decisions (2000). Through a series of reflective exercises, classroom observations, and method application, pre-service teachers examined their beliefs to discover that trending away from traditional methods of mathematics instruction could have a positive impact on student learning.

Research regarding teacher mathematical beliefs (Georgiou et al., 2002; Stuart and Thurlow, 2000) suggests a relationship to intelligence theories, even if the connection has not been explicitly stated. Dweck's (1986) research warrants consideration of the motivational processes that affect learning; namely, attending to the existence of a distinction between beliefs about ability for entity and incremental theorists. Differences in teachers' intelligence beliefs may underlie differences in teaching practices.

Mindset beliefs and pedagogical decisions

The implications of a mathematics teachers' intelligence beliefs are significant, especially when considering the work of Rattan and colleagues who found that undergraduate and graduate student instructors with an entity belief were more likely to comfort and demotivate students (2012). Therefore, fostering a belief in the malleable view of intelligence that focuses on effort based-achievements may be a worthy challenge for teacher education programs to consider (Jonsson, et al., 2012). Pre-service and in-service educators believe instructional decisions to be the "most important determinant of student performance" (Patterson et al., 2016, p. 187). Yet what teaching practices promote a culture that develops a belief in the malleability of intelligence? In her recent book, Boaler (2016) recommends that educators adhere to a growth mindset and teach in alignment with these beliefs. The pedagogical practices that are recommended have positive educational implications.

Hold high expectations

To begin, Boaler recommends believing in the ability of all students via establishing an ethos of high expectations for all students, even those who may not be motivated or have demonstrated a struggle (2016). Researchers have found that teacher beliefs influence the classroom culture (Bohlmann & Weinstein, 2013; Leroy et al., 2007). After observing fifteen teachers and 193 students in west coast schools, researchers classified two distinctly different classrooms. Classrooms categorized as “highly differentiated” integrated ability grouping of students and tasks, focused on student performance, and demonstrated favoritism by making public evaluations of student ability (Bohlmann & Weinstein, 2013). Classrooms that were “equitable” included flexible groupings, focused on student learning and fostered an ethos of respect for all students by curbing adverse statements about student ability. Self-reports of teacher perceptions of students’ ability and student ability perceptions were collected (2013).

In classrooms that were observed to have greater differentiation practices, teachers who categorized students as low in math ability were more likely to have these same students rate their mathematics ability low as well. In other words, student and teacher perceptions of mathematics ability were significantly correlated. Interestingly, in classrooms that demonstrated more equitable practices, the correlation was not evident (Bohlmann & Weinstein, 2013).

To further emphasize the relationship between teachers’ beliefs and classroom conduct, researchers Leroy et al. (2007) found that teachers with a fixed mindset were more likely to create an environment of competition, emphasizing ability and decreasing student motivation. Their analysis of over three hundred French educators’ intelligence beliefs revealed a negative and significant impact between the above-mentioned variables.

Teacher behaviors also affected students’ math ability perceptions. In classrooms where teachers focused on ability, students’ high reasoning skills predicted low math ability self-ratings. However, in equitable classrooms, high reasoning skills predicted near perfect ability ratings. The findings help form an understanding of how teacher beliefs shape students’ mathematical competence. "The worst case scenario for a child (likely resulting in the lowest self-ratings of ability) would be to have more advanced cognitive skills, be the recipient of low teacher expectations, and be in a classroom that is observed to use more ability-based practices" (Bohlmann & Weinstein, 2013, p. 296).

According to the theoretical model proposed by Georgiou and colleagues the inferences teachers make about student ability directly affects their instructional responses (2002). Greek educators were asked how they would respond to students' low performance in all academic areas, particularly math and language. When educators perceived the failure to be a result of low student ability, they were more likely to respond with pity. As such, the teachers may place lower expectations on the student. The resulting correlation between attributions of failure and response of pity was positive and moderately strong (r = .30). Responding with anger was negatively correlated (r=-.31), indicating that educators do not get upset when working with a student perceived to have low ability. On the contrary, teachers who attributed the failure to a lack of effort were likely to respond with anger (r=.50) or give up, although, the correlation was not as strong (r=.20). Furthermore, teachers who perceived students to have low-ability levels and believe they could help the students succeed were likely to cease offering assistance (2002). These findings raise cause for concern and indicate that mathematics instructors may benefit from viewing intelligence as malleable. "Fostering the belief that achievement does not depend on a fixed ability but is instead malleable and dependent on effort seems to be an important challenge for teacher education, particularly in mathematics" (Jonnson et al, 2012, p. 397). Patterson et al. may agree, after finding that teachers' intelligence beliefs were a significant predictor of the view that ability plays a vital role in student success within the STEM subjects

(2016). It is perhaps in the best interest of schools of education to consider the influence teacher beliefs have on their future students.

Georgiou and colleagues sought to explain why teachers either give up or persevere when working with failing students (2002). Using a series of self-reported questionnaires, researchers analyzed how 277 Greek elementary educators would behave when interacting with failing students (a culture that adheres to many Western beliefs). They uncovered that teacher beliefs about student failure were directly related to teacher behavior. When teachers attributed student failure to low ability, they were more likely to respond with sympathy, reduced anger, and perseverance. On the contrary, if the failure was perceived to be caused by low effort, anger and reduced support were the likely responses. Georgiou and colleagues proposed that teachers who perceive struggling students to be a challenge as opposed to a **trouble** will respond with "better and persevering treatment" (2002, p. 593). One way to see obstacles as a challenge may be to adopt a growth mindset within the subject at hand. Dweck found that educators with an entity theory were more likely to persist when working with students of low ability (Dweck & Bempechat, 1983).

Value effort

Boaler also recommends that educators communicate the role of effort in promoting achievement (2016). One current study has explored the results of teachers who hold an incremental view of intelligence and found that, like educators who focus on mastery-oriented practices (Stipek et al., 2001), these classroom environments focused on student learning (Park et al., 2016). Mastery-oriented behaviors practices include the application of effort and attending to perseverance (Dweck & Leggett, 1988). Park et al. investigated the relationship between teachers' intelligence beliefs and their instructional decisions, contending that instructional decisions are more likely than beliefs to affect students "because teachers' behavioral and verbal communications are more proximal to students than teachers' thoughts and beliefs" (p. 309). Through a one-year longitudinal study of 424 first and second grade student and 58 grade-school teachers, it was found that instructors who focused on emphasizing performance were more likely to align with fixed mindset beliefs (2016). Performance goals indicate an emphasis on innate ability as opposed to learning goals which emphasize effort (Dweck & Leggett, 1988). In fact, the direction of relationship between an instructors' intelligence beliefs and practices deemed to be performance-oriented was negative. Furthermore, an HLM analysis indicated a significant and negative relationship between teachers' performance-driven instructional decisions (i.e. focusing on achievement vs. learning and growth) and students' math scores. Even more alarming, is that the greater the emphasis on classroom performance and student ability, the more students believed in an entity theory by the end of the school year. In fact, teachers' self-reported instructional decisions proved to be a significant *predictor* of students' intelligence beliefs by the end of the school year. Researchers say these results warrant cause for alarm, considering that entity beliefs of students could intensify if students receive subsequent instruction from entity theorists with performance-oriented pedagogy (Park et al., 2016).

Attend to type of praise

Praise given to students is another pedagogical hallmark for educators that adhere to an incremental view of intelligence (Boaler, 2016). Understanding intelligence views would benefit teacher education program and students in the program, especially because beliefs about the nature of intelligence have predicted how teachers respond to students (Bohlmann & Weinstein, 2013; Leroy et al., 2007; Jonsson & Beach, 2012). In a series of two studies of Swedish pre-service teachers, Jonsson and Beach discovered that adherence to an entity view of intelligence was positively correlated with the type of praise educators preferred. Entity theorists were more likely to emphasize person praise (as opposed to performance praise). An example of person praise might include the promotion of static traits with comments such as, “you are so smart.” On the other hand, incremental theorists were more likely to praise students’ process. Performance praise would foster malleable qualities through phrases including, “you demonstrated great effort when completing the task.” In addition, a stepwise multiple regression with the dependent variable person praise and predictor variable entity theory of intelligence indicated that entity beliefs significantly predicted teachers’ preference for person praise. Jonsson and Beach’s findings suggest that teachers who believe intelligence is static would be more likely to attribute student performance to innate ability and praise student aptitude (2012).

Furthermore, research has shown that children praised for success or intelligence develop performance as opposed to learning goals. As such, students favored being viewed as intelligent over acquiring new knowledge. Students who focus on performance responded to failure with “helpless” reactions including that evasion of learning opportunities that were perceive to be challenging and could potentially result in failure. Research indicated that helpless responses accompanied a deterioration of academic performance after experiencing a setback (Dweck & Leggett, 1988; Elliott & Dweck, 1988). Mueller and Dweck compared behaviors of students who were praised for intelligence or effort. Through a series of six studies, and varying populations of students, researchers concluded that children praised for intelligence were significantly more likely to attribute their performance to “smartness.” In essence, these students came to understand that performance reflected ability, an attribute of students with a fixed mindset. Instructors who praised students for success may send the message that performance is a measure of intellect and children may gauge their ability from a single performance. However, students praised for hard work were not likely to correlate intelligence with performance on a single assessment (1998, p. 49). Perhaps pre-service teachers who adhere to an incremental theory of intelligence would exhibit a similar response, attributing failure to a lack of effort as opposed to innate ability.

Conclusion

The aforementioned research offers an understanding of how educators view intelligence and the influence on pedagogical decisions. However, it still remains unknown if pre-service teachers would respond to struggling students differently than the graduate students' instructors in Rattan and colleagues' research (2012). Would pre-service teachers with an entity view keep in accordance with Dweck and Leggett's (1998) research of intelligence theories and attribute a poor academic performance to be the result of innate ability? Would pre-service teacher who hold an incremental view attribute student performance to a lack of effort? Gutshall contended that the clinical teaching experience may foster a change in pre-service teachers' application of intelligence beliefs (2014). While beliefs and practices are related, it is not enough to simply measure beliefs because individuals are often unable to accurately represent their views. Therefore, beliefs should be measured by interpreting teacher words, actions and intentions (Pajares, 1992). As such, this researcher will measure pre-service teacher's mindset beliefs and interpret their intentions when working with hypothetical students to determine if the results of Rattan and colleagues research would be the same with the population of pre-service educators.

CHAPTER 3

METHODS

This study investigated the mindset beliefs of pre-service teachers and their corresponding outlook and purported pedagogy when interacting with a hypothetical student. Specifically, using a series of self-reported data on the theories of math intelligence, attitudes toward teaching, delineation of performance on a math test, and selection of pedagogical practice this research sought to explain the association between an incremental view of intelligence and pre-service teachers' intentions and teaching practices. Education programs, school districts, and future educators may benefit from learning ways to change and challenge their views of intelligence. To that end, the study was framed by one primary question:

Do pre-service teachers' beliefs about the malleability of intelligence affect their inferences about student ability and preference for certain pedagogical practices in mathematics?

Additionally, the following questions were examined:

1. What is the relationship between teacher attitude toward teaching and theory of intelligence for mathematics?
2. What is the relationship between teacher perceptions of a student's test score to depict math ability or effort and theory of intelligence for mathematics?
3. What is the relationship between teacher expectations about a student's future math performance and theory of intelligence for mathematics?
4. What is the relationship between teacher pedagogical decisions and theory of intelligence for mathematics?

Sampling

A convenience sample of graduate and undergraduate students from a university in the northwest was utilized in this observational study. All participants were working in a program to obtain an initial licensure and elementary certification during the spring semester of 2017. Specifically, twenty-one students were seeking a Bachelor of Science in an Elementary Education Program, two students were seeking a Bachelor of Science in Elementary Education through a Degree Completion Program, twenty students were enrolled in a Master of Arts in Teaching Program, two students were seeking dual certifications (see Table 2). The sample included fifty-four women (88.5%), five men (8.2%), and two (3.3%) unidentified. The students ranged in age from eighteen to fifty-four years. The participants experienced similar coursework in preparation for a degree in elementary education. Of particular importance, participants took the same sequence of math methods and math content courses. Therefore, all pre-service teachers had similar knowledge of pedagogical practices for teaching mathematics. Elementary education students were selected for this study because researchers have found this population to be apprehensive about mathematics and communicate self-doubts about teaching the subject (McGee, Wang, & Polly, 2013).

Data Collection & Analyses

Pre-service teachers agreeing to take part in the study completed a series of self-reported assessments. Rattan granted permission for the use of all instruments in the study of replication (see Appendix B). The data sets and analyses used in this study included four pre-designed surveys and one hypothetical student scenario (see Appendices C-H).

1. *Theory of Intelligence for mathematics* (see Appendix C)

Dweck and Henderson (1989) created the original three-item survey to measure beliefs about the nature of intelligence. The Intelligence Theory Scale was expanded to four items measuring entity beliefs about mathematics ability, ensuring the self-reported data captures content-specific views of an instructor (Good, Rattan, Dweck, 2012). Through four Likert-type items, participants rated their agreement with an entity theory of intelligence (6) or, by default, an incremental theory (1). Good and colleagues found the survey to have a good reliability rating, alpha = 0.94 (2012).

2. *Attitudes toward teaching in relationship to Theory of Intelligence* (see Appendix D)

   Rattan and colleagues designed an eight-item survey to measure participants' sentiments about mathematical instruction (2012). The self-reported questionnaire quantified teaching attitudes using a six-point scale beginning at (1) strongly disagree through (6) strongly agree. The internal reliability rating of the questionnaire was .72, explored using Cronback's alpha.

3. *Hypothetical student scenarios* (see Appendix E)

   Recent research incorporated the use of hypothetical student scenarios to determine pre-service teachers' beliefs about students (Gutshall, 2014). Pajares also supported having educators respond to "dilemmas as vignettes because they help researchers make increasingly accurate inferences about teacher beliefs (1992, p. 327). As such, this researcher used a previously designed scenario to establish the hypothetical teaching situation to which participants must respond (Rattan, Good, & Dweck, 2012).

4. *Teacher perceptions of a test score to depict hypothetical student's mathematical ability and effort* (see Appendix E)

A one-item assessment will measure participants' perception of a student's mathematical ability after learning he had failed a single math exam. In other words, the item captured an instructors' likelihood to use a single test score to presume a lack of math intelligence or effort (Rattan, Good, & Dweck, 2012). Participants determined the percentages (from 0-100) of the exam score which resulted from a lack of mathematical ability and hard work.

5. *Teacher expectations about hypothetical student's future performance in math* (see Appendix G)

   A two-item assessment was created to provide an understanding of participants' presumptions about a student's performance in subsequent mathematical tasks (Rattan, Good, & Dweck, 2012). The assessment items depicted an educators' expectations using a seven-point scale; a (1) indicated the student would not improve while a (7) indicated improvement was extremely likely. The assessments were explored using Cronbach's alpha and had a reliability rating of .77 when reverse-coded.

6. *Pedagogical decisions to be used with hypothetical student* (see Appendix H)

   To measure the instructional intentions of each participant, researchers designed a six-item assessment. Four items measured the degree to which participants would elect a pedagogical response referred to as a *comforting* practice because it may communicate low expectations (Rattan, Good, & Dweck 2012). Two items assessed the election of an instructional decision that may decrease student engagement in mathematics and subsequent performance. In addition, Rattan and colleagues included seven additional responses in the survey which were neutral in design. As such, the election of a neutral response would indicate that the participant was not communicating low expectations nor decreasing student engagement. Participants' responses were quantified using a seven-point scale ranging from (1) extremely unlikely to (7) extremely likely. The full assessment achieved a reliability rating of 0.77. However, when the survey items were analyzed by their respective groups (comforting strategies and strategies that may reduce engagement) the reliability ratings decreased to 0.52 for the former and 0.75 for the later. The important element in this assessment was that participants would have to make presumptions about the students' ability (see #5) in order to select one pedagogical response.

Table 1

Data Sets and Analyses

	Analysis	Predictor	Outcome	Predictor measure	Outcome measure	Test
1.	Theory of Intelligence for mathematics		Theory of intelligence score		Theory of Intelligence scale 4 items (1) to (6) scale	Average scale score to determine alignment with an entity or incremental theory
2.	Attitudes toward teaching in relationship to Theory of Intelligence	Theory of Intelligence (TI)	Attitude toward teaching (ATT)	Theory of Intelligence scale 4 items (1) to (6) scale	Attitude toward teaching score 2 items (1) to (6) scale	Mean-centered regression of ATT by TI
3.	Teacher perceptions of hypothetical student's test score to depict math ability and effort*	Theory of Intelligence (TI)	Teacher perceptions (TP)	Theory of Intelligence scale 4 items (1) to (6) scale	Perception of test score to indicate ____% lack of math intelligence + ____ % lack of hard work 1 item 0-100 scale	Mean-centered regression of TP by TI
4.	Teacher expectations about hypothetical student's future performance in math*	Theory of Intelligence (TI)	Teacher expectations (TE)	Theory of Intelligence scale 4 items (1) to (6) scale	Presumptions of future performance in math 2 items (1) to (7) scale	Mean-centered regression of TE by TI

5. Pedagogical decisions to be used with hypothetical student*	Theory of Intelligence (TI)	Teacher pedagogical decisions (TPD)	Theory of Intelligence scale 4 items (1) to (6) scale	Instructional intentions 6 items (1) to (7) scale	Mean-centered regression of TPD and TI

**These variables will be measured after participants read a hypothetical student scenario (see appendix E)*

Inclusion criteria for this study designated the conditions for a participant to be included in the analysis. First, students had to be enrolled in full-time student teaching from George Fox University during the spring of 2017. Second, students must have completed all required coursework for a degree in elementary education.

The researcher emailed the instructor of each cohort, requesting permission to survey students via an electronic platform. Upon receiving the instructor's permission, the instructor sent a pre-written email to the students requesting his or her participation in the study. The email stated:

Future Teacher Education Graduate,

Congratulations! In a few short months you will graduate from your GFU program and become a teacher! Your views and beliefs as pre-service teachers are valuable to the profession.

Therefore, I would like to invite you to participate in an important research study specifically designed for pre-service teachers.

Would you be willing to take a brief (15 minutes) online survey? When you complete the survey, you can enter to win a $25 Starbucks gift card!

You may begin the survey by clicking the link below. The survey will close on April 5th.

https://docs.google.com/forms/d/e/1FAIpQLSeIjLDqqJPbFXdTPtJWB9vi1plh8oR5yZpOTqkqMa_xAqPupw/viewform?usp=sf_link

Thank you in advance for participating in this research.

The survey data will be stored in Google Drive and analyzed using the Statistical Package for the Social Sciences (SPSS).

Dependent and Independent Variables

Dependent and independent variables were conceptualized and operationalized as follows:

Independent Variable

1. *Theory of Intelligence for Mathematics*

   The variable was conceptualized as belief in one's aptitude for learning mathematics as static and fixed (an entity view) or malleable and able to be cultivated with effort (an incremental view). The variable was operationalized as a continuous variable depicting participants' agreement with either an entity or incremental theory of intelligence. Treatment designation of a (4) or above indicated alignment with an entity mindset, and (3) or below indicated alignment with an incremental mindset.

Dependent Variables

1. *Attitudes toward teaching*

   This variable was conceptualized as one's position surrounding instruction in mathematics and operationalized as a continuous variable depicting agreement with specific view of mathematics. Treatment designation of (1-3) indicated a strong disagreement with the attitude, (4) indicated a neutral view, while (5-7) signified a strong alignment with the attitude.

2. *Teacher expectations of hypothetical student's test score to depict math ability and effort*

   This variable was conceptualized as the infrastructure of a mathematical performance, consisting of hard work and innate ability. It was operationalized as a continuous variable representing participants' belief that a poor, solitary mathematical performance could be explained by assigning percentages to students' low level of effort and ability. Treatment designation range from 0-100, with 0 representing no contributing effect to 100 indicating full onus of the effect.

3. *Teacher expectations about hypothetical students' future performance in math*

   The variable was conceptualized as beliefs in a student's success or failure in subsequent mathematical endeavors. It was operationalized as a continuous variable depicting participants' prediction of a student's mathematical potential. Treatment designation of (1-3) indicated belief in improvement was unlikely (4) indicated a neutral view, while (5-7) signified improvement was extremely likely.

4. *Pedagogical decisions to be used with hypothetical student*

   The variable was conceptualized as teaching practices which comfort students or may reduce motivation (Rattan, Good, & Dweck, 2012). Operationalized as a continuous variable which illuminated participants' preferred instructional practices and likelihood to comfort or demotivate students. Treatment designation of (1-3) indicated that selection of the instructional practice was highly unlikely (4) indicated a neutral view, while (5-7) signified that using the instructional practice was highly likely. (Note: scale used in replication survey ranged from 1-6.)

Role of the Researcher

I am a graduate student completing this research as part of the requirements for a doctoral degree in educational leadership (EdD.). Additionally, for the past six years I have been employed at a university in the northwest. As an Assistant Professor of Teacher Education, I have been deeply involved with program development and curriculum design associated with educating pre-service teachers. In particular, my responsibilities include implementing research based-practices to develop pre-service teachers' knowledge of mathematics and mathematics pedagogy. Consequently, I have a vested interest in the outcomes of this study.

Research Ethics

George Fox University Institutional Review Board (IRB) approval was required for this study. Additionally, informed consent was an important component of this research, especially considering that the study occurred at my degree-granting institution. I will share the purpose of the study with prospective to help them understand their role in providing data about their perspectives and beliefs regarding student learning. To reduce potential bias, I disclosed the complete methods and objectives of the research after the final assessments are administered. Participation was voluntary and all individuals involved in the study read a letter of consent before proceeding with the electronic survey (see Appendix A). Pre-service teachers were assured that adverse consequences will not occur if they decline to partake in the research.

To ensure anonymity and confidentiality, I did not have members of the course indicate their names on the surveys. All email addresses were kept on a password protected computer until they are destroyed after the raffle winner has been selected. In the letter of consent participants were informed that the results of the study will only be used for research purposes. Information was analyzed and presented in an anonymous fashion and no individual will be personally identified. The researcher was the only individual who had access to these materials. After three years, the researcher will personally destroy all relevant materials and delete the survey responses.

Potential Contributions of the Research

The contributions of the research are multi-faceted. To begin, teacher education programs curricular decisions may be informed of by the results of the study. In particular, the extent to which obtaining knowledge about the Mindset Theory impacts pre-service teachers would be important for faculty to understand as they make design courses.

Secondly, this study would continue the dialogue regarding how mindset theory affects instructional practices in mathematics. As mentioned previously, Rattan, Good, & Dweck (2012) found that graduate student instructors with a fixed mindset were more likely to offer comfort to students when they held a fixed mindset. But how might teachers, trained in the methods and educational theories, respond?

CHAPTER 4

Results

Introduction

The purpose of this research was to replicate a study done by Rattan et al. (2012) to determine if the beliefs that pre-service teachers hold about mathematical intelligence (as opposed to graduate student instructors) would accompany inferences about student ability and preference for certain pedagogical practices in mathematics. Elementary education majors, who were in their final semester of a teacher preparation program at one university in Oregon, were invited to complete a series of online surveys via Google Forms. This chapter reports on the data collected from the five surveys. The data analysis began by importing and transferring the survey responses into the SPSS V.24 Student Package. The data was then cleaned by organizing and correctly specifying the levels of measurement for each variable, transforming variables where necessary, and computing indices from combinations of individual items where appropriate – given Rattan's original study. Survey responses were recoded from descriptors of agreement or likelihood such as 'strongly agree' or 'very likely' to numeric form. Descriptive statistics were analyzed to understand the intelligence beliefs of the participants. Individual regressions were also analyzed for each variable of interest including teacher perceptions, expectations, and pedagogical decisions. The regression analyses elucidated research questions one, two, three, and four.

Participants

The surveys were sent to pre-service teachers enrolled in their final teacher preparation course from one private university, during the spring 2017 semester. The collection window was open from March 22, 2017 through April 18, 2017. The researcher requested that the initial invitation be sent via email by the course instructor and the response window was set to close on April 5, 2017. One program coordinator also sent invitation emails to participants. The initial invitations yielded nineteen responses. A follow up invitation was sent on April 3, 2015, providing eight additional responses. Due to the limited participation, the response window was extended through April 18, 2015. Students were sent a final participation request via email on April 11, 2015, generating thirty-three responses. In total, survey data were collected from sixty-one students, however, forty-five student responses were included in the analyses. There was one key criterion for being included in the study, that the participant be enrolled in an elementary education program. As a result, the number of potential participants decreased due to different factors. Five pre-service teachers were omitted because they did not indicate a program of study and eleven were omitted because they were seeking high school certification.

Table 2 shows the distribution of the sample across programs. The largest number of respondents were from the elementary education program at both the bachelor and master levels.

Table 2

Demographic Characteristics by Program Type (N=61)

Program	Frequency	Percent
Elementary Education (Bachelor of Science)*	21	34.4
Elementary Education Degree Completion (Bachelor of Science)*	2	3.3
Master of Arts in Teaching Multiple Subjects (elementary)*	20	32.8
Dual Enrollment* Elementary Education (Bachelor of Science) and Master of Arts in Teaching Multiple Subjects (elementary)	1	1.6
Dual Enrollment* Master of Arts in Teaching (high school) and Multiple Subjects (elementary)	1	1.6
Master of Arts in Teaching Single Subject (high school)	11	18.1
unidentified	5	8.2

Note. *denotes included in data analysis

Table 3 shows the demographic characteristics of the participants. The information includes age, gender, and ethnicity. The largest percentage of respondents were between the ages of eighteen and forty-four years. There were more female than male respondents, a common trend in teacher education. Two students did not identify gender. The largest percentage of respondents were white (90.2%). This statistic is higher than the ethnicity statistics presented for Caucasian students (73.5%) by the university from which the sample was collected (GFU diversity statistics, 2012).

Table 3

Demographic Characteristics of Participants (N=61)

Characteristic	Demographic characteristic	Frequency	Percent
Age distribution			
18-24		33	54.1
25-34		15	24.6
35-44		8	13.1
45-54		5	8.2
Gender			
Female		54	88.5
Male		5	8.2
Unidentified		2	3.3
Ethnicity			
African American		1	1.61
Asian		3	4.9
Hispanic		2	3.3
Pacific Islander		0	0
White		55	90.2
Native American		0	0
Other		2	3.3

Scale Reliability Analysis

In the original study, Rattan and colleagues included reliability scores for each survey (2012). As a result, the researcher was confident that the results of each survey could be depended upon to be accurate. It was also important from a replication standpoint to determine the internal scale reliabilities to ensure that the surveys performed in the way they were designed when administered to a different population.

Cronbach's alpha was conducted to establish the internal reliability for each scale. As a measure of internal consistency, Cronbach's alpha determined if the participants rated the items in a similar or consistent fashion. If excluding a survey item would increase the reliability of the scale it is included in the tables that follow (see Appendix J for Item-Total Statistics tables). The following Cronbach's alpha summary follows the format described by Laerd (2013).

Scale Reliability Analysis

Theory of Math Intelligence Survey Reliability Analysis.

The 'Theory of Math Intelligence' construct consisted of four survey items. The scale had a high level of internal consistency, as determined by a Cronbach's alpha of 0.882 (see Table 4). If survey item number 1, "People have a certain amount of math intelligence, and they can't really do much to change it," were removed the internal consistency would increase to 0.928. The increased reliability rating implies that the item should be removed. However, since both alpha levels were strong, the survey item was retained to make comparisons with the findings from Rattan and colleagues' research (2012).

Table 4

Results of Theory of Math Intelligence Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha If Item #1 Were Deleted
.882	.898	4	.928

Attitude Toward Teaching Survey Reliability Analysis.

The 'Attitude Toward Teaching'(ATT) construct consisted of seven survey items. The scale had a high level of internal consistency, as determined by a Cronbach's alpha of 0.812 (see

Table 5). If survey item #2, "I'll need a firm mastery of teaching for my future work," were deleted the internal consistency would increase to 0.842. Since 0.812 is a high internal consistency, the survey item was retained for discussion purposes.

Table 5

Results of Attitude Toward Teaching Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha If Item #2 Were Deleted
.812	.882	7	.842

Teacher Expectations Survey Reliability Analysis.

The 'Teacher expectations about hypothetical students' future performance in mathematics' construct consisted of two survey items. The scale had a low, negative level of internal consistency, as determined by a Cronbach's alpha of -0.678 (see Table 6).

Table 6

Results of Teacher Expectations Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
-.678	-.775	2

Pedagogical Decision Survey Reliability Analysis.

The pedagogical decisions construct consisted of eleven survey items, two items depicting an instructor's election of an 'Unhelpful pedagogical decision," four items depicting 'Comforting and/or Consoling pedagogical decisions," and five survey items deemed neutral in nature (Rattan et al., 2012). Rattan et al. included reliability ratings of the individual scales used to measure 'Unhelpful' and 'Comforting and/or Consoling pedagogical decisions.' Researchers found that combining these two scales increased the reliability of the survey. For discussion purposes, this replication study also included the reliability of these six survey items as separate and joint constructs as well.

Unhelpful Pedagogical Decision Survey Reliability Analysis.

The 'Unhelpful pedagogical decisions' construct consisted of two survey items. The scale had a moderate to weak level of internal consistency, as determined by a Cronbach's alpha of 0.531 (see Table 7).

Table 7

Results of Unhelpful Pedagogical Decision Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.531	.532	2

Pedagogical Decision to Comfort and/or Console Survey Reliability Analysis.

The 'Pedagogical decision to comfort and/or console' construct consisted of four survey items. The scale had a moderate, positive level of internal consistency, as determined by a Cronbach's alpha of 0.664 (see Table 8). If survey item #5, "Talk to him about his achievements in other areas and emphasize them" were deleted from the survey, Cronbach's alpha would increase to 0.753. The increased reliability rating implies that the item should be removed. However, the alpha of 0.664 was retained for several reasons. As this was a replication study, and Rattan et al. did not delete the survey item, the alpha was retained for comparison purposes. Furthermore, when the two scales were joined ('Comforting and/or Consoling' plus 'Unhelpful') the alpha increased to 0.775 and excluding a survey item did not increase the reliability (see Table 9).

Table 8

Results of Pedagogical Decision to Comfort and/or Console Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha If Item #5 Were Deleted
.664	.646	4	.753

Unhelpful, Comforting and/or Consoling Pedagogical Decision Survey Reliability Analysis.

After combining the six survey items which assessed a teachers' instructional decision to enlist a comforting/consoling practice with the two survey items depicting an unhelpful practice, the scale had a strong, positive level of internal consistency, as determined by a Cronbach's alpha of 0.775 (see Table 9). As mentioned above, excluding any items from this survey would not increase the reliability.

Table 9

Results of Unhelpful, Comforting and/or Consoling Pedagogical Survey Reliability Analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.775	.766	6

Research Questions

Linear regression is used to determine the change in a dependent variable for one unit of change in the independent variable. This statistical test was employed to answer the research questions because an understanding of the relationship between the theory of intelligence and the outcome variables (attitude, perception, expectations, and pedagogical decisions) was sought.

A linear regression requires that several assumptions be met for valid model interpretation. The assumptions were assessed and the linear regression was run for the dependent variables (pre-service teachers' attitude, perception, expectations, and pedagogical decisions) on the independent variable (theory of intelligence) in order to determine the degree in which the independent variable explained the variation in the dependent variables. The linear regression model summary follows the formatting described by Laerd (2013). The following will address all non-figurative assumptions, for graphic assumption reports see Appendix K. The results that follow pertain to the analytical procedures discussed in chapter 3, Table 1.

Research question 1: What is the relationship between teacher attitude toward teaching and theory of intelligence for mathematics?

Assumption 1 – two variables are used and measured at the continuous level. Design assumption was met because there was one independent and one dependent variable; the dependent variable in this study was pre-service teachers' theory of intelligence and the dependent variable was teacher attitude toward teaching mathematics. Both items were used and measured using series of survey items on an ordinal Likert scale.

Assumption 2 – a linear relationship exists between the dependent and independent variables. For the assumption of a linear relationship to exist between the dependent variable (teacher attitude) and independent variable (theory of intelligence), no curvilinear relationships must be found. No curvilinear relationships were identified between the dependent variable and independent variable.

Assumption 3 – a significant outlier does not exist. The Casewise Diagnostic table did highlight one case greater than $\pm$ 3 standard deviations (case number 24) with a large standardized residual of -3.315.

Assumption 4 – an independence of observations occurs. Independence of residuals existed, as checked by a Durbin-Watson statistic of 1.587.

Assumption 5 – data indicates homoscedasticity. There was homoscedasticity, as assessed by a visual inspection of a plot of standardized residuals verses standardized predicted values.

Assumption 6 – residuals are approximately normally distributed. Residuals were normally distributed as assessed by visual inspection of a normal probability plot.

Linear regression results. Laerd (2013) asserts that different strengths of association are used as guidelines when interpreting regression statistics. Values between .1 and .3 indicate a small strength of association, .3 to .5 indicate a medium association, and values between .5 and 1.0 indicate a large strength of association between the variables. As seen on Laerd (2013) the following is a technical report of the regression model.

A linear regression was calculated to understand the effect of a pre-service teacher's theory of intelligence for mathematics on attitudes toward teaching. The model established that a pre-service teacher's theory of intelligence had a slight to moderate negative correlation with a pre-service teacher's attitude toward teaching, $r = -0.389$, $p = .008$, $F(1, 43) = 7.672$, $p < .008$. In addition, theory of intelligence accounted for 15.1% of the explained variability in attitudes toward teaching. The regression equation was:

Y (predicted attitudes toward teaching) = 40.96 + -.331(x) theory of intelligence score. Participants' average attitude toward teaching decreased as the agreement with an entity theory of intelligence for mathematics increased.

Table 10

Linear Regression Results for Attitudes Toward Teaching by Theory of Math Intelligence

Model Summary[b]									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.389[a]	.151	.132	2.970	.151	7.672	1	43	.008

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Survey #2 (added all scores range 1-42)

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	40.959	.974		42.044	.000
	Theory of Intelligence	-.331	.119	-.389	-2.770	.008

a. Dependent Variable: Attitude Toward Teaching

Research question 2: What is the relationship between teacher perceptions of a student's test score to depict math ability or effort and theory of intelligence?

Assumption 1 – two variables are used and measured at the continuous level. Design assumption was met because there was one independent and one dependent variable.

Assumption 2 – a linear relationship exists between the dependent and independent variables. For the assumption of a linear relationship to exist between the dependent variable (teacher perceptions) and independent variable (theory of intelligence), no curvilinear relationships must be found. No curvilinear relationships were identified between the dependent variable and independent variable.

Assumption 3 – a significant outlier does not exist. The Casewise Diagnostic table did not highlight a significant outlier, therefore, one does not exist.

Assumption 4 – an independence of observations occurs. Independence of residuals existed, as checked by a Durbin-Watson statistic of 2.397.

Assumption 5 – data indicates homoscedasticity. Homoscedasticity of residuals was violated, as assessed by a visual inspection of a plot of standardized residuals verses standardized predicted values.

Assumption 6 – residuals are approximately normally distributed. Residuals were not normally distributed as assessed by visual inspection of a normal probability plot.

Linear regression results. A linear regression was calculated to understand the effect of theory of intelligence for mathematics on teachers' perceptions of a test score to depict a student's lack of hard work or effort. The regression established that theory of intelligence had a weak, positive correlation with a teacher's perception of a student's lack of hard work, $r = 0.147$, $p = .400$, $F(1, 33) = .726$, $p < .400$ and theory of intelligence accounted for 2.2% of the explained variability in teacher perceptions.

Y (perception of a test score to indicate lack of hard work/effort) = 53.44 + .875(x) theory of intelligence score. Participants' average perception that a test score indicates a belief in a lack of hard work or effort scarcely increased as the agreement with an entity theory of intelligence for mathematics increased.

Table 11

Linear Regression Results for Perception of a Test Score to Indicate Lack of Hard Work/Effort by Theory of Math Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.147[a]	.022	-.008	23.087	.022	.726	1	33	.400

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Survey #3 (0-100%)

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	53.443	8.988		5.946	.000
	Theory of Intelligence	.875	1.027	.147	.852	.400

a. Dependent Variable: Perception of a Test Score to Indicate Lack of Hard Work

Research question 3: What is the relationship between teacher expectations about a student's future math performance and theory of intelligence?

Assumption 1 – two variables are used and measured at the continuous level. Design assumption was met because there was one independent and one dependent variable.

Assumption 2 – a linear relationship exists between the dependent and independent variables. For the assumption of a linear relationship to exist between the dependent variable (teacher expectations) and independent variable (theory of intelligence), no curvilinear relationships must be found. No curvilinear relationships were identified between the dependent variable and independent variable.

Assumption 3 – a significant outlier does not exist. The Casewise Diagnostic table did not highlight a significant outlier, therefore, one does not exist.

Assumption 4 – an independence of observations occurs. Independence of residuals existed, as checked by a Durbin-Watson statistic of 2.119.

Assumption 5 – data indicates homoscedasticity. Homoscedasticity of residuals was violated, as assessed by a visual inspection of a plot of standardized residuals verses standardized predicted values.

Assumption 6 – residuals are approximately normally distributed. Residuals were not normally distributed as assessed by visual inspection of a normal probability plot.

Linear regression results. A linear regression was calculated to understand the effect of theory of intelligence for mathematics on participants' expectations about a hypothetical student's future performance in mathematics. The following data is the result of reverse-coding the second survey item. The regression established that an entity theory of intelligence had a slight negative correlation with a teacher's expectations of future math success, $r = -0.371$, $p = .012$, $F(1, 43) = 6.856$, $p < .012$ and theory of intelligence accounted for 13.8% of the explained variability in teacher expectations.

Y (predicted expectations about future mathematical performance) = 4.78 + -.144 (x) theory of intelligence score. Participants' average expectations of student's future success in math decreased as the agreement with an entity theory of intelligence for mathematics increased.

Table 12

Linear Regression Results for Teacher Expectations by Theory of Math Intelligence

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.737	.449		10.539	.000
	Theory of Intelligence	-.144	.055	-.371	-2.618	.012

a. Dependent Variable: Teacher Expectations of Future Performance in Mathematics

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.371[a]	.138	.117	1.371	.138	6.856	1	43	.012

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Teacher_Expectations_Scale_RC

Research question 4: What is the relationship between teacher pedagogical decisions and theory of intelligence?

Several linear regressions were calculated to understand the effect of theory of intelligence for mathematics on participants' instructional intentions. The instructional intentions were analyzed in three separate linear regressions for the following outcome variables: comfort or consoling practices, unhelpful practices, and a combination of both.

Assumption 1 – two variables are used and measured at the continuous level. Design assumption was met because there was one independent and one dependent variable.

Assumption 2 – a linear relationship exists between the dependent and independent variables. For the assumption of a linear relationship to exist between the dependent variable (teacher expectations) and independent variable (theory of intelligence), no curvilinear relationships must be found. No curvilinear relationships were identified between the dependent variable and independent variable.

Assumption 3 – a significant outlier does not exist. The Casewise Diagnostic table highlighted one case greater than ± 3 standard deviations with a large standardized residual of 4.669 (case 27).

Assumption 4 – an independence of observations occurs. Independence of residuals existed for all three outcome variables, as checked by a Durbin-Watson statistic of 2.037 for comfort or consoling practices, 2.140 for unhelpful practices, and 2.157 for the combination of practices.

Assumption 5 – data indicates homoscedasticity. Homoscedasticity of residuals was violated for all three outcome variables, as assessed by a visual inspection of a plot of standardized residuals verses standardized predicted values.

Assumption 6 – residuals are approximately normally distributed. Residuals were not normally distributed as assessed by visual inspection of a normal probability plot.

Linear regression results. The first linear regression established that theory of intelligence had a moderate, positive correlation with a teacher's instructional decision to comfort or console a student, $r = .530$, $p = .001$, $F(1, 42) = 16.730$, $p < .001$. Theory of intelligence accounted for 28% of the explained variability in teacher instructional decisions.

Y (pedagogical decision to comfort and/or console) = 8.27 + .417 (x) theory of intelligence score. Participants' average pedagogical decision to comfort or console a student increased as the agreement with an entity theory of intelligence for mathematics increased.

Table 13

Linear Regression Results for Pedagogical Decision to Comfort or Console by Theory of Math Intelligence

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.273	.841		9.837	.000
	Theory of Intelligence	.417	.103	.530	4.046	.000

a. Dependent Variable: Pedagogical Decision to Comfort or Console

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.530[a]	.280	.263	2.562	.280	16.370	1	42	.000

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Comfort_Console_Scale

The second linear regression established that theory of intelligence had a strong, positive correlation with a teacher's election of an unhelpful practice, $r = .683$, $p = .001$, $F(1,43) = 37.510$, $p < .001$. Theory of intelligence accounted for 46.6% of the explained variability in teacher instructional decisions.

Y (predicted decision to enlist an unhelpful pedagogical practice) = 2.45 + .361(x) theory of intelligence score. Participants' average pedagogical decision to comfort or console a student increased as the agreement with an entity theory of intelligence for mathematics increased.

Table 14

Linear Regression Results for Unhelpful Pedagogical Decision Regression Analysis by Theory of Math Intelligence

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.446	.480		5.090	.000
	Theory of Intelligence	.361	.059	.683	6.125	.000

a. Dependent Variable: Unhelpful Pedagogical Decision

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.683[a]	.466	.453	1.465	.466	37.510	1	43	.000

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Unhelpful Practices Scale

The third linear regression established that theory of intelligence had a strong, positive correlation with a teacher's election of a comforting and consoling or unhelpful pedagogical decision, $r = .653$, $p = .001$, $F(1, 42) = 31.206$, $p < .001$. Theory of intelligence accounted for 42.6% of the explained variability in teacher instructional decisions.

Y (predicted decision to enlist a practice deemed comforting, consoling, or unhelpful) = 10.65 + .772(x) theory of intelligence score. Participants' average election of a comforting, consoling, or unhelpful practice increased as the agreement with an entity theory of intelligence for mathematics increased.

Table 15

Results for Comforting, Consoling, or Unhelpful Pedagogical Decision Regression Analysis by Theory of Math Intelligence

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	10.653	1.128		9.446	.000
	Theory of Intelligence	.772	.138	.653	5.586	.000

a. Dependent Variable: Comforting, Consoling, or Unhelpful Pedagogical Decision

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.653[a]	.426	.413	3.436	.426	31.206	1	42	.000

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Comfort_and_Unhelpful_Scale

Conclusion

In summary, a series of linear regressions were conducted to understand pre-service teacher's beliefs about the malleability of math intelligence and its effect on their attitude toward teaching, perception of a test score to depict ability or effort, expectations for future math performance, and pedagogical decisions. The linear regression models moderately established that a stronger adherence to an entity theory of math intelligence may result in a decrease in pre-service teacher's attitude toward teaching. A relationship between pre-service teacher's theory of math intelligence and perception of a test score to depict a lack of student hard work or effort established a positive and weak correlation ($r = 0.147$). In addition, pre-service teachers with a stronger adherence to an entity theory of math intelligence were also found to have negative expectations about the future success of students in mathematics (after learning of one test score). Finally, pre-service teacher's intelligence beliefs were found to influence their pedagogical decisions. The decision to comfort or console students or elect an unhelpful pedagogical decision increased as pre-service teacher's agreement with entity theory of math intelligence increased.

Chapter 5

Conclusion

Introduction

Teachers' adherence to beliefs about intelligence for mathematics range from viewing the construct as a malleable quality to seeing one's aptitude as a fixed trait (Boaler, 2016). Teacher preparation programs may be interested in discovering how these intelligence beliefs influence the instructional decisions of pre-service teachers. A recent study by Rattan et al. found that graduate student instructors, who hold the title of 'teacher,' respond in alignment with their beliefs about intelligence. In fact, instructors with a fixed mindset were found to have the following: negative expectations about students' future mathematical performance, believe that a low test score was indicative of a lack of math intelligence, and prefer comforting or unhelpful pedagogical strategies when working with students (2012). Would pre-service teachers trained in the methods and philosophies of instruction respond in a similar fashion? The primary impetus for this study was to replicate the work of Rattan and her colleagues to discover the intelligence beliefs of aspiring educators, in particular those completing an extensive teacher education program. This study examined pre-service teachers' attitudes toward teaching mathematics, perceptions of a test score to depict ability or effort, expectations for future math performance, and pedagogical decisions.

Discussion of Findings

The discussion that follows expounds on the findings from chapter four and will address the following research questions:

1. What is the relationship between teacher attitude toward teaching and theory of intelligence for mathematics?

2. What is the relationship between teacher perceptions of a student's test score to depict math ability or effort and theory of intelligence for mathematics?
3. What is the relationship between teacher expectations about a student's future math performance and theory of intelligence for mathematics?
4. What is the relationship between teacher pedagogical decisions and theory of intelligence for mathematics?

Teacher Attitude

Evidence from this study suggests that pre-service teacher's attitude toward teaching decreases slightly as the adherence to an entity theory of intelligence increases. The linear model used in this study revealed a moderate negative relationship (r = -0.389, p = .008) between the dependent variable (pre-service teacher attitude toward teaching) and the independent variable (theory of intelligence). Since a significant relationship exists we can conclude that the enjoyment of teaching may be reduced if a pre-service teacher believes that intelligence is a fixed quality. This explanation does not align with Rattan et al.'s work, which did not indicate a relationship between the variables. Rattan and colleagues noted that the sole intent of the survey was to establish that a difference in attitude toward the profession did not exist (2012). In doing so, the researchers explained that a difference in attitude was removed as a plausible reason for variation in participants' intelligence views. However, the results of the replication study indicate that 15.1% of the variance in attitudes toward the profession can be explained by pre-service teacher's beliefs about intelligence.

The results of this survey emphasize the practical implication of understanding an educator's intelligence beliefs. If adherence to an entity view can influence a construct as simple as how the profession is viewed, what might be the far-reaching consequences? For example, past research has indicated that educators with entity beliefs adopt other negative attitudes such as stereotypes and critical judgments (Jonsson and Beach, 2012). Furthermore, teachers who have an attitude that a student is a challenge are more likely to persevere when working with struggling students (Georgiou, 2002). Taken together, these studies suggest that an educator with a fixed mindset may have negative attitudes about the profession and adopt detrimental views of their students.

Teacher Perception of Test Score to be the Result of a Lack of Math Ability or Hard Work/Effort

The findings from this study suggest that a relationship between the dependent variable (teacher's perception of a failing grade to result from a lack of hard work or effort, as opposed to a lack of math ability) and alignment with the independent variable (entity view of intelligence) exists. However, the correlation between the variables was small (r = 0.147, p = .400), not statistically significant, and should be interpreted with caution.

As such, the results of this replication study do not align with research surrounding the views of entity theorists. First, Rattan et al.'s study highlighted the converse, "the more participants endorsed an entity (vs. incremental) theory, the greater *percentage* of the student's grade was attributed to a 'lack of math intelligence' as opposed to a 'lack of hard work'" (*emphasis mine,* 2012, p. 734). Additionally, past research has indicated that entity theorists view performance as indicative of high levels of intelligence while incremental theorists are more likely to view ***effort*** as a major contributor to success (Dweck & Leggett, 1988; Dweck, 2006). Furthermore, entity theorists have been found to view ***effort*** as an indicator of low intelligence (Dweck & Leggett, 1988; Mueller & Dweck, 1998). Especially in the field of mathematics, entity theorists communicate a message that ability is responsible for student performance

(Beach, 2003). The findings of this replication study may indicate that pre-service teachers with entity beliefs are starting to understand the role effort could play in student failure. Perhaps the cultural messages stemming from Dweck's (2006) work has an influence on the views of future teachers, even for individuals holding entity beliefs.

Another plausible explanation for the difference in findings could also be attributed to several factors. First, the survey question as stated, "His grade on the test = __% lack of hard work + __% lack of math intelligence" (sum = 100%)" may have been misinterpreted by the participants. Participant responses indicated this potential confusion as six pre-service teachers explicitly stated their lack of understanding (i.e. "I can't determine what was hard work or intelligence"), requested additional information (i.e. "It truly depends on the student" and "not enough information"), or opted to leave the question blank. Due to the error in survey design, the results should be interpreted with caution.

Delineating the amount of hard work or intelligence that contribute to an academic performance may also be challenged due to culturally-bound views (Stevenson and Lee, 1990; Kurtz-Costes, 2005; Jonsson and Beach, 2012). For example, researchers Kurtz-Costes identified American children as more likely to associate academic ability with effort, believing that intelligent people work hard ***and*** can increase intelligence via effort. German children did not view hard work as a characteristic of an intelligent person (2005). On the other hand, Jonsson and Beach asserted that ability ***or*** effort are the determinants Swedish teachers blame for a failure (2012). While participants from this replication study were primarily white (90.2%), an individual's ethnicity does not include a measure of cultural values, including their view of effort and intelligence. Future research may want to include cross-cultural comparisons and a measure of cultural values and the influence on intelligence views.

Teacher Expectations About Future Math Performance

This current study suggests that the dependent variable (pre-service teacher's expectations about a student's future mathematical performance, after learning of one failing test score) had a moderate relationship with the independent variable (entity view of intelligence). While the relationship was moderate (r = -0.371, p = .012), the results should be interpreted with caution considering that some of the model assumptions were not met and the results were not statistically significant.

Nevertheless, findings from this study have some practical implications as finding that expectations for a student's success decrease as a pre-service teacher believes more strongly in an entity theory of intelligence can negatively influence students. The outcomes from this study align with Rattan et al.'s (2012) research, further suggesting that a teacher with a fixed mindset, regardless of his or her educational training, may be more likely to hold lower expectations for a student after learning of one failing math score.

Holding low expectations may affect the performance of women in mathematics courses. Educators who believe more strongly in an entity theory have been found to accept pre-conceived notions, or stereotypes, of individuals (Jonsson and Beach, 2012). Since mathematics educators may be more likely to nurture entity beliefs (Jonsson et al., 2012; Myers, Nichols and White, 2012), educators with entity views would also foster an environment which emphasized student competence and achievement (Park et al., 2016). Students in such classrooms would be influenced by the ethos created and determine whether or not they felt a sense of belonging. Women, in particular, would be most affected by these environments; further discouraging their intentions to continue career-trajectory preparations in the STEM fields (Good et al., 2012). In sum, it would seem that adherence to an entity view could be detrimental for students.

These findings, taken together with previous research, may advance our understanding of how a desire to exert effort is decreased for all students in classrooms with teachers who hold an entity view of mathematics intelligence. Current mathematical practices call for educators to hold high expectations, foster effort, and believe in the ability of all students, especially those who have demonstrated past failures (Boaler, 2016). If a teacher with a fixed mindset holds lower expectations for students' future success (Rattan et al., 2012), these beliefs could be conveyed to and adopted by students (Bohlmann & Weinstein, 2013). The end result may be a decrease in motivation and the employment of effort, which negatively influences mathematical performance (Steinmayr and Spinath, 2009; Murayama et al., 2013).

Teacher Pedagogical Decisions

Evidence from this study indicates that pre-service teacher's pedagogical decisions had a moderate to strong relationship with the independent variable (entity theory of intelligence). Recall that the pedagogical decisions were analyzed as separate subscales (comforting/consoling and unhelpful). The decision to elicit a comforting/consoling practice had a moderate relationship of $r = .503$, $p = .001$ as did unhelpful at $r = .683$, $p = .001$. When combined, the resulting correlation was found at $r = .653$, $p = .001$. Regardless of the type of instructional decision selected, this study indicated that the more a pre-service teacher agreed with an entity theory of intelligence, the more likely he or she would be to comfort, console, or enact an unhelpful practice when working with a student. While the results were significant, it must be noted that the model may not have much strength given that several of the assumptions were not met.

Nonetheless, these findings confirm Rattan et al.'s results (2012). Their study concluded that comforting/consoling and unhelpful pedagogical decisions were preferred to a greater degree for instructors who had a stronger alignment with an entity theory of intelligence as opposed to those holding an incremental view. Previous research has established that teachers with strong entity beliefs were more likely to elect instructional decisions that foster a culture of competition (Leroy, Bressoux, Sarraxin, and Trouilloud, 2007), emphasize performance (Park et al., 2016), and praise person as opposed to process (Jonsson and Beach, 2012). The findings from this study contribute a more robust understanding of the instructional techniques pre-service teachers with an entity view of intelligence might elect when working with a hypothetical student.

Future research may want to understand more clearly how pre-service teachers' instructional intentions compare with elected practices. Kagan concludes that "teacher's beliefs usually reflect the actual nature of the instruction the teacher provides to students" (1992, p. 73). Beliefs applied in practice with students, with all the nuances and complexities of classroom teaching, may be different than theoretical hopes or intentions. As Gutshall recommends, "beliefs in and of themselves may be less reliable and valid compared to the classroom and practical application of beliefs" (2014, p. 799).

Implications of the Study

The primary purpose of the present replication research was to further understand the influence of intelligence beliefs on a new population, namely, pre-service teachers. The intended contribution would provide teacher education programs with insight associated with how entity beliefs may influence the perceptions, expectations, and intended instructional practices these beginning teachers may elect.

Of particular interest for mathematics educators, the findings suggest that the more pre-service teachers adhere to an entity view of intelligence, the more likely they would be to comfort a student for a presumed lack of mathematics ability. The findings also suggest that these same future educators would be more likely to prefer instructional practices in mathematics that would be considered unhelpful because they "could reduce engagement" (Rattan et al., p. 734, 2012). Both of these results are consistent with the research of Rattan et al. (2012) and, as such, raise alarm for mathematics methodologists who equip future educators. There now exist two studies that indicate unhelpful instructional techniques educators (both trained and untrained in the methods of teaching) might select if they also adhere to an entity view of intelligence.

While this study indicates that pre-service teachers may be changing their views regarding the role of effort, teacher education programs may want to consider the current research landscape before dismissing the downside of fostering entity beliefs. The findings presented in this study are the first (known by this researcher) to indicate that entity theorists slightly endorse effort over ability. The current research landscape reveals that mathematics teachers have a propensity to view intelligence as a product of innate ability (Beach, 2003; Jonsson et al., 2012; Myers, Nichols, & White, 2003). It is more likely to consider past research which has shown that beliefs about mathematics tend to be driven by previous learning experiences (Swars et al., 2016; Sloan, 2010) from mathematics educators who endorse the view that intelligence is fixed. Mathematics educators with a fixed mindset adopt more traditional, rule-driven beliefs and emphasize achievement more than effort (Stipek et al., 2001). This is not the case with other disciplines, such as social sciences, where intelligence is viewed as a malleable construct (Jonsson et al., 2012). Since elementary educators instruct in all the content areas, including mathematics, teacher preparatory programs may want to spend isolated time focusing on intelligence beliefs and how they envision supporting the learning of mathematics, especially in regards to struggling students. Methods courses can often be taught in isolation (i.e. math methods, social studies methods, art and music methods), perhaps perpetuating beliefs held in each domain. Jonsson et al. recommend methods courses incorporate the voices of student teachers from a variety of disciplines (2012). In such an environment, perhaps beliefs about intelligence from educators in the arts or social sciences may encourage a malleable view of intelligence as beliefs are challenged and implications for pedagogy are discussed.

Limitations of the Research

The aforementioned findings should be carefully interpreted for a myriad of reasons. As previously mentioned, several models may not have much strength given that multiple assumptions were not met. In addition, several correlations did not have p-values below .05 indicating that the results may have occurred by chance and limiting the strength of conclusions that could be drawn.

Another limitation involved the survey construction. While the survey questions were taken directly from a communication with the lead researcher (see Appendix B), one Likert scale differed from the format followed in the replication study. The pedagogical decisions survey was supposed to capture participants' preferences using a (1) to (7) Likert scale; however, the replication study used (1) to (6). Furthermore, the precise wording of the options within the Likert scales (i.e. 'agree a lot' as opposed to 'extremely likely') was not requested from the lead researcher and may have differed in the replication study. Finally, the 'Attitude toward Teaching' survey was supposed to consist of eight items. The question, "I want to always continue teaching," was not included due to researcher error. Consequently, the reliability of the surveys may be reduced because of researcher error in replicating the items.

Limitations could also be identified during administration and subsequent interpretation of the survey. Originally, the researcher planned to administer the survey during face-to-face sessions with each cohort of pre-service teachers. Instead, participants took the survey online and no advanced directives were provided. Although it was assumed that all the participating teachers would understand the survey items (especially since they were taken from a prominent research study) the decision was made to use an electronic platform; the decision came at a cost. If administration involved a face-to-face survey collection with adequate explanation of each survey item, as opposed to an online format, the findings may have been different. Furthermore, as this was a replication study, the survey administration should have followed the same format as Rattan et al. to reduce potential variables of difference. However, the administration protocol was not requested nor implemented in the replication study.

During the administration, participants also indicated confusion surrounding the survey item, "His grade on the test = __% lack of hard work + __% lack of math intelligence" (sum = 100%)." While the definitions for each construct (hard work and intelligence) were operationalized as follows: hard work, "how hard a person works or how much they practice in a particular area," and ability, "how naturally smart or talented a person is in a particular area" (Patterson et al., 2016, p. 184) participants could not ask clarifying questions, thereby increasing confusion surrounding the survey items (i.e. differentiating between "hard work" and "intelligence") and decreasing the validity of the data. This researcher learned that data collection is a vital part of survey research and has the potential to limit the findings.

An additional limitation of the study involved question design. Pre-service teachers were asked to self-report their responses which increases the possibility that participants answered in accordance with their beliefs; however, their actions remained unknown. Gutshall (2014) called attention to the potential discrepancy between beliefs and actions using similar data collection methods. Boesen et al. also found that teachers may react in a positive manner to a reform initiative and even believe they are implementing the model. However, educators can struggle to ascertain, process, and teach in accordance with the reform message. Educators can "react positively and believe they are implementing the reform without actually doing so" (2014, p. 84). Future researchers may want to explore how intelligence beliefs influence educational decisions in practice.

Conclusion

I began this investigation seeking to exonerate pre-service teachers, hoping to uncover data contrary to Rattan et al.'s concerning designation, "Instructors with a fixed mindset comfort and demotivate students" (2012). The analyses revealed, however, that pre-service teachers with a fixed mindset *would* be more likely to elect unhelpful and comforting strategies, potentially decreasing student motivation. In addition, pre-service teachers with a stronger adherence to an entity theory *would* be more likely to have lower expectations for a student's future math performance after learning about one failing math score. The data, while disheartening, illuminated an important reality for this researcher; namely, that understanding an individual's theory of intelligence is a vital component of teacher education training. Methods are essential and philosophies are irreplaceable, but transforming belief systems may be the key behind preparing educators that will help the next generation of students find success in mathematics. Continually engaging pre-services teachers in reflection about their beliefs and subsequent instructional decisions, both corporately and individually, should be a component of teacher preparation.

Through this study, I also learned several valuable lessons about conducting research. Replicating and conducting survey research is a complex endeavor. Each facet of data collection involves more than simply obtaining survey questions; requests for replication methods includes understanding coding and survey design as well. Additional precision checks should be conducted to confirm that data is transcribed accurately and alignment between survey construction and research methods are followed. Taken together, the multiple researcher errors could decrease the validity and potential value of the research. Nevertheless, the process was humbling and indispensable to confirm the complexity of conducting a quantitative study.

The practice of data analysis was also exhilarating and stretching. I found myself increasingly interested in the analysis of the survey results and perplexed by the findings. God created beauty in written expression but there also exists beauty in numerical representations. Decoding the beauty presented through data from SPSS involved a more robust understanding of statistics than I imagined and I realized that data analysis is a definite area of interest and one where I would like to continue growing.

I also replicated a study that was not perfect. Problems existed in the original study; for example, the pedagogical practices were categorized as comforting and unhelpful without being thoroughly conceptualized or supported by research. As such, it would be difficult for educations to ascertain which practices would be considered comforting or unhelpful. Furthermore, Rattan et al. claimed that comforting practices could demotivate students without providing data to support how each practice from the survey would be interpreted by students. Future research may want to explore the influence of each instructional decision used in a survey and clearly conceptualize categories, before making generic claims about the potential influence on constructs such as student motivation.

I remain inspired by the continued research endeavors of Dweck and her colleagues. I enjoyed the challenge of replicating a study conducted by lead researchers in the field who continually explore the many aspects of our humanity that are influenced by the theory of intelligence. Personally, I think the results of the replication study uncover the heart of God for

His people; mainly, a call to remember that all intentions reflect the condition of our hearts (what we believe). “For whatever is in your heart the mouth speaks” (Matthew 12:34, NLT). As such, I believe that acknowledging the great potential in all students, hoping for their future success, and selecting instructional strategies that challenge students to grow stems from a heart that believes in the goodness of all creation. As scholars, I think it is our calling to foster a growth mindset in our own personal lives, and in the lives of those we are blessed to teach.

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Appendix A

Letter of Consent

Pre-Service Teacher Beliefs and Decision-Making

Dear Future Educator,

My name is Rachel Curtiss and I am a doctoral student at George Fox University in Newberg, Oregon. As part of completing my Ed.D., I am conducting research to provide greater understanding of the views held by beginning teachers and the choices of instruction that follow. This study has been approved by the GFU Institutional Review Board (IRB).

The surveys should take less than 15 minutes to complete. The questions are about your personal views and are not designed to create any distress. Nevertheless, please be aware that your participation is voluntary and you may decline to continue at any time or decline to answer any question at your discretion.

The results of this study will only be used for research purposes. Information will be analyzed and presented in an anonymous fashion and no individual will be personally identified. I will be the only individual who will have access to these materials. After three years, I will personally destroy all relevant materials and delete the survey responses.

Thank you for your time and for considering this project. If you have any questions regarding this research, please contact me at curtiss.rachel@gmail.com, my advisor at George Fox University, Dr. Patrick Allen at pallen@georgefox.edu or IRB member Dr. Terry Huffman at thuffman@georgefox.edu.

Remember, at the end of the survey you can enter to win a $25 Starbucks gift card!
(Two $25 gift cards will be awarded.)

Appendix B

Permission to use Surveys

Wed, Jan 25, 2017 at 9:01 AM

Dear Rachel,

I am happy to share the materials, and I have attached the materials for Study 3 as that is what most people tend to ask for. I would love to hear what you are working on for your dissertation (and the results once you have them). Please feel free to reach out with any questions, or if the attached are not the full set of what you were hoping to get.

Best,
Aneeta

--
Aneeta Rattan, Ph.D.
Assistant Professor
Organisational Behaviour
London Business School

Appendix C

Theories of Math Intelligence Survey (Rattan, Good, & Dweck, 2012; Good, Rattan, Dweck, 2012)

- People have a certain amount of math intelligence, and they can't really do much to change it.
- People's math intelligence is something about them they can't change very much.
- To be honest, people can't really change how intelligent they are in math.
- You can learn new things, but you can't really change your basic math intelligence.

Appendix D

Attitudes Toward Teaching Survey (Rattan, Good, & Dweck, 2012)

- In general, I enjoy teaching.
- I'll need a firm mastery of teaching for my future work.
- I want to always continue teaching.
- I know how useful teaching is
- When I teach, I encourage conversation among students.
- When I teach, I encourage students to share their questions in class.
- When I teach, I offer students choices about what they do and how they do it.
- When I teach, I encourage students to work with each other.

Appendix E

Hypothetical Student Scenario (Rattan, Good, & Dweck, 2012)

Original scenario:

Imagine that you are TAing an introductory course in your department. For this course, you teach a mandatory section of about 20 students. As the section TA, you teach important material not covered in lecture, grade all student work, and hold office hours each week. The quarter has just begun and you have graded your students' first exam covering the concepts that you have been teaching in section. You decide to have each student come to office hours, one at a time, so you can speak to them about their test.

The next student who you are meeting with about the test is Jason. Just before Jason arrives, you look back at his test and notice that he has received one of the lowest scores in the class on the test, a failing grade.

Modified scenario:

Imagine that you are teaching a mathematics class in elementary school. For this class, you have 28 students. As the full-time instructor, important material not covered in the content areas, and stay late each week to grade papers and meet with students. The year has just begun and you have graded your students'' first test covering the mathematics concepts you have been teaching in the unit. You decide to have each student meet with you, either during lunch/recess or after school, one at a time, so you can speak to them about their test.

The next student who you are meeting with about the test is Jason. Just before Jason arrives, you look back at his test and notice that he has received one of the lowest scores in the class on the test, a failing grade.

Appendix F

Test Score Response (Rattan, Good, & Dweck, 2012)

His grade on the test = __% lack of hard work + __% lack of math intelligence”
(sum = 100%)

Appendix G

Teacher Expectations About Future Student Performance Survey (Rattan, Good, & Dweck, 2012)

- In your opinion, what is the likelihood that he will improve his grade substantially on the next test?
- In your opinion, what is the likelihood that on the next test, he will earn the same grade as he did for this test?

Appendix H

Pedagogical Responses Survey (Rattan, Good, & Dweck, 2012)

Comfort/Console:

- Talk to him about what other subjects might be more suitable to his skills.
- Console him for his grade by telling him that plenty of people have trouble in this field but go on to be very successful in other fields.
- Explain that not everyone is meant to pursue a career in this field.
- Talk to him about his achievements in other areas and emphasize them.

Unhelpful:

- Talk to him about dropping the class. (Adapted for an elementary context to read: Talk to him about joining a lower-level math group.)
- Make a point not to call on him as often in class so he won't be embarrassed if he doesn't know the answer.

Filler items

- Tell him that if he wants to improve, he can.
- Tell him that you know he can improve if he works hard in this subject.
- Tell him that you thought he should have done better than he did.
- Tell him that you know he can do better on the next test.
- Tell him that it is obvious that he did not study enough for the test.
- Tell him that you don't feel this was his best work.
- Tell him that he needs to try harder next time.

Appendix I

Letter of Participation

Future Teacher Education Graduate,

Congratulations! In a few short months you will graduate from your GFU program and become a teacher! Your views and beliefs as pre-service teachers are valuable to the profession.

Therefore, I would like to invite you to participate in an important research study specifically designed for pre-service teachers.

Would you be willing to take a brief (15 minutes) online survey? When you complete the survey, you can enter to win a $25 Starbucks gift card!

You may begin the survey by clicking the link below. The survey will close on April 5th.

https://docs.google.com/forms/d/e/1FAIpQLSeIjLDqqJPbFXdTPtJWB9vi1plh8oR5yZpOTqkqMa_xAqPupw/viewform?usp=sf_link

Thank you in advance for participating in this research.

Rachel Curtiss
Teacher & Doctoral Student at GFU

Appendix J

Item-Total Statistics Tables

Item-Total Statistics for Theory of Intelligence for Mathematics Survey

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #1 TOI	5.31	8.083	.584	.355	.928
Survey #1 TOI	5.36	7.734	.856	.822	.804
Survey #1 TOI	5.67	9.227	.814	.692	.840
Survey #1 TOI	5.47	7.845	.813	.787	.821

Item-Total Statistics for Attitude Toward Teaching against Theory of Intelligence

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #2 ATT	32.91	7.083	.639	.501	.770
Survey #2 ATT	33.27	8.745	.227	.181	.842
Survey #2 ATT	32.96	8.680	.424	.259	.806
Survey #2 ATT	32.87	7.982	.659	.577	.775
Survey #2 ATT	32.84	7.680	.717	.651	.764
Survey #2 ATT	33.47	6.255	.688	.597	.762
Survey #2 ATT	33.02	7.477	.622	.522	.774

Item-Total Statistics for Teacher Expectations of Future Success against Theory of Intelligence

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #4 TE	4.31	2.128	-.279	.078	.
Survey #4 TE	5.33	.864	-.279	.078	.

Item-Total Statistics for Pedagogical Decision to Comfort Student against Theory of Intelligence

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #5 TPD (talk about achiev.other areas)	6.36	7.818	.121	.033	.753
Survey #5 TPD (console him for his grade)	8.55	4.626	.467	.221	.595
Survey #5 TPD (explain that not everyone)	9.66	5.439	.615	.600	.499
Survey #5 TPD (talk to him about what subject suitable)	9.32	4.408	.637	.619	.446

Item-Total Statistics for for Unhelpful Pedagogical Decision against Theory of Intelligence

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #5 TPD (make a point not to call)	2.02	1.386	.362	.131	.
Survey #5 TPD (talk to him about joining)	3.04	1.498	.362	.131	.

Item-Total Statistics for Comfort/Console or Unhelpful Pedagogical Decision against Theory of Intelligence

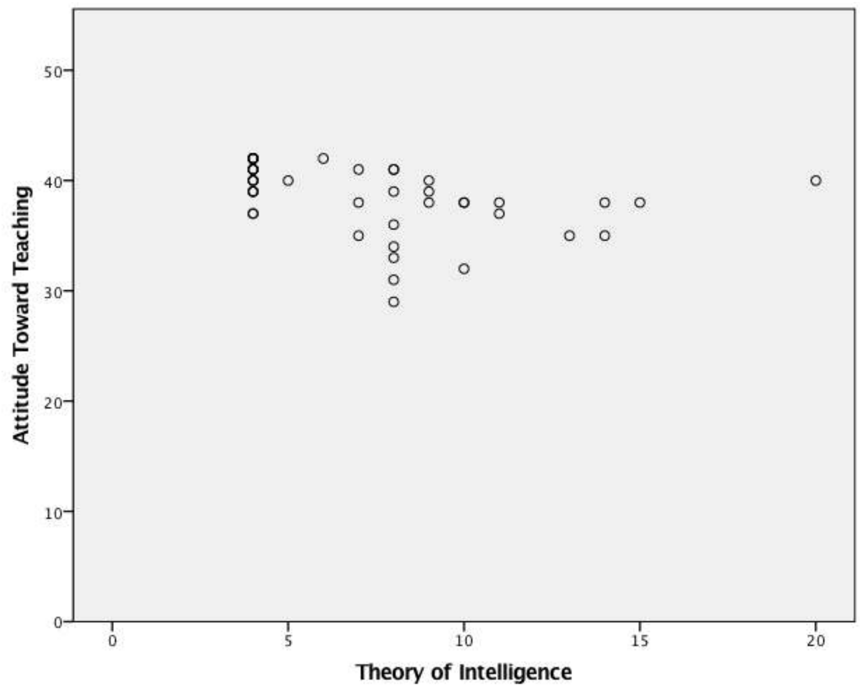
Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Survey #5 TPD (make a point not to call)	13.25	13.634	.566	.453	.730
Survey #5 TPD (talk to him about joining)	14.30	14.585	.513	.527	.743
Survey #5 TPD (talk about achiev.other areas)	11.32	18.827	.106	.132	.816
Survey #5 TPD (console him for his grade)	13.50	13.837	.475	.249	.759
Survey #5 TPD (explain that not everyone)	14.61	13.917	.780	.741	.686
Survey #5 TPD (talk to him about what subject suitable)	14.27	12.715	.720	.646	.685

Appendix K

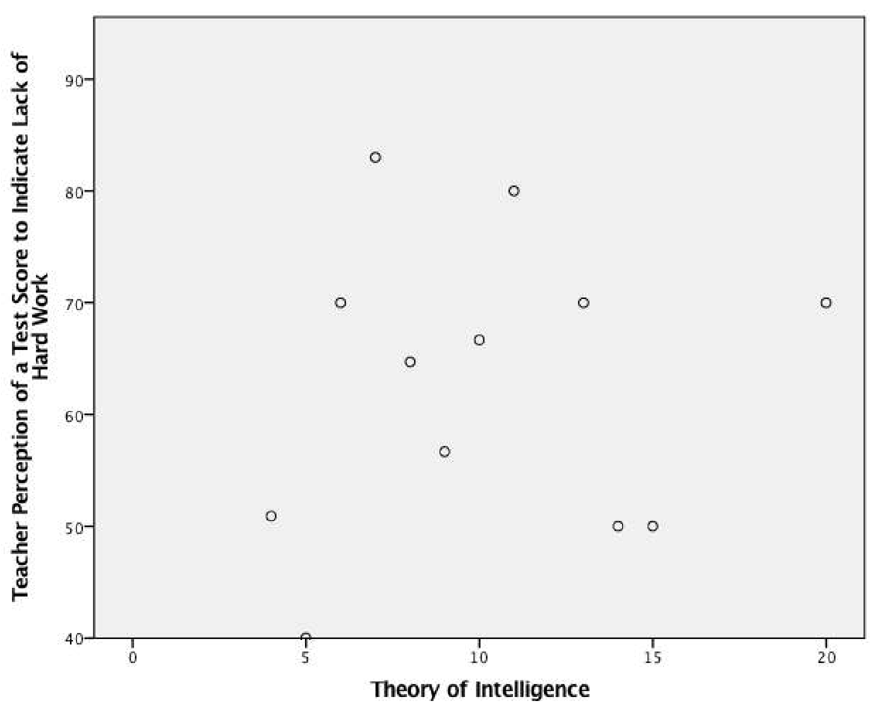
Assumptions

Assumptions of Linearity Tests

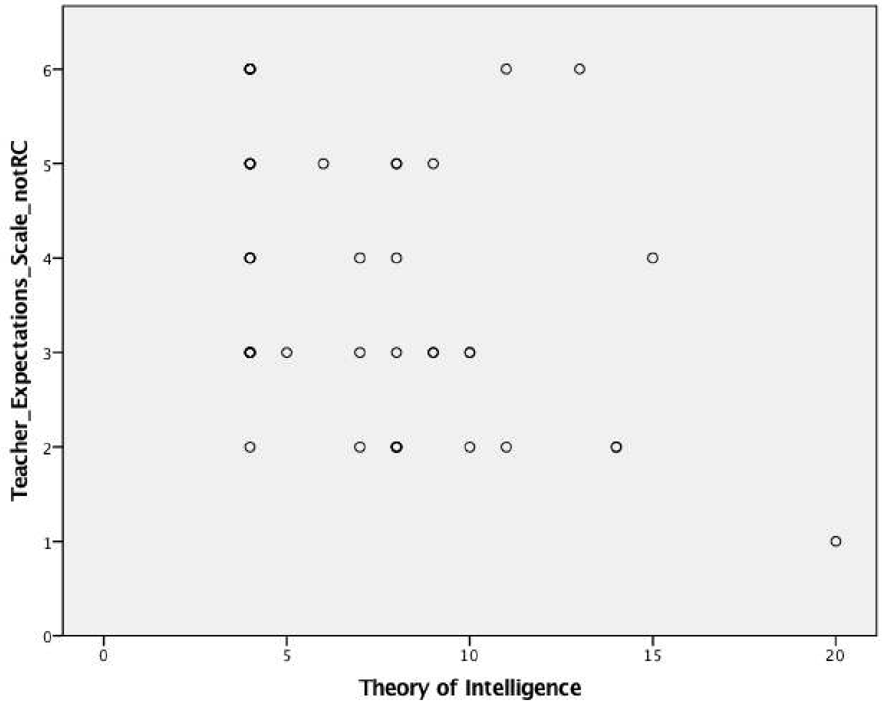
Linearity Test for Attitude Toward Teaching against Theory of Intelligence.



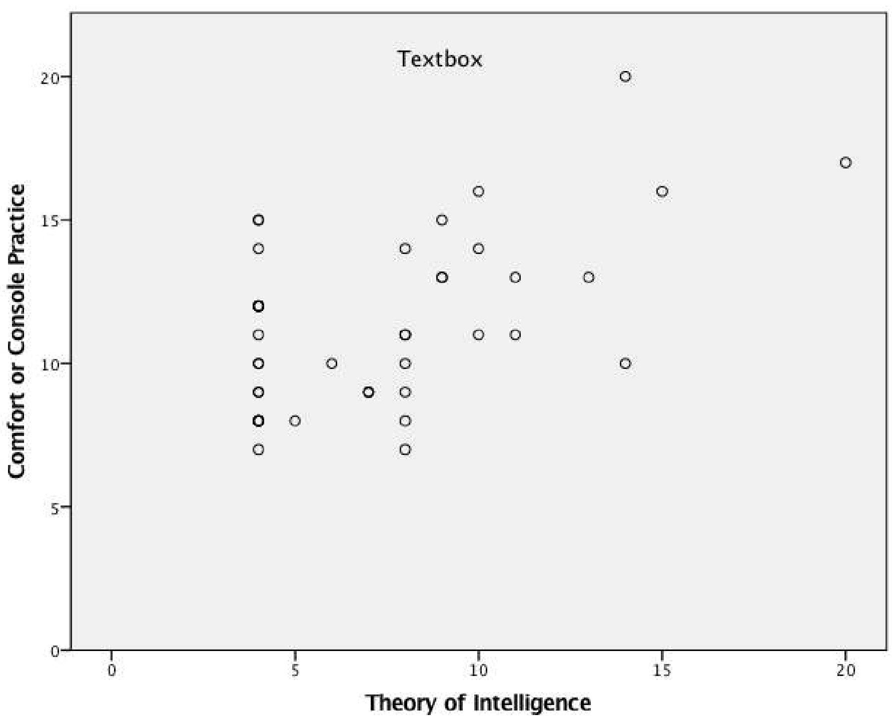
Linearity Test for Teacher Perception of Test Score to Depict Hard Work against Theory of Intelligence.



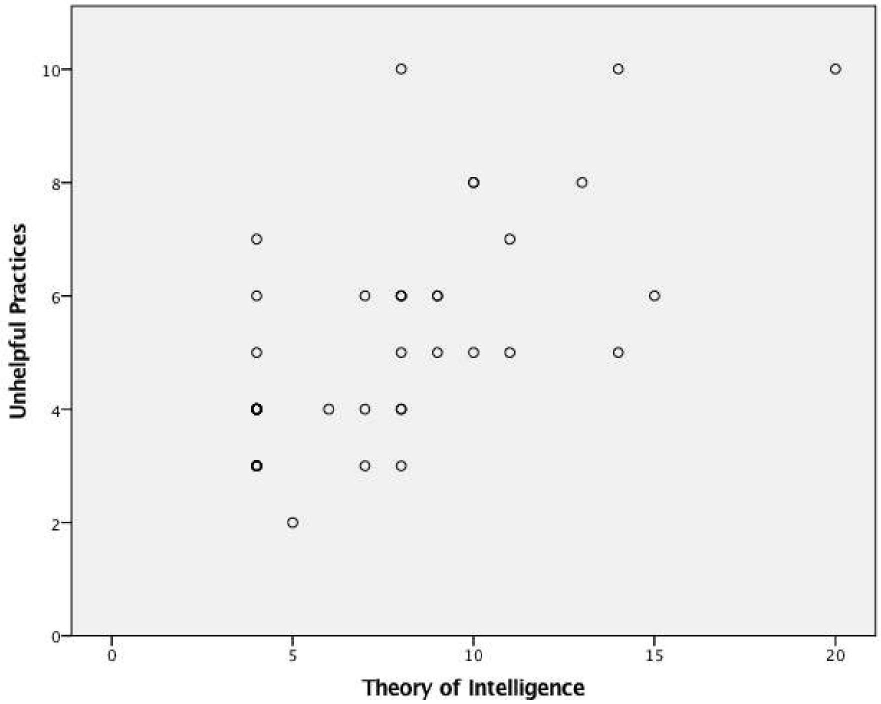
Linearity Test for Teacher Expectations of Future Success against Theory of Intelligence.



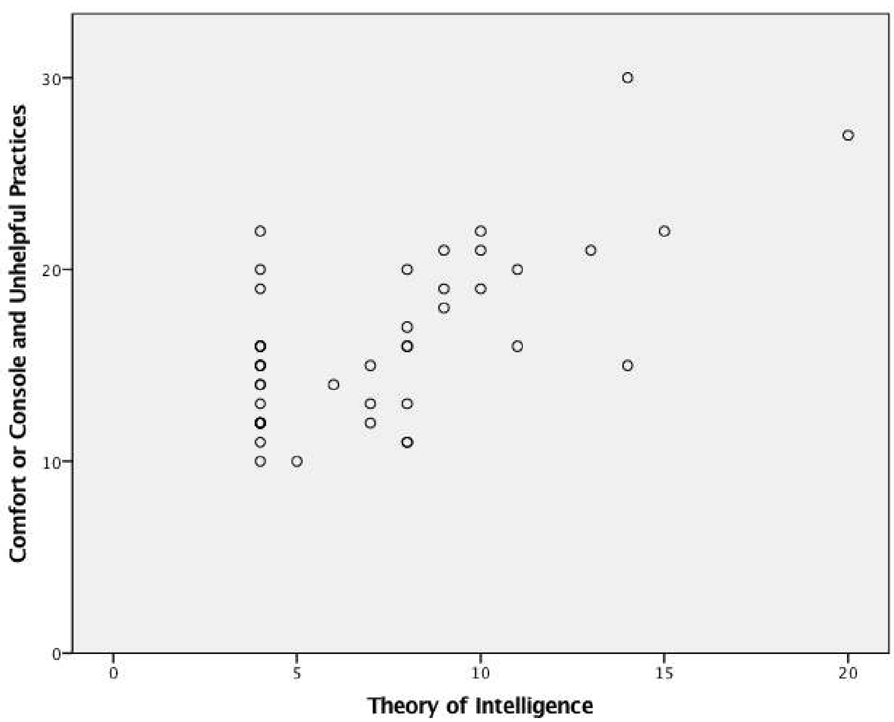
Linearity Test for Pedagogical Decision to Comfort Student against Theory of Intelligence.



Linearity Test for Unhelpful Pedagogical Decision against Theory of Intelligence.

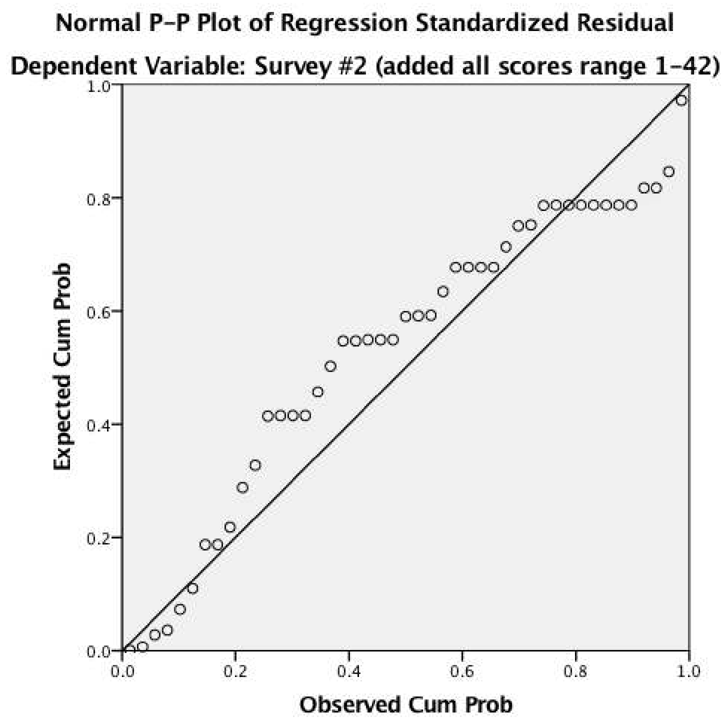


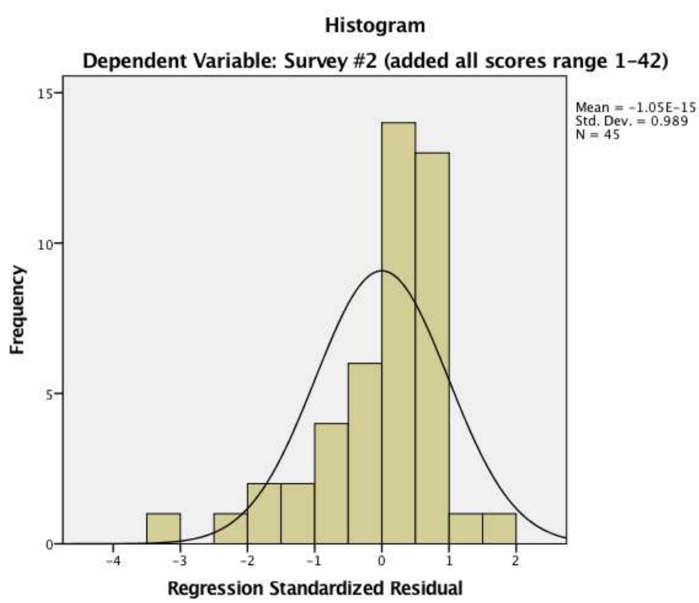
Linearity Test for Comfort/Console or Unhelpful Pedagogical Decision against Theory of Intelligence.



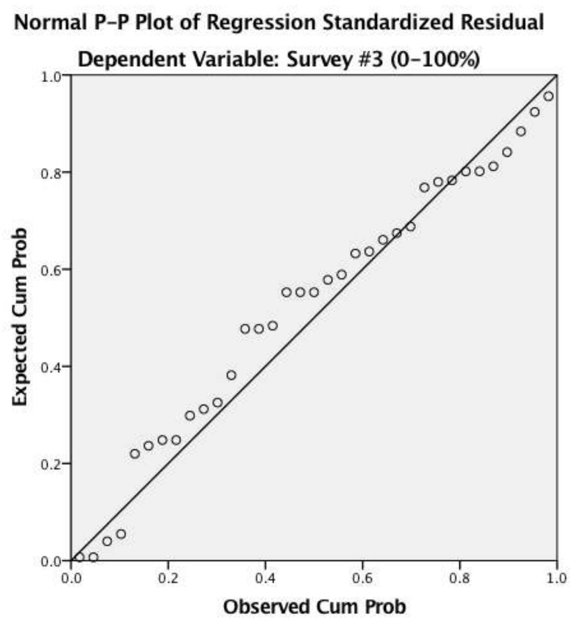
Assumptions of Normality Tests

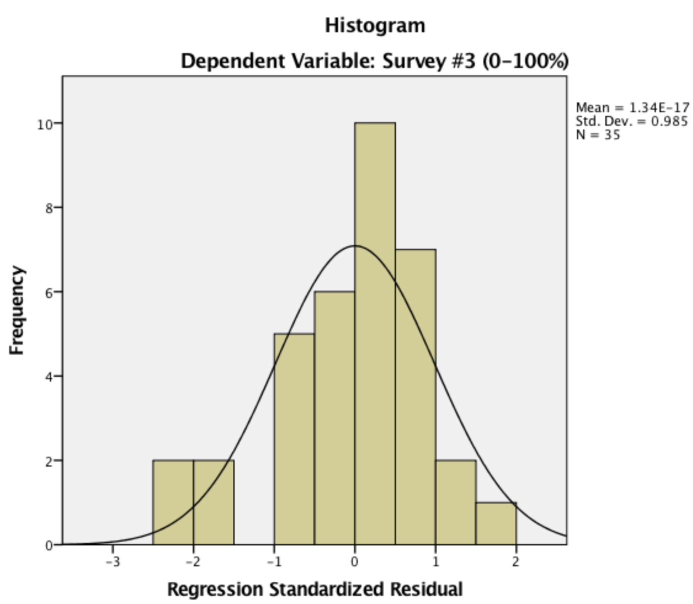
Assumptions of Normality Tests for Attitude Toward Teaching against Theory of Intelligence.



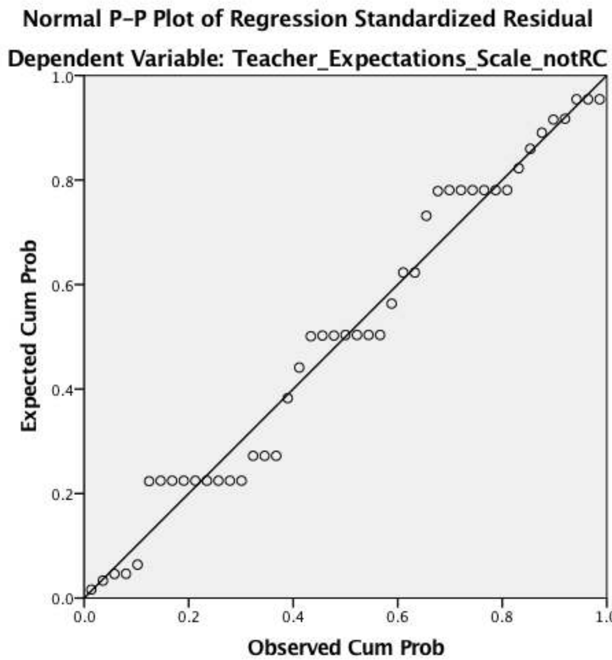


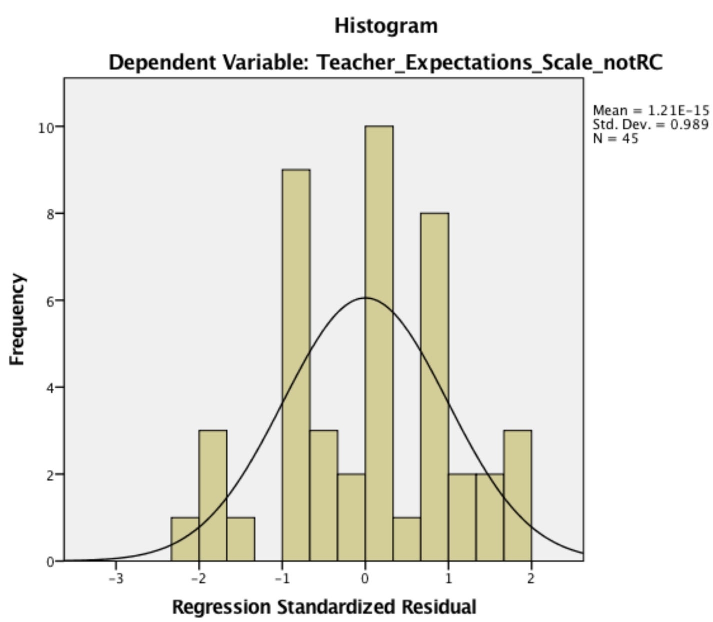
Assumptions of Normality Tests for Teacher Perception of Test Score to Depict Hard Work against Theory of Intelligence.



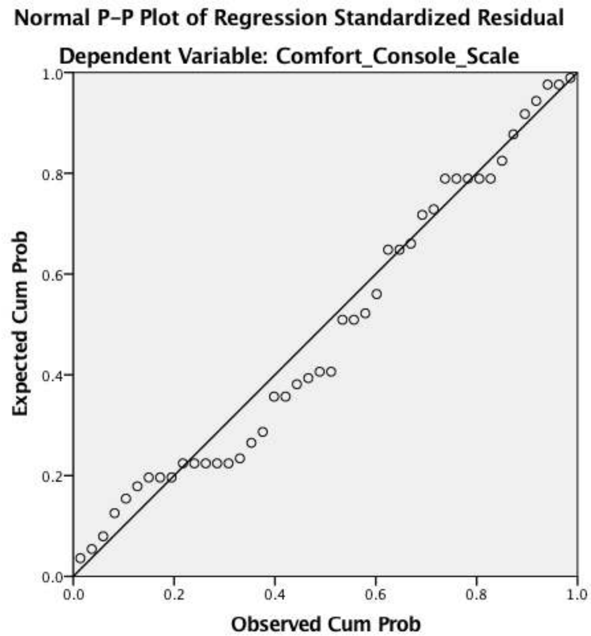


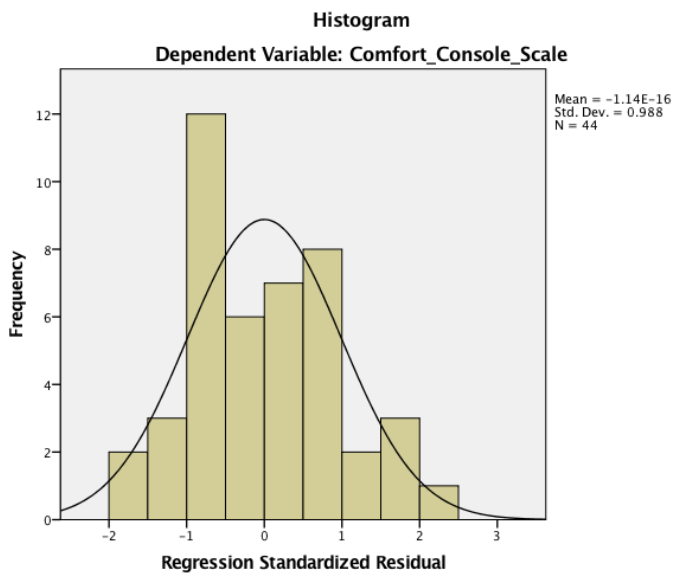
Assumptions for Normality Tests For Teacher Expectations of Future Success against Theory of Intelligence.



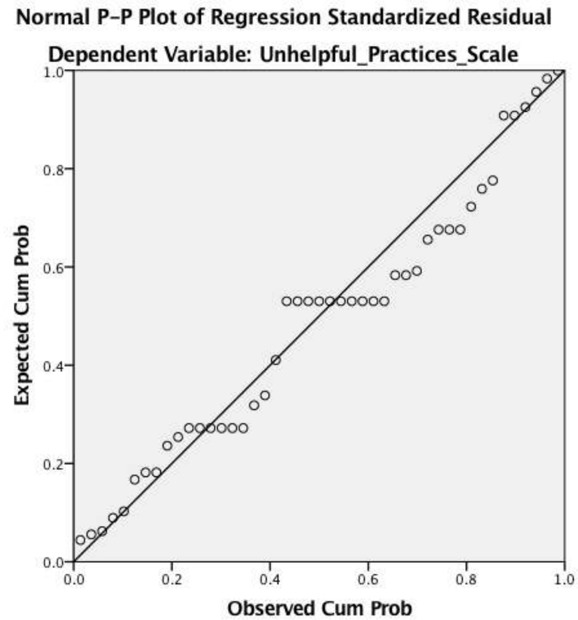


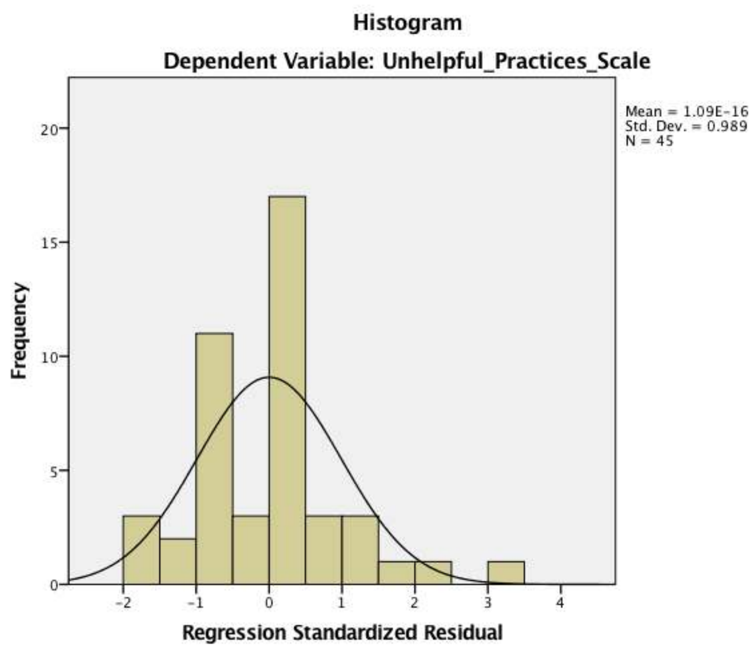
Assumptions of Normality Tests for Pedagogical Decision to Comfort Student against Theory of Intelligence.



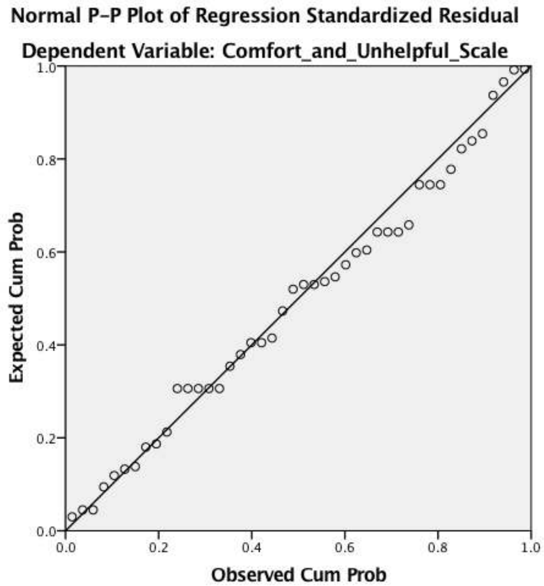


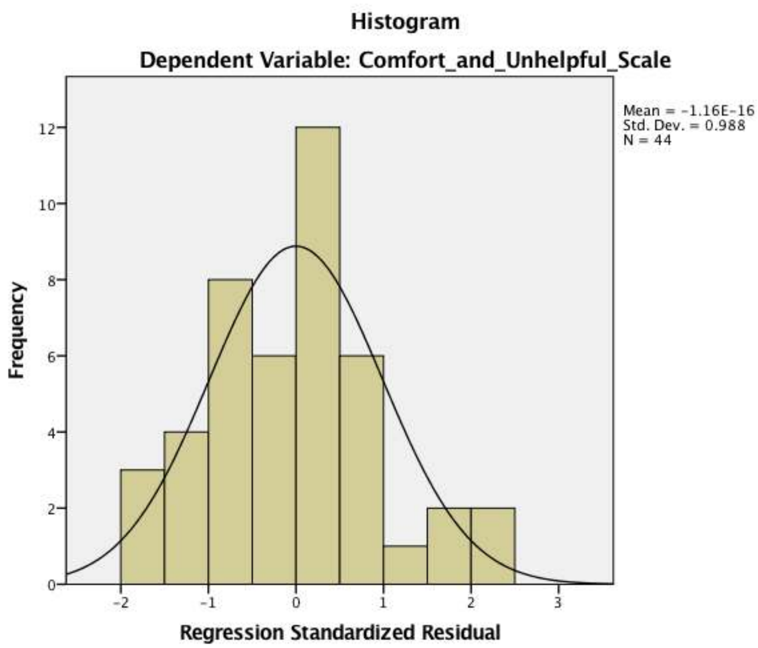
Assumptions of Normality Tests for Unhelpful Pedagogical Decision against Theory of Intelligence.





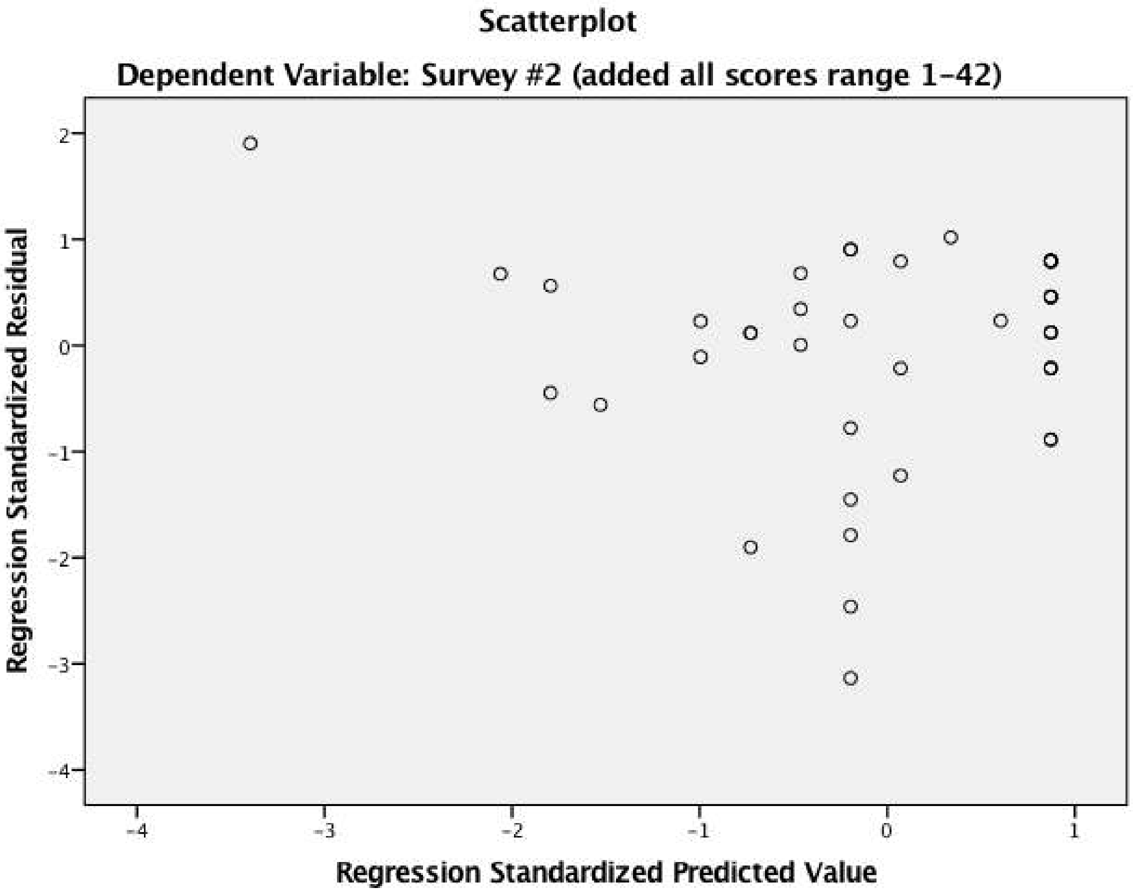
Assumptions for Normality Tests for Comfort/Console or Unhelpful Pedagogical Decision against Theory of Intelligence.



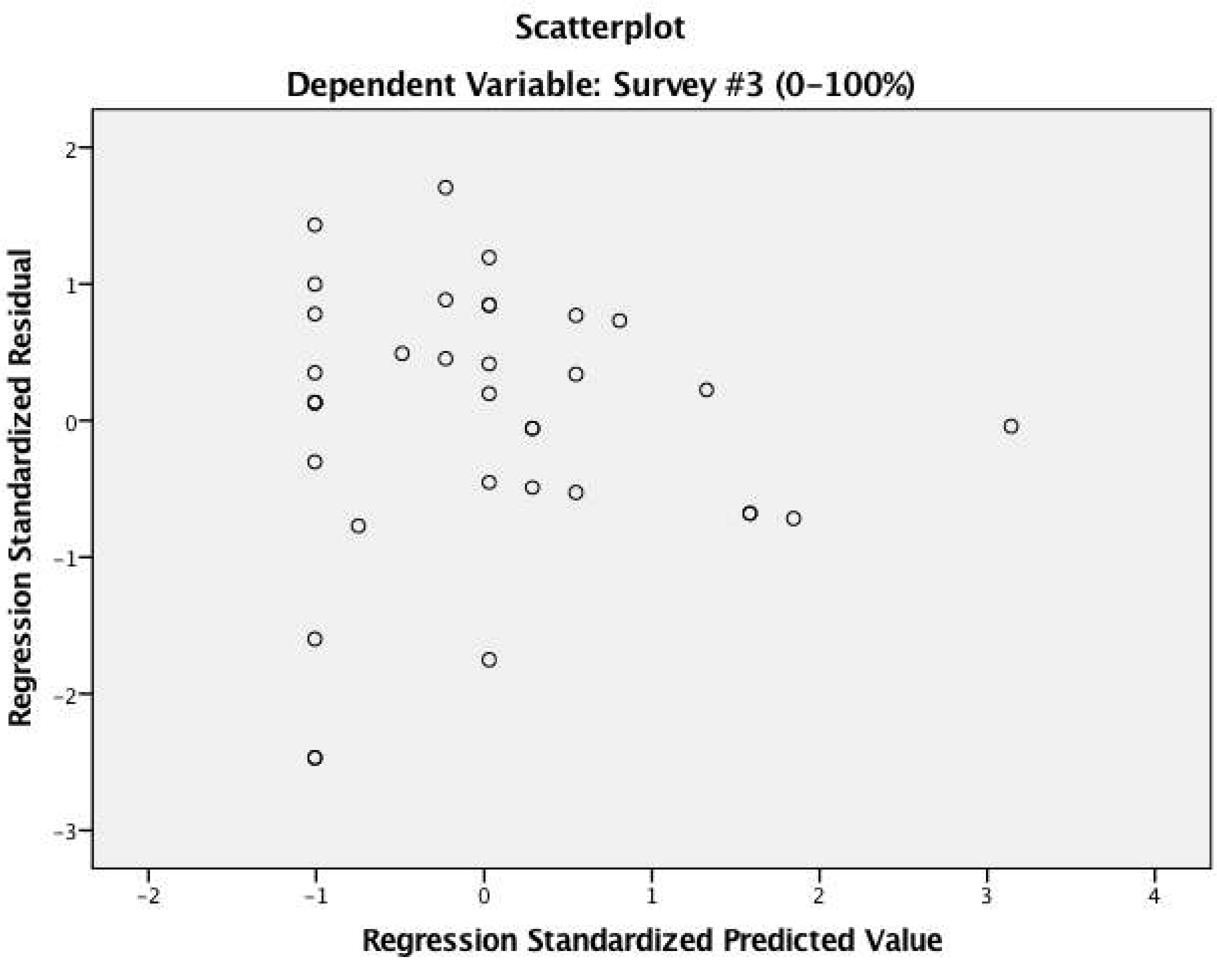


Assumption of Homoscedasticity Tests

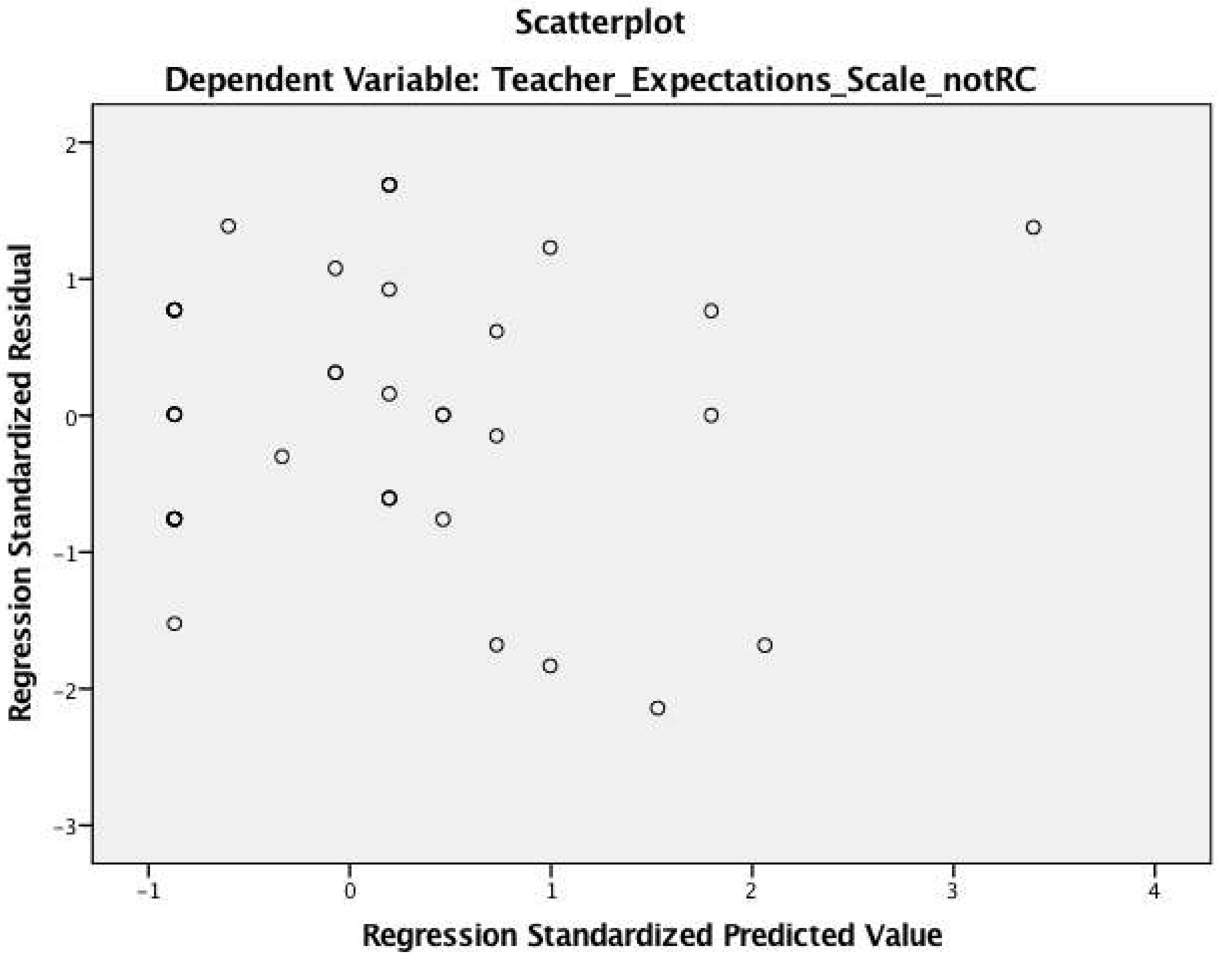
Assumption of Homoscedasticity Tests for Attitude Toward Teaching against Theory of Intelligence.



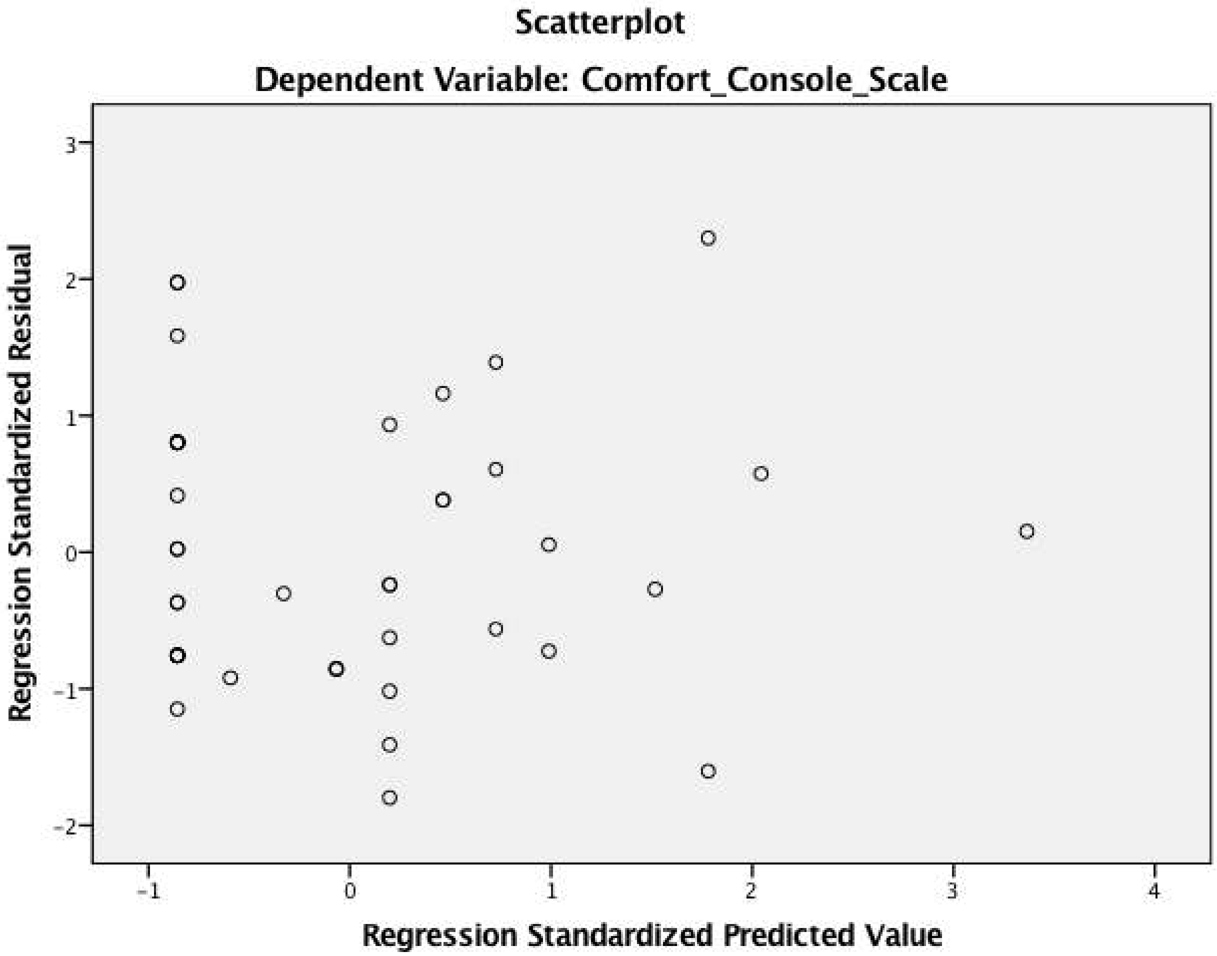
Assumption of Homoscedasticity Tests for Teacher Perception of Test Score to Depict Hard Work against Theory of Intelligence.



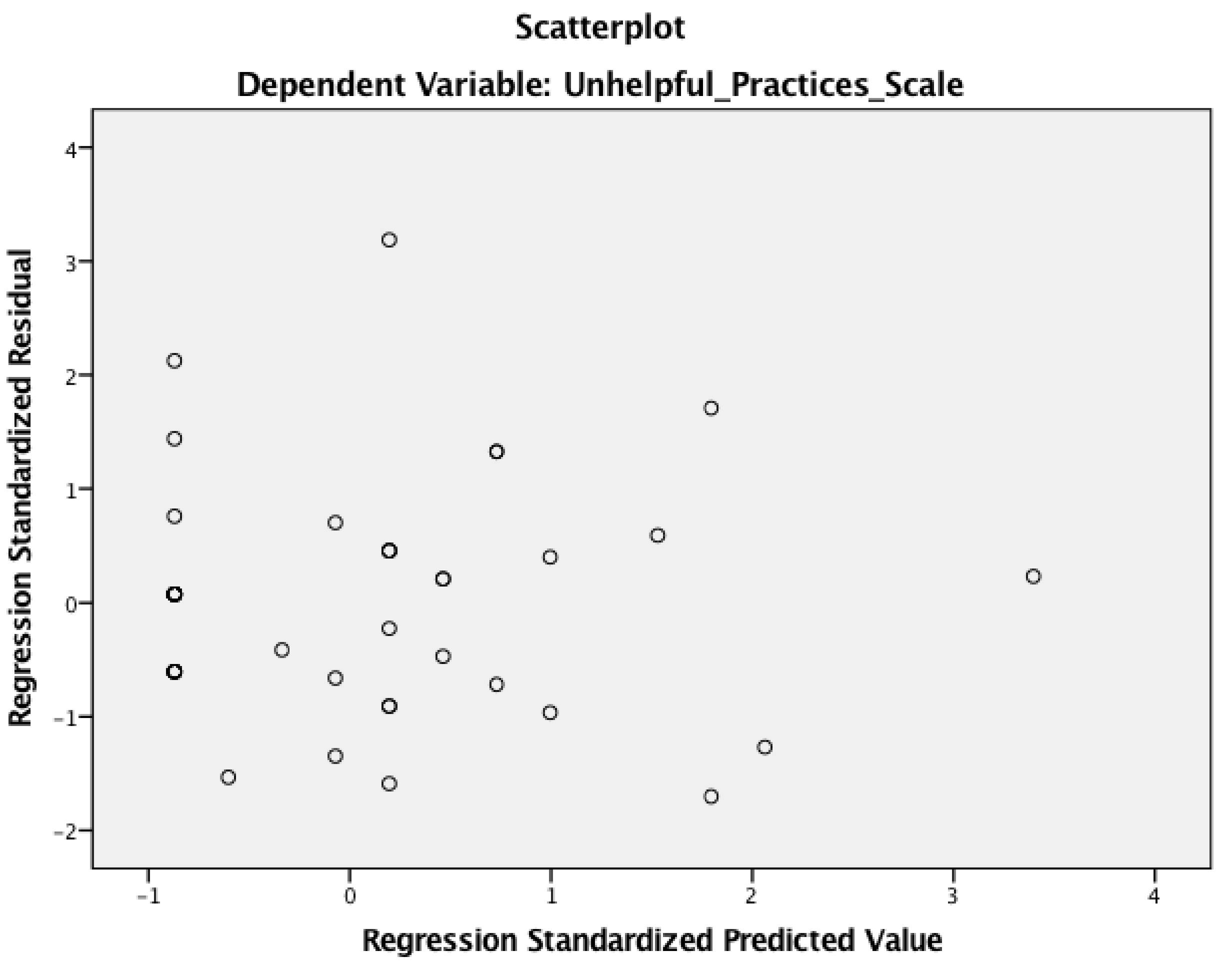
Assumption of Homoscedasticity Tests for Teacher Expectations of Future Success against Theory of Intelligence.



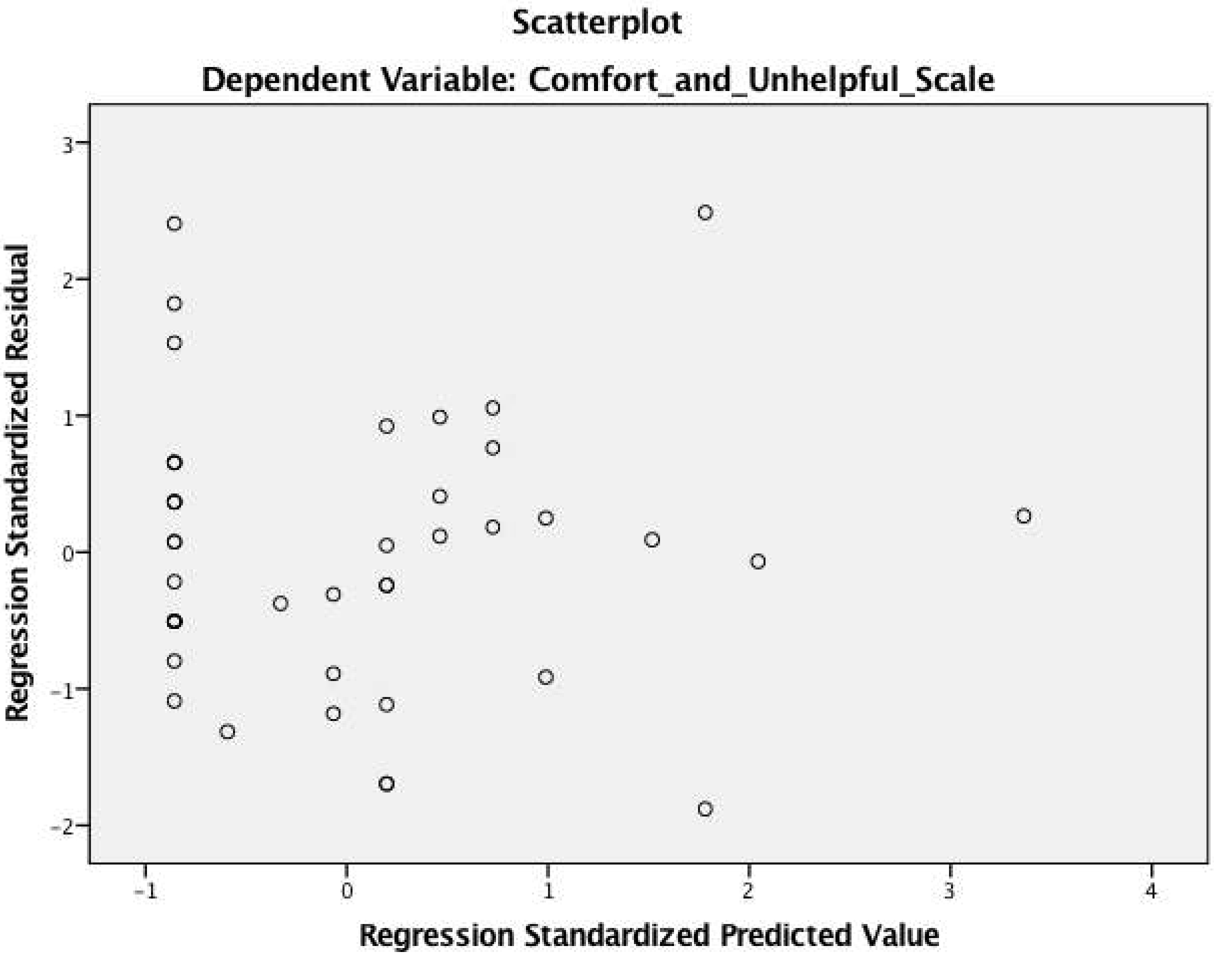
Assumption of Homoscedasticity Tests for Pedagogical Decision to Comfort Student against Theory of Intelligence.



Assumption of Homoscedasticity Tests for Unhelpful Pedagogical Decision against Theory of Intelligence.



Assumption of Homoscedasticity Tests for Comfort/Console or Unhelpful Pedagogical Decision against Theory of Intelligence.



Appendix L

Residual Statistics Charts for Attitude Toward Teaching against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.389[a]	.151	.132	2.970	1.587

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Survey #2 (added all scores range 1-42)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	387.094	1	387.094	.726	.400[b]
	Residual	17588.792	33	532.994		
	Total	17975.886	34			

a. Dependent Variable: Survey #3 (0-100%)

b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	40.959	.974		42.044	.000
	Survey #1 (added all scores range 1-24)	-.331	.119	-.389	-2.770	.008

a. Dependent Variable: Survey #2 (added all scores range 1-42)

Appendix L

Residual Statistics

Residual Statistics Teacher Charts for Perception of Test Score to Depict Hard Work against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.147[a]	.022	-.008	23.087	2.397

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Survey #3 (0-100%)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	387.094	1	387.094	.726	.400[b]
	Residual	17588.792	33	532.994		
	Total	17975.886	34			

a. Dependent Variable: Survey #3 (0-100%)

b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	53.443	8.988		5.946	.000
	Survey #1 (added all scores range 1-24)	.875	1.027	.147	.852	.400

a. Dependent Variable: Survey #3 (0-100%)

Residual Statistics Charts for Teacher Expectations of Future Success against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.504[a]	.254	.236	1.306	2.119

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)
b. Dependent Variable: Teacher_Expectations_Scale_notRC

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.955	1	24.955	14.628	.000[b]
	Residual	73.356	43	1.706		
	Total	98.311	44			

a. Dependent Variable: Teacher_Expectations_Scale_notRC
b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.185	.428		19.108	.000
	Survey #1 (added all scores range 1-24)	.201	.053	.504	3.825	.000

a. Dependent Variable: Teacher_Expectations_Scale_notRC

Residual Statistics Charts for Pedagogical Decision to Comfort Student against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.530[a]	.280	.263	2.562	2.037

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Comfort_Console_Scale

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	107.457	1	107.457	16.370	.000[b]
	Residual	275.702	42	6.564		
	Total	383.159	43			

a. Dependent Variable: Comfort_Console_Scale

b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.273	.841		9.837	.000
	Survey #1 (added all scores range 1-24)	.417	.103	.530	4.046	.000

a. Dependent Variable: Comfort_Console_Scale

Residual Statistics Charts for Unhelpful Pedagogical Decision against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.683[a]	.466	.453	1.465	2.140

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)

b. Dependent Variable: Unhelpful_Practices_Scale

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80.508	1	80.508	37.510	.000[b]
	Residual	92.292	43	2.146		
	Total	172.800	44			

a. Dependent Variable: Unhelpful_Practices_Scale

b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.446	.480		5.090	.000
	Survey #1 (added all scores range 1-24)	.361	.059	.683	6.125	.000

a. Dependent Variable: Unhelpful_Practices_Scale

Residual Statistics Charts for Comfort/Console or Unhelpful Pedagogical Decision against Theory of Intelligence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.653[a]	.426	.413	3.436	2.157

a. Predictors: (Constant), Survey #1 (added all scores range 1-24)
b. Dependent Variable: Comfort_and_Unhelpful_Scale

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	368.407	1	368.407	31.206	.000[b]
	Residual	495.843	42	11.806		
	Total	864.250	43			

a. Dependent Variable: Comfort_and_Unhelpful_Scale
b. Predictors: (Constant), Survey #1 (added all scores range 1-24)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	10.653	1.128		9.446	.000
	Survey #1 (added all scores range 1-24)	.772	.138	.653	5.586	.000

a. Dependent Variable: Comfort_and_Unhelpful_Scale