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Development and Validation of a Scale to Measure Misconceptions About Educational Psychology Among Pre-Service Teachers

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DEVELOPMENT AND VALIDATION OF A SCALE TO MEASURE MISCONCEPTIONS ABOUT EDUCATIONAL PSYCHOLOGY AMONG PRE-SERVICE TEACHERS

by

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ABSTRACT

Misconceptions are widespread or commonly held beliefs explicitly contradicted by empirical evidence. When teachers harbor misconceptions or unjustified beliefs about teaching, learning, and human motivation, the potential pedagogical consequences are profound, and these inaccurate beliefs may be instilled into future students through ineffective teaching strategies and gross misinterpretations of learning science. While existing research has examined misconceptions about general psychology and neuroscience among various populations, no prior work has evaluated pre-service teachers' misconceptions about topics of educational psychology, comprising inaccurate beliefs about teaching, learning, and human motivation. The purpose of this research is to describe the development and validation of a scale to measure misconceptions about educational psychology among pre-service teachers. Employing an experimental 2 (scale: true/false, six-point Likert-type) x 2 (valence: positive, mixed) x 2 (order: true/false presented first, Likert-type presented first) factorial, repeated measures design, a randomized experiment was performed to systematically evaluate the conditions under which the proposed scale for misconceptions of educational psychology performed best. As expected, the Likert-type scale was more sensitive to detecting misconceptions relative to the true/false scale. However, contrary to extant research on the valence effect, mixed-valence scales outperformed the positively-valenced scales across conditions indicating that misconceptions are best measured with a Likert-type response format using a heterogeneous mix of positively- and negatively-valenced items rather than a homogeneous set of positively-valenced items. Implications for practice and future research are discussed.

Dedicated to my Buffy Eliza,

Bella Mia, and Benny Arthur.

I work hard so my dogs can have a better life.

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You know who you are.

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CHAPTER 1: INTRODUCTION

Widespread beliefs contradicted by empirical evidence are termed 'misconceptions' (Gardner & Brown, 2013), which differ from scientific ambiguities and do not include implicit beliefs or domain knowledge (G. M. Sinatra, personal communication, May 21, 2014). The extant literature indicates that misconceptions of science, math, and general psychology result in persistent and negative effects (see Chinn & Brewer, 1993; Hughes, Lyddy, & Lambe, 2013b; Ryan & McCrae, 2005), and such beliefs are highly resistant to change even when the individual is confronted with accurate information or data to contradict their existing belief. Scientific misconceptions have been at the forefront of research in this area (Lombardi & Sinatra, 2012; Sinatra, Kienhues, & Hofer, 2014; Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001), as many decisions rooted in scientific understandings are both personally and socially relevant, impacting individuals and society profoundly. Science illiteracy and misconceptions are rampant among the general public, leading to poor decision-making contrary to society's best interests (Sinatra et al., 2014). While extant research in educational psychology has frequently investigated teachers' beliefs (Fives & Buehl, 2008), and prior research has established the existence of misconceptions about various psychological topics (Gardner & Brown, 2013; Lilienfeld, Lynn, Ruscio, & Beyerstein, 2010; Vaughan, 1977), no prior research has attempted to explicitly identify, measure, or mitigate misconceptions about educational psychology among pre-service teachers for important, scientifically studied topics related to effective teaching, learning, and human motivation.

Problem Statement

Although earlier work has examined misconceptions within the fields of math, science, and general psychology, the extant literature has not specifically delineated educational psychology misconceptions from those of general psychology. The implications of such alternative and inaccurate conceptions about important topics related to effective teaching, learning, and human motivation among pre-service teachers have also not been investigated. As such, the present study provides additional insight into the development of a valid and reliable scale to effectively and efficiently measure misconceptions about important topics of educational psychology among pre-service teachers. Insights are provided through a literature review of existing misconceptions studies in psychology, science, and education, in addition to a brief review of the beliefs and conceptual change literature.

Despite the existence of numerous studies in the teacher education, conceptual change, and misconceptions literature evaluating the prevalence of misconceptions in numerous fields among various populations, an evident lack of analytic attention has been given to the identification and remediation of misconceptions about educational psychology (i.e., teaching, learning, and human motivation) among pre-service teachers. This issue is addressed by discussing the development of a new scale to identify and measure misconceptions about educational psychology among pre-service teachers as it has evolved through the extant literature.

Purpose

Literature on teacher education is abundant, but efforts have focused on issues such as increasing practice-based teacher education programs (Zeichner, 2012), including professional

ethics courses in teacher education programs (Warnick & Silverman, 2011), the utility of web-based portfolios (Oner & Adadan, 2011), and the impact of high-stakes education reform on pre-service teachers (Brown, 2010). Prior research has evaluated the role of educational psychology in teacher education (Patrick, Anderman, Bruening, & Duffin, 2011), but has not evaluated whether misconceptions about relevant topics of educational psychology related to teaching, learning, and human motivation exist among pre-service teachers. Higher education programs focused on preparing pre-service teachers provide the ideal opportunity and platform to properly educate this population of future educators about the latest in educational psychology research and critical thinking about research claims related to teaching, learning, and human motivation. The present inquiry contributes to the educational psychology, teacher education, and measurement fields through the development of a valid and reliable scale to measure these pragmatically-relevant misconceptions among pre-service teachers.

An abundance of research about misconceptions is readily found within the science education literature, revealing a discipline rife with misconceptions. According to Sinatra et al., "there are a myriad of challenges when confronted with understanding not only the complex scientific issues of our time but also the need to make personally relevant decisions that have a scientific basis," a notion that can surely be applied beyond purely scientific misconceptions to other areas in which misconceptions are maintained despite the publication of new scientific discoveries (2014, p. 123). For instance, when pre-service teachers carry into their classroom misconceptions about teaching, learning, and human motivation that are unsubstantiated or explicitly refuted by empirical evidence, the risk of using poorly informed techniques and instructional tools becomes problematic due to the influence of teacher beliefs on the construction of learning environments,

the development of curricula, and the use of pedagogical tools (Woolfolk Hoy, Davis, & Pape, 2006). Although the literature in teacher education is abundant and has addressed issues such as the role of educational psychology in the instruction of pre-service teachers (Patrick et al., 2011), further research in teacher education is still needed to identify and remediate misconceptions about educational psychology among teacher candidates due to the profound influence these beliefs have upon the teachers' future classroom and students.

Thus, identifying and eradicating these misconceptions by restructuring pre-service teachers' understandings of basic educational psychology before they reach the classroom is a worthwhile pursuit that will protect scarce resources including student and teacher time and public funding sources. It has long been established that misconceptions and popular myths about general psychology exist (Gardner & Brown, 2013; Gardner & Dalsing, 1986; Gardner & Hund, 1983; Lilienfeld et al., 2010), and numerous prior studies have examined the existence and extent of misconceptions about general psychology topics among college students (1986), undergraduate psychology students (2013), and academicians (1983). While some of these studies included items tangentially related to topics of educational psychology such as the alleged Mozart effect or the popular myth that humans only use 10% of their brain (Hughes et al., 2013b), none of these psychology misconceptions instruments have clearly delineated misconceptions of educational psychology from those of general psychology. In teacher education one of the most egregious misconceptions is the overreliance on the empirically-refuted notions of learning styles and multiple intelligences, such that pre-service teachers frequently express their desire to accommodate these learning style and/or multiple intelligence labels in the classroom. This desire is driven by the misguided premise that doing so will improve academic achievement and

optimize student learning regardless of subject area. However, this is an instructional strategy unsupported by research (e.g., Kirschner & van Merrienboer, 2013; Pashler, McDaniel, Rohrer, & Bjork, 2008) and is nothing more than a waste of teacher time and school resources.

For educators, misconceptions are particularly deleterious due to their high resistance to extinction and the fact that harboring such misconceptions negatively affects an individual's ability to learn new and accurate information (Chinn & Brewer, 1993; Hughes et al., 2013b). Even trained academics in fields such as psychology and other social sciences are susceptible to the phenomenon of harboring misconceptions about psychological constructs (Gardner & Hund, 1983). It therefore stands to reason that misconceptions about teaching, learning, and human motivation are particularly detrimental among pre-service teachers because they are actively building teaching knowledge and will soon be responsible for educating children based on their certified command of pedagogy, developmental theories, and effective, evidence-based instructional strategies.

Significance

Educational psychology is defined herein as topics related to teaching, learning, and human motivation. To date, no prior work has specifically investigated misconceptions of pre-service teachers related to educational psychology, nor does a scale to measure these misconceptions currently exist. The existence of such pragmatically-relevant misconceptions about teaching, learning, and human motivation among pre-service teachers is exacerbated if the misconceptions progress from the pre-service teacher's personal belief to the in-service teacher's behaviors and instructional tactics in the classroom. The development of a scale tailored to

measure misconceptions of educational psychology among pre-service teachers is a necessary, timely, and valuable contribution to the fields of educational psychology, teacher education, and measurement. Future research in the area using the proposed scale will produce important knowledge that will refine and improve teacher education curricula to forestall further entrenchment of these inaccurate and deeply-held beliefs.

Structure

The five chapters that follow comprise the present line of inquiry. The Introduction (Chapter 1) presented the introduction, problem statement, and the study's purpose and significance to the fields of educational psychology, teacher education, and measurement. The Literature Review is presented in Chapter 2, providing a review of literature pertinent to this inquiry regarding misconceptions, beliefs, and knowledge; misconceptions about general psychology and education, strategies to overcome misconceptions, and measurement fidelity, which includes a brief coverage of the literature in measurement error, method biases, and the valence effect. Chapter 3 presents a discussion of the study Methods, including the participants, instrumentation, design, and procedures for both studies reported within. The Results are presented in Chapter 4, and the Discussion and Conclusion for this research is presented in Chapter 5.

CHAPTER 2: LITERATURE REVIEW

When teachers harbor misconceptions or unjustified beliefs about teaching, learning, and human motivation, the pedagogical consequences can be severe. It is likely these teachers will unintentionally perpetuate such false beliefs upon students through ineffective teaching strategies or misinterpretations of learning science. Misconceptions among teachers are particularly deleterious due to the substantial influence teacher beliefs exert upon curriculum development, pedagogy, and the construction of effective learning environments. Prior research has explicated the prevalence of erroneous beliefs about general psychology and neuroscience among various populations but has rarely examined misconceptions among teachers and has not evaluated teachers' misconceptions about pragmatic topics about educational psychology. Consequently, the purpose of this review is to highlight theoretical, inferential, and measurement concerns specifically related to misconceptions of educational psychology. Recommendations for future research and the development of appropriate instrumentation to measure and mitigate misconceptions are also discussed.

Several closely related but discrete areas of the literature are pertinent to the examination of educational psychology misconceptions and the process through which these misconceptions can be mitigated. Specifically, it is important to define misconceptions in the broader sense through which they have been previously tested in the science, math, and psychology education literature. Further, misconceptions cannot be fully understood without attending to the constructs of beliefs and knowledge, and remediation of misconceptions is only possible through an understanding of epistemic cognition, motivated reasoning, and conceptual change (Sinatra et al., 2014).

Operational Definitions

Misconceptions are widespread or commonly held beliefs that are explicitly contradicted by empirical, scientific evidence, sometimes referred to as preconceptions, personal epistemologies, alternative conceptions or frameworks, naïve science/conceptions/explanations, or mistaken beliefs (Gardner & Brown, 2013; Hammer & Elby, 2002; Hamza & Wickman, 2008; Hughes et al., 2013b; Morrison & Lederman, 2003; Pine, Messer, & St. John, 2001; Piquette & Heikkinen, 2005; Taylor & Kowalski, 2004). Misconceptions are prevalent and have been studied in a variety of fields (Gardner & Brown, 2013) because such alternative conceptions can undermine effective learning processes by inhibiting an individual's ability to assimilate the new, correct information into their pre-existing, albeit inaccurate schema (Chi, 2005). Misconceptions differ from scientific ambiguities, which are personal beliefs that do not have clear empirical support (G. M. Sinatra, personal communication, May 21, 2014) and exclude domain knowledge and implicit beliefs. Misconceptions do not occur by lack of exposure to certain topics but materialize when fallacious knowledge must be 'unlearned' to create an accurate conceptual understanding.

The U.S. moon mission was fabricated, humans did not evolve from fish, and Elvis (Presley) is still alive: these are just a few of the many contentious beliefs individuals hold and ardently defend under scrutiny. While not the focus of this review, these generalized examples provide insight into the depth of individuals' beliefs about empirically contradicted facts. Behavior that ensues based upon unwarranted beliefs breeds action, and championing pseudo-scientific and self-evident beliefs is not limited to the general population: educators, including those charged with teaching science, respond likewise through self-report, embracing and

perpetuating mythical manifestos like the existence of the Loch Ness monster and Bigfoot (Losh & Nzekwe, 2010).

Explaining worldly perceptions and determining the reason for observed and exhibited behaviors and the conclusions subsequently made may be justified in one of two ways. Some individuals, including scholars and researchers, explain and interpret physical and psychological phenomena by examining evidence that can be replicated across individuals, contexts, and conditions, often described as using the scientific method. The systematic approach supports the generalization of conclusions because the knowledge gained is justified by objective interpretation of the evidence. Alternatively, perceptions of reality can be of a personal nature, substantiated primarily by individual or group experience and augmented by entrenched beliefs developed over a lifetime.

The impact of misconceptions is profound. Misconceptions and science illiteracy among the general public leads to poor decision-making contrary to the best interests of society and the individuals within it (Sinatra et al., 2014), resulting in compromised judgment, irrational thinking, and the inability to learn new and accurate information (Chinn & Malhotra, 2002). These types of misconceptions include beliefs doubting the existence of climate change, questioning the suitability of genetically-modified organisms (GMOs) for the food supply, and parents rejecting medically-recommended vaccinations for their children, despite scientific evidence to the contrary. Misconceptions both inside and outside the classroom have a significant impact on society, whether the belief is about human intelligence, brain-based instruction, or as simple as understanding how HIV/AIDS is transmitted and what the true outcome of infection is in light of medical advances (Johnson & Sinatra, 2014). Even in-service

teachers with the best of intentions maintain misconceptions about topics such as learning styles (Pashler et al., 2008), brain-based education initiatives (Dekker, Lee, Howard-Jones, & Jolles, 2012), and general student learning (Kirschner & van Merriënboer, 2013), despite a dearth of empirical support or substantial evidence to the contrary. However, no research to date has examined the existence, strength, or remediation of faulty beliefs pre-service teachers may harbor about important topics of educational psychology, nor has a published literature review to that effect been located.

The impact of teacher misconceptions is severe, primarily because teachers harboring misconceptions about educational psychology may perpetuate their false beliefs upon students (Hughes et al., 2015; Sadler & Sonnert, 2016). When these misconceptions about effective teaching, learning, and human motivation are entertained by pre-service teachers, the impact on students and learning is profound. When teachers carry misconceptions about educational psychology into their classroom, the risk of using poorly informed techniques and ineffective instructional tools becomes problematic. Misconceptions about effective teaching strategies and inaccurate beliefs among teachers about learning are particularly egregious because their beliefs directly influence curriculum development, pedagogy, and the construction of effective learning environments (Woolfolk Hoy et al., 2006).

While extant research in educational psychology has frequently investigated teacher beliefs (Fives & Buehl, 2008) and prior research has established the existence of misconceptions about psychology (Gardner & Brown, 2013; Lilienfeld et al., 2010), science (Broughton, Sinatra, & Nussbaum, 2013; Cordova, Sinatra, Jones, Taasoobshirazi, & Lombardi, 2014; Heddy & Sinatra, 2013; Lombardi & Sinatra, 2012; Smolleck & Hershberger, 2011; Sinatra et al., 2014;

Vosniadou et al., 2001), mathematics (Green, Piel, & Flowers, 2008; Ryan & McCrae, 2005), and neuromyths (Dekker et al., 2012; Pickering & Howard-Jones, 2007), no prior work has attempted to identify whether and to what extent misconceptions about important topics of educational psychology exist among teachers. Pre-service teachers are preparing to embark upon independent teaching endeavors, conceivably armed with inaccurate information about teaching, learning, and human motivation. It is thus imperative to identify and eradicate such misconceptions among teachers to avoid the risk of using ill-informed and possibly harmful instructional techniques and perpetuating their educational psychology misconceptions upon their students. Identifying these potential misconceptions and eradicating them by restructuring pre-service teachers' understandings before they reach their future classroom is undeniably a worthwhile goal, in no small part due to the scarcity of resources available within most educational systems.

Additionally, no published literature review has been located that addresses the existence or measurement of misconceptions about teaching, learning, and human motivation (e.g., 'educational psychology') among pre-service or in-service teachers, despite the obvious importance of such knowledge among future educators. Seldom have misconceptions about human motivation been addressed, while teachers are also rarely assessed in this area, a topic and population that are both paramount in producing effective and knowledgeable educators. The purpose of this review is to highlight the gap in the literature regarding misconceptions by reviewing and evaluating what has already been learned about misconceptions in psychology and education. Thus, rather than provide an exhaustive review of the extant work in pseudo-scientific ideas (e.g., ghosts, extraterrestrials), public misconceptions of science, or metaphysical beliefs,

this instead is a review of the psychological and neuroscientific misconceptions studied to date. In addition, the practical implications associated with teacher misconceptions are highlighted and key measurement criteria are outlined that will allow researchers to accurately assess misconceptions as the first step toward eradicating false beliefs about teaching, learning, and human motivation.

Over the past four decades, misconceptions were labeled and defined in myriad ways. The psychology and education fields define misconceptions differently, often neglecting to indicate operationalized application or how the misconception influences professional practice. Simplistic definitions for misconceptions in psychology include "mistaken beliefs" (Gardner & Dalsing, 1986, p. 33; Gardner & Hund, 1983, p. 20), "common misbeliefs" (McCutcheon, 1991, p. 647), and "rules of thumb" (Chew, 2005, p. 212). In the field of psychology, misconceptions are defined as "widely held beliefs contradicted by established evidence" (Gardner & Brown, 2013, p. 211) and as "inaccurate claims that lack empirical support" (Hughes et al., 2015, p. 34). The science education literature defines a misconception as "a belief that conflicts with currently accepted scientific explanations" (Tippett, 2010, p. 953) and as "notions that are in sharp contrast to accepted scientific understanding" (Sinatra et al., 2014, p. 132). Neuromyths are strikingly similar to misconceptions, and commonly defined as "popular beliefs about what brain science can actually deliver to education" (Goswami, 2004, p. 2) or "popular accounts of brain functioning which originate in valid scientific evidence that has been extrapolated beyond the existing data" (Geake, 2008, p. 124).

Misconceptions are primarily studied in psychology and content-area education (e.g., misconceptions about mathematics concepts), however within educational psychology the bulk

of empirical investigation is specifically focused upon science education. Science education primarily addresses misconceptions through investigating the constructs of epistemic cognition and beliefs, motivated reasoning, plausibility judgments, and conceptual change. In aggregate, these constructs represent individual beliefs, mental models, and worldviews about controversial and politically-motivated beliefs about topics such as climate change and labeling of genetically-modified organisms (Sinatra et al., 2014), the continued classification of Pluto as a planet (Broughton et al., 2013), HIV/AIDS (Johnson & Sinatra, 2014), and the ability to revise those beliefs when confronted with contradictory evidence (Sinatra et al., 2014).

Sinatra et al. defined epistemic beliefs as "the beliefs people hold about the nature of knowledge and knowing" (2014, p. 126), which function to some extent as a naïve or intuitive theory about scientific information and knowledge, not unlike popular but erroneous perceptions of psychology as nothing more than common sense (Furnham, Callahan, & Rawles, 2003). *Epistemic beliefs* play a critical role in an individual's interpretation of scientific material and are particularly relevant when faced with contradictory information or explanations that must be incorporated into their existing knowledge due to the influence these beliefs have upon the individual's ability to reason about that knowledge (Sinatra et al., 2014). One of the most prevalent examples regarding the influence of epistemic beliefs are attitudes related to evolution, with some teachers embracing absolutist religious beliefs (Trani, 2004) that inhibit scientific understanding and teaching of natural selection (Sinatra, Southerland, McConaughy, & Demastes, 2003).

An additional factor contributing to peoples' misunderstanding of scientific information is *motivated reasoning*. According to Kunda (1990), motivation plays a role in individuals'

reasoning due to biased cognitive processing. Sinatra et al. (2014) explained that although people can make a good faith attempt to be rational in scientific decision making, they may still be hampered by motivated reasoning as "motivations bias what information they attend to and what strategies they use to construct, assess, and evaluate that information" (p. 129). For instance, a teacher may believe in the concept of learning styles and revise their pedagogical approach under the false pretense that tailoring their instruction to individual learning styles will positively impact student learning outcomes. When faced with empirical data suggesting that the accommodation of learning styles has a nil or even a negative effect on student learning outcomes (Willingham, Hughes, & Dobolyi, 2015), the teacher feels an immediate personal consequence posing a threat to their teaching efficacy. They are therefore likely to reject or ignore the empirically-based information and discount the scientific evidence (Chinn & Brewer, 1993). Even in the face of disconfirming evidence, teachers exhibit personal bias and filter out information inconsistent with their existing beliefs (Fives & Buehl, 2012). Further, basic human physiology underlies the maintenance of personal bias through the brain's perceptual filter that regulates the degree of attention allotted to incoming information (Lee & Sherman, 2008). To preserve an established (although inaccurate) belief, the teacher is likely to selectively attend to scientific evidence through both psychological and physiological information filtering.

Misconceptions are also influenced by flawed thinking processes (Lilienfeld, Lynn, Namy, & Woolf, 2009). Humans are vulnerable to logical and thinking fallacies often described as cognitive biases, because of their tendency to erroneously identify, categorize, evaluate, and interpret evidence. Misinterpretation primarily occurs when individuals attribute causality to events that are merely related (spurious correlation), when fixating on evidence that supports

their beliefs while ignoring or rejecting contradictory evidence (confirmation bias), and when encountering evidence that implicates negative self-impressions (self-justification bias). In these situations, individuals discount objective knowledge and evidence because dissonance is perceived as a threat leading to stress and anxiety, feelings that abate when the misconception is embraced (Gregoire, 2003).

Misconceptions may also perpetuate due to structural misclassification of acquired information. Often described as an ontological perspective of mental representation, when an individual inappropriately relates new information to existing knowledge, distortions may develop. Thus, a teacher who is elated over the accomplishments of a struggling student may erroneously categorize the newfound success as the result of teaching the student in the student's learning style, in contrast to categorizing their success based on the development of a flawless lesson plan. Individuals must possess both the ability and willingness to recognize misclassification as a prerequisite to modify representations and promote conceptual change (Chi, 2005; Murphy & Mason, 2006).

The continued acceptance of misconceptions can be described as an evaluation of plausibility, in which *plausibility judgments* play a critical role in the maintenance and revision of erroneous beliefs. An accurate explanation must first seem plausible to a misconception-bearing individual before they are willing to accept it as valid and consider altering their already engrained although inaccurate belief. Lombardi, Nussbaum, and Sinatra define plausibility judgments as "a judgment of potential truthfulness when evaluating explanations" (2016, p. 35), such that if an individual does not find an explanation plausible, the potential for accepting the explanation is temporary at best. For instance, if a teacher doubts the plausibility of evidence-

based information negating the belief that accommodating learning styles in the classroom facilitates academic achievement, what may result is only "provisional acceptance" of the explanation (Lombardi et al., 2016, p. 36). If teachers doubt the plausibility of evidence-based information related to effective instructional strategies or learning contexts, a tendency to disregard the accurate explanation and information follows.

Misconceptions comprise the basis of conceptual change literature. The conceptual change approach is often employed in science education to facilitate "the restructuring of individuals' knowledge to overcome their misconceptions and align their understanding with scientifically accepted ideas" (Sinatra et al., 2014, p. 132). This is often successfully achieved through various instructional approaches including refutational text (Broughton, Sinatra, & Reynolds, 2010; Sinatra & Broughton, 2011; Tippett, 2010) and lecture (Bensley et al., 2014; Kowalski & Taylor, 2009). Several conceptual change models exist (e.g., Dole & Sinatra, 1998; Gregoire, 2003; Pintrich, Marx, & Boyle, 1993; Posner, Strike, Hewson, & Gertzog, 1982), although consistent elements appear across models that focus upon how learners construct flawed representations or mental models about various topics.

Mental models represent a conglomerate of various beliefs and emotions that individuals employ to appraise the legitimacy of the information with their current beliefs. These models of conceptual change focus on characteristics of the learner such as strength, coherence, and commitment to their existing conception, motivation to process new information (Pintrich et al., 1993), social context (Dole & Sinatra, 1998), and affective factors when attempting to change the beliefs of teachers (Gregoire, 2003). Additionally, the complexity, coherence, and plausibility of the accepted scientific explanations for various phenomena are important considerations

during the change process. Most of the research in the conceptual change literature is designed to determine which strategies or instructional techniques are best for fostering accurate comprehension (Kendeou & van den Broek, 2005) and eliminating the misconception. Successful knowledge restructuring has been achieved in both psychology and education through the use of refutational text (Broughton et al., 2010; Sinatra & Broughton, 2011; Tippett, 2010) and refutational lecture (Bensley et al., 2014; Kowalski & Taylor, 2009), processes that involve stating the misconception, explaining why the misconception is invalid, followed by asserting the accepted, evidence-based fact and why that conception is both accepted and valid (Hynd, 2001).

Based on the totality of the literature in epistemic beliefs, motivated reasoning, plausibility judgments, and conceptual change research, misconceptions have been addressed in a multitude of ways. Across these topics, the general theme encompasses false beliefs that require revision and methods for accomplishing this change. The diversity in misconceptions research warrants a clear definition. Therefore, based upon the variation in misconceptions emphasis across diverse strands of literature, for the purposes of the present inquiry, misconceptions are operationally defined as *entrenched beliefs related to teaching, learning, and human motivation that are explicitly refuted by multiple strands of methodologically-sound empirical evidence*.

Misconceptions, Beliefs, and Knowledge

Undoubtedly, beliefs remain at the core of the present inquiry. Nearly three decades ago, Pajares asserted the fundamental nature of beliefs to an individual's decision-making process (1992). Applied to teacher education, beliefs play a pivotal role in the day-to-day process of

teaching because "the beliefs teachers hold influence their perceptions and judgments, which, in turn, affect their behavior in the classroom" (1992, p. 307). Pajares defiend beliefs as the judgment some individual makes regarding the "truth or falsity of a proposition" (1992, p. 316), and further emphasized prior findings in the teacher education literature indicating that educational beliefs are often highly resistant to change (1992). Beliefs that are explicitly refuted by empirical evidence are misconceptions, and are distinct from scientific ambiguities, domain knowledge, and implicit beliefs (G. M. Sinatra, personal communication, May 21, 2014; Gardner & Brown, 2013; Hammer & Elby, 2002; Hamza & Wickman, 2008; Hughes et al., 2013; Morrison & Lederman, 2003; Pine et al., 2001; Piquette & Heikkinen, 2005; Taylor & Kowalski, 2004). Since Pajares' call to action for research on teacher beliefs, the field has blossomed leading to a rich literature addressing a variety of teacher beliefs.

Teachers' knowledge embodies a relevant sub-genre of the teacher beliefs literature as it pertains to misconceptions about educational psychology. Although Pajares did not explicitly distinguish knowledge from beliefs (1992), Fives and Buehl later asserted the inclusion of beliefs within knowledge (2008). Pre-service teacher beliefs about teachers' knowledge is highly relevant for those who educate pre-service teachers, particularly if such beliefs "guide [pre-service teachers] to value or disregard information presented throughout the course of their teacher education" (Fives & Buehl, 2008, p. 137). This prospect is particularly troubling when taken together with the difficulty of effectuating conceptual change among deeply seated beliefs. According to Fives and Buehl, teachers' knowledge includes anything that will contribute to the act of teaching (2008), and it thus follows that teachers' knowledge influences the adoption of pedagogical techniques, therefore flawed knowledge may lead to the adoption of ineffective

teaching practices in the classroom. Pajares indicated the same based on prior findings suggesting "a strong relationship between teachers' educational beliefs and their planning, instructional decisions, and classroom practices" (1992, p. 326). Misconceptions are particularly problematic because they are rooted in beliefs that are highly resistant to extinction and exert a direct influence upon the acquisition of knowledge, impacting the ability of pre-service teachers to learn accurate, empirically-supported information (Hughes et al., 2013b). Among pre-service teachers, misconceptions about educational psychology and appropriate teaching practices are especially harmful and pose significant risk to the teacher's potential to produce a quality instructional experience for their students.

Misconceptions about General Psychology

Misconceptions

Various psychology misconceptions have been proposed over the course of several decades including a variety of beliefs related to personality, the nature of mental illness, and abnormal human behavior. Misconceptions often addressed in this area include: (a) the efficacy of inkblot tests in revealing personality traits, (b) the conception of schizophrenics as harboring multiple personalities, (c) the influence of a full moon on psychiatric hospital admissions and commission of crimes, (d) the utility of polygraph tests in detecting dishonesty, (e) the folk notion that opposites attract, and (f) the effectiveness of hypnosis in helping individuals retrieve forgotten memories (Hughes et al., 2013b; Standing & Huber, 2003). Additional psychological misconceptions specifically related to human learning included the myth that human brains

operate at a capacity of only 10%, infant intelligence is increased by exposure to classical music (the Mozart effect), individuals are exclusively left- or right-brained (hemisphericity), and that people can learn new information while they sleep (Bangerter & Heath, 2004; Brown, 1983; Della Sala, 1999; Higbee & Clay, 1998; Hughes et al., 2013b; Lyddy & Hughes, 2012; Standing & Huber, 2003). Although prior work in psychology has superficially investigated some misconceptions tied to concepts of educational psychology, there has not been a clear delineation of one branch of psychology from the other.

History

The study of psychological misconceptions is not a novel or contemporary endeavor. Although superstitions were studied in the early 1900s (Conklin, 1919; Dresslar, 1910), misconceptions about psychology were formally addressed beginning in the 1920s (Garrett & Fisher, 1926), and formal tests to measure misconceptions of psychology were developed continuously into the 1970s (Holley & Buxton, 1950; McKeachie, 1960; Vaughan, 1977). These early instruments were composed of 80 to 100 inaccurate statements related to psychology and required respondents to indicate whether each statement was true or false, setting the stage for future research on psychology misconceptions. The later 1970s and 1980s witnessed a proliferation of research about psychology misconceptions among diverse samples including high-performing college students (Best, 1982), introductory psychology students (Brown, 1983), university faculty (Gardner & Hund, 1983), and undergraduate students (Gardner & Dalsing, 1986; Lamal, 1979).

The 1990s led to an abundance of misconception research, including a new and improved test of misconceptions (McCutcheon, 1991), examinations of critical thinking, academic achievement, and misconception frequency (McCutcheon, Apperson, Hanson, & Wynn, 1992), the existence of misconceptions among prospective psychology students (Furnham, 1992), a comparison of misconceptions between psychology and non-psychology majors (Furnham, 1993), and a cross-national investigation of misconceptions between American and British students (McCutcheon, Furnham, & Davis, 1993). Although the aforementioned studies varied in population and measurement approaches, the prolific nature of misconceptions about psychology were reported across studies. The literature during this era focused primarily on measuring the existence of misconceptions rather than mitigating the inaccurate beliefs or making inferences about other constructs related to the maintenance of these misconceptions.

Contemporary Application

Accordingly, it has long been established that misconceptions and popular myths about psychology have been examined using diverse samples (Lilienfeld et al., 2010). As exhibited in Table 1, psychological misconceptions have often been studied among undergraduate students in terms of both their existence and frequency (Amsel, Baird, & Ashley, 2011; Glass, Bartels, Ryan, & Stark-Wroblewski, 2008; Higbee & Clay, 1998; Kowalski & Taylor, 2004; Kuhle, Barber, & Bristol, 2009; Standing & Huber, 2003; Thompson & Zamboanga, 2004).

Table 1 Empirical Research of Misconceptions in General Psychology

Citation	Purpose(s)	Measurement	Finding(s)	Sample
Standing and Huber (2003)	Determined the extent of myth acceptance as it related to the amount of college-level psychology education	20-item Test Your Psychology IQ questionnaire, true/false response format	Rejection of myths increased with university psychology courses, but decreased considerably with the number of psychology courses taken at a junior college	*n* = 94 Undergraduates at a liberal-arts college enrolled in at least one psychology course at either a junior college or university
Kowalski and Taylor (2004)	Evaluated whether psychological misconceptions decreased upon completion of an introductory psychology course, and whether GPA and critical thinking ability predicted decreases in post-test misconceptions	36-item questionnaire to assess psychological misconceptions, true/false response format	A statistically significant change in students' misconceptions occurred after completing the introductory psychology course. Students who thought more critically and performed at higher academic levels were less likely to harbor psychological misconceptions.	*n* = 90 Introductory psychology students enrolled at a small, private university
Glass et al. (2008)	Generalized Standing and Huber's (2003) findings	20-item Test Your Psychology IQ questionnaire, true/false response format	Findings indicated that Midwestern Americans were more prone to myth acceptance and there were no significant differences between the university and junior college student samples, and were inconsistent with Standing and Huber's (2003) findings.	*N* = 295 Midwestern Americans enrolled in a university (*n* = 171), junior college (*n* = 79), as well as a local community (*n* = 45) sample
Amsel et al. (2009)	Determined existence of students' misconceptions about core beliefs in psychology, and whether their psychology knowledge was changed via conceptual change post-instruction; assessed whether scientific and intuitive beliefs about the discipline could be prompted in alternate contexts (professor perspective vs. self-perspective)	15-item Psychology as a Science (PAS) Questionnaire, seven-point Likert-type agreement scale response format	Found that students in the randomly assigned professor perspective group rated psychology as more scientific than those in the self-perspective condition.	*n* = 227 Introductory psychology students enrolled in six different class sections
Kuhle et al. (2009)	Evaluated whether psychology undergraduates harbored misconceptions about psychology, and related the misconceptions to performance in the introductory psychology course.	10-item Knowledge of Psychology Test (adapted from Vaughan, 1977), true/false response format	A significant negative correlation was found between number of misconceptions held and the course grade, as 83% of all students maintained five or more misconceptions.	*n* = 178 Undergraduate students enrolled in introductory psychology courses
Amsel et al. (2011)	Determined beliefs about the scientific nature of psychology as a discipline, and assessed those beliefs as	15-item Psychology as a Science (PAS) Questionnaire, seven-point Likert-type	Found that more academically advanced students and students who were potential or actual psychology majors harbored	*n* = 438 American undergraduate psychology students

Citation	Purpose(s)	Measurement	Finding(s)	Sample
	a function of year in college and academic status in psychology	agreement scale response format	stronger beliefs in the discipline of psychology as a science, after accounting for gender and number of psychology courses completed.	
Lyddy and Hughes (2012)	Examined students' beliefs about psychology at different stages of their undergraduate careers, and determined whether belief in psychology as a scientific discipline increased with experience in the subject.	15-item Psychology as a Science (PAS) Questionnaire, seven-point Likert-type agreement scale response format 26-item Revised Paranormal Beliefs Scale (R-PBS), seven-point Likert-type agreement scale response format 20-item psychology misconceptions questionnaire, seven-point Likert-type agreement scale response format	No relationship was found between misconception endorsement and greater appreciation of psychology as a science, and misconceptions were still endorsed even after substantial experience in the field of psychology. However, students with more experience in psychology did have stronger beliefs in psychology as a science, but still endorsed about half of the misconceptions.	*N* = 178 Undergraduate students enrolled in introductory psychology courses for various time frames including four months (*n* = 83), 18 months (*n* = 55), and 30 months (*n* = 40)
Taylor and Kowalski (2012)	Compared true/false and forced choice response formats and determined whether different formats led to different estimates of misconception endorsement among students.	39-item questionnaire, true/false response format 39-item questionnaire, forced choice (A or B) format	Accuracy levels were different between the true/false format (33.05%) and the forced choice format (41.29%), indicating that the true/false format led to overestimation of students' misconceptions. A statistically significant difference was found for accuracy when comparing the true/false and forced choice formats.	*n* = 155 Introductory psychology students
Hughes et al. (2015a)	Examined the extent to which students in various stages of education endorsed false claims about psychology.	30-item questionnaire, seven-point Likert-type agreement scale response format	Doctoral students endorsed fewer misconceptions than master's and undergraduate students, with level of misconception rejection varying significantly across educational level.	*N* = 670 International sample of undergraduate (*n* = 49), master's (*n* = 83), and doctoral (*n* = 538) students
Hughes et al. (2015b)	Attempted to determine whether misconception endorsement varied as a function of training in psychology.	42-item Psychology Misconception Questionnaire (PMQ), using a true/false response format with an additional "unsure" option	Students enrolled in graduate programs rejected significantly more misconceptions and endorsed fewer misconceptions than the undergraduate students. Graduate students also expressed less uncertainty than undergraduate students.	*N* = 557 Convenience sample of international students enrolled in psychology undergraduate (*n* = 519), master's (*n* = *7*), or doctoral (*n* = 31) programs.

More recently, the area of psychological misconceptions has trended toward sub-disciplinary areas such as behavior analysis (Arntzen, Lokke, Lokke, & Eilertsen, 2010; Lamal, 1995) and forensic psychology (Shaw & Woodworth, 2013). Additional work has also included misconceptions about psychology as a science (Amsel et al., 2011), the efficacy of a psychology course in remediating misconceptions about psychology (Glass et al., 2008; Standing & Huber, 2003), the predictive ability of misconceptions upon coursework performance (Kuhle et al., 2009), and prior knowledge, aptitude, critical thinking, and ability as predictors of misconceptions (Kowalski & Taylor, 2004; Thompson & Zamboanga, 2004). It is well-established that misconceptions about psychology exist, and the shift in recent literature has been toward more effective measurement of the misconceptions in addition to the prediction and correction of these inaccurate beliefs. Prior instruments have been criticized based upon validity concerns related to dichotomized true/false response formats as well as ambiguously phrased and outdated items. Additionally, research has found the frequently employed true/false format to be highly vulnerable to acquiescence and correct guesses (Griggs & Ransdell, 1987; Hughes, Lyddy, & Kaplan, 2013a; Ruble, 1986; Taylor & Kowalski, 2012).

Across the contemporary psychology misconception literature, three themes emerged: (a) the interest in perceptions of psychology as a science, (b) the relationship between discipline-specific knowledge levels and frequency of disciplinary misconceptions, and (c) the impact of discipline-based instruction in effectively correcting misconceptions. Five of the listed studies utilized a true/false response format to identify misconceptions among the various populations, while four studies employed a Likert-type scale to not only identify but measure the intensity of the misconceptions. However, ambiguity prevails even among samples of college students

regarding variation of misconception frequency. Similarities among studies include the heightened perception of psychology as a science among those with more advanced education, and decreased acceptance of misconceptions among those with higher course grades and critical thinking skills.

Although many definitions and approaches for measuring misconceptions of psychology have been devised over the years, the same thread of inquiry has been maintained and ties the literature together: the identification and measurement of inaccurate beliefs about empirically-supported findings in the field of psychology. While this brief review of the existing literature in psychology misconceptions exhibits the clear disciplinary interest in the topic of misconceptions, a gap remains for misconceptions about educational psychology among teachers, specifically related to topics of teaching, learning, and human motivation. Recently, the gap has narrowed with the addition of research about educational 'neuromyths,' discussed next.

Misconceptions about Neuroscience and Education

The improvement of education and student learning outcomes is an often-addressed topic of social concern. However, many people harbor misguided notions about how to effectuate improvement in these areas, and seemingly simple ideas to improve the student learning experience and outcomes are propelled quickly through popular media, social media, and word-of-mouth. The term 'neuromyth' describes the false beliefs propagated about the human brain related to learning resulting from the intersection of neuroscience and education (Organisation for Economic Cooperation, and Development, 2002). In the more specific field of educational psychology, 'urban legends' and 'urban myths' are addressed, comprising neuromyths and myths

about learning, technology in learning, and educational policy (de Bruyckere, Kirschner, & Hulshof, 2015; Kirschner & van Merriënboer, 2013). Due to the similarities and paucity of other research in this area, the fields of neuroscience and education are thus addressed as one topic herein.

Neuromyths proliferate because they are often initiated by an empirical principle with some underlying neuroscientific substantiation but are misinterpreted and subsequently communicated to the layperson. The underlying neuroscience is embellished and misapplied to educational endeavors with the intention of advancing teaching and learning outcomes, resulting in further proliferation of these seemingly easy-to-understand and easy-to-apply concepts among the general public and teachers alike. Individuals lacking domain-specific knowledge of neuroscience therefore disseminate myths about the brain's role in learning by inaccurately applying neuroscientific findings to the field of education for purposes unintended by the original researchers.

Misconceptions

The bridge between neuroscience and education results from the attempted and improper application of neuroscientific research findings to education. In these types of studies, researchers investigated beliefs related to: (a) the efficacy of brain-based education, (b) hemispheric and modality dominance, (c) learning styles, and (d) multiple intelligences (Dekker et al., 2012; Geake, 2008). While not expressly addressing topics of educational psychology (i.e., teaching, learning, and human motivation), the misconceptions in many of these studies inch

ever closer to the field and encompass a variety of learning strategies and beliefs about intelligence and memory, while still falling short on topics related to academic motivation, as displayed in Table 2.

Table 2 Empirical Research of Neuromyths

Citation	Purpose(s)	Measurement	Finding(s)	Sample
Herculano-Houzel (2002)	Identified misconceptions about neuroscience among the general public	95-item survey, using a yes/no/I don't know response format	Neuroscience literacy was improved by level of education, in addition to reading of popular science magazines, with the worst neuroscience illiteracy occurring on topics related to learning and memory.	*n* = 2,158 Members of the general public in Rio de Janeiro, Brazil
Dekker, Lee, and Howard-Jones (2012)	Investigation to determine the prevalence and predictors for belief in neuromyths	32-item questionnaire with statements related to the brain and learning, including 15 neuromyth items, using a correct/incorrect/do not know response format	An average of 49% of teachers in the study believed in the neuromyths and were particularly prone to belief in neuromyths perpetuated by commercialized education programs, and additional general knowledge among the teachers predicted increased endorsement of the neuromyths.	*n* = 242 Primary and secondary school teachers with an expressed interest related to the neuroscience of learning
Gleichgerrcht, Luttges, Salvarezza, and Campos (2015)	Attempted to evaluate belief in neuromyths among a specific population of teachers.	Used a revised version of Dekker et al.'s (2012) instrument, including 12 neuromyth items, using a correct/incorrect/do not know response format	Findings were consistent with prior research in other geographic areas that neuroscience misconceptions were frequently endorsed, and often related to factual information about brain structure and function. Additional self-reported knowledge about the brain predicted likelihood for belief in neuromyths as well.	*N* = 3,451 Teachers in Latin America from Argentine (*n* = 551), Chile (*n* = 598), Peru (*n* = 2,222) and other Latin American countries (*n* = 80)
Tardif, Doudin, and	Evaluation of beliefs in	15-item neuromyth questionnaire, using a	Findings were consistent with prior studies, and	*n* = 283 Teachers and

Citation	Purpose(s)	Measurement	Finding(s)	Sample
Meylan (2015)	neuromyths among teachers and student teachers, specifically in terms of hemispheric dominance, modality dominance, and the Brain Gym© method.	four-point Likert scale for agreement, utility, and frequency of use	extended Dekker et al.'s (2012) findings by establishing that teachers and student teachers expressed belief in hemispheric and modality dominance claims and recommendations were made to provide close collaboration between neuroscience and educators to produce critical evaluation of pedagogical approaches.	student teachers in Switzerland, including in-service high school teachers (n = 44), college teachers (n = 57), first-year primary student teachers (n = 160), teachers' trainers (n = 22)

The field of education has primarily focused on what are labeled "neuromyths," "urban myths," and "urban legends," which encompass the application of educational psychology principles inappropriately applied to enhance classroom learning (de Bruyckere et al., 2015; Kirschner & van Merriënboer, 2013). A primary concern in this area is the improper application of neuroscientific research findings to the field of education, generally applied outside the intended context of the research findings. Three broad urban myths encountered in the field of educational psychology include: (a) learners as digital natives, (b) learners and their learning styles, and (c) learners as self-educators (2013), the crux of which is that students are not the best judge of what constitutes effective learning. Similar to neuroscientific findings, the myths and legends apply results from synthetic research contexts and tend to generalize the findings. For instance, Tardif, Doudin, and Meylan (2015) found in a sample of teachers and teachers-in-training that 85% believed people use one brain hemisphere more often than the other, and 96% believed people learn better when instruction and instructional information is provided in their preferred learning style. Studies also show that teachers who claim to know more about the brain

and have greater interest in neuroscience are also more likely to endorse neuromyths (Dekker et al., 2012; Gleichgerrcht, Luttges, Salvarezza, & Campos, 2015). More recently, attention in educational psychology has been directed toward specific myths related to education including: (a) myths related to learning, (b) neuromyths, (c) myths related to technology in education, and (d) myths related to educational policy (de Bruyckere et al., 2015).

History

Even during the late 1990s the error in applying brain-based research to educational practice was made, alleging that allowing neuroscience to guide educational practice meaningfully was a faulty approach (Bruer, 1997). The distinction between cognitive neuroscience and the subsequent enthusiastic promotion is also clearly made, further indicating that sometimes the "scientific evidence flatly contradicts the brain-based claims" (Geake, 2008, p. 124). Geake further identified the various misconceptions about neuroscience as applied to education, although he did not clearly identify the need for a scale to identify, much less mitigate, such faulty beliefs (2008). The field of neuroscience has proliferated wildly in recent years, driving great public interest in neuromyths related to 'brain-based' education initiatives, programs, and learning strategies (Beck, 2010; Pasquinelli, 2012), despite the lack of direct empirical evidence to support such beliefs. A review of empirical work in neuromyths and psychological misconceptions related to education are exhibited in Table 3. Such neuromyths include the perception that individuals can effectively train their brain using commercial tools such as Brain Gym® and brain-based education initiatives.

Table 3 Psychology Misconceptions and Neuromyths Based on Educational Concepts

Misconception Description	Source(s)
Accommodating the multiple intelligences: Teachers should tailor their instruction to accommodate their students' different types of intelligence (e.g., linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, intrapersonal, interpersonal).	de Bruyckere, Kirschner, and Hulshof (2015) Waterhouse (2006a)
Behaviorism concepts: Negative reinforcement is equivalent to punishment.	Arntzen, Lokke, Lokke, and Eilertsen (2010) Kuhle, Barber, and Bristol (2009)
Brain development and stimuli: Children exposed to environments rich in stimulus have better-developed brains.	Dekker, Lee, Howard-Jones, and Jolles (2012)
Brain size and intelligence: There is a correlation between brain size and intelligence.	Herculano-Houzel (2002)
Brain training: One can improve their cognitive abilities by playing brain training games such as Brain Gym®.	de Bruyckere, Kirschner, and Hulshof (2015)
Clarity under pressure: Human beings think most clearly when they are under pressure.	de Bruyckere, Kirschner, and Hulshof (2015)
Creativity and schooling: The schooling process ruins children's innate ability to be creative.	de Bruyckere, Kirschner, and Hulshof (2015)
Critical periods for learning: Childhood includes critical periods after which children are no longer able to learn certain things.	Dekker, Lee, Howard-Jones, and Jolles (2012)
Developmental differences in brain function and learning: Education cannot mitigate learning problems in students with developmental differences in brain function.	Dekker, Lee, Howard-Jones, and Jolles (2012)
Digital natives, technology, and education: The new generation of learners inherently know how to learn from developing technologies and media and old methods of instruction do not work for them.	de Bruyckere, Kirschner, and Hulshof (2015) Kirschner and van Merriënboer (2013)
Efficacy of discovery and self-guided learning: Students will learn better if they discover things for themselves rather than having their teacher explain everything to them. Instruction with minimal guidance produces better learning outcomes than does direct instruction. Students should be given control over what and how they are learning.	de Bruyckere, Kirschner, and Hulshof (2015) Holmes (2016) Kirschner and van Merriënboer (2013)
Efficacy of rote memorization: Repeated exposure to the same information, also known as rote learning,	Holmes (2016) Kuhle, Barber, and Bristol

Misconception Description	Source(s)
improves learning.	(2009)
Efficacy of teaching to students' learning style: Students will learn material better and academic achievement will increase if instruction is presented to students in their preferred learning style.	de Bruyckere, Kirschner, and Hulshof (2015) Dekker, Lee, Howard-Jones, and Jolles (2012) Kirschner and van Merriënboer (2013)
First- and second-language acquisition: It is important that a child acquires their native language before attempting to learn a second language, otherwise neither language will be learned.	Dekker, Lee, Howard-Jones, and Jolles (2012)
Gender and learning differences: Males and females have fundamentally different brains and therefore do not learn in the same ways.	de Bruyckere, Kirschner, and Hulshof (2015)
Gender difference in math achievement: Boys are inherently better at mathematics than girls.	de Bruyckere, Kirschner, and Hulshof (2015)
Hemisphericity of the brain: People are either left-brained and analytical or right-brained and creative. Coordination exercises can improve integration between a student's left- and right-brain to facilitate learning.	de Bruyckere, Kirschner, and Hulshof (2015) Dekker, Lee, Howard-Jones, and Jolles (2012) Lyddy and Hughes (2012)
Intelligence and heredity: Intelligence is the result of genetics and cannot be changed by education or life experience.	Herculano-Houzel (2002)
Knowledge obsolescence: Knowledge has become obsolete with the advent of the internet.	de Bruyckere, Kirschner, and Hulshof (2015)
Learning while asleep: People have the ability to learn new information while they are sleeping. *Memory and age:* Adults cannot memorize information as easily as children can.	Brown (1983) Lyddy and Hughes (2012) Standing and Huber (2003) Kuhle, Barber, and Bristol (2009)
Multitasking: People are capable of effectively multitasking with more than one thinking tasks without a loss of concentration or loss of accuracy.	de Bruyckere, Kirschner, and Hulshof (2015)
Nature of human memory: Human brains have a single memory system where every memory is permanently stored.	de Bruyckere, Kirschner, and Hulshof (2015) Herculano-Houzel (2002) Standing and Huber (2003)

Interest in educational myths and legends has taken hold in the field of educational psychology in the last several years. In 2006, an entire issue of *Educational Psychologist* was dedicated to a scholarly dialogue about the efficacy of multiple intelligences theory, the Mozart effect, and emotional intelligence, with evidence to refute and support these theories presented by several scholars in the field (Alexander, 2006; Cherniss, Extein, Goleman, & Weissberg, 2006; Gardner & Moran, 2006; Rauscher & Hinton, 2006; Waterhouse, 2006a, 2006b). Clear evidence has been presented to refute these mistaken educational psychology beliefs on a conceptual basis, but no scale has been developed to quantitatively measure the existence of these beliefs among teachers or any other population of interest.

Contemporary Application

The term neuromyths is somewhat misleading, because the actual misconceptions are not faulty beliefs about neuroscience specifically; rather the misconceptions arise from the inappropriate application of neuroscience to the field of education by the layperson untrained in neuroscience and/or education. The misguided translation between neuroscientific research findings and the application of such findings to education is the basis of these misconceptions: substantiated, confluent findings in neuroscience research are mistakenly transformed and applied in ways unintended by the researchers. Ultimately, the misconception source (neuroscience) is not the issue, rather the breakdown occurs when consumers of research filter empirical evidence to support their beliefs, leading to subjective evaluation and erroneous application of empirical data.

Although not nearly as prolific as the psychological misconceptions literature, the neuromyths and education literature reveals great insight into the reasons underlying the proliferation of such beliefs among both the general public (Beck, 2010; Herculano-Houzel, 2002; Pasquinelli, 2012) and educators (Dekker et al., 2012; Pickering & Howard-Jones, 2007). Neuromyths are often disseminated to consumers as brain-based research alongside images of the brain that lead the reader to more readily accept the claims as fact, promoting the perceived legitimacy of such beliefs (McCabe & Castel, 2008). Prior work in this area has aptly acknowledged the misapplication of neuroscience research to education initiatives, including concepts of hemisphericity, brain plasticity, and the danger of selling unsubstantiated brain-based learning strategies to unwitting teachers, school districts, and parents (Lindell & Kidd, 2011).

Empirical research into the prevalence of neuromyths is minimal, however Dekker et al. recently published findings from their study of 242 primary and secondary teachers in the United Kingdom and the Netherlands who expressed an existing interest in the neuroscience of learning (2012). Aside from investigating the prevalence of neuromyths among this population, the authors also examined potential predictors of such beliefs (2012). Participants were presented with 32 statements about the brain and learning, of which 15 of the statements were neuromyths that on average were endorsed by 49% of the participating teachers and were frequently predicted by higher levels of general knowledge and interest in neuroscience (2012). Findings included embracing false beliefs including the efficacy of learning styles in the classroom, the utility of exercises to improve left- and right-brain coordination, the effect of food and water intake upon brain functioning and academic achievement, and the pervasive myth that humans

use only 10% of their brain (2012). Most importantly, the results of this study suggested that additional general knowledge related to the brain did not exert a protective effect against belief in pseudoscientific beliefs. Though this study is closely tied to the suggestion to develop a scale to identify misconceptions of educational psychology among a population of teachers, Dekker et al.'s (2012) findings indicate the necessity of evaluating in greater depth the prevalence and predictors of misconceptions related to teaching, learning, and human motivation among a population of pre-service teachers in the United States.

Summary. Much of the education literature specifically addresses the alleged tie between neuroscience and the field of education, often highlighting concerns about the validity of such initiatives, programs, and strategies (Dekker et al., 2012; Pickering & Howard-Jones, 2007; for reviews, see also Geake, 2008; Goswami, 2004; Lindell & Kidd, 2011; Purdy, 2008; Sylvan & Christodoulou, 2010). Pasquinelli extended this description to include the clarification that neuromyths "tend to survive the circulation of correct information, and to be inflated by sensationalist press releases" (2012, p. 90), not unlike scientific misconceptions discussed in great depth within the educational psychology literature (e.g., Sinatra et al. 2014). Thus, neuromyths and misconceptions are indistinguishable as presented in both the education and psychology literatures. Though one study did specifically investigate the prevalence of neuromyths among primary and secondary school teachers (Dekker et al., 2012), it was conducted in the UK and Netherlands and may not necessarily generalize to the population of teachers in other countries.

If pre-service teachers are riddled with misconceptions about scientific knowledge and facts, their ability to effectively teach students is surely compromised. The problem extends

beyond the teachers and is carried through to their students and their students' parents, creating an even broader social problem. Thus, identifying whether these ill-supported beliefs also exist among pre-service teachers is a worthwhile pursuit, if for no other reason than to prevent the development of these faulty beliefs by restructuring teacher education programs to ensure the communication of legitimate educational approaches. The clear delineation of these urban legends provides a lens through which the field should pinpoint more specific misconceptions that can be measured quantitatively. Kirschner and van Merriënboer clearly assert "that educators, educational policymakers and educational researchers should reject educational approaches that lack sufficient scientific support and methodologically sound empirical evidence" (2013, p. 178), however, to date there is no such scale to identify the acceptance or rejection of such errant beliefs about educational psychology.

Strategies to Overcome Misconceptions

A turn to the literature on conceptual change is necessary, as well as advocating a five-step process to mitigate educational psychology misconceptions. First, to overcome these damaging misconceptions through the conceptual change process, we must first be able to effectively measure the prevalence and depth of these misconceptions, a task that requires the production of a pragmatic and operationalized definition of misconceptions. Overall, the research on misconceptions is varied within and across disciplines. Second, misconceptions about various topics exist among a variety of populations and are typically overcome through a conceptual change protocol that incorporates some sort of cognitive conflict or dissatisfaction with an existing belief (Gregoire, 2003), motivation to change that belief (Dole & Sinatra, 1998), and a

plausible, comprehensible, and coherent piece of accurate information (1998). While various conceptual change models have been validated, it is asserted that Gregoire's Cognitive-Affective Model of Conceptual Change (CAMCC; 2003) is the most appropriate model to employ when attempting to change the beliefs of pre-service teachers about educational psychology topics. The CAMCC is beneficial in this circumstance because it addresses typical conceptual change processes (e.g., dissonance and plausibility and intelligibility of correct conception) while also incorporating affective and motivational factors relevant to changing the belief (Gregoire, 2003).

Third, to facilitate such conceptual change from these misconceptions to evidence-supported conceptions of educational psychology concepts, a refutational text or lecture seems the most appropriate approach given its prior success in restructuring knowledge within psychological and educational research (Bensley et al., 2014; Broughton et al., 2010; Kowalski & Taylor, 2009; Sinatra & Broughton, 2011; Tippett, 2010). The conditions under which refutational instruction will facilitate conceptual change include the learner's recognition of the inadequacy of their prior knowledge to solve a new problem, along with intelligibility, plausibility, and utility of the incoming information (Tippett, 2010). Such a protocol would include a statement of the misconception followed by the creation of doubt through the explanation of why that misconception is invalid and a statement of an evidence-based accurate claim about the topic and why that claim is acceptable and valid (Hynd, 2001).

Fourth, mitigating misconceptions, regardless of the field in which the mistaken belief exists, must be conducted by facilitating conceptual change in the individual to overcome the inaccurate belief and replace it with a new and accurate belief. The conceptual change process is particularly challenging because pre-instructional, inaccurate conceptions are likely to interfere

with the process of learning accurate information (Chinn & Malhotra, 2002). Anomalous data that clearly refutes the belief has been used extensively in the facilitation of conceptual change to remediate misconceptions. Thus, it seems that providing teachers with anomalous data that directly contradicts their existing conception of an inappropriate teaching practice should in theory combat their misconception immediately. However, this is unlikely to occur because individuals will often resist this change and instead persistently retain their existing conception while rejecting the new, accurate information to protect their entrenched belief to satisfy a robust personal or social goal (Chinn & Brewer, 1993). Prior research has revealed that emotions dominate the restructuring of knowledge when individuals are confronted with evidence that conflicts with their belief (Sinatra et al., 2014). Thus, simply presenting pre-service teachers with information that contradicts their belief is insufficient to initiate belief change. Therefore the development of a conceptual change protocol that considers affective and motivational factors relevant to teacher belief systems is suggested. As proposed by Gregoire (2003), this approach is pivotal in mitigating inaccurate beliefs about educational psychology among teachers.

Fifth, following the development of a validated scale to measure misconceptions of teaching, learning, and human motivation among pre-service teachers, the conceptual change process so often tested in the field of educational psychology could be utilized to help these teachers overcome these potentially harmful erroneous beliefs. As suggested by Hughes et al. (2013b), various methods beyond simple self-report quantitative questionnaires should be employed to truly understand the origin and nature of these inaccurate beliefs. The information gleaned from qualitative inquiries related to these misconceptions would provide a useful baseline to inform the development of techniques to restructure understandings of these

important topics of educational psychology. For instance, operational conceptual change protocols could be developed after careful evaluation of the origin and nature of these misconceptions and the values these teachers tie to their mistaken beliefs. Such protocols could be employed in undergraduate teacher education coursework to mitigate these misconceptions and hamper deeper entrenchment of the beliefs. A review of teacher education programs and in-service teacher trainings should help teachers become more aware of their personal beliefs and how those beliefs influence pedagogy and student motivation. By continuing to adhere to absolutist beliefs, teachers are shortchanging their students and perpetuating their own personal biases onto their students rather than promoting empirically-supported constructs. However, any change to be implemented among teachers will require the buy-in of school administrators and districts who should be charged with reevaluating the teaching methods employed in their classrooms, schools, and districts.

Measurement Fidelity

Measuring Misconceptions

Although the development of a scale to identify misconceptions is certainly not a new endeavor, existing instruments have methodological criticisms that must be considered and addressed prior to the development of new scales. Criticisms include the response format, out-of-date items negated by new scientific findings, test items that address topics outside the scope of introductory psychology textbooks, ambiguously worded items, and vulnerability of the true/false format test to acquiescence and correct guessing due to chance alone (Griggs &

Ransdell, 1987; Hughes et al., 2013a; Ruble, 1986; Taylor & Kowalski, 2012). A major drawback in prior measurement of misconceptions is the overuse of true/false response formats, which do a poor job of detecting misconceptions (McCutcheon, 1991), in addition to constraining responses to be wholly true or false and inflating estimates of misconceptions due to acquiescence (Bensley et al., 2014). Additionally, aside from the difficulty of constructing effective true/false questions, they are also more likely to yield response bias and potential overestimation of misconceptions (Taylor & Kowalski, 2012).

Thirty years ago, recommendations were advanced for future researchers to construct less ambiguous items and to include study findings "hotly debated by psychologists" (Ruble, 1986, p. 36). The proposed definition of misconceptions allows for the inclusion only of those items that are explicitly refuted by empirical evidence. Additionally, it is noted that misconceptions by definition do not comprise a relative lack of domain knowledge, therefore a response option indicating the participant's lack of knowledge should be conspicuous and distinct from the ordinary Likert scale (e.g., Lyddy & Hughes, 2012). Conflating a 'neutral' scale response and 'don't know' response into a single scale point undoubtedly skews the results, generating faulty interpretations and misguided inferences.

While earlier work led to the development of a new psychology misconceptions instrument that remedied many such criticisms of Vaughan's widely-used Test of Common Beliefs (McCutcheon, 1991; Vaughan, 1977), these criticisms have been explicitly addressed in more recent studies evaluating the impact of response format and item language upon misconception frequency (Hughes et al., 2013a; Taylor & Kowalski, 2012). Recent efforts have been made to quantitatively address earlier criticisms concerning the assessment of

misconceptions. Taylor and Kowalski (2012) studied introductory psychology students and compared the efficacy for accurately assessing psychology misconceptions of true/false versus forced choice formats in which respondents were asked to select the 'most true' of two provided options. Their study revealed that the true/false format resulted in an accuracy rate of only 33.05%, while the forced choice format resulted in a 41.29% accuracy rate, suggesting that the true/false format resulted in an overestimation of misconceptions among their sample. It was also inferred that misconception prevalence may fluctuate over time and samples, suggesting that future researchers conduct a pretest of their instrument and consider the possibility of cohort effects within their results (2012). Meanwhile, other psychology misconceptions researchers were concurrently examining analogous measurement concerns in this area.

Similar to Taylor and Kowalski's measurement study, Hughes et al. (2013a) conducted a systematic investigation of the impact of response format and item language upon endorsement of psychological misconceptions. Their study included four alternative 40-item questionnaires composed of 30 misconceptions and 10 filler items tested among a population of undergraduates in the United States and Europe. Question phrasing (ambiguous versus non-ambiguous) and response format (true/false versus seven-point Likert-type scale) were manipulated by the researchers among the randomly assigned groups, and the results indicated both the response format of the instrument and the item language independently inflated the estimation of misconceptions. The authors suggested that future researchers include items based upon distinct criteria rather than subjective judgment and employ alternate techniques beyond the narrow realm of self-report questionnaires (2013a). Taken together, Taylor and Kowalski (2012) and

Hughes et al.'s (2013a) findings suggest that much improvement can be made in the construction of such scales to measure misconceptions.

The current research builds on prior work by the researcher over several years to develop a validated scale to identify misconceptions about various educational psychology concepts that can conceivably be employed with populations of both pre-service and in-service teachers (McAfee & Hoffman, 2014; McAfee, Xu, & Hoffman, 2015; McAfee, Xu, & Hoffman, 2016a; McAfee, Xu, & Hoffman, 2016b). Several iterations of the proposed scale have included as few as 15 to as many as 60 misconception items as evidenced in Appendices B, C, D, and E. The response format has consistently incorporated a Likert-type scale for level of respondent agreement, although the first iteration also included a response for the respondent's level of confidence in each item. Requesting the respondent's confidence level reduced the response rate and therefore was eliminated in future iterations. As a result of the piloted scales to date, it is anticipated that a scale that explicitly identifies 10 to 15 particularly pervasive misconceptions about educational psychology is likely to produce a more stable factor structure. Although factor structure instability has stalled the validation of this scale, Study 1 and 2 contribute additional progress toward the validation of the proposed scale.

Measurement Error

Measurement error is a fundamental concern in scientific research due to the necessary accounting of variance among statistical procedures, a calculation that must be accurate in order to produce valid practical inferences about a data source. Such errors of measurement include

irregularities in respondent scores resulting from a given sample of tasks or occasions, such that the degree of measurement error must be estimated by the researcher for the set of observations in question (Crocker & Algina, 2008). The validity of conclusions drawn from a given data set is threatened when measurement error is introduced, which is composed of both a random and a systematic component (Crocker & Algina, 2008; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). According to Podsakoff et al., random errors are less problematic than systematic errors (2003), however both random and systematic errors of measurement generate a source of concern in the interpretation of test scores (Crocker & Algina, 2008). Random measurement errors occur due to "purely chance happenings" (2008, p. 106), reducing the consistency and utility of test scores, and include distractions, guessing, administration and scoring errors, content sampling, and the examinee's state (2008). Alternatively, systematic measurement errors occur due to "some particular characteristic of the person or the test that has nothing to do with the construct being measured" (2008, p. 105), resulting in inaccurate test scores, misleading conclusions, and reduced practical utility (Campbell & Fiske, 1959). However, systematic errors of measurement are consistent across testing occasions (2008). During measure development, systematic measurement error is most concerning because it can result in a spurious relationship between constructs (Podsakoff et al., 2003). However, researchers can reduce the introduction of measurement error in the development of new measures through careful attention to the content of items, the type of scale, and the response format (Fiske, 1982). The present study was informed by these recommendations and careful consideration was given to the nature of the scale to improve fidelity in measuring misconceptions of educational psychology among pre-service teachers.

Method Biases

When developing a new measure, researchers must consider common method biases with the potential to produce a rival explanation for any correlations observed in the data (Podsakoff et al., 2003). Potential sources of method biases include: (a) self-report bias or common rater effects, (b) item characteristic effects, (c) item context effects, and (d) measurement context effects, as discussed by Podsakoff et al. (2003). In the present inquiry, self-report bias and item characteristic effects are of particular interest. The latter can be actively contemplated during measure development; the former may be statistically accounted for during statistical analysis. Thus, ideally one should take potential method biases into account during the scale development phase so that item characteristic effects can be minimized to reduce the likelihood of skewed results.

Self-report bias and response styles. Response styles are inherently problematic in the context of survey research because of their potentially deleterious impact upon the means, variances, correlations, and factor analytic results of construct measurement (Kam, 2016a; van Vaerenbergh & Thomas, 2013). According to Kam and Zhou, "the term *response style* refers to systematic differences in response scale use between individuals, regardless of item content or respondents' standing on the trait being assessed" (2015, p. 764). When respondents provide the measure of both predictor and criterion variables, artifactual covariance results (Podaskoff et al., 2003), leading to non-trivial bias in the measurement of constructs and statistical inferences (Kam & Meyer, 2015). This common rater effect is referred to as *self-report bias,* the potential source of which may be any of the following: (a) consistency motif, (b) implicit theories, (c) social desirability, (d) leniency biases, (e) acquiescence biases, (f) mood state, or (g) transient

mood state (2003). In developing a scale to reliably and validly measure misconceptions about educational psychology among pre-service teachers, we must rely upon the pre-service teachers to provide evidence of their beliefs through the use of self-report measures. Therefore, self-report biases present a potential limitation to this and any subsequent study employing the scale reported here.

Social desirability. The tendency to respond to survey items such that respondents feel they are presenting themselves favorably regardless of what they truly feel or believe about a particular topic or issue is referred to as a socially desirable response and represents a conspicuous source of systematic error in measurement (Kam & Meyer, 2015; Podaskoff et al., 2003; Rauch, Schweizer, & Moosbrugger, 2007). The socially desirable response exerts a deleterious effect upon research findings because it produces biased answers, changing the calculated mean of the data (2003). This response pattern may also lead to the determination of spurious relationships between variables, concealing true relationships in the data (Ganster, Hennessey, & Luthans, 1983; Podaskoff et al., 2003). Social desirability is undoubtedly a concern in measuring misconceptions about educational psychology among pre-service teachers because many misconceptions are rooted in a positively-framed manner. For example, brain-based education initiatives and brain games are often marketed and sold to unwitting consumers, including pre-service and in-service teachers, as a certain method by which to improve intelligence and academic achievement. Thus, if a statement implicating the utility of such brain games in improving academic achievement were presented as part of this scale, a pre-service teacher may be likely to endorse the socially desirable response that the use of such games does in fact improve intelligence and academic achievement.

Acquiescence. Acquiescence and the bias that follows it presents an additional limitation with self-report social science research. In collecting data through self-reporting, acquiescence must be considered and items must be developed to reduce the likelihood of acquiescent responses at best, and at worst, account for acquiescent responses post hoc. Kam and Zhou assert that "acquiescent participants may prefer to use one side of a scale, such as 'agree' and 'strongly agree,' rather than the other" (2015, p. 765), thereby artificially skewing the distribution of response data (Schweizer, 2012). This response style results from the systematic tendency of a respondent to deflate or inflate their scores, ultimately shifting the mean of the response distribution and producing positive item correlation bias and weakened negative correlations between regularly and reverse-keyed items (Kam & Zhou, 2015). When performing a subsequent factor analysis, a given construct will then artificially load on two factors as a result of this bias (DiStefano & Motl, 2006; Kam & Zhou, 2015; Kam & Meyer, 2012; Marsh, 1996; Quilty, Oakman, & Risko, 2009). However, a structural equation model can be developed that specifically incorporates the acquiescence factor, promoting improved model fit (Friborg, Martinussen, & Rosenvinge, 2006).

According to Bentler, Jackson, and Messick (1971), acquiescence bias is the tendency of respondents to consistently agree with items on a survey irrespective of the item's content. Such unfounded agreement with items on a given instrument is likely to result in distorted correlations among construct measures (1971). The literature has often operationalized acquiescence through an averaging or summing of responses to items with assorted content (Rammstedt & Farmer, 2013; Rammstedt, Goldberg, & Borg, 2010; Weijters, Baumgartner, & Schillewaert, 2013). The measurement of acquiescence such that a given participant has agreed or disagreed with items in

a survey regardless of the item's actual content has been proposed through three methods: (a) summation of item scores across the entire survey (De Beuckelaer, Weijters, & Ruttan, 2010; Kam, 2016a), (b) summation of scores on items with opposite content (Kam, 2017; Rammstedt & Farmer, 2013), or (c) summation of items with heterogeneous content (Baumgartner & Steenkamp, 2001; De Beuckelaer et al., 2010; Kam 2016a; Weijters et al., 2013). When a researcher is unable to adequately prevent acquiescence *a priori*, the measurement of acquiescence among respondents is important so that corrections can be made in the data prior to drawing inferential conclusions and introducing practical recommendations.

Confounding of acquiescence with construct content or genuine ambivalence. Three measurement methods have been recommended for identifying acquiescent responses in a given data set (Kam, 2016a). However, two of the three methods to measure acquiescence have been argued as insufficient due to the likelihood such a measurement actually confounds acquiescence with other variables. De Beuckelaer et al. (2010) found that summing item scores across an entire survey confounded acquiescence with the substantive content of a given construct, while Rammstedt and Farmer (2013) later determined that summing scores on items with opposing content ultimately confounded acquiescence with authentic attitudinal ambivalence. To date, research has supported the third method of measuring acquiescence by summing items with heterogeneous content (Baumgartner & Steenkamp, 2001; Weijters et al., 2013), although there is some lack of agreement among methodologists on this issue (De Beuckelaer et al., 2010).

Valence Effect

The tendency of respondents to agree or disagree with a given survey item regardless of the actual content is problematic in educational and psychological research (Kam, 2016a). Logically inconsistent answers to positively- and negatively-worded items are often produced by respondents regardless of the item's objective content (Kam, 2016a; 2016b). Extant work on the item wording, or item keying, effect has established that a scale with a heterogeneous mix of positively and negatively worded items loads on separate factors when performing factor analyses, effectively decomposing the variance of items into that which is due to trait and that which is due to the wording of the item (Kam, 2016b). Simulation studies have established that if 10% or more individuals respond carelessly to survey items, the detection of a second factor is likely such that factors for positively-worded and negatively-worded items result (Kam & Meyer, 2015; Schmitt & Stults, 1985; Woods, 2006). Multitrait-multimethod CFA has been suggested as a response to this issue, effectively accounting for the trait and method components of positively- and negatively-worded items by incorporating a factor for both item types into the analysis.

Prior research has established that measures of acquiescence are prone to weak convergent validity and often confound with item valence (Kam, 2016a). Survey items are rarely constructed with a truly neutral tone, particularly in the *evaluative aspect* in which the respondent assesses the item in terms of its favorability (2016a). To wit, an item for which a common teaching practice or strategy is touted as beneficial to academic achievement is likely to be interpreted as favorable and is therefore a positively-valenced item. In turn, this favorability is acknowledged by the respondent such that they are then inclined to agree with the item due to

the implied positive outcome (e.g., the common teaching practice *increases* academic achievement). The same item written in a less favorable manner, such that a common teaching practice or strategy is questioned or asserted *not* to be beneficial to academic achievement is likely to be interpreted as less favorable and is therefore a negatively-valenced item. This lack of favorability would then be acknowledged by the respondent with a response in which they are inclined to disagree with the item due to the implied negative outcome (e.g., the common teaching practice *does not increase* academic achievement). To reduce the confounding of item valence with acquiescence, researchers should include in their surveys a balanced number of positively- and negatively-valenced items (De Beuckelaer et al., 2010; Kam, 2016a).

Research Questions

The purpose of this investigation was to develop and validate a scale to measure pre-service teachers' misconceptions about important topics of educational psychology. To accomplish this, Study 1 functioned as a pilot to determine the performance of scale items through reliability and factor analyses, while Study 2 is a systematic evaluation of the conditions under which such a scale performed best. These two studies, taken together, comprise the establishment and support for the validity and reliability of the proposed scale.

Study 1

Research Question 1.1. Do the scores produced by the Study 1 scale demonstrate adequate reliability in a sample of undergraduate students enrolled in teacher education coursework?

Research Question 1.2. What is the underlying factor structure of the Study 1 scale in a sample of undergraduate students enrolled in teacher education coursework?

Study 2

Research Question 2.1. What is the effect of response format (true/false or Likert-type) upon the responses to the Study 2 scale in a sample of pre-service teachers?

Research Question 2.2. What is the effect of valence (exclusively positively-valenced or mixed-valence) upon the performance of the Study 2 scale in a sample of pre-service teachers?

CHAPTER 3: METHOD

Study 1

The purpose of Study 1 was exploratory in order to obtain additional information about the scale's reliability and latent factor structure following three years of iterative development.

Participants

Study 1 participants were recruited from a total of 3,735 undergraduate students enrolled in at least one course within a college of education in a large, metropolitan university in the southeastern United States. Purposive, homogeneous sampling was conducted for this study due to the substantive focus of the researcher on the particular beliefs of pre-service teachers in the United States. Participation in Study 1 was voluntary, and the total number of participants in Study 1 was 173. The age of participants ranged from 16 to 50, with an average age of 22.31 years (SD = 6.93). The vast majority of participants (75.4%, n = 98) indicated plans to pursue K-12 teaching certification in the state of Florida and therefore qualified for inclusion in the study under the criterion of 'pre-service teachers.'

Instrumentation

The scale employed in Study 1 was developed over a period of three years to efficiently and accurately assess pre-service teachers' beliefs about various pragmatic topics of educational

psychology using a 50-item scale. Table 4 provides a listing of the items included in the Study 1 scale.

Table 4 Scale Items, Study 1

#	Item	Topic	Citation(s)
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	Learning	Dekker et al. (2012); Hughes et al. (2013b)
2	Students who multitask accomplish more in less time.	Motivation	Rogers & Monsell (1995); Rubinstein, Meyer, & Evans (2001)
3	Students who want to master a topic will earn the highest grades.	Motivation	Harackiewicz et al. (2002)
4	Students learn best when the teacher tells them exactly what they need to know.	Motivation	Anderson, Greeno, Reder, & Simon (2000); Fosnot (2005); Waxman, Padron, & Arnold (2001)
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	Motivation	Deci & Ryan (2002)
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	Learning	Gottfredson (2004); Visser, Ashton, & Vernon (2006); Waterhouse (2006)
7	I.Q. is fixed.	Learning	Sternberg (2004)
8	Good teaching requires aligning instruction to the multiple intelligences of students.	Teaching	Gottfredson (2004); Visser, Ashton, & Vernon (2006); Waterhouse (2006)
9	Non-verbal gestures from teachers can increase student academic achievement.	Teaching	
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.	Learning	Rogers & Monsell (1995); Rubinstein, Meyer, & Evans (2001)
11	Effective teaching requires the alignment of instruction to students' learning styles.	Teaching	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
12	Most students are effectively able to assess the reasons for their own behavior.	Motivation	Feldon (2010)
13	Instructional materials should be designed based on a student's learning style.	Teaching	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
14	A teacher's teaching expertise transfers across subjects.	Teaching	
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.	Learning	Anderson, Greeno, Reder, & Simon (2000); Fosnot (2005); Waxman, Padron, & Arnold (2001)
16	Students with the best memory get the highest grades.	Learning	Stevenson et al. (2014)
17	Some students have true photographic memories.	Learning	Loftus & Loftus (1980)
18	Generally, students use only 10% of their brain for school work.	Learning	Dekker et al. (2012); Hughes et al. (2013b)
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student	Teaching	Gottfredson (2004); Visser, Ashton, & Vernon (2006); Waterhouse

#	Item	Topic	Citation(s)
	achievement.		(2006)
20	Heredity does NOT influence motivation.	Motivation	Plomin (1990)
21	Learning is optimized when teachers present materials that consider the student's intelligence type.	Teaching	Gottfredson (2004); Visser, Ashton, & Vernon (2006); Waterhouse (2006)
22	A teacher's teaching expertise transfers across students.	Teaching	
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.	Teaching	
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	Learning	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
25	Academic achievement increases when teachers present material in the student's preferred learning style.	Teaching	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
26	Students who earn the highest grades have learned the most.	Motivation	Harackiewicz et al. (2002)
27	Teachers should group students of similar abilities together to enhance academic achievement.	Teaching	Oakes (2005) Weinstein (1996)
28	If a student is interested in a topic, their interest will endure over time.	Motivation	Pekrun et al. (2014)
29	Students who take responsibility for their own learning achieve the most academically.	Motivation	Harackiewicz et al. (2002)
30	Students with the most interest in a topic will get the highest grades.	Motivation	Harackiewicz et al. (2002)
31	Interest in a topic is usually fixed over time.	Motivation	Pekrun et al. (2014)
32	The majority of intelligence tests are biased against certain people.	Learning	Sternberg (2004)
33	There is no such thing as general intelligence.	Learning	Sternberg (2004)
34	Motivation is NOT influenced by genetics.	Motivation	Plomin (1990)
35	Teachers should offer unsolicited help to students who appear to be struggling.	Teaching	Pintrich & Schunk (2002); Dweck & Leggett (1988)
36	Most students know their own motives.	Motivation	Feldon (2010)
37	Playing classical music to infants increases their intelligence.	Learning	Hughes et al. (2013)
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	Motivation	van Loon et al. (2013)
39	Procrastination is a way to enhance academic achievement.	Learning	You (2015)
40	Students will remember more of what they see than what they hear.	Learning	Clark & Paivio (1991); Mayer (2008)
41	Student academic achievement is improved when teachers give students control over how they complete tasks.	Teaching	Williams (1996)
42	Students preoccupied with grades have inferior learning outcomes.	Learning	Harackiewicz et al. (2002)
43	Most students are effectively able to assess the source of their own motivation.	Motivation	Feldon (2010)

#	Item	Topic	Citation(s)
44	Students who are really intelligent have a good memory.	Learning	Chuderski (2015)
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	Motivation	Deci & Ryan (2002)
46	Students cannot do much about eliminating test anxiety.	Learning	Spielberger & Vagg (1995); Wigfield & Eccles (1989)
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	Teaching	Gottfredson (2004); Visser, Ashton, & Vernon (2006); Waterhouse (2006)
48	Teachers should defer to the students to decide how they want to learn.	Teaching	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
49	Learning is optimized when teachers present material in students' preferred learning styles.	Teaching	Dekker et al. (2012); Kirschner & van Merrienboer (2013); Pashler et al. (2008)
50	Generally, students have similar levels of academic motivation.	Motivation	Skinner et al. (2008)

Each item was based upon empirically-unsupported or refuted theories, practices, and strategies of teaching, learning, and human motivation in the fields of psychology and educational psychology. Items were further categorized by topic (as displayed in Table 4) to encompass a variety of areas within educational psychology where inaccurate or misguided beliefs exist that are likely to be influential upon daily teaching practice, strategy use, and instructional design. As displayed in Appendix E, responses were gathered using a seven-point Likert-type scale with a separate response option for participants to indicate their self-reported lack of knowledge.

The Study 1 scale comprised 50 false statements related to teaching strategies, human learning and motivation, and various beliefs about teaching practices and academic achievement. Each claim made in the statements were either unsupported or debunked by empirical evidence. Topics within these 50 statements included: (a) hemisphericity of the brain, (b) efficacy of multitasking, (c) goal orientation, (d) direct instruction versus constructivist learning, (e)

behaviorism, (f) multiple intelligences, (g) learning styles, (h) malleability of IQ, (i) nature of human memory, (j) brain capacity, (k) heredity and motivation, (l) classical music and intelligence, (m) ability grouping, (n) task complexity and motivation, (o) learned helplessness, and (p) procrastination. Study 1 scale items are displayed in Table 4.

Initial content validation of the scale was performed over a three-year period through a comprehensive review of the literature, combined with iterative item review and approval from several subject matter experts in the field of educational psychology. The literature review revealed several misconceptions about psychological constructs that also applied to the field of educational psychology, each of which were already empirically established as misconceptions during the past several decades (Bangerter & Heath, 2004; Della Sala, 1999; Higbee & Clay, 1998; Hughes et al., 2013b; Lyddy & Hughes, 2012; Standing & Huber, 2003). Analysis of the scale by various experts in the field of educational psychology resulted in some reworded, additional, or deleted items. Reliability of the items as established by four pilot studies between June of 2014 and February 2015 ranged from $\alpha = .589$ to $\alpha = .865$ indicating acceptable to good reliability of existing scale items. Implementation of Study 1 was conducted using Qualtrics surveying software allowing anonymous, electronic study participation.

Design and Procedure

Study 1 was intended to be an initial reliability and validity study for the sake of evaluating the performance of the scale items. Data from the 50-item scale were collected anonymously through self-report from a sample of undergraduate, pre-service teachers in

February of 2016. In compliance with FERPA regulations and the IRB approval obtained prior to conducting Study 1, student email addresses were not released to the researcher and the recruitment email was disseminated to potential participants with the assistance of the college's office of undergraduate studies. Upon receipt of the recruitment email, participants were routed to an electronic survey, displayed in Appendix F.

First, each participant was requested to provide informed consent. The informed consent process indicated the purpose of the study was to evaluate the opinions undergraduate pre-service teachers have of topics related to the teacher education curriculum and advised potential participants of the amount of time required if they elected to participate. Participants were informed that they would be asked to indicate their beliefs about 50 statements related to common topics among pre-service teachers using a provided seven-point Likert-type scale. To improve response fidelity, participants were *not* informed that the statements were in fact misconceptions about teaching, learning, and human motivation. Participants were also advised of the confidentiality and protection of their responses through encryption of the data via the surveying software.

Subsequent to providing consent, participants were directed to the first page of the electronic survey. This electronic survey comprised five pages, each displaying 10 statements in a matrix format, with a seven-point Likert-type scale ranging from "strongly disagree" to "strongly agree," in addition to an "I have no knowledge on this topic" response option. The specific instructions for survey completion were provided at the top of each of the five pages, as displayed in Appendix F. The 50 statements included in the Study 1 scale were all falsehoods, such that any level of agreement with a statement was considered endorsement of the

misconception. Any level of disagreement was interpreted to mean the participant did not have the misconception. Data analysis for Study 1 included an evaluation of the descriptive statistics for the purpose of understanding misconception endorsement among the sample of pre-service teachers. Additionally, an exploratory factor analysis was performed to better understand the underlying structure of the data and to construct a final scale for Study 2 that efficiently measured misconceptions of educational psychology among pre-service teachers. Limitations of Study 1 included the low response rate (4.6%) and narrow sample of participants (a single college in a single university educated by a limited group of teacher educators).

A human subject protocol approval for both studies was received through the University of Central Florida (UCF) Institutional Review Board (IRB). Initial approval for Study 1 was obtained effective June 25, 2014 (approval letter displayed in Appendix H) while a modification to the initial study was approved effective February 24, 2016 (approval letter displayed in Appendix I). Results and data were reported only in aggregated form to protect participant anonymity. All electronic data and files are stored in password-protected files on a password-protected computer in perpetuity, accessible only by the researcher.

Study 2

The purpose of Study 2 was to validate the final 15-item scale resulting from Study 1 by performing an experiment in which the scale's performance for measuring misconceptions about educational psychology among pre-service teachers was tested under various conditions. Specifically, the researcher was interested in determining whether the true/false or Likert-type

response format was more sensitive to detecting misconceptions. Further, the effect of valence on misconception endorsement and scale reliability was examined.

Participants

Study 2 participants were recruited from a total of 386 junior- and senior-level undergraduate students enrolled in Internship I (n = 140) or Internship II (n = 246) coursework within a college of education at a large, metropolitan university in the southeastern United States. Purposive, homogeneous sampling was conducted for this study due to the researcher's substantive focus upon the particular beliefs of pre-service teachers in the United States. Participation in Study 2 was voluntary, and 73 total Study 2 participants fully completed both the true/false and the Likert-type scales. The age of participants ranged from 20 to 54, with an average age of 24.6 years (SD = 5.542). Because all participants were enrolled in their first (63.0%, n = 46) or second (37.0%, n = 27) teacher education internship required to complete a teaching degree and obtain state certification in Early Childhood, Elementary, or Secondary Education, all participants were assumed to qualify under the criterion of 'pre-service teachers.' Study 2 participants were further assumed to comprise a sample with a substantively equal baseline of coursework knowledge because pre-requisite coursework in the education major was required to be complete prior to enrollment in any Internship coursework.

Instrumentation

The scale employed in Study 2 was developed over a four year period to efficiently and accurately measure pre-service teachers' beliefs about various pragmatic topics of educational psychology using a brief, 15-item scale. Table 5 provides a listing of the items included in the Study 2 scale.

Table 5 Scale Items, Study 2

#	Item	Topic	Citation(s)
1	Student academic achievement is improved when teachers give students control over how they complete tasks.	Motivation	Williams (1996)
2	Some students have true photographic memories.	Learning	Loftus and Loftus (1980)
3	Generally, students use only 10% of their brain.	Learning	Dekker et al. (2012); Hughes et al. (2013b)
4	Effective teaching requires the alignment of instruction to students' learning styles.	Teaching	Dekker et al. (2012); Kirschner & van Merriënboer, 2013; Pashler et al. (2008)
5	Good teaching requires aligning instruction to the multiple intelligences of students.	Teaching	Gottfredson (2004); Visser, Ashton, and Vernon (2006); Waterhouse (2006)
6	A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).	Motivation	Deci and Ryan (2002)
7	Student motivation is influenced by their genetics. ***Student motivation is not influenced by their genetics.***	Motivation	Plomin (1990)
8	Differentiated instruction tailored to a student's intelligence type enhances student academic achievement. ***Differentiated instruction tailored to a student's intelligence type does not enhance student academic achievement.***	Teaching	Gottfredson (2004); Visser, Ashton, and Vernon (2006); Waterhouse (2006)
9	Teachers should offer unsolicited help to students who appear to be struggling. ***Teachers should not offer unsolicited help to students who appear to be struggling.***	Teaching	Pintrich and Schunk (2002) Dweck and Leggett (1988)
10	Playing classical music to infants increases their intelligence. ***Playing classical music to infants does not increase their intelligence.***	Learning	Hughes et al. (2013)
11	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	Motivation	van Loon et al. (2013)
12	Academic achievement increases when teachers	Teaching	Dekker et al. (2012);

#	Item	Topic	Citation(s)
	present material in the student's preferred learning style. ***Academic achievement does not increase when teachers present material in the student's preferred learning style.***		Kirschner & van Merriënboer, 2013; Pashler et al. (2008)
13	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences. ***Academic achievement is not enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.***	Teaching	Gottfredson (2004); Visser, Ashton, and Vernon (2006); Waterhouse (2006)
14	Academic achievement is improved when instruction is customized for left- and right-brained learners. ***Academic achievement is not improved when instruction is customized for left- and right-brained learners.***	Teaching	Dekker et al. (2012); Hughes et al. (2013b)
15	Students preoccupied with grades have inferior learning outcomes. ***Students preoccupied with grades do not have inferior learning outcomes.***	Motivation	Harackiewicz et al. (2002)

NOTE: ***bold and italicized font indicates mixed-valence version of the item***

Each scale item was based upon empirically-unsupported or refuted theories, practices, and strategies about teaching, learning, and human motivation in educational psychology. Items were further categorized by topic (as displayed in Table 5) to encompass a variety of areas within educational psychology where inaccurate or misguided beliefs exist that are likely to be influential upon daily teaching practice, strategy use, and instructional design. Responses were gathered using a true/false scale in addition to a six-point, Likert-type scale.

The scale included 15 statements related to teaching strategies, human learning and motivation, and various beliefs about teaching practices and academic achievement either unsupported or debunked by empirical evidence. Topics within these 15 statements included: (a) student autonomy and motivation, (b) the existence of photographic memories, (c) the 10% brain

usage myth, (d) learning styles and academic achievement, (e) multiple intelligences and academic achievement, (f) behaviorism, (g) heredity and motivation, (h) learned helplessness, (i) classical music and intelligence, (j) task complexity and motivation, (k) hemisphericity and academic achievement, and (l) goal orientation. Study 2 scale items are displayed in Table 5.

Initial content validation of the scale was performed over a four-year period through a comprehensive review of the literature in addition to item review and approval from subject matter experts in the field of educational psychology. The 50-item Study 1 data collected in February 2016 exhibited excellent reliability at $\alpha = .916$. Implementation of Study 2 was conducted using Qualtrics surveying software allowing anonymous, electronic study participation.

Design and Procedure

Study 2 employed an experimental 2 (scale: true/false, six-point Likert-type) x 2 (valence: positive, mixed) x 2 (order: true/false presented first, Likert-type presented first) factorial, repeated measures design to systematically evaluate the conditions under which the proposed scale to measure misconceptions performed best. These conditions included the scale with which participants were asked to respond, the valence of the items, and the order in which the two scales were presented to participants. The variables of valence and order were between-subjects factors, whereas the response format was a between- and within-subjects factor.

Study 2 data were collected anonymously through self-report from a sample of undergraduate, pre-service teachers enrolled in a teaching internship required for K-12 teaching

certification in the state of Florida during January of 2018. In compliance with FERPA regulations and the IRB approval for Study 2, identifiable student information was not released to the researcher. Participants were recruited via a flyer distributed at the internship orientation, during which a QR code and short URL linking participants to the Qualtrics survey was included on a paper flyer distributed to every orientation attendee. Additionally, recruitment emails were distributed to prospective participants by the Director of Clinical Experiences via the Webcourses@UCF/Canvas course pages for EDE 3942 (Internship I) and EDE 4943 (Internship II) following the Spring 2018 internship orientations in early January. Upon following the QR code or short URL on the paper recruitment flyer, participants were routed to an electronic survey, displayed in Appendix G.

First, each participant was requested to provide informed consent. The informed consent process indicated the purpose of the study was to evaluate the opinions undergraduate pre-service teachers have of topics related to the teacher education curriculum and advised potential participants of the amount of time required if they elected to participate. Participants were informed that they would be asked to indicate their beliefs about 15 unique statements related to common educational topics using a provided true/false and six-point, Likert-type scale. To improve response fidelity, participants were *not* informed the statements were in fact misconceptions about teaching, learning, and human motivation. Participants were advised of the confidentiality and protection of their responses through encryption of the data via the surveying software.

All participants were randomly and equally assigned by the Qualtrics software to one of four possible conditions, exhibited in Table 6.

Table 6 Assignment Conditions, Study 2

	True/False followed by Likert-type	**Likert-type followed by True/False**
+ only (positive valence)	Condition 1	Condition 2
+ and – (mixed-valence)	Condition 3	Condition 4

Two conditions included 15 positively-valenced items (Positive Valence; Conditions 1 and 2) and two conditions included a heterogeneous mix of 15 positively- and negatively-valenced items (Mixed Valence; Conditions 3 and 4). Conditions 1 and 3 required participants first respond to each of the 15 statements using a true/false response scale, followed by a request to respond to the same 15 statements using a six-point Likert-type scale. Conditions 2 and 4 required participants first respond to 15 statements using a six-point Likert-type scale, followed by a request to respond to the same 15 statements using a true/false scale. Each scale was presented separately for participants, and the order of items within each scale were randomized within and between participants to control for order effects.

Subsequent to providing consent, participants were directed to the first page of the electronic survey. This electronic survey comprised two pages, each displaying 15 statements. The six-point, Likert-type scale ranged from “strongly disagree” to “strongly agree.” The specific instructions for survey completion were provided at the top of each of the two pages, as displayed in Appendix G. When presented in one of the positively-valenced conditions, all 15 statements included in the Study 2 scale were falsehoods, such that any level of agreement with a

statement was considered endorsement of the misconception. Any level of disagreement in the positively-valenced condition was interpreted to mean the participant did not have the misconception. When presented in one of the mixed-valence conditions, eight of the 15 statements were written such that any level of disagreement with a statement was considered endorsement of the misconception, while any level of agreement with the remaining seven statements was considered endorsement of the misconception. When presented in one of the positively-valenced conditions, a "true" response for any of the 15 items indicated endorsement of the misconception. In one of the mixed-valence conditions, a "true" response for Items 1-6 and 11 and a "false" response for Items 7-10 and 12-15 indicated endorsement of the misconception.

Data analysis for Study 2 included an evaluation of the descriptive statistics for the purpose of understanding misconception endorsement among the sample of pre-service teachers. Additionally, inferential analyses were performed to better understand the impact of response format, valence, and order upon misconception endorsement. Limitations of Study 2 included the small sample size (n = 73), restricting the breadth of available analyses and the narrow sample of participants (a single college in a single university educated by a limited group of teacher educators). Several analyses were performed on the data resulting from Study 2, as exhibited in Table 7.

Table 7 Research Questions and Primary Analyses, Study 2

Research Question	Variables		Analysis
What is the effect of response format (true/false or Likert-type) upon the performance of the Study 2 scale in a sample of pre-service teachers?	**IV:**	Scale (True/False, Likert-type)	Cronbach's α reliability analyses
	DV:	Scale-level and item-level misconception endorsement	Dependent *t* and McNemar's tests for within-subjects analysis
What is the effect of valence (exclusively positively-valenced or mixed-valence) upon the performance of the Study 2 scale in a sample of pre-service teachers?	**IV:**	Valence (Positive, Mixed)	Cronbach's α reliability analyses
	DV:	Scale-level and item-level misconception endorsement	Generalizability ("G") theory analyses Logistic regression analyses

Several primary analyses were performed, including: (a) reliability analyses using Cronbach's α, (b) generalizability ("G") studies, (c) a dependent *t*-test to determine whether a mean difference existed between participant responses to each of the true/false scaled items and the six-point, Likert-type scaled items, and (d) item-level simple logistic regression procedures to determine the odds of misconception endorsement based upon the valence (positive or mixed) and order (true/false presented first or Likert-type presented first). Logistic regressions were performed for each of the true/false and dichotomized Likert-type responses, such that misconception endorsement was defined as 0 for endorsement (any form of agreement) and 1 for non-endorsement (any form of disagreement). This dichotomization of the Likert-type items allowed for a direct comparison of misconception endorsement within participants according to response format.

A human subject protocol approval was received through the University of Central Florida (UCF) Institutional Review Board (IRB). Initial approval for Study 2 was obtained effective June 25, 2014 (approval letter displayed in Appendix H) while a modification to the initial study was approved effective October 10, 2017 (approval letter displayed in Appendix J). Results and data were reported only in aggregated form to protect participant anonymity. All electronic data and files are stored in password-protected files on a password-protected computer in perpetuity, accessible only by the researcher.

CHAPTER 4: RESULTS

The primary purpose of this line of inquiry was to develop and validate a scale to help teacher educators assess the existence of pre-service teachers' misconceptions about fundamental topics of educational psychology related to teaching, learning, and human motivation. Two studies were conducted to develop this scale; Study 1 explored the reliability and validity of the items that were implemented in Study 2. The purpose of Study 2 was to continue to validate the scale and contribute to the measurement literature by investigating which of the four tested methods for measuring misconceptions performed best, based on the experimentally manipulated variables of response format and valence.

Study 1

Descriptive Statistics

Prior to performing inferential analyses on the Study 1 data, the descriptive statistics were examined. Undergraduate students enrolled in at least one course in a college of education were asked to indicate their level of agreement using a seven-point Likert-type scale with each of 50 items in the electronic survey. Participants were also provided the option to indicate "I have no knowledge on this topic." Responses for which a participant acknowledged having no knowledge were treated as missing and therefore not analyzed. Prior to analysis, responses were recoded such that endorsement of a misconception (any form of agreement) was coded as a 0 and non-endorsement (any form of agreement) was coded as a 1. The descriptive statistics for each item

were examined and are displayed in Table 8. It was observed that no single standard deviation among the 50 items stood out upon gross observation as remarkably larger than the other items.

Table 8 Descriptive Statistics, Study 1

#	Item	*n*	Mean	S.D.
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	149	.11	.319
2	Students who multitask accomplish more in less time.	148	.30	.459
3	Students who want to master a topic will earn the highest grades.	148	.24	.430
4	Students learn best when the teacher tells them exactly what they need to know.	149	.35	.478
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	149	.23	.421
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	147	.14	.351
7	I.Q. is fixed.	147	.52	.501
8	Good teaching requires aligning instruction to the multiple intelligences of students.	146	.05	.228
9	Non-verbal gestures from teachers can increase student academic achievement.	148	.05	.213
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.	148	.68	.467
11	Effective teaching requires the alignment of instruction to students' learning styles.	139	.05	.219
12	Most students are effectively able to assess the reasons for their own behavior.	139	.40	.491
13	Instructional materials should be designed based on a student's learning style.	138	.11	.312
14	A teacher's teaching expertise transfers across subjects.	137	.28	.453
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.	138	.66	.476
16	Students with the best memory get the highest grades.	139	.50	.502
17	Some students have true photographic memories.	139	.04	.204
18	Generally, students use only 10% of their brain for school work.	139	.19	.391
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.	139	.03	.168
20	Heredity does NOT influence motivation.	139	.36	.482
21	Learning is optimized when teachers present materials that consider the student's intelligence type.	136	.06	.236
22	A teacher's teaching expertise transfers across students.	135	.21	.412

#	Item	*n*	Mean	S.D.
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.	136	.25	.435
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	136	.26	.439
25	Academic achievement increases when teachers present material in the student's preferred learning style.	136	.05	.222
26	Students who earn the highest grades have learned the most.	136	.67	.472
27	Teachers should group students of similar abilities together to enhance academic achievement.	135	.47	.501
28	If a student is interested in a topic, their interest will endure over time.	136	.24	.426
29	Students who take responsibility for their own learning achieve the most academically.	134	.06	.238
30	Students with the most interest in a topic will get the highest grades.	136	.27	.447
31	Interest in a topic is usually fixed over time.	134	.40	.492
32	The majority of intelligence tests are biased against certain people.	133	.12	.327
33	There is no such thing as general intelligence.	134	.24	.428
34	Motivation is NOT influenced by genetics.	134	.32	.469
35	Teachers should offer unsolicited help to students who appear to be struggling.	134	.07	.251
36	Most students know their own motives.	132	.39	.490
37	Playing classical music to infants increases their intelligence.	134	.09	.287
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	132	.15	.360
39	Procrastination is a way to enhance academic achievement.	134	.79	.408
40	Students will remember more of what they see than what they hear.	134	.20	.403
41	Student academic achievement is improved when teachers give students control over how they complete tasks.	129	.09	.280
42	Students preoccupied with grades have inferior learning outcomes.	128	.29	.455
43	Most students are effectively able to assess the source of their own motivation.	129	.36	.481
44	Students who are really intelligent have a good memory.	129	.35	.478
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	129	.43	.496
46	Students cannot do much about eliminating test anxiety.	126	.66	.476
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	129	.07	.256
48	Teachers should defer to the students to decide how they want to learn.	127	.28	.452

#	Item	*n*	Mean	S.D.
49	Learning is optimized when teachers present material in students' preferred learning styles.	129	.07	.256
50	Generally, students have similar levels of academic motivation.	129	.60	.492

Additionally, the percentage of respondents endorsing a misconception is displayed for each item in Table 9.

Table 9 Misconception Endorsement, Study 1

Item #	Item	Misconception (%)	No Misconception (%)
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	88.6%	11.4%
2	Students who multitask accomplish more in less time.	70.3%	29.7%
3	Students who want to master a topic will earn the highest grades.	75.7%	24.3%
4	Students learn best when the teacher tells them exactly what they need to know.	65.1%	34.9%
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	77.2%	22.8%
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	85.7%	14.3%
7	I.Q. is fixed.	47.6%	52.4%
8	Good teaching requires aligning instruction to the multiple intelligences of students.	94.5%	5.5%
9	Non-verbal gestures from teachers can increase student academic achievement.	95.3%	4.7%
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.	31.8%	68.2%
11	Effective teaching requires the alignment of instruction to students' learning styles.	95.0%	5.0%
12	Most students are effectively able to assess the reasons for their own behavior.	60.4%	39.6%
13	Instructional materials should be designed based on a student's learning style.	89.1%	10.9%
14	A teacher's teaching expertise transfers across subjects.	71.5%	28.5%
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.	34.1%	65.9%
16	Students with the best memory get the highest grades.	49.6%	50.4%
17	Some students have true photographic memories.	95.7%	4.3%
18	Generally, students use only 10% of their brain for school work.	81.3%	18.7%
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.	97.1%	2.9%
20	Heredity does NOT influence motivation.	64.0%	36.0%

Item #	Item	Misconception (%)	No Misconception (%)
21	Learning is optimized when teachers present materials that consider the student's intelligence type	94.1%	5.9%
22	A teacher's teaching expertise transfers across students.	78.5%	21.5%
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.	75.0%	25.0%
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	74.3%	25.7%
25	Academic achievement increases when teachers present material in the student's preferred learning style.	94.9%	5.1%
26	Students who earn the highest grades have learned the most.	33.1%	66.9%
27	Teachers should group students of similar abilities together to enhance academic achievement.	52.6%	47.4%
28	If a student is interested in a topic, their interest will endure over time.	76.5%	23.5%
29	Students who take responsibility for their own learning achieve the most academically.	94.0%	6.0%
30	Students with the most interest in a topic will get the highest grades.	72.8%	27.2%
31	Interest in a topic is usually fixed over time.	59.7%	40.3%
32	The majority of intelligence tests are biased against certain people.	88.0%	12.0%
33	There is no such thing as general intelligence.	76.1%	23.9%
34	Motivation is NOT influenced by genetics.	67.9%	32.1%
35	Teachers should offer unsolicited help to students who appear to be struggling.	93.3%	6.7%
36	Most students know their own motives.	60.6%	39.4%
37	Playing classical music to infants increases their intelligence.	91.0%	9.0%
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	84.8%	15.2%
39	Procrastination is a way to enhance academic achievement.	20.9%	79.1%
40	Students will remember more of what they see than what they hear.	79.9%	20.1%
41	Student academic achievement is improved when teachers give students control over how they complete tasks.	91.5%	8.5%
42	Students preoccupied with grades have inferior learning outcomes.	71.1%	28.9%
43	Most students are effectively able to assess the source of their own motivation.	64.3%	35.7%
44	Students who are really intelligent have a good memory.	65.1%	34.9%
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	57.4%	42.6%
46	Students cannot do much about eliminating test anxiety.	34.1%	65.9%
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	93.0%	7.0%
48	Teachers should defer to the students to decide how they want to learn.	71.7%	28.3%
49	Learning is optimized when teachers present material in students' preferred learning styles.	93.0%	7.0%
50	Generally, students have similar levels of academic motivation.	40.3%	59.7%

Misconception endorsement varied, and the majority of participants did not endorse eight of the 50 items (Items 7, 10, 15, 16, 26, 39, 46, and 50), including items related to intelligence quotients (IQ), multitasking, direct instruction, memory, procrastination, test anxiety, and academic motivation. Thirteen misconceptions (Items 8, 9, 11, 17, 19, 21, 25, 29, 35, 37, 41, 47, and 49) were endorsed by more than 90% of participants, including multiple items related to learning styles, multiple intelligences, and motivation, in addition to items related to photographic memory and learned helplessness.

Research Question 1.1: Do the scores produced by the Study 1 scale demonstrate adequate reliability in a sample of undergraduate students enrolled in teacher education coursework?

The purpose of the first research question for Study 1 was to determine the internal consistency of the proposed scale by performing reliability analyses using Cronbach's alpha. Participant responses obtained from the misconceptions scale were judged to be very reliable for the undergraduate, pre-service teachers from whom the data were collected, with a reliability coefficient of .827. An evaluation of the item-total statistics did not reveal any negative corrected item-total correlations, nor were any zero-corrected item-total correlations discovered, as displayed in Table 10.

Table 10 Research Question 1.1 Item-Total Statistics

Item #	Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	13.44	40.886	.248	.825
2	Students who multitask accomplish more in less time.	13.25	39.944	.318	.823

Item #	Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
3	Students who want to master a topic will earn the highest grades.	13.32	40.469	.253	.825
4	Students learn best when the teacher tells them exactly what they need to know.	13.21	39.601	.362	.822
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	13.34	40.457	.264	.824
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	13.43	40.938	.226	.825
7	I.Q. is fixed.	13.04	40.609	.178	.827
8	Good teaching requires aligning instruction to the multiple intelligences of students.	13.52	41.491	.200	.826
9	Non-verbal gestures from teachers can increase student academic achievement.	13.49	41.509	.140	.827
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.	12.89	39.376	.404	.821
11	Effective teaching requires the alignment of instruction to students' learning styles.	13.51	41.119	.318	.825
12	Most students are effectively able to assess the reasons for their own behavior.	13.17	39.804	.317	.823
13	Instructional materials should be designed based on a student's learning style.	13.25	39.731	.355	.822
14	A teacher's teaching expertise transfers across subjects.	13.44	40.532	.337	.823
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.	12.88	39.348	.412	.820
16	Students with the best memory get the highest grades.	13.04	40.176	.247	.825
17	Some students have true photographic memories.	13.53	41.703	.131	.827
18	Generally, students use only 10% of their brain for school work.	13.38	41.281	.117	.828
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.	13.53	41.650	.157	.827
20	Heredity does NOT influence motivation.	13.19	40.210	.255	.825
21	Learning is optimized when teachers	13.50	41.403	.190	.826

Item #	Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
	present materials that consider the student's intelligence type				
22	A teacher's teaching expertise transfers across students.	13.35	40.478	.265	.824
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.	13.28	40.257	.272	.824
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	13.29	39.429	.428	.820
25	Academic achievement increases when teachers present material in the student's preferred learning style.	13.50	41.084	.302	.825
26	Students who earn the highest grades have learned the most.	12.91	39.267	.414	.820
27	Teachers should group students of similar abilities together to enhance academic achievement.	13.08	39.879	.295	.824
28	If a student is interested in a topic, their interest will endure over time.	13.32	40.239	.296	.824
29	Students who take responsibility for their own learning achieve the most academically.	13.48	41.367	.172	.826
30	Students with the most interest in a topic will get the highest grades.	13.31	40.622	.216	.826
31	Interest in a topic is usually fixed over time.	13.18	39.066	.443	.819
32	The majority of intelligence tests are biased against certain people.	13.43	41.132	.180	.826
33	There is no such thing as general intelligence.	13.32	41.032	.144	.828
34	Motivation is NOT influenced by genetics.	13.21	40.522	.207	.826
35	Teachers should offer unsolicited help to students who appear to be struggling.	13.50	41.739	.073	.828
36	Most students know their own motives.	13.17	39.114	.433	.820
37	Playing classical music to infants increases their intelligence.	13.46	41.313	.166	.826
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	13.40	40.968	.198	.826
39	Procrastination is a way to enhance academic achievement.	12.75	40.346	.292	.824
40	Students will remember more of what they see than what they hear.	13.36	40.816	.203	.826
41	Student academic achievement is improved when teachers give students control over how they complete tasks.	13.48	41.579	.108	.827

Item #	Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
42	Students preoccupied with grades have inferior learning outcomes.	13.26	40.497	.224	.826
43	Most students are effectively able to assess the source of their own motivation.	13.22	39.447	.392	.821
44	Students who are really intelligent have a good memory.	13.22	39.836	.325	.823
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	13.13	40.204	.247	.825
46	Students cannot do much about eliminating test anxiety.	12.89	39.748	.340	.822
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	13.49	41.332	.197	.826
48	Teachers should defer to the students to decide how they want to learn.	13.26	39.806	.346	.822
49	Learning is optimized when teachers present material in students' preferred learning styles.	13.51	41.031	.352	.824
50	Generally, students have similar levels of academic motivation.	12.96	39.645	.339	.822

Although Items 7, 18, 20, 33, 34, 35, and 41 did not contribute to the overall reliability of the scale, the items were retained due to their substantive relevance at the item level. The iterative elimination and resulting reliability coefficient for each of the Study 1 items is displayed in Table 11. Careful consideration was given to rewriting these items for the sake of clarity prior to including them in the Study 2 scale.

Research Question 1.2: What is the underlying factor structure of the Study 1 scale in a sample of undergraduate students enrolled in teacher education coursework?

The purpose of this investigation was to explore the factor structure underlying the misconception item responses in the Study 1 data set. The key objective of factor analysis is to

reduce a large set of items or variables into a smaller set of factors that remain capable of accounting for a large portion of the total item variability. The identity of each factor resulting from the present exploratory factor analysis was determined after a review of those items that correlated highest with each respective factor. Items that correlated the highest with a given factor defined the factor as judged by what conceptually tied the items together. A successful factor analytic result in the present study was one in which a few factors explained a large portion of the total variability and the factors could be assigned a meaningful conceptual name using the assortment of items that correlated most highly with it. The present inquiry sought statistical evidence to suggest that items aligned in a predictable manner based on that which thematically tied them together conceptually.

In the context of Study 1, attainment of such success resulted in validity evidence supporting the conclusion that the scores obtained from the Study 1 scale were a valid assessment of a student's misconceptions about educational psychology due to the internal structure evidence produced. Thus, confidence exists when similar items are summed for total scores to represent the different dimensions of an individual's overall misconceptions about teaching, learning, and human motivation.

Analyses were performed using IBM SPSS Statistics Version 24. The maximum likelihood estimation procedure was used to extract the factors from the variable data. Kaiser's rule was first used to determine which factors were most eligible for interpretation because this rule requires that a given factor is capable of explaining at least the equivalent of at least one variable's variance. Further, only factors with an eigenvalue exceeding 2.0 were retained. This not unreasonable given that the objective of factor analysis is to reduce several variables into

fewer factors. Using these rules, four factors were extracted. The eigenvalues and percentage of variance explained by each of the four retained factors are displayed in Table 11.

Table 11 Research Question 1.2 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation		
Factor	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	5.941	11.882	11.882	2.069	4.137	4.137	3.891	7.782	7.782
2	4.018	8.036	19.917	4.878	9.756	13.893	3.307	6.614	14.397
3	2.725	5.451	25.368	3.238	6.475	20.368	2.902	5.803	20.200
4	2.356	4.712	30.080	2.030	4.060	24.429	2.114	4.229	24.429

Extraction Method: Maximum Likelihood

Together, these factors were capable of explaining roughly 30.1% of all the variable variances. A plot of eigenvalues for all retained and excluded factors is provided in Figure 1.

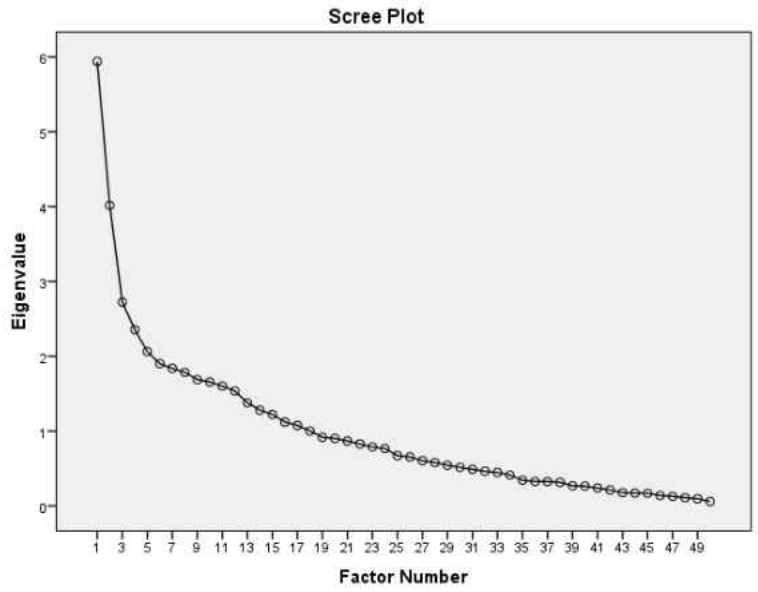


Figure 1 Research Question 1.2, Scree Plot

A review of the initial factor loadings suggest that the proper solution was attainable through maximum likelihood, as it was capable of converging in 14 iterations, and no warning about non-positive definite results was encountered. Thus, one important condition for proceeding with the interpretation was met. Additionally, the table of communalities displayed in Table 12 was evaluated to ensure no communality exceeded a value of 1.0 prior to proceeding with interpretation of the factor analytic results.

Table 12 Research Question 1.2 Communalities

#	Item	Initial	Extraction
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	.615	.395
2	Students who multitask accomplish more in less time.	.595	.139
3	Students who want to master a topic will earn the highest grades.	.458	.137
4	Students learn best when the teacher tells them exactly what they need to know.	.519	.185
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	.543	.142
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	.521	.183
7	I.Q. is fixed.	.514	.098
8	Good teaching requires aligning instruction to the multiple intelligences of students.	.745	.668
9	Non-verbal gestures from teachers can increase student academic achievement.	.608	.322
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.	.466	.203
11	Effective teaching requires the alignment of instruction to students' learning styles.	.725	.611
12	Most students are effectively able to assess the reasons for their own behavior.	.500	.249
13	Instructional materials should be designed based on a student's learning style.	.664	.428
14	A teacher's teaching expertise transfers across subjects.	.660	.570
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.	.628	.273
16	Students with the best memory get the highest grades.	.562	.110
17	Some students have true photographic memories.	.565	.032
18	Generally, students use only 10% of their brain for school work.	.386	.025
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.	.656	.596
21	Learning is optimized when teachers present materials that consider the student's intelligence type.	.678	.388
22	A teacher's teaching expertise transfers across students.	.603	.293
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.	.577	.121
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	.682	.358
25	Academic achievement increases when teachers present material in the student's preferred learning style.	.851	.885

#	Item	Initial	Extraction
26	Students who earn the highest grades have learned the most.	.471	.212
27	Teachers should group students of similar abilities together to enhance academic achievement.	.451	.161
28	If a student is interested in a topic, their interest will endure over time.	.564	.119
29	Students who take responsibility for their own learning achieve the most academically.	.551	.087
30	Students with the most interest in a topic will get the highest grades.	.502	.100
31	Interest in a topic is usually fixed over time.	.615	.281
32	The majority of intelligence tests are biased against certain people.	.524	.070
33	There is no such thing as general intelligence.	.498	.052
34	Motivation is NOT influenced by genetics.	.473	.080
35	Teachers should offer unsolicited help to students who appear to be struggling.	.552	.005
36	Most students know their own motives.	.628	.455
37	Playing classical music to infants increases their intelligence.	.597	.082
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	.529	.080
39	Procrastination is a way to enhance academic achievement.	.486	.190
40	Students will remember more of what they see than what they hear.	.544	.071
41	Student academic achievement is improved when teachers give students control over how they complete tasks.	.544	.063
42	Students preoccupied with grades have inferior learning outcomes.	.543	.070
43	Most students are effectively able to assess the source of their own motivation.	.551	.281
44	Students who are really intelligent have a good memory.	.614	.123
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	.549	.157
46	Students cannot do much about eliminating test anxiety.	.501	.200
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	.814	.656
48	Teachers should defer to the students to decide how they want to learn.	.589	.269
49	Learning is optimized when teachers present material in students' preferred learning styles.	.717	.356
50	Generally, students have similar levels of academic motivation.	.602	.190

Communalities are interpreted similar to multiple R^2 in multiple regression, such that they indicate the degree to which the factors explain the variance of the variables. In a proper solution, two sets of communalities are provided, including the initial and extracted sets. The extraction communality exceeded 1.0 for item 20, presenting a theoretical impossibility so the item was removed from the analysis.

The maximum likelihood solution was further indicated as proper, therefore final interpretation of the results was permissible. Once the factors were extracted using maximum

likelihood, a linear transformation of the data was necessary to more easily accomplish interpretation of the results. Among the various rotational procedures available, Promax was selected due to its assumption that nonzero correlations among the factors were theoretically tenable or at least plausible. The factor correlation matrix was then interpreted, as displayed in Table 13.

Table 13 Research Question 1.2 Factor Correlation Matrix

Factor	1	2	3	4
1	1.000	.132	.155	.445
2	.132	1.000	.172	.003
3	.155	.172	1.000	.288
4	.445	.003	.288	1.000

Extraction Method: Maximum Likelihood
Rotation Method: Promax with Kaiser Normalization

Due to the non-substantial correlations among the factors (several ≤ .30), the oblique Promax rotation was deemed inappropriate and the analysis was subsequently performed using the orthogonal Varimax rotation procedure. The orthogonally rotated factor matrix was considered and is displayed in Table 14. A review of the rotated factor matrix suggested that the four factors grouped the items in a theoretically understandable manner.

Table 14 Research Question 1.2 Rotated Factor Matrix

#	Item	Factor 1	2	3	4
1	Academic achievement is improved when instruction is customized for left- and right-brained learners.	**.928**			.150
2	Students who multitask accomplish more in less time.	**.779**	-.144		.148
3	Students who want to master a topic will earn the highest grades.	**.521**	.170	.101	.214
4	Students learn best when the teacher tells them exactly what they need to know.	**.458**			.404
5	A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).	**.402**		.115	
6	The student who is aware of his/her intelligence style knows the best way for them to learn.	**.395**	.178	-.218	.295
7	I.Q. is fixed.	**.386**		.339	
8	Good teaching requires aligning instruction to the multiple intelligences of students.	**.248**			
9	Non-verbal gestures from teachers can increase student academic achievement.	.221	**.603**	-.114	
10	Students who are able to multi-task are more intelligent than those who cannot multi-task.		**.477**	.201	
11	Effective teaching requires the alignment of instruction to students' learning styles.	.114	**.468**	.220	
12	Most students are effectively able to assess the reasons for their own behavior.	.315	**.411**	-.150	
13	Instructional materials should be designed based on a student's learning style.	-.108	**.410**		
14	A teacher's teaching expertise transfers across subjects.		**.387**	.178	.157
15	Students that learn through lectures consistently perform better than those that construct knowledge on their own.		**.378**	.227	
16	Students with the best memory get the highest grades.		**.372**		.124
17	Some students have true photographic memories.	.154	**.370**	.205	
18	Generally, students use only 10% of their brain for school work.		**.338**		.144
19	Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.	-.100	**.319**	.270	
21	Learning is optimized when teachers present materials that consider the student's intelligence type.		**.315**	.289	
22	A teacher's teaching expertise transfers across students.		**.313**		
23	Years of teaching experience almost always has a positive influence on teaching effectiveness.		**.308**	.134	
24	Teachers should defer to the students to decide in which learning style they prefer to learn.	.148	**.299**		
25	Academic achievement increases when teachers present material in the student's preferred learning style.		**.296**	.268	
26	Students who earn the highest grades have learned the most.		**.284**	.164	
27	Teachers should group students of similar abilities together to enhance academic achievement.		**.271**	.237	
28	If a student is interested in a topic, their interest will endure over time.	.249	**.268**		
29	Students who take responsibility for their own learning achieve the most academically.	.194	**.261**	.126	
30	Students with the most interest in a topic will get the highest grades.	.141	**.231**		-.106

#	Item	Factor 1	2	3	4
31	Interest in a topic is usually fixed over time.		**.229**	.130	
32	The majority of intelligence tests are biased against certain people.		**.222**		-.114
33	There is no such thing as general intelligence.	-.163	**.176**	.146	
34	Motivation is NOT influenced by genetics.	-.114	**.167**		
35	Teachers should offer unsolicited help to students who appear to be struggling.		**.150**		
36	Most students know their own motives.	.102	.146	**.651**	
37	Playing classical music to infants increases their intelligence.		-.120	**.598**	.147
38	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	.180	.111	**.524**	.194
39	Procrastination is a way to enhance academic achievement.	.398	-.134	**.515**	.359
40	Students will remember more of what they see than what they hear.		.141	**.468**	
41	Student academic achievement is improved when teachers give students control over how they complete tasks.		.240	**.462**	
42	Students preoccupied with grades have inferior learning outcomes.			**.265**	-.146
43	Most students are effectively able to assess the source of their own motivation.			**.253**	
44	Students who are really intelligent have a good memory.			**.234**	-.137
45	A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.		.110	**.230**	
46	Students cannot do much about eliminating test anxiety.			**.149**	
47	Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.				
48	Teachers should defer to the students to decide how they want to learn.	.276			**.770**
49	Learning is optimized when teachers present material in students' preferred learning styles.	.242	.177		**.718**
50	Generally, students have similar levels of academic motivation.		-.124	.283	**.700**

Extraction Method: Maximum Likelihood
Rotation Method: Varimax with Kaiser Normalization (rotation converged in 9 iterations)

For the first factor, the coefficients suggested that responses were very similar among items related to learning styles, multiple intelligences, gesturing, and autonomy in relation to academic achievement. For the second factor, the coefficients suggested the way participants responded to the items was very similar for student strategy focused items related to interest, constructivism, multitasking, procrastination, test anxiety, goal orientation, and extrinsic rewards. For the third factor, the coefficients suggested the way participants responded to the items was very similar for student motivation related items. For the fourth and final factor, the

coefficients suggested the way participants responded to the items was very similar for items related to heritability of motivation and intelligence. For example, if a participant was prone to endorsing a misconception related to an academic achievement focused item about learning styles, they were also likely to endorse a misconception related to an academic achievement focused item about multiple intelligences. The names for the four resulting factors were as follows: (a) Factor 1 - Teaching and Academic Achievement, (b) Factor 2 – Student Strategies, (c) Factor 3 – Student Motivation, and (d) Factor 4 - Heritability.

Study 2

Descriptive Statistics

Prior to performing inferential analyses on the Study 2 data, the descriptive statistics were examined. Participation by condition is displayed in Table 15.

Table 15 Participation by Condition, Study 2

		Order		
		True/False Scale First	**Likert-type Scale First**	**Total**
Valence	**Positive**	*Condition 1* 14	*Condition 2* 22	36
	Mixed	*Condition 3* 17	*Condition 4* 20	37
	Total	31	42	73

A sample of pre-service teachers enrolled in Internship I or Internship II coursework were asked to indicate their level of agreement using a six-point, Likert-type scale with each of 15 items in the electronic survey. On a separate survey page, they were also asked to indicate whether they believed each of the same 15 items to be true or false. The mean and standard deviation for each true/false item was examined and is displayed in Table 16.

Table 16 Research Question 2.1 Descriptive Statistics for True/False Response Format

#	Item	*n*	Mean	S.D.
1	Student academic achievement is improved when teachers give students control over how they complete tasks.	73	.08	.277
2	Some students have true photographic memories.	73	.11	.315
3	Generally, students use only 10% of their brain.	73	.67	.473
4	Effective teaching requires the alignment of instruction to students' learning styles.	73	.05	.229
5	Good teaching requires aligning instruction to the multiple intelligences of students.	73	.04	.200
6	A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).	73	.38	.490
7	Student motivation is [not] influenced by their genetics.	73	.22	.417
8	Differentiated instruction tailored to a student's intelligence type [does not enhance] enhances student academic achievement.	73	.05	.229
9	Teachers should [not] offer unsolicited help to students who appear to be struggling.	73	.15	.360
10	Playing classical music to infants [does not increase] increases their intelligence.	73	.32	.468
11	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	73	.34	.478
12	Academic achievement [does not increase] increases when teachers present material in the student's preferred learning style.	73	.05	.229
13	Academic achievement is [not] enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	73	.01	.117
14	Academic achievement is [not] improved when instruction is customized for left- and right-brained learners.	73	.26	.442
15	Students preoccupied with grades [do not] have inferior learning outcomes.	73	.45	.501

Misconceptions are indicated by lower scores.

For each Likert-type item, the mean and standard deviation were also examined and are displayed in Table 17. The six-point, Likert-type scale responses were dichotomized in order to perform this analysis such that any form of agreement (0, 1, or 2) was recoded to "misconception" (0), and any form of disagreement (3, 4, or 5) was recoded to "no misconception" (1).

Table 17 Research Question 2.1 Descriptive Statistics for Likert-type Response Format

#	Item	*n*	Six-Point		Dichotomized	
			Mean	S.D.	Mean	S.D.
1	Student academic achievement is improved when teachers give students control over how they complete tasks.	73	.86	.871	.05	.229
2	Some students have true photographic memories.	73	1.42	1.235	.11	.315
3	Generally, students use only 10% of their brain.	73	3.25	1.507	.63	.486
4	Effective teaching requires the alignment of instruction to students' learning styles.	73	.62	.860	.04	.200
5	Good teaching requires aligning instruction to the multiple intelligences of students.	73	.68	1.039	.04	.200
6	A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).	73	2.40	1.470	.38	.490
7	Student motivation is [not] influenced by their genetics.	73	1.82	1.427	.30	.462
8	Differentiated instruction tailored to a student's intelligence type [does not enhance] enhances student academic achievement.	73	.70	1.023	.10	.296
9	Teachers should [not] offer unsolicited help to students who appear to be struggling.	73	1.04	1.184	.11	.315
10	Playing classical music to infants [does not increase] increases their intelligence.	73	2.12	1.312	.25	.434
11	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	73	1.79	1.443	.29	.456
12	Academic achievement [does not increase] increases when teachers present material in the student's preferred learning style.	73	.75	1.038	.07	.254
13	Academic achievement is [not] enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	73	.58	.865	.04	.200
14	Academic achievement is [not] improved when instruction is customized for left- and right-brained learners.	73	1.70	1.266	.22	.417
15	Students preoccupied with grades [do not] have inferior learning outcomes.	73	2.25	1.199	.42	.498

Misconceptions are indicated by lower scores for both the six-point and dichotomized scales.

Additionally, the percentage of respondents endorsing a misconception is displayed for each item and by scale in Table 18.

Table 18 Research Question 2.1 Comparison of Misconception Endorsement

		True/False		Likert-type	
Item #	**Item**	**Misconception (%)**	**No Misconception (%)**	**Misconception (%)**	**No Misconception (%)**
1	Student academic achievement is improved when teachers give students control over how they complete tasks.	91.8%	8.2%	94.5%	5.5%
2	Some students have true photographic memories.	89.0%	11.0%	89.0%	11.0%
3	*Generally, students use only 10% of their brain.*	32.9%	67.1%	37.0%	63.0%
4	Effective teaching requires the alignment of instruction to students' learning styles.	94.5%	5.5%	95.9%	4.1%
5	Good teaching requires aligning instruction to the multiple intelligences of students.	95.9%	4.1%	95.9%	4.1%
6	A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).	61.6%	38.4%	61.6%	38.4%
7	*Student motivation is [not] influenced by their genetics.*	78.1%	21.9%	69.9%	30.1%
8	Differentiated instruction tailored to a student's intelligence type [does not enhance]	94.5%	5.5%	90.4%	9.6%

Item #	Item	True/False		Likert-type	
		Misconception (%)	No Misconception (%)	Misconception (%)	No Misconception (%)
	enhances student academic achievement.				
9	*Teachers should [not] offer unsolicited help to students who appear to be struggling.*	84.9%	15.1%	89.0%	11.0%
10	Playing classical music to infants [does not increase] increases their intelligence.	68.5%	31.5%	75.3%	24.7%
11	Students will be more motivated to complete an easy task than one they perceive to be more difficult.	65.8%	34.2%	71.2%	28.8%
12	Academic achievement [does not increase] increases when teachers present material in the student's preferred learning style.	94.5%	5.5%	93.2%	6.8%
13	Academic achievement is [not] enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	98.6%	1.4%	95.9%	4.1%
14	*Academic achievement is [not] improved when instruction is customized for left-*	74.0%	26.0%	78.1%	21.9%

Item #	Item	True/False		Likert-type	
		Misconception (%)	No Misconception (%)	Misconception (%)	No Misconception (%)
	and right-brained learners.				
15	*Students preoccupied with grades [do not] have inferior learning outcomes.*	54.8%	45.2%	57.5%	42.5%

As was the case in Study 1, misconception endorsement again varied widely, however in Study 2 this variance also existed between scales. For seven (Items 1, 4, 5, 6, 8, 12, and 13) of the 15 items, over 90% of participants endorsed the misconception on at least one of the two scales. These seven items included misconceptions related to student autonomy, accommodation of learning styles and multiple intelligences in the classroom, and extrinsic rewards. Of those seven items, only two (Items 1 and 4) were endorsed by over 90% of participants on both the true/false and the Likert-type scale, including the items related to student autonomy and the effectiveness of teaching aligned to student learning styles, both of which were positively-valenced in all four experimental conditions.

For five (Items 3, 7, 9, 14, and 15) of the 15 items, a majority of participants did not endorse the misconception on at least one of the two scales. These five items included misconceptions related to brain capacity, genetics and student motivation, learned helplessness, hemisphericity of the brain, and performance-oriented learning. Of those five items, only Item 3 was not endorsed by the majority of participants on both the true/false and the Likert-type scale. Item 3 was related to brain capacity and was also positively-valenced in all four experimental conditions. A component of this experimental design was presentation order (true/false first or

Likert-type first), which functioned as a counter-balancing measure because all participants completed both the true/false and Likert-type scales. Random assignment took presentation order into consideration and analyses were conducted to ensure order effects did not occur. An examination of item-level logistic regression analyses (displayed in Tables 19 and 20) revealed no statistically significant order effects, thus additional analyses to determine the influence of response format and valence were performed without including the order variable.

Table 19 Summary of Logistic Regressions (True/False)

		B	S.E.	Wald	df	*p*	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Item 1	**Order**	1.400	1.123	1.554	1	.212	4.054	.449	36.601
Item 2	**Order**	.232	.772	.090	1	.764	1.261	.278	5.728
Item 3	**Order**	-.049	.505	.009	1	.923	.952	.354	2.561
Item 4	**Order**	-.322	1.029	.098	1	.755	.725	.096	5.451
Item 5	**Order**	.405	1.248	.105	1	.745	1.500	.130	17.325
Item 6	**Order**	-.026	.487	.003	1	.957	.974	.375	2.530
Item 7	**Order**	-.716	.573	1.561	1	.211	.489	.159	1.502
Item 8	**Order**	18.952	7218.871	.000	1	.998	.000		
Item 9	**Order**	.300	.677	.196	1	.658	1.350	.358	5.090
Item 10	**Order**	-.318	.508	.394	1	.530	.727	.269	1.967
Item 11	**Order**	-.842	.503	2.797	1	.094	.431	.161	1.156
Item 12	**Order**	.836	1.180	.502	1	.479	2.308	.228	23.311
Item 13	**Order**	17.489	7218.871	.000	1	.998	.000		
Item 14	**Order**	-.557	.538	1.075	1	.300	.573	.200	1.643
Item 15	**Order**	.230	.477	.232	1	.630	1.259	.494	3.209

Table 20 Summary of Logistic Regressions (Dichotomized Likert-type)

	B	S.E.	Wald	df	*p*	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Item 1	.836	1.180	.502	1	.479	2.308	.228	23.311
Item 2	.232	.772	.090	1	.764	1.261	.278	5.728
Item 3	-.356	.496	.515	1	.473	.700	.265	1.853
Item 4	.405	1.248	.105	1	.745	1.500	.130	17.325
Item 5	-1.039	1.249	.693	1	.405	.354	.031	4.086
Item 6	-.981	.496	3.913	1	.058	.375	.142	.991
Item 7	-.438	.514	.727	1	.394	.645	.236	1.766

Item 8	-.018	.803	.000	1	.982	.982	.203	4.744
Item 9	.882	.854	1.068	1	.301	2.417	.453	12.881
Item 10	-.405	.546	.552	1	.458	.667	.229	1.943
Item 11	-.565	.522	1.174	1	.279	.568	.204	1.580
Item 12	.109	.945	.013	1	.908	1.115	.175	7.112
Item 13	18.638	7218.871	.000	1	.998	.000		
Item 14	.264	.581	.206	1	.650	1.302	.417	4.069
Item 15	.503	.486	1.068	1	.301	1.653	.637	4.286

Research Question 2.1: What is the effect of response format (true/false or Likert-type) upon the responses to the Study 2 scale in a sample of pre-service teachers?

The purpose of the first research question was to determine whether response format (true/false or Likert-type) had an effect upon scale performance in the sample of pre-service teachers for whom misconceptions were being measured. Two approaches were employed to determine the impact of response format, including reliability analyses and a dependent *t*-test.

Reliability analyses by response format. Reliability analyses using Cronbach's alpha were performed for the both the true/false and the Likert-type scale, as exhibited in Table 21.

Table 21 Research Question 2.1 Reliability Analyses, Cronbach's α

		Valence		Order	
	Overall	**Positive**	**Mixed**	**True/False → Likert-type**	**Likert-type→ True/False**
True/False	.5824	.3049	.6730	.3274	.6465
Likert-type	.7283	.7037	.7563	.7152	.7465
Δ	*.1459*	*.3988*	*.0833*	*.3878*	*.1000*

Responses to the misconception items in the Study 2 scale were determined to be acceptably reliable for the Likert-type overall scale (α = .7283), and poor for the true/false overall scale (α = .5824). Differences in reliability between true/false and Likert-type scales also occurred between valence conditions. Reliability analyses were also performed for the both the

positively-valenced (α = .7037) and mixed-valence (α = .7563) conditions. Responses to the misconception items in the Study 2 scale were determined to be acceptably reliable for the both the positively-valenced and mixed-valence items in the Likert-type scale condition, as well as in the mixed-valence true/false scale condition (α = .6730). However, the reliability was poor for the positively-valenced true/false scale condition (α = .3049).

Comparison between response formats. Two analyses were performed to determine whether a difference existed in misconception endorsement between the true/false and six-point Likert-type response formats. Although dichotomized data can be treated as continuous, allowing for the use of a parametric procedure (dependent *t*-test) over a non-parametric procedure (McNemar's test), both analyses were performed to determine whether response format had an effect upon scale performance in a within-subjects analysis between the true/false and six-point, Likert-type scale conditions. Performing both analyses resulted in a corroboration of findings between the two procedures. Results of the dependent *t* test are displayed in Table 22; results of the McNemar's test are displayed in Table 23.

Table 22 Research Question 2.1 Dependent *t* Test Statistics

					95% CI				
Item	**Scale**	**Mean**	**N**	**SD**	**Lower**	**Upper**	***t***	**df**	***p***
1	**True/False**	.08	73	.277	-.027	.082	1.000	72	.321
	Likert-type	.05	73	.229					
2	**True/False**	.11	73	.315	-.067	.067	.000	72	1.000
	Likert-type	.11	73	.315					
3	**True/False**	.67	73	.473	-.006	.088	1.757	72	.083
	Likert-type	.63	73	.486					
4	**True/False**	.04	73	.200	-.039	.039	.000	72	1.000
	Likert-type	.04	73	.200					
5	**True/False**	.04	73	.200	-.055	.055	.000	72	1.000
	Likert-type	.04	73	.200					
6	**True/False**	.38	73	.490	-.095	.095	.000	72	1.000

	Likert-type	.38	73	.490					
7	**True/False**	.22	73	.417	-.167	.003	-1.933	72	.057
	Likert-type	.30	73	.462					
8	**True/False**	.05	73	.229	-.102	.020	-1.349	72	.182
	Likert-type	.10	73	.296					
9	**True/False**	.15	73	.360	-.006	.088	1.757	72	.083
	Likert-type	.11	73	.315					
10	**True/False**	.32	73	.468	-.002	.139	1.925	72	.058
	Likert-type	.25	73	.434					
11	**True/False**	.34	73	.478	*.001*	*.108*	*2.043*	*72*	*.045*
	Likert-type	.29	73	.456					
12	**True/False**	.05	73	.229	-.075	.048	-.445	72	.658
	Likert-type	.07	73	.254					
13	**True/False**	.01	73	.117	-.066	.011	-1.424	72	.159
	Likert-type	.04	73	.200					
14	**True/False**	.26	73	.442	-.050	.132	.903	72	.369
	Likert-type	.22	73	.417					
15	**True/False**	.45	73	.501	-.075	.130	.532	72	.596
	Likert-type	.42	73	.498					

Within-subjects mean differences between scales occurred in one (Item 11; $t = 2.043$, df = 72, $p = .045$) of the 15 items on the dependent t test; Item 11 was a positively-valenced item in all conditions. A marginally significant difference occurred with Item 7 ($t = -1.933$, df = 72, $p = .057$,) and Item 10 ($t = 1.925$, df = 72, $p = .058$), which were negatively-valenced in the in two of the four conditions. The non-parametric McNemar's test revealed no statistically significant differences between scales on any of the fifteen items. Although the dependent t test is more powerful in detecting statistically significant differences for parametric data, the McNemar's test was the more appropriate test in this instance.

Table 23 Research Question 2.1 McNemar's Test Statistics

Item	N	*p*
1	73	.625
2	73	1.000
3	73	.250
4	73	1.000
5	73	1.000
6	73	1.000
7	73	.109
8	73	.375
9	73	.250
10	73	.125
11	73	.125
12	73	1.000
13	73	.500
14	73	.549
15	73	.791

Research Question 2.2: What is the effect of valence (exclusively positively-valenced or mixed-valence) upon the performance of the Study 2 scale in a sample of pre-service teachers?

The purpose of the second research question was to determine whether valence (exclusively positively-valenced or mixed-valence) had an effect upon scale performance in the sample of pre-service teachers for whom misconceptions were being measured. To determine this, three approaches were employed to determine the impact of response format, including reliability analyses, generalizability or "G" theory, and a logistic regression analysis. Logistic regression analyses were performed to examine the degree to which valence biased item-level responses for both the true/false and Likert-type response formats.

Reliability analyses of valence. As discussed in Research Question 2.1 and displayed in Table 20, the reliability analyses were illustrative of the difference in reliability between the true/false and Likert-type scales and demonstrated that valence was a less significant concern in

terms of scale-level reliability. Nevertheless, even for the Likert-type scale the mixed-valence condition was more reliable than the positively-valenced condition ($\Delta = .0833$). This finding suggests that a heterogeneous mix of positively- and negatively-valenced items presented with a Likert-type response format are best for measuring misconceptions about educational psychology among pre-service teachers.

Logistic regression analyses of valence. A logistic regression analysis was performed for each of the 15 true/false items and each of the 15 Likert-type items to determine whether valence was a statistically significant predictor of misconception endorsement at the item-level. The purpose of this analysis was to examine on an item-by-item basis whether valence influenced the participants' endorsement of a misconception using a dichotomized dependent variable. This allowed the performance of a logistic regression with a dichotomous outcome, permitting relative comparisons to be made with the true/false scale condition for which the outcome was inherently dichotomous.

Of the 30 separate analyses, valence was a statistically significant predictor for misconception endorsement on Items 9 and 15 in the true/false scale condition (displayed in Table 24).

Table 24 Research Question 2.2 Summary of Logistic Regressions (True/False)

		B	S.E.	Wald	df	*p*	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Item 1	**Valence**	.030	.852	.001	1	.972	1.030	.194	5.476
Item 2	**Valence**	-.542	.771	.493	1	.483	.582	.128	2.638
Item 3	**Valence**	-.290	.500	.336	1	.562	.749	.281	1.993
Item 4	**Valence**	-1.128	1.180	.914	1	.339	.324	.032	3.268
Item 5	**Valence**	-.693	1.248	.309	1	.579	.500	.043	5.770
Item 6	**Valence**	.044	.481	.009	1	.926	1.045	.407	2.686
Item 7	**Valence**	-.964	.601	2.572	1	.109	.381	.117	1.239
Item 8	**Valence**	.029	1.029	.001	1	.978	1.029	.137	7.729
Item 9	**Valence**	*2.628*	*1.080*	*5.922*	*1*	*.015*	*13.846*	*1.668*	*114.964*
Item 10	**Valence**	-.342	.507	.456	1	.499	.710	.263	1.918
Item 11	**Valence**	.408	.496	.677	1	.411	1.504	.569	3.978
Item 12	**Valence**	.029	1.029	.001	1	.978	1.029	.137	7.729
Item 13	**Valence**	-17.619	6698.828	.000	1	.998	.000		
Item 14	**Valence**	.762	.549	1.929	1	.165	2.143	.731	6.283
Item 15	**Valence**	*1.312*	*.496*	*6.992*	*1*	*.008*	*3.714*	*1.404*	*9.824*

Valence was also a statistically significant predictor of misconceptions endorsement on Items 9 and 15 in the Likert-type scale condition (displayed in Table 25).

Table 25 Research Question 2.2 Summary of Logistic Regressions (Likert-type)

		B	S.E.	Wald	df	*p*	Exp(B)	95% C.I. for Exp(B) Lower	Upper
Item 1	**Valence**	1.186	1.180	1.010	1	.315	3.273	.324	33.035
Item 2	**Valence**	-1.191	.853	1.948	1	.163	.304	.057	1.619
Item 3	**Valence**	-.161	.485	.110	1	.740	.851	.329	2.203
Item 4	**Valence**	-18.775	6698.828	.000	1	.998	.000		
Item 5	**Valence**	-.693	1.248	.309	1	.579	.500	.043	5.770
Item 6	**Valence**	-.188	.482	.151	1	.697	.829	.322	2.133
Item 7	**Valence**	*-1.338*	*.557*	*5.768*	*1*	*.016*	*.263*	*.088*	*.782*
Item 8	**Valence**	.348	.802	.188	1	.664	1.417	.294	6.829
Item 9	**Valence**	*2.162*	*1.098*	*3.879*	*1*	*.049*	*8.690*	*1.011*	*74.719*
Item 10	**Valence**	-.561	.554	1.027	1	.311	.571	.193	1.689
Item 11	**Valence**	.172	.518	.111	1	.739	1.188	.431	3.277
Item 12	**Valence**	-1.445	1.144	1.596	1	.207	.236	.025	2.219
Item 13	**Valence**	-18.775	6698.828	.000	1	.998	.000		
Item 14	**Valence**	.687	.581	1.398	1	.237	1.987	.637	6.204
Item 15	**Valence**	*1.083*	*.492*	*4.852*	*1*	*.028*	*2.955*	*1.127*	*7.747*

Item 7, Likert-type scale. Overall, the binary logistic model specified fit the data well (χ^2_{model} = 6.299, df = 1, p = .012), with the explanatory variable accounting for roughly 11.7% (Nagelkerke R^2) of the differences between the positively-valenced and mixed-valence conditions considered in this analysis. A review of the variables inserted into the equation revealed that valence was statistically significant (p = .016) in its explanation of misconception endorsement. According to these results, a pre-service teachers were between 22% and 91% less likely to believe that student motivation is influenced by their genetics when the item was presented with a negative valence. While the model overall is statistically significant, the classification table indicates its capacity to predict misconception endorsement is just 19.9% better than chance (50%). The classification table for this analysis is displayed in Table 26, and the full logistic regression equation table is displayed in Table 27.

Table 26 Research Question 2.2 Classification Table, Likert-type Item 7

Observed	Predicted		% Correct
	Misconception	No Misconception	
Misconception	51	0	100.0
No Misconception	22	0	0
Overall %			69.9

Table 27 Research Question 2.2 Variables in the Equation, Likert-type Item 7

	B	S.E.	Wald	df	*P*	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Valence	-1.338	.557	5.768	1	.016	.263	.088	.782
Constant	-.272	.332	.672	1	.413	.762		

Item 9, Likert-type scale. Overall, the binary logistic model specified fit the data well (χ^2_{model} = 5.804, df = 1, p = .016), with the explanatory variables accounting for roughly 15.3% (Nagelkerke R^2) of the differences between the positively-valenced and mixed-valence conditions considered in this analysis. A review of the variables inserted into the equation revealed that valence was marginally statistically significant (p = .049) in its explanation of misconception endorsement. According to these results, pre-service teachers were between 1.01 and 74.72 times more likely to believe that teachers should offer unsolicited help to students who appear to be struggling when presented as a negatively-valenced item. In this case, respondents were more likely to endorse the misconception when it was presented on a mixed-valence scale. While the model overall is statistically significant, the classification table indicates its capacity to predict misconception endorsement is 39.0% better than chance (50%). The classification table for this analysis is displayed in Table 28, and the full logistic regression equation table is displayed in Table 29.

Table 28 Research Question 2.2 Classification Table, Likert-type Item 9

Observed	Predicted		% Correct
	Misconception	No Misconception	
Misconception	65	0	100.0
No Misconception	8	0	0
Overall %			89.0

Table 29 Research Question 2.2 Variables in the Equation, Likert-type Item 9

	B	S.E.	Wald	df	*P*	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Valence	2.162	1.098	3.879	1	.049	8.690	1.011	74.719
Constant	-3.584	1.014	12.495	1	.000	.028		

Item 15, Likert-type scale. Overall, the binary logistic model specified fit the data well (χ^2_{model} = 5.041, df = 1, p = .025), with the explanatory variables accounting for roughly 9.0% (Nagelkerke R^2) of the differences between the positively-valenced and mixed-valence conditions considered in this analysis. A review of the variables inserted into the equation revealed that valence was statistically significant (p = .028) in its explanation of misconception endorsement. According to these results, pre-service teachers were between 1.13 and 7.75 times as likely to believe that students preoccupied with grades have inferior learning outcomes when the item was presented with a negative valence. Again, respondents were more likely to endorse the misconception when it was presented on a mixed-valence scale. While the model overall is statistically significant, the classification table indicates its capacity to predict misconception endorsement is just 13.0% better than chance (50%). The classification table for this analysis is displayed in Table 30, and the full logistic regression equation table is displayed in Table 31.

Table 30 Research Question 2.2 Classification Table, Likert-type Item 15

	Predicted		% Correct
Observed	**Misconception**	**No Misconception**	
Misconception	26	16	61.9
No Misconception	11	20	64.5
Overall %			63.0

Table 31 Research Question 2.2 Variables in the Equation, Likert-type Item 15

	B	S.E.	Wald	df	*P*	Exp(B)	95% C.I. for Exp(B)	
							Lower	**Upper**
Valence	1.083	.492	4.852	1	.028	2.955	1.127	7.747
Constant	-.860	.360	5.720	1	.017	.423		

Item 9, true/false scale. Overall, the binary logistic model specified fit the data well (χ^2_{model} = 10.154, df = 1, p = .001), with the explanatory variables accounting for roughly 22.7% (Nagelkerke R^2) of the differences between the positively-valenced and mixed-valence conditions considered in this analysis. A review of the variables inserted into the equation revealed that valence was statistically significant (p = .015) in its explanation of misconception endorsement. According to these results, pre-service teachers were between 1.67 and 114.96 times more likely to believe that teachers should offer unsolicited help to students who appear to be struggling when presented as a negatively-valenced item. In this case, respondents were more likely to endorse the misconception when it was presented on a mixed-valence scale. While the model overall is statistically significant, the classification table indicates its capacity to predict misconception endorsement is 34.9% better than chance (50%). The classification table for this analysis is displayed in Table 32, and the full logistic regression equation table is displayed in Table 33.

Table 32 Research Question 2.2 Classification Table, True/False Item 9

Observed	Predicted		% Correct
	Misconception	No Misconception	
Misconception	62	0	100.0
No Misconception	11	0	0
Overall %			84.9

Table 33 Research Question 2.2 Variables in the Equation, True/False Item 9

	B	S.E.	Wald	df	*P*	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Valence	2.628	1.080	5.922	1	.015	13.846	1.668	114.964
Constant	-3.584	1.014	12.495	1	.000	.028		

Item 15, true/false scale. Overall, the binary logistic model specified fit the data well (χ^2_{model} = 7.380, df = 1, p = .007), with the explanatory variables accounting for roughly 12.9% (Nagelkerke R^2) of the differences between the positively-valenced and mixed-valence conditions considered in this analysis. A review of the variables inserted into the equation revealed that valence was statistically significant (p = .008) in its explanation of misconception endorsement. According to these results, pre-service teachers were between 1.40 and 9.82 times as likely to believe that students preoccupied with grades have inferior learning outcomes when the item was presented with a negative valence. Again, respondents were more likely to endorse the misconception when it was presented on a mixed-valence scale. While the model overall is statistically significant, the classification table indicates its capacity to predict misconception endorsement is just 15.8% better than chance (50%). The classification table for this analysis is displayed in Table 34, and the full logistic regression equation table is displayed in Table 35.

Table 34 Research Question 2.2 Classification Table, True/False Item 15

Observed	Predicted		% Correct
	Misconception	No Misconception	
Misconception	26	14	65.0
No Misconception	11	22	66.7
Overall %			65.8

Table 35 Research Question 2.2 Variables in the Equation, True/False Item 15

	B	S.E.	Wald	df	*P*	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Valence	1.312	.496	6.992	1	.008	3.714	1.404	9.824
Constant	-.860	.360	5.720	1	.017	.423		

Due to the statistically significant influence of valence upon misconception endorsement for Items 9 and 15 across both the true/false and Likert-type scales, these items were identified as potentially problematic as a result of some unintentionally negatively-valenced wording in each item even within the positively-valenced condition. Therefore, reliability analyses were repeated for each scale while excluding Items 9 and 15 to determine whether the inclusion of these two unintentionally negatively-valenced items artificially decreased the reliability of the positively-valenced scale. Valence was manipulated for half the items by employing the inverse of verbs in the positively-valenced items. For example, "does" was converted to "does not," "increase" was converted to "does not increase," and "should" was converted to "should not" to manipulate valence. Items 9 and 15 included other negative language that could have been interpreted as such by respondents. The inclusion of the words 'unsolicited' and 'struggling' in Item 9 (*teachers should offer unsolicited help to students who appear to be struggling*) and the word 'inferior' in Item 15 (*students preoccupied with grades [do not] have inferior learning outcomes*) could have unintentionally imparted negative valence within these two items.

As displayed in Table 36, although the positively-valenced Likert-type scale reliability increased slightly (Δ = +.0134) as a result of removing these two items, the positively-valenced true/false scale reliability actually decreased substantially (Δ = -.1874) upon removal of the two items. Reliability for all other scales increased with the removal of these items (overall Likert-type α = .7477; overall true/false α = .5830; mixed-valence Likert-type α = .7758; mixed-valence true/false α = .6888).

Table 36 Research Question 2.1 Revised Reliability Analyses, Cronbach's α

	Overall	Positive (All Items)	Mixed (All Items)	Overall	Valence Positive (#s 1-8, 10-14)	Mixed (#s 1-8, 10-14)
True/False	.5824	.3049	.6730	.5830	.1175	.6888
Likert-type	.7283	.7037	.7563	.7477	.7171	.7758
Δ	*.1459*	*.3988*	*.0833*	*.1647*	*.5996*	*.0870*

Generalizability ("G") theory. To address the second research question, a generalizability ("G") study was performed to determine the generalizability and quality of scores on the Likert-type scale. Conducting a g study allowed the researcher to determine the extent to which the sample Likert-type scale to measure misconceptions was representative of a universe of similar misconception measurements. Generalizability coefficients were used to examine the effects that people, items, and valence had on responses. As displayed in Table 37, the G coefficient changed minimally when comparing various models that accounted for valence, age, gender, race, internship level, and major.

Table 37 Research Question 2.2 Generalizability ("G") Study, Variance Components

	Persons	Item	Error	G Coefficient	Δ
Null	.19044	.63532	1.25548	.69468	
Valence	.19429	.63532	1.25548	.69841	+.0037
Age, Valence	.18815	.63532	1.25548	.69211	-.0063
Gender, Valence	.16246	.63532	1.25548	.65998	-.0322
Race, Valence	.16238	.63532	1.25548	.65987	-.0001
Internship Level, Valence	.20180	.63532	1.25548	.70683	+.0470
Major, Valence	.17941	.63532	1.25548	.68188	-.0165

For these models, the g coefficients ranged from .65987 (accounting for race) to .70683 (accounting for internship level), indicating that slight bias was present based upon age (G = .69211), gender (G = .65998), race (G = .65987), and major (G = .68188) although the scale results were generally robust to the demographic features of participants. However, valence did not appear to be a significant contributor to the overall consistency of the scale (G = .69841), compared with the null model (G = .69468).

Additionally, the G study was further used to project the number of additional items necessary to render the scale more reliable. A projected G coefficient was calculated for item quantities ranging from five to 65, and as expected, the larger the number of scale items, the larger the g coefficient. Results from this G study analysis are displayed in Table 38.

Table 38 Research Question 2.2 Generalizability ("G") Study, Items

# of Items	G coefficient
5	.43623
6	.48146
7	.51998
8	.55318
9	.58208
10	.60746
11	.62994
12	.64999
13	.66797
14	.68419
15	.69891
20	.75580
25	.79461
30	.82278
35	.84415
40	.86092
45	.87443
50	.88555
55	.89486
60	.90277
65	.90958

CHAPTER 5: DISCUSSION AND CONCLUSION

The overall goal of this research was to develop and validate a scale that effectively and efficiently measure misconceptions about educational psychology among pre-service teachers. To effectuate that goal, two data sets were examined. The goal of Study 1 was to develop and refine the scale and determine the underlying factor structure. Study 2 systematically tested the performance of the refined scale under deliberate, randomly assigned conditions to validate the scale and determine the most efficient method by which to measure misconceptions about educational psychology within this population.

This research contributes to both the educational psychology and measurement literature. The contribution of this work to the field of educational psychology includes the identification of a gap in the extant literature regarding the absence of a scale to measure the existence of misconceptions about educational psychology among pre-service teachers. In response to this gap, Studies 1 and 2 addressed the development and validation of the final Study 2 scale, an important contribution to the field of educational psychology. Additionally, Study 2 contributes to the measurement literature by establishing both the quality of the proposed scale and providing empirical evidence to justify the use of heterogeneously-valenced items in scale development, a result contrary to existing work in the field (DiStefano & Motl, 2006; Kam, 2016b; Kam & Meyer, 2015; Quilty, Oakman, & Risko, 2009). This finding is remarkable because evidence in the current study undermined the assertion that negatively-valenced items result in decreased scale reliability (Roszkowski & Soven, 2010).

General Conclusions

Study 1

Research Question 1.1: Do the scores produced by the Study 1 scale demonstrate adequate reliability in a sample of undergraduate students enrolled in teacher education coursework?

Study 1 contributes to the existing literature in two ways: (a) by identifying the gap in the educational psychology literature regarding the absence of a scale to measure misconceptions about teaching, learning, and human motivation among pre-service teachers, and (b) by producing an exploratory reliability and validity study of the pilot scale, informing the development of the Study 2 scale items. The Study 1 findings suggested the existence of several misconceptions about educational psychology among the sample of undergraduate, pre-service teachers. Additionally, Study 1 produced evidence to support the content and construct validity of the 50 proposed items and established the high reliability of the proposed scale ($\alpha = .827$). Although some items (7, 18, 20, 33, 34, 35, and 41) failed to contribute to the overall reliability of the Study 1 scale, some were retained in Study 2 due to their substantive relevance to effective teaching. However, in spite of this finding, the retained items were meticulously rewritten and evaluated prior to their inclusion in the Study 2 scale to ensure clarity.

Research Question 1.2: What is the underlying factor structure of the Study 1 scale in a sample of undergraduate students enrolled in teacher education coursework?

Initial validation of the proposed scale to measure misconceptions of educational psychology among pre-service teachers was also performed by conducting exploratory factor analysis on the initial data set collected in Study 1. The goal of this endeavor was to explore the underlying factor structure associated with the items included in the Study 1 scale. The results of this analysis indicated that a few factors were able to explain a large proportion of the total variability and the four underlying factors were successfully assigned a meaningful conceptual theme. The findings related to this analysis indicated the items that loaded on each factor aligned in a predictable manner based on a consistent conceptual theme across the items.

The successful convergence of the exploratory factor analytic model supported that the instrument used in Study 1 was a valid assessment of pre-service teachers' misconceptions about educational psychology. The four resulting factors explained approximately 30.1% of all the variable variances. The first factor, *teaching and academic achievement*, suggested that participants responded similarly to items related to academic achievement, learning styles, multiple intelligences, gesturing, and autonomy. The second factor was related to *student strategies* relevant to interest, constructivism, multitasking, procrastination, test anxiety, goal orientation, and extrinsic rewards. Factor three was dominated by items related to student motivation, while the fourth factor comprised items related to heritability.

Study 2

Research Question 2.1: What is the effect of response format (true/false or Likert-type) upon the responses to the Study 2 scale in a sample of pre-service teachers?

The extant work addressing psychological misconceptions has often been criticized as new scales are developed for measuring misconceptions in any field. These criticisms included the response format (e.g., dichotomous vs. Likert-type vs. forced choice), out-of-date items negated by recent scientific findings, test items addressing topics outside the scope of a given curriculum (such as introduction to psychology), ambiguously worded items, and the vulnerability of a dichotomized true/false testing format to acquiescence and guessing (Griggs & Ransdell, 1987; Hughes, Lyddy, & Kaplan, 2013; Ruble, 1986; Taylor & Kowalski, 2012). The Study 1 scale was carefully crafted and iteratively refined over a three-year period with each of these methodological criticisms considered and addressed as the scale was developed. Insights gained from the 50-item Study 1 scale informed the development of the final, 15-item Study 2 scale. Items incorporated into the Study 2 scale were based on two criteria: (a) egregious and/or apparent misconceptions revealed during Study 1, and (b) misconceptions deemed to critically interfere with the provision of effective teaching.

Response format was systematically investigated within Study 2 to determine whether scale performance was superior for true/false or Likert-type response formats when measuring misconceptions. Consistent with existing work in this area (Hughes et al., 2013a; Taylor & Kowalski, 2012), Study 2 provided evidence at the scale-level indicating the true/false scale less reliably detected misconceptions compared with the granular six-point, Likert-type format. As displayed in Table 20, reliability analyses indicated weaker reliability for the overall true/false

scale compared with the Likert-type scale in every instance. Reliability estimates were most disparate in the positively-valenced condition (Δ = .3988), with the least disparity occurring in the mixed-valence condition (Δ = .0833), a remarkable finding in regard to the investigation of valence, suggesting that item format had less influence on reliability when the instrument includes both positively and negatively-valenced items than when it uses only positively-valenced items.

Response format was further evaluated at the item-level using a dependent *t* test to determine whether proportions of misconception endorsement differed between item formats for each item. Within-subjects proportions were significantly different only for Item 11 and marginally so for Item 7, although both exhibited medium effect sizes. At the item-level, this finding indicates the true/false response format and the Likert-type response format performed comparably for the remainder of the items (1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15), as participants' endorsement of each misconception on one scale did not differ significantly from their endorsement of the same misconception on the other scale. The similarity in responses across response formats exhibited in the current study contradicts the findings of prior work in which estimates of misconceptions were inflated (Bensley et al., 2014; Taylor & Kowalski, 2012) or remained undetected (McCutcheon, 1991) when measured with a true/false scale. In Study 2, both scales employed identical statements to which participants were required to indicate their belief about the statement as true or false or their level of agreement using the Likert-type response format. Therefore, this finding may indicate the use of well-constructed, non-ambiguous items throughout the proposed scale providing evidence to support the validity of the scale for future use in measuring misconceptions about educational psychology among pre-

service teachers. However, the item-level analyses should be interpreted with caution due to the small sample size and the scale-level finding of low reliability for the true/false response format.

Research Question 2.2: What is the effect of valence (exclusively positively-valenced or mixed-valence) upon the performance of the Study 2 scale in a sample of pre-service teachers?

Participants' tendency to agree or disagree with a given survey item regardless of its actual content is a well-established problem in both educational and psychological research (Kam, 2016a). The item keying, wording, or valence effect describes logically inconsistent responses to positively- versus negatively-worded items by means other than the item's objective content (Kam, 2016a; 2016b). The valence effect was systematically investigated within Study 2 to determine whether scale performance was superior for exclusively positively-valenced versus mixed-valence formats comprised of heterogeneous items when measuring misconceptions. Extant work on the valence effect indicates that positively- and negatively-valenced items typically load on separate factors during factor analysis, resulting in trait and method factors (DiStefano & Motl, 2006; Kam, 2016b; Kam, 2017; Kam & Meyer, 2015; Marsh, 1996; Peabody, 1967; Quilty, Oakman, & Risko, 2009). This typically necessitates the use of multitrait-multimethod confirmatory factor analysis (MTMM CFA) to recover the factor structure and account for the trait and method components of both positively- and negatively-valenced items (Kam, 2016b). Typically, responses to scales with only positively-valenced items exhibit higher reliability than scales that include negatively-valenced items, indicating additional random error and less effective measurement (Furr, 2011; Kam, 2012; Roszkowski & Soven, 2010).

Contrary to the existing literature indicating that negatively-valenced items reduce the reliability and increase the error associated with a given scale, the current study revealed *increased* reliability for both scales in which mixed-valence items were incorporated, therefore eliminating the need for MTMM analysis. Although the true/false scale in all conditions performed weakly compared with the Likert-type scale in measuring misconceptions, the reliability difference between the positive- and mixed-valence true/false scales was substantial (Δ = .3681), favoring mixed-valence scales with heterogeneous items. As displayed in Table 20, reliability analyses indicated remarkably weaker reliability for the positively-valenced true/false scale (α = .3049) compared with the mixed-valence true/false scale (α = .6730), and marginally weaker reliability (Δ = .0526) for the positively-valenced Likert-type scale (α = .7037) compared with the mixed-valence Likert-type scale (α = .7563). As was the case for the overall scale reliabilities, the Likert-type scale was again revealed as preferable to the true/false scale across valence conditions and indicating the heterogeneous mix of positively- and negatively-valenced items produced a more reliable and less error-prone measurement of misconceptions than the scale delivered to participants with a set of homogeneous positive items.

This finding contributes to the measurement literature by undermining existing evidence supporting the discipline's preference toward scales with a homogeneous, positively-valenced set of items for increased scale reliability. Rather than catch careless respondents as anticipated (Zhang & Savalei, 2016), it appeared the negatively-valenced items in Study 2 received the same depth of deliberate consideration and contemplation as the positively-valenced items, rendering the mixed-valence scale more useful in detecting misconceptions than initially anticipated. It should be noted, however, that the data set used in Study 2 was comprised only of those

participants who completed both the true/false and Likert-type scales in their entirety. Thus, it is worth considering that the individuals evaluated in Study 2 may have already been inherently more motivated to respond to each item thoughtfully compared with those individuals who failed to complete one or both scales. Regardless, the preference toward heterogeneous items is a contribution to the measurement literature, providing insight and information for future researchers studying the valence effect.

Logistic regressions for each item also revealed that valence had little effect on all but three of the Likert-type items (Items 7, 9, and 15). For these three items, valence accounted for 11.7%, 15.3%, and 9.0% of the variance in misconception endorsement, and each item was negatively-valenced in the mixed-valence condition. The regression analyses performed for each item on the true/false scale also indicated all but two items (Items 9 and 15) were not affected by valence. Coincidentally, valence was predictive of misconception endorsements for Items 9 and 15 on both the true/false and Likert-type scales, indicating that the items may be substantively weak and responses susceptible to the influence of positive and negative wording.

Further review of these two items and how they may have diverged from the other 13 items indicated that the influence of item wording may have extended beyond the intended experimentally controlled positive- and negative-valence wording (is/is not, does/does not, increases/decreases). For both Items 9 and 15, other negative wording existing in the remainder of the item in both the positive- and mixed-valence conditions. Item 9 included the word "unsolicited" and "struggling" in both the positive- and mixed-valence conditions, while Item 15 included the word "inferior" in both conditions. It therefore stands to reason that the inherently negative wording in the remainder of the item caused unintended valence to continue to

influence misconception endorsement for these items. This finding comports with existing work addressing the valence effect that asserts respondents will often respond differently to items with positively wording compared to those items with negative wording (Kam, 2017; Marsh, 1996; Peabody, 1967).

The revelation of these two problematic items through logistic regression suggested that although the items were not immediately identifiable as negatively-valenced they could be interpreted as such by respondents. To determine whether this was influential upon the initial reliability analyses performed on the Study 2 data set, the reliability analyses were performed again but excluded Items 9 and 15 from the analysis. It was anticipated that the removal of these two items would increase the reliability of the positively-valenced items, however the reliability decreased substantially for the positively-valenced true/false scale and increased only minimally for the positively-valenced Likert-type scale. This suggests that some unmeasured factor beyond valence was influential upon these items and if used in future research both items should be revised to ensure each item incorporates only a single valence indicator.

In addition to reliability and logistic regression analyses, a generalizability (g) study was also conducted to determine the performance and quality of scores on both the positively-valenced and mixed-valence scales. The G study produced several models accounting for valence and each of the participant-level variables including age, gender, race, internship level, and major. Minimal change in the calculated G coefficient between the null and each alternative model indicated that the Likert-type scale was consistently reliable regardless of participants' demographic characteristics. Because the true/false scales were already established as less

reliable and therefore not preferable in measuring misconceptions, the generalizability study was deemed unnecessary for these items.

The implications of this research contribute to the existing literature in both educational psychology and measurement. First, a review of the literature in several fields signaled the need for a scale to measure misconceptions of educational psychology. Next, a pilot scale with content and items validated by educational psychology subject matter experts was developed and tested among a group of pre-service teachers. Finally, a carefully crafted experiment with four randomly assigned conditions was performed to validate the final 15-item Study 2 scale. This experiment resulted in the collection of empirical evidence supporting the reliability of the proposed scale and the utility of a heterogeneous mix of positively- and negatively-valenced items in scale development. The latter finding is notable due to existing research generally encouraging use of exclusively positively-valenced items to enhance scale reliability (Roszkowski & Soven, 2010) and avoid the unintentional production of a method factor (DiStefano & Motl, 2006; Kam & Meyer, 2015; Quilty, Oakman, & Risko, 2009). These findings support prior research indicating the valence effect is not necessarily generalizable across studies and limited to particular scales (Kam, 2017). Additionally, the Study 2 findings comport with existing research establishing the strength of the Likert-type response format relative to the true/false response format (Hughes et al., 2013a; Taylor & Kowalski, 2012). Taken together, these findings contribute to both fields and provide novel insights about measuring misconceptions, scale development, and the need for this scale to improve the quality and delivery of teacher education.

Although the sample size was limited and results are not necessarily generalizable outside a population of pre-service teachers, the strength of these findings lie in the counterbalanced experimental design, limiting potential threats to internal validity. Response fidelity was carefully considered throughout the study, taking into account potential testing and order effects. Every item was randomized within- and between-individuals, and participants were randomly assigned to one of four counterbalanced conditions. These considerations amplify the credibility of these findings and support the validity and reliability of the proposed scale.

Limitations and Recommendations

The findings of the current studies are limited to a sample of undergraduate, pre-service teachers and are not necessarily generalizable in other contexts. A larger sample size may have yielded different results, and future work in this area should replicate the current study under more expansive conditions, including a larger sample size and evaluating pre-service teachers educated at a variety of institutions. Additionally, the proposed scale should be validated with a diverse sample of in-service teachers and teacher educators to determine the performance of the proposed scales with new populations. It would also be worthwhile to learn more about the existence and strength of misconceptions among educators at multiple levels of influence.

Mitigating misconceptions requires a deep understanding of the individual's values, attitudes, beliefs, and emotions relating to each misconception. While initial validation of the proposed quantitative scale is useful and provides a significant contribution to the field, additional mixed-method and/or qualitative research would yield substantial insight to facilitate conceptual change among those harboring misconceptions. Because simple instruction is

insufficient to effectuate belief change, refutational text and conceptual change protocols must be developed based upon the underlying values, attitudes, beliefs, and emotions that produce the misconception (Bensley et al., 2014; Broughton et al., 2010; Gregoire, 2003; Kowalski & Taylor, 2009; Sinatra & Broughton, 2011; Tippett, 2010). This type of information cannot be adequately inferred without qualitative data from the appropriate population of individuals. The inherent human resistance to belief change presents a substantial obstacle to mitigating misconceptions and must be overcome with plausible facts, evidence, and a convincing reason to change the belief (Chinn & Brewer, 1993; Fives & Buehl, 2012; Hynd, 2001; Lombardi et al., 2016; Sinatra et al., 2014). The development of refutational texts or lectures to overcome misconceptions about educational psychology would be facilitated by the qualitative information gathered through think-aloud protocols producing insight regarding beliefs, misunderstandings, and the origin of the misconceptions. This information could then be used to specifically refute the faulty conception. Eventually, the use of appropriate refutational texts can be used in conjunction with the proposed scale to more immediately overcome the misconceptions through simple instruction in teacher professional development sessions. As it turns out - those who can't do, teach … and they probably shouldn't be doing that either.

APPENDIX A: PILOT STUDY 1, JUNE 2014

PILOT STUDY 1 SCALE
JUNE 2014

Directions:
Each statement below represents a topic investigated by researchers. Read each statement carefully and then indicate the degree of your belief regarding the accuracy of each statement. If you completely agree with the accuracy of the statement indicate completely agree. If you completely disagree with the accuracy of the statement indicate completely disagree, or indicate the most appropriate rating based upon your belief concerning the accuracy of each statement.

Then, for each statement indicate the degree of confidence you have for each assessment you made, using the scale provided.

It is very important that you select "I don't know" as your response if you do not have any knowledge or belief about the statement.

Level of Agreement Scale:

0	**1**	**2**	**3**	**4**	**5**	**6**
I don't know or not certain	Completely disagree	Mostly Disagree	Somewhat Disagree	Somewhat Agree	Mostly Agree	Completely Agree

Level of Confidence Scale:

0	**1**	**2**	**3**	**4**	**5**	**6**
Completely Unconfident	Mostly Unconfident	Somewhat Unconfident	Neither Confident or Unconfident	Somewhat Confident	Mostly Confident	Completely Confident

Items:
1. *A belief in a higher being enhances student learning.*
2. **A teacher's lack of awareness of cultural factors may lead to reduced learning by the students.**
3. *Motivation is NOT influenced by genetics.*
4. *There is no such thing as "temporary" interest.*
5. *The most successful learners are those that minimally rely on the teacher and take responsibility for their own learning.*
6. *Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.*
7. **Motivation is influenced by heredity.**
8. *Some people have true photographic memories.*
9. *Students typically recall 10% of what they read.**
10. *A teacher's teaching expertise transfers across students and subjects.*
11. **A teacher who groups students of diverse abilities together can enhance student**

academic achievement.

12. **The memory of everything we have experienced is stored permanently in our brains, even if we cannot access all of it all of the time.**
13. *Interest is more important than anything else if you want to master a topic.*
14. *There is no such thing as optimal motivation.*
15. **The larger your brain is the higher IQ you have.**
16. **Students are usually less interested in a topic when they believe they will receive a reward.**
17. *I.Q. is fixed.*
18. **It is essential to have a strong memory in order to be considered intelligent.**
19. **Teachers should differentiate instruction to teach English language learners based on their individual learning needs.**
20. **Repeated exposure to a second language is insufficient to teach students a second language.**
21. *The majority of intelligence tests are biased against certain ethnic or racial groups.*
22. *Virtually all child prodigies "burn out" by adulthood.**
23. *Playing classical music to infants increases their intelligence.*
24. **The amount of teaching experience a teacher has is minimally influential on teaching effectiveness.**
25. *Holding immature or underperforming students back a grade can be helpful.**
26. *It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.*
27. **I.Q. scores are relatively unstable in childhood.**
28. **Half the people in this country are below average in intelligence.**
29. *Most color-blind people see the world in black and white.**
30. *A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.*
31. **Motivation toward a subject may vary according to the level of your subject knowledge.**
32. *It is uncommon for individuals to repress the memories of traumatic experiences.**
33. *People with amnesia can still recall some details of their earlier lives.**
34. *Most people with brain injury look and act disabled.**
35. *People need less sleep as they get older.**
36. **I.Q. tests are an effective method of predicting students' success in school.**
37. **Academic achievement is NOT improved when instruction is delineated between left- and right-brained learners.**
38. *Memory improves by consuming certain brain foods.*
39. *Academic achievement increases when teachers present material in the student's preferred learning style.*
40. *Negative reinforcement is a type of punishment.**
41. *Students who are nervous about taking tests cannot do much about eliminating test anxiety.*
42. *A teacher who uses non-verbal behavior effectively promotes academic achievement in second language learners.*

43. **If a student considers a task to be too easy, motivation to complete the task will decrease.**
44. *Generally, everyone is about the same when it comes to academic motivation.*
45. *Blind people have especially well-developed senses of hearing and touch.**
46. *Humans need their entire brain to function effectively.**
47. **The amount of effort dedicated toward a task can be hindered by emotions such as happiness, excitement, or enthusiasm.**
48. *Newborn babies are virtually blind and deaf.**
49. **If you think you will fail at a task, you will likely underperform others with similar abilities on the task despite your abilities.**
50. **It is possible to be interested in a specific topic one day but not the next day.**
51. *Learners rarely care about both grades and gaining expertise. It is either one or another.*
52. *There is a close link between genius and insanity.**
53. **The presentation of information in an individual's preferred learning style has minimal impact upon academic achievement.**
54. *Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
55. *Most individuals are effectively able to assess the source of their own motivation.*
56. *The human tongue's tastes can be described as a "map" of four tastes.**
57. *The best way to ensure a desired behavior will persist after training is to regularly reward the behavior during training.*
58. **People use the majority of their brain the majority of the time.**
59. *Students preoccupied with grades have inferior learning outcomes.*
60. *There is such a thing as an "addictive personality."**

*****denotes distractor item

italicized font indicates false item

bold font indicates true item

Pilot Study 1: Endorsement of Misconceptions

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
A belief in a higher being enhances student learning.	23	54.8%
A teacher's lack of awareness of cultural factors may lead to reduced learning by the students.	8	19.0%
Motivation is NOT influenced by genetics.	20	47.6%
There is no such thing as "temporary" interest.	24	57.1%
The most successful learners are those that minimally rely on the teacher and take responsibility for their own learning.	15	35.7%
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.	16	38.1%
Motivation is influenced by heredity.	1	2.4%
Some people have true photographic memories.	25	59.5%
A teacher's teaching expertise transfers across students and subjects.	37	90.2%
A teacher who groups students of diverse abilities together can enhance student academic achievement.	3	7.3%
The memory of everything we have experienced is stored permanently in our brains, even if we cannot access all of it all of the time.	3	7.3%
Interest is more important than anything else if you want to master a topic.	35	85.4%
There is no such thing as optimal motivation.	2	4.9%
The larger your brain is the higher IQ you have.	1	2.4%
Students are usually less interested in a topic when they believe they will receive a reward.	2	4.9%
I.Q. is fixed.	6	14.6%
It is essential to have a strong memory in order to be considered intelligent.	0	-
Teachers should differentiate instruction to teach English language learners based on their individual learning needs.	3	7.3%
Repeated exposure to a second language is insufficient to teach students a second language.	1	2.4%
The majority of intelligence tests are biased against certain ethnic or racial groups.	24	58.5%
Playing classical music to infants increases their	29	70.7%

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
intelligence.		
The amount of teaching experience a teacher has is minimally influential on teaching effectiveness.	3	7.3%
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	18	43.9%
I.Q. scores are relatively unstable in childhood.	3	7.3%
Half the people in this country are below average in intelligence.	4	9.8%
A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	35	85.4%
Motivation toward a subject may vary according to the level of your subject knowledge.	2	4.9%
I.Q. tests are an effective method of predicting students' success in school.	3	7.3%
Academic achievement is NOT improved when instruction is delineated between left- and right-brained learners.	10	25.0%
Memory improves by consuming certain brain foods.	37	92.5%
Academic achievement increases when teachers present material in the student's preferred learning style.	28	70.0%
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	10	25.6%
A teacher who uses non-verbal behavior effectively promotes academic achievement in second language learners.	28	71.8%
If a student considers a task to be too easy, motivation to complete the task will decrease.	1	2.6%
Generally, everyone is about the same when it comes to academic motivation.	24	61.5%
The amount of effort dedicated toward a task can be hindered by emotions such as happiness, excitement, or enthusiasm.	1	2.5%
If you think you will fail at a task, you will likely underperform others with similar abilities on the task despite your abilities.	4	10.3%
It is possible to be interested in a specific topic one day but not the next day.	28	71.8%
Learners rarely care about both grades and gaining expertise. It is either one or another.	24	61.5%

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (*%*)
The presentation of information in an individual's preferred learning style has minimal impact upon academic achievement.	31	79.5%
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	23	58.9%
Most individuals are effectively able to assess the source of their own motivation.	22	56.4%
The best way to ensure a desired behavior will persist after training is to regularly reward the behavior during training.	31	79.4%
People use the majority of their brain the majority of the time.	23	58.9%
Students preoccupied with grades have inferior learning outcomes.	27	69.2%

For *italicized* items – agreement indicates a misconception.
For **bolded** items – disagreement indicates a misconception.

Pilot Study 1: Reliability Analysis

Cronbach's α	N of items
.865	45

Pilot Study 1: Item-Total Statistics

Item	Cronbach's α if Item Deleted
A belief in a higher being enhances student learning.	.867
A teacher's lack of awareness of cultural factors may lead to reduced learning by the students.	.871
Motivation is NOT influenced by genetics.	.862
There is no such thing as "temporary" interest.	.861
The most successful learners are those that minimally rely on the teacher and take responsibility for their own learning.	.867
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.	.865

Item	Cronbach's α if Item Deleted
Motivation is influenced by heredity.	.860
Some people have true photographic memories.	.862
A teacher's teaching expertise transfers across students and subjects.	.866
A teacher who groups students of diverse abilities together can enhance student academic achievement.	.860
The memory of everything we have experienced is stored permanently in our brains, even if we cannot access all of it all of the time.	.857
Interest is more important than anything else if you want to master a topic.	.866
There is no such thing as optimal motivation.	.864
The larger your brain is the higher IQ you have.	.860
Students are usually less interested in a topic when they believe they will receive a reward.	.863
I.Q. is fixed.	.865
It is essential to have a strong memory in order to be considered intelligent.	.867
Teachers should differentiate instruction to teach English language learners based on their individual learning needs.	.858
Repeated exposure to a second language is insufficient to teach students a second language.	.859
The majority of intelligence tests are biased against certain ethnic or racial groups.	.864
Playing classical music to infants increases their intelligence.	.861
The amount of teaching experience a teacher has is minimally influential on teaching effectiveness.	.856
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	.868
I.Q. scores are relatively unstable in childhood.	.860
Half the people in this country are below average in intelligence.	.858
A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	.863
Motivation toward a subject may vary according to the level of your subject knowledge.	.864
I.Q. tests are an effective method of predicting students' success in school.	.859
Academic achievement is NOT improved when instruction is delineated between left- and right-brained learners.	.867
Memory improves by consuming certain brain foods.	.866
Academic achievement increases when teachers present material in the student's preferred learning style.	.856
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	.865
A teacher who uses non-verbal behavior effectively promotes academic achievement in second language learners.	.866
If a student considers a task to be too easy, motivation to complete the task	.856

Item	Cronbach's α if Item Deleted
will decrease.	
Generally, everyone is about the same when it comes to academic motivation.	.857
The amount of effort dedicated toward a task can be hindered by emotions such as happiness, excitement, or enthusiasm.	.859
If you think you will fail at a task, you will likely underperform others with similar abilities on the task despite your abilities.	.868
It is possible to be interested in a specific topic one day but not the next day.	.863
Learners rarely care about both grades and gaining expertise. It is either one or another.	.861
The presentation of information in an individual's preferred learning style has minimal impact upon academic achievement.	.865
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	.866
Most individuals are effectively able to assess the source of their own motivation.	.863
The best way to ensure a desired behavior will persist after training is to regularly reward the behavior during training.	.865
People use the majority of their brain the majority of the time.	.864
Students preoccupied with grades have inferior learning outcomes.	.858

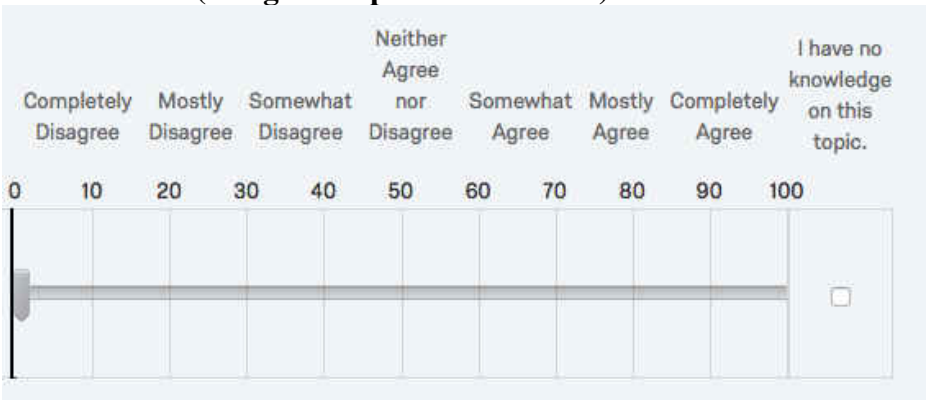
APPENDIX B: PILOT STUDY 2 SCALE, SEPTEMBER 2014

PILOT STUDY 2 SCALE
SEPTEMBER 2014

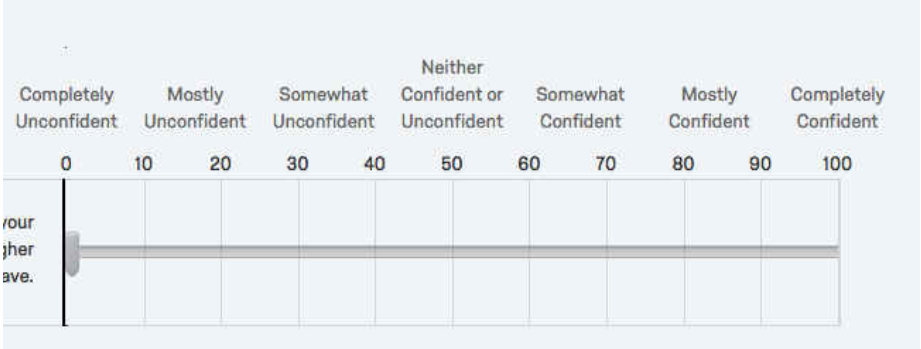
Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate the degree of your belief regarding the accuracy of each statement, on a scale of 0 to 100, where 0 indicates that you have no knowledge on the topic and a score of 100 indicates that there is nothing that could change your mind about the accuracy of the statement. The slider bar allows you to indicate the most appropriate rating based upon your belief concerning the accuracy of each statement.

It is very important that you select "I have no knowledge on this topic" as your response if you do not have any knowledge or belief about the statement. If you have knowledge about the topic but do not have particularly strong feelings one way or another about the statement, then select "neither agree or disagree."

Level of Agreement Scale (using a 100-point slider scale):



Level of Confidence Scale (using a 100-point slider scale):



Items:
1. **The larger your brain is the higher IQ you have.**
2. *Playing classical music to infants increases their intelligence.*
3. **If a student considers a task to be too easy, motivation to complete the task will**

decrease.

4. *There is no such thing as "temporary" interest.*
5. **The amount of teaching experience a teacher has is minimally influential on teaching effectiveness.**
6. There is a close link between genius and insanity.*
7. **I.Q. tests are an effective method of predicting students' success in school.**
8. **The amount of effort dedicated toward a task can be hindered by emotions such as happiness, excitement, or enthusiasm.**
9. *The most successful learners are those that minimally rely on the teacher and take responsibility for their own learning.*
10. *The majority of intelligence tests are biased against certain ethnic or racial groups.*
11. *A teacher's teaching expertise transfers across students and subjects.*
12. *Interest is more important than anything else if you want to master a topic.*
13. *Learners rarely care about both grades and gaining expertise. It is either one or another.*
14. *Academic achievement increases when teachers present material in the student's preferred learning style.*
15. Newborn babies are virtually blind and deaf.*
16. *Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
17. Negative reinforcement is a type of punishment.*
18. There is such a thing as an "addictive personality."*
19. *Some people have true photographic memories.*
20. *Students preoccupied with grades have inferior learning outcomes.*
21. **People use the majority of their brain the majority of the time.**
22. *Most individuals are effectively able to assess the source of their own motivation.*
23. Holding immature or underperforming students back a grade can be helpful.*
24. **A teacher who groups students of diverse abilities together can enhance student academic achievement.**
25. *Memory improves by consuming certain brain foods.*
26. Students typically recall 10% of what they read.*
27. **Motivation toward a subject may vary according to the level of your subject knowledge.**
28. *It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.*
29. **The memory of everything we have experienced is stored permanently in our brains, even if we cannot access all of it all of the time.**
30. **Teachers should differentiate instruction to teach English language learners based on their individual learning needs.**
31. Most color-blind people see the world in black and white.*
32. *A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.*
33. Virtually all child prodigies "burn out" by adulthood.*
34. **It is essential to have a strong memory in order to be considered intelligent.**
35. *Memory can be likened to a filing cabinet in the brain into which we deposit material and*

from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.

36. *I.Q. is fixed.*
37. It is uncommon for individuals to repress the memories of traumatic experiences.*
38. **The presentation of information in an individual's preferred learning style has minimal impact upon academic achievement.**
39. The human tongue's tastes can be described as a "map" of four tastes.*
40. *A teacher who uses non-verbal behavior effectively promotes academic achievement in second language learners.*
41. *Motivation is NOT influenced by genetics.*
42. **Repeated exposure to a second language is insufficient to teach students a second language.**
43. **Motivation is influenced by heredity.**
44. People with amnesia can still recall some details of their earlier lives.*
45. **Students are usually less interested in a topic when they believe they will receive a reward.**
46. Humans need their entire brain to function effectively.*
47. *The best way to ensure a desired behavior will persist after training is to regularly reward the behavior during training.*
48. Blind people have especially well-developed senses of hearing and touch.*
49. *A belief in a higher being enhances student learning.*
50. *Generally, everyone is about the same when it comes to academic motivation.*
51. Students who are nervous about taking tests cannot do much about eliminating test anxiety.
52. **It is possible to be interested in a specific topic one day but not the next day.**

*denotes distractor item

italicized font indicates false item

bold font indicates true item

Pilot Study 2: Reliability Analysis

Cronbach's α	N of items
.589	39

Pilot Study 2: Item-Total Statistics

Item	Cronbach's α if Item Deleted
The larger your brain is the higher IQ you have.	.589
Playing classical music to infants increases their intelligence.	.584
If a student considers a task to be too easy, motivation to complete the task will decrease.	.566
There is no such thing as "temporary" interest.	.584
The amount of teaching experience a teacher has is minimally influential on teaching effectiveness.	.617
I.Q. tests are an effective method of predicting students' success in school.	.593
The amount of effort dedicated toward a task can be hindered by emotions such as happiness, excitement, or enthusiasm.	.570
The most successful learners are those that minimally rely on the teacher and take responsibility for their own learning.	.592
The majority of intelligence tests are biased against certain ethnic or racial groups.	.610
A teacher's teaching expertise transfers across students and subjects.	.573
Interest is more important than anything else if you want to master a topic.	.569
Learners rarely care about both grades and gaining expertise. It is either one or another.	.580
Academic achievement increases when teachers present material in the student's preferred learning style.	.565
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	.575
Some people have true photographic memories.	.563
Students preoccupied with grades have inferior learning outcomes.	.585
People use the majority of their brain the majority of the time.	.590
Most individuals are effectively able to assess the source of their own motivation.	.576
A teacher who groups students of diverse abilities together can enhance student academic achievement.	.584
Memory improves by consuming certain brain foods.	.586
Motivation toward a subject may vary according to the level of your subject knowledge.	.554

Item	Cronbach's α if Item Deleted
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	.557
The memory of everything we have experienced is stored permanently in our brains, even if we cannot access all of it all of the time.	.564
Teachers should differentiate instruction to teach English language learners based on their individual learning needs.	.576
A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.	.575
It is essential to have a strong memory in order to be considered intelligent.	.592
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.	.582
I.Q. is fixed.	.581
The presentation of information in an individual's preferred learning style has minimal impact upon academic achievement.	.606
A teacher who uses non-verbal behavior effectively promotes academic achievement in second language learners.	.575
Motivation is **NOT** influenced by genetics.	.598
Repeated exposure to a second language is insufficient to teach students a second language.	.609
Motivation is influenced by heredity.	.607
Students are usually less interested in a topic when they believe they will receive a reward.	.595
The best way to ensure a desired behavior will persist after training is to regularly reward the behavior during training.	.572
A belief in a higher being enhances student learning.	.586
Generally, everyone is about the same when it comes to academic motivation.	.576
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	.561
It is possible to be interested in a specific topic one day but not the next day.	.573

APPENDIX C: PILOT STUDY 3 SCALE, NOVEMBER 2014

PILOT STUDY 3 SCALE
NOVEMBER 2014

Directions:
This statement represents a topic investigated by researchers. Read the statement carefully and then indicate the degree of your belief regarding the accuracy of the statement. Selecting "strongly agree" means that there is nothing that could change your mind about the accuracy of the statement.

It is very important that you select "I have no knowledge on this topic" as your response if you do not have any knowledge or belief about the statement. If you have knowledge about the topic but do not have particularly strong feelings one way or another about the statement, then select "neither agree nor disagree."

Level of Agreement Scale:

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
I have no knowledge on this topic.	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

Items:
1. *It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.*
2. **A teacher who groups students of similar abilities together can enhance student academic achievement.**
3. *Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
4. *Academic achievement increases when teachers present material in the student's preferred learning style.*
5. *Memory improves by consuming certain brain foods.*
6. *Generally, everyone is about the same when it comes to academic motivation.*
7. *Motivation is NOT influenced by genetics.*
8. *Most individuals are effectively able to assess the source of their own motivation.*
9. *There is no such thing as "temporary" interest.*
10. *Students who are nervous about taking tests cannot do much about eliminating test anxiety.*
11. **Motivation is NOT influenced by heredity.**
12. *Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.*
13. *Some people have true photographic memories.*

14. **IQ and brain size are unrelated.**
15. **The amount of teaching experience a teacher has is highly influential on teaching effectiveness.**

italicized font indicates false item

bold font indicates true item

Pilot Study 3: Endorsement of Misconceptions

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	61	34.9%
A teacher who groups students of similar abilities together can enhance student academic achievement.	41	23.7%
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	41	23.7%
Academic achievement increases when teachers present material in the student's preferred learning style.	72	41.6%
Memory improves by consuming certain brain foods.	97	56.1%
Generally, everyone is about the same when it comes to academic motivation.	7	4.0%
*Motivation is **NOT** influenced by genetics.*	61	35.3%
Most individuals are effectively able to assess the source of their own motivation.	74	42.8%
There is no such thing as "temporary" interest.	28	16.2%
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	19	10.9%
Motivation is NOT influenced by heredity.	53	30.6%
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.	121	69.9%
Some people have true photographic memories.	117	67.6%
IQ and brain size are unrelated.	73	42.2%
The amount of teaching experience a teacher has is highly influential on teaching effectiveness.	39	22.5%

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
For *italicized* items – agreement indicates a misconception. For **bolded** items – disagreement indicates a misconception.		

Pilot Study 3: Reliability Analysis

Cronbach's α	N of items
.631	15

Pilot Study 3: Item-Total Statistics

Item	Cronbach's α if Item Deleted
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	.618
A teacher who groups students of similar abilities together can enhance student academic achievement.	.616
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	.601
Academic achievement increases when teachers present material in the student's preferred learning style.	.573
Memory improves by consuming certain brain foods.	.624
Generally, everyone is about the same when it comes to academic motivation.	.622
Motivation is NOT influenced by genetics.	.612
Most individuals are effectively able to assess the source of their own motivation.	.618
There is no such thing as "temporary" interest.	.618
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	.624
Motivation is NOT influenced by heredity.	.602
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed.	.628
Occasionally, something gets lost and we forget.	

Item	Cronbach's α if Item Deleted
Some people have true photographic memories.	.617
IQ and brain size are unrelated.	.630
The amount of teaching experience a teacher has is highly influential on teaching effectiveness.	.612

APPENDIX D: PILOT STUDY 4 SCALE, FEBRUARY 2015

PILOT STUDY 4 SCALE
FEBRUARY 2015

Directions:
This statement represents a topic investigated by researchers. Read the statement carefully and then indicate the degree of your belief regarding the accuracy of the statement. Selecting "strongly agree" means that there is nothing that could change your mind about the accuracy of the statement.

It is very important that you select "I have no knowledge on this topic" as your response if you do not have any knowledge or belief about the statement. If you have knowledge about the topic but do not have particularly strong feelings one way or another about the statement, then select "neither agree nor disagree."

Level of Agreement Scale:

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
I have no knowledge on this topic.	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

Items (all statements are false):

1. Students focused on grades perform at a lower level than their peers who are primarily concerned with mastering the material.
2. Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.
3. Memory improves by eating certain brain foods.
4. Multitasking is an effective way to accomplish more in less time without negatively impacting the results of the tasks.
5. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
6. Students who take fully online courses learn less than those who take face-to-face courses.
7. Repeating instruction to a learner virtually guarantees they will remember content.
8. A teacher who groups students of similar abilities together can enhance student academic achievement.
9. Academic achievement increases when teachers present material in the student's preferred learning style.
10. Interest is more important than anything else if you want to master a topic.
11. It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.
12. Students who expect academic success put forth greater effort than those expecting

academic challenges.

13. Students who are nervous about taking tests cannot do much about eliminating test anxiety.
14. People have little control over their memories.
15. A great strategy to enhance academic performance is to provide a reward to students, such as extra credit or money.
16. Some people have true photographic memories.
17. People have preferred ways of thinking.
18. Motivation is NOT influenced by genetics.
19. There is no such thing as “temporary” interest.
20. Most individuals are effectively able to assess the source of their own motivation.

Pilot Study 4: Endorsement of Misconceptions

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
Students focused on grades perform at a lower level than their peers who are primarily concerned with mastering the material.	110	50.2%
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed. Occasionally, something gets lost and we forget.	158	72.1%
Memory improves by eating certain brain foods.	132	60.3%
Multitasking is an effective way to accomplish more in less time without negatively impacting the results of the tasks.	91	41.6%
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	117	53.4%
Students who take fully online courses learn less than those who take face-to-face courses.	111	50.7%
Repeating instruction to a learner virtually guarantees they will remember content.	83	37.9%
A teacher who groups students of similar abilities together can enhance student academic achievement.	114	52.1%
Academic achievement increases when teachers present material in the student's preferred learning style.	151	68.9%
Interest is more important than anything else if you want to master a topic.	154	70.3%
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	118	53.9%
Students who expect academic success put forth greater effort than those expecting academic challenges.	142	64.8%
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	49	22.4%
People have little control over their memories.	62	28.3%
A great strategy to enhance academic performance is to provide a reward to students, such as extra credit or money.	96	43.8%
Some people have true photographic memories.	149	68.0%
People have preferred ways of thinking.	161	73.5%
Motivation is NOT influenced by genetics.	95	43.4%
There is no such thing as “temporary” interest.	32	14.6%
Most individuals are effectively able to assess the source of	153	69.9%

Item	Respondents Endorsing Misconception (*n*)	Respondents Endorsing Misconception (%)
their own motivation.		

Pilot Study 4: Reliability Analysis

Cronbach's α	N of items
.666	20

Pilot Study 4: Item-Total Statistics

Item	Cronbach's α if Item Deleted
Students focused on grades perform at a lower level than their peers who are primarily concerned with mastering the material.	.672
Memory can be likened to a filing cabinet in the brain into which we deposit material and from which we can withdraw it later if needed.	.639
Occasionally, something gets lost and we forget.	.659
Memory improves by eating certain brain foods.	.654
Multitasking is an effective way to accomplish more in less time without negatively impacting the results of the tasks.	.649
Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.	.655
Students who take fully online courses learn less than those who take face-to-face courses.	.663
Repeating instruction to a learner virtually guarantees they will remember content.	.660
A teacher who groups students of similar abilities together can enhance student academic achievement.	.654
Academic achievement increases when teachers present material in the student's preferred learning style.	.649
Interest is more important than anything else if you want to master a topic.	.661
It is a good idea for a teacher to offer help to a learner when the teacher suspects the learner is struggling.	.651
Students who expect academic success put forth greater effort than those expecting academic challenges.	.659
Students who are nervous about taking tests cannot do much about eliminating test anxiety.	.651
People have little control over their memories.	

Item	Cronbach's α if Item Deleted
A great strategy to enhance academic performance is to provide a reward to students, such as extra credit or money.	.652
Some people have true photographic memories.	.652
People have preferred ways of thinking.	.640
Motivation is NOT influenced by genetics.	.651
There is no such thing as "temporary" interest.	.659
Most individuals are effectively able to assess the source of their own motivation.	.657

APPENDIX E: STUDY 1 SCALE, FEBRUARY 2016

STUDY 1 SCALE
FEBRUARY 2016

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate the degree of your belief regarding the accuracy of the statement. Selecting "strongly agree" means that there is nothing that could change your mind about the accuracy of the statement.

It is very important that you select "I have no knowledge on this topic" as your response if you do not have any knowledge or belief about the statement. If you have knowledge about the topic but do not have particularly strong feelings one way or another about the statement, then select "neither agree nor disagree."

Level of Agreement Scale:

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
I have no knowledge on this topic.	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

Items (all statements are false):
1. Academic achievement is improved when instruction is customized for left- and right-brained learners.
2. Students learn best when the teacher tells them exactly what they need to know.
3. A good way for teachers to promote academic achievement is through the use of material rewards (i.e., a treasure box, treats, etc.).
4. The student who is aware of his/her intelligence style knows the best way for them to learn.
5. I.Q. is fixed.
6. Good teaching requires aligning instruction to the multiple intelligences of students.
7. Non-verbal gestures from teachers can increase student academic achievement.
8. Students who multitask accomplish more in less time.
9. Students who want to master a topic will earn the highest grades.
10. Students who are able to multi-task are more intelligent than those who cannot multi-task.
11. Effective teaching requires the alignment of instruction to students' learning styles.
12. Most students are effectively able to assess the reasons for their own behavior.
13. A teacher's teaching expertise transfers across subjects.
14. Instructional materials should be designed based on a student's learning style.
15. Students that learn through lectures consistently perform better than those that construct knowledge on their own.
16. Students with the best memory get the highest grades.
17. Some students have true photographic memories.

18. Generally, students use only 10% of their brain for school work.
19. Differentiated instruction tailored to a student's intelligence type is useful to enhance student achievement.
20. Heredity does NOT influence motivation.
21. Learning is optimized when teachers present materials that consider the student's intelligence type
22. A teacher's teaching expertise transfers across students.
23. Years of teaching experience almost always has a positive influence on teaching effectiveness.
24. Teachers should defer to the students to decide in which learning style they prefer to learn.
25. Academic achievement increases when teachers present material in the student's preferred learning style.
26. Students who earn the highest grades have learned the most.
27. Teachers should group students of similar abilities together to enhance academic achievement.
28. If a student is interested in a topic, their interest will endure over time.
29. Students who take responsibility for their own learning achieve the most academically.
30. Students with the most interest in a topic will get the highest grades.
31. Interest in a topic is usually fixed over time.
32. The majority of intelligence tests are biased against certain people.
33. There is no such thing as general intelligence.
34. Motivation is NOT influenced by genetics.
35. Teachers should offer unsolicited help to students who appear to be struggling.
36. Most students know their own motives.
37. Playing classical music to infants increases their intelligence.
38. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
39. Procrastination is a way to enhance academic achievement.
40. Students will remember more of what they see than what they hear.
41. Student academic achievement is improved when teachers give students control over how they complete tasks.
42. Students preoccupied with grades have inferior learning outcomes.
43. Most students are effectively able to assess the source of their own motivation.
44. Students who are really intelligent have a good memory.
45. A great strategy to enhance academic performance is to provide rewards to students like extra credit or money.
46. Students cannot do much about eliminating test anxiety.
47. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
48. Teachers should defer to the students to decide how they want to learn.
49. Learning is optimized when teachers present material in students' preferred learning styles.
50. Generally, students have similar levels of academic motivation.

APPENDIX F: STUDY 2 SCALE, JANUARY 2018

STUDY 2 SCALE – CONDITION 1

Electronic survey accessible via https://ucf.qualtrics.com/jfe/form/SV_6WFh4yF7WL0lxjf.

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate whether you believe the statement is true or false by selecting the appropriate response.

True/False Items 1 – 15 (response of "true" indicates a misconception)

Response Scale:

1	**2**
True	False

1. Student academic achievement is improved when teachers give students control over how they complete tasks.
2. Some students have true photographic memories.
3. Generally, students use only 10% of their brain.
4. Effective teaching requires the alignment of instruction to students' learning styles.
5. Good teaching requires aligning instruction to the multiple intelligences of students.
6. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
7. Student motivation is influenced by their genetics.
8. Differentiated instruction tailored to a student's intelligence type enhances student academic achievement.
9. Teachers should offer unsolicited help to students who appear to be struggling.
10. Playing classical music to infants increases their intelligence.
11. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
12. Academic achievement increases when teachers present material in the student's preferred learning style.
13. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
14. Academic achievement is improved when instruction is customized for left- and right-brained learners.
15. Students preoccupied with grades have inferior learning outcomes.

STUDY 2 SCALE – CONDITION 1
(continued)

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate your level of agreement by selecting the appropriate response.

Likert-type Items 16 – 30 (any response indicating agreement indicates a misconception)

Response Scale:

1	**2**	**3**	**4**	**5**	**6**
Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

16. Student academic achievement is improved when teachers give students control over how they complete tasks.
17. Some students have true photographic memories.
18. Generally, students use only 10% of their brain.
19. Effective teaching requires the alignment of instruction to students' learning styles.
20. Good teaching requires aligning instruction to the multiple intelligences of students.
21. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
22. Student motivation is influenced by their genetics.
23. Differentiated instruction tailored to a student's intelligence type enhances student academic achievement.
24. Teachers should offer unsolicited help to students who appear to be struggling.
25. Playing classical music to infants increases their intelligence.
26. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
27. Academic achievement increases when teachers present material in the student's preferred learning style.
28. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
29. Academic achievement is improved when instruction is customized for left- and right-brained learners.
30. Students preoccupied with grades have inferior learning outcomes.

STUDY 2 SCALE – CONDITION 2

Electronic survey accessible via https://ucf.qualtrics.com/jfe/form/SV_6WFh4yF7WL0lxjf.

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate your level of agreement with the statement by placing an × or a ✓ in the box in the first column of the box on the left. Then, indicate how certain you are about your response by placing an × or a ✓ in the first column of the box on the right.

Likert-type Items 1 – 15 (any response indicating agreement indicates a misconception)

Response Scale:

1	2	3	4	5	6
Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

1. Student academic achievement is improved when teachers give students control over how they complete tasks.
2. Some students have true photographic memories.
3. Generally, students use only 10% of their brain.
4. Effective teaching requires the alignment of instruction to students' learning styles.
5. Good teaching requires aligning instruction to the multiple intelligences of students.
6. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
7. Student motivation is influenced by their genetics.
8. Differentiated instruction tailored to a student's intelligence type enhances student academic achievement.
9. Teachers should offer unsolicited help to students who appear to be struggling.
10. Playing classical music to infants increases their intelligence.
11. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
12. Academic achievement increases when teachers present material in the student's preferred learning style.
13. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
14. Academic achievement is improved when instruction is customized for left- and right-brained learners.
15. Students preoccupied with grades have inferior learning outcomes.

STUDY 2 SCALE – CONDITION 2
(continued)

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate whether you believe the statement is true or false by selecting the appropriate response.

True/False Items 16 – 30 (response of "true" indicates a misconception)

Response Scale:

1	**2**
True	False

16. Student academic achievement is improved when teachers give students control over how they complete tasks.
17. Some students have true photographic memories.
18. Generally, students use only 10% of their brain.
19. Effective teaching requires the alignment of instruction to students' learning styles.
20. Good teaching requires aligning instruction to the multiple intelligences of students.
21. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
22. Student motivation is influenced by their genetics.
23. Differentiated instruction tailored to a student's intelligence type enhances student academic achievement.
24. Teachers should offer unsolicited help to students who appear to be struggling.
25. Playing classical music to infants increases their intelligence.
26. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
27. Academic achievement increases when teachers present material in the student's preferred learning style.
28. Academic achievement is enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.
29. Academic achievement is improved when instruction is customized for left- and right-brained learners.
30. Students preoccupied with grades have inferior learning outcomes.

STUDY 2 SCALE – CONDITION 3

Electronic survey accessible via https://ucf.qualtrics.com/jfe/form/SV_6WFh4yF7WL0lxjf.

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate whether you believe the statement is true or false by selecting the appropriate response.

True/False Items 1 – 15 (response of "true" indicates a misconception except where item is *italicized*)

Response Scale:

1	**2**
True	False

1. Student academic achievement is improved when teachers give students control over how they complete tasks.
2. Some students have true photographic memories.
3. Generally, students use only 10% of their brain.
4. Effective teaching requires the alignment of instruction to students' learning styles.
5. Good teaching requires aligning instruction to the multiple intelligences of students.
6. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
7. *Student motivation is not influenced by their genetics.*
8. *Differentiated instruction tailored to a student's intelligence type does not enhance student academic achievement.*
9. *Teachers should not offer unsolicited help to students who appear to be struggling.*
10. *Playing classical music to infants does not increase their intelligence.*
11. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
12. *Academic achievement does not increase when teachers present material in the student's preferred learning style.*
13. *Academic achievement is not enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
14. *Academic achievement is not improved when instruction is customized for left- and right-brained learners.*
15. *Students preoccupied with grades do not have inferior learning outcomes.*

STUDY 2 SCALE – CONDITION 3
(continued)

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate your level of agreement by selecting the appropriate response.

Likert-type Items 16 – 30 (any response indicating agreement indicates a misconception, except where item is *italicized*)

Response Scale:

1	**2**	**3**	**4**	**5**	**6**
Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

16. Student academic achievement is improved when teachers give students control over how they complete tasks.
17. Some students have true photographic memories.
18. Generally, students use only 10% of their brain.
19. Effective teaching requires the alignment of instruction to students' learning styles.
20. Good teaching requires aligning instruction to the multiple intelligences of students.
21. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
22. *Student motivation is not influenced by their genetics.*
23. *Differentiated instruction tailored to a student's intelligence type does not enhance student academic achievement.*
24. *Teachers should not offer unsolicited help to students who appear to be struggling.*
25. *Playing classical music to infants does not increase their intelligence.*
26. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
27. *Academic achievement does not increase when teachers present material in the student's preferred learning style.*
28. *Academic achievement is not enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
29. *Academic achievement is not improved when instruction is customized for left- and right-brained learners.*
30. *Students preoccupied with grades do not have inferior learning outcomes.*

STUDY 2 SCALE – CONDITION 4

Electronic survey accessible via https://ucf.qualtrics.com/jfe/form/SV_6WFh4yF7WL0lxjf.

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate whether you believe the statement is true or false by selecting the appropriate response.

True/False Items 1 – 15 (response of "true" indicates a misconception except where item is *italicized*)

Response Scale:

1	**2**
True	False

1. Student academic achievement is improved when teachers give students control over how they complete tasks.
2. Some students have true photographic memories.
3. Generally, students use only 10% of their brain.
4. Effective teaching requires the alignment of instruction to students' learning styles.
5. Good teaching requires aligning instruction to the multiple intelligences of students.
6. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
7. *Student motivation is not influenced by their genetics.*
8. *Differentiated instruction tailored to a student's intelligence type does not enhance student academic achievement.*
9. *Teachers should not offer unsolicited help to students who appear to be struggling.*
10. *Playing classical music to infants does not increase their intelligence.*
11. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
12. *Academic achievement does not increase when teachers present material in the student's preferred learning style.*
13. *Academic achievement is not enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
14. *Academic achievement is not improved when instruction is customized for left- and right-brained learners.*
15. *Students preoccupied with grades do not have inferior learning outcomes.*

STUDY 2 SCALE – CONDITION 4
(continued)

Directions:
Each statement represents a topic investigated by researchers. Read each statement carefully and then indicate your level of agreement by selecting the appropriate response.

Likert-type Items 16 – 30 (any response indicating agreement indicates a misconception, except where item is *italicized*)

Response Scale:

1	**2**	**3**	**4**	**5**	**6**
Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree

16. Student academic achievement is improved when teachers give students control over how they complete tasks.
17. Some students have true photographic memories.
18. Generally, students use only 10% of their brain.
19. Effective teaching requires the alignment of instruction to students' learning styles.
20. Good teaching requires aligning instruction to the multiple intelligences of students.
21. A good way for teachers to promote academic achievement is through the use of material rewards (e.g., a treasure box, treats, etc.).
22. *Student motivation is not influenced by their genetics.*
23. *Differentiated instruction tailored to a student's intelligence type does not enhance student academic achievement.*
24. *Teachers should not offer unsolicited help to students who appear to be struggling.*
25. *Playing classical music to infants does not increase their intelligence.*
26. Students will be more motivated to complete an easy task than one they perceive to be more difficult.
27. *Academic achievement does not increase when teachers present material in the student's preferred learning style.*
28. *Academic achievement is not enhanced when teachers address the multiple intelligences, such as naturalistic, musical, spatial, and intrapersonal intelligences.*
29. *Academic achievement is not improved when instruction is customized for left- and right-brained learners.*
30. *Students preoccupied with grades do not have inferior learning outcomes.*

APPENDIX G: INITIAL IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Morgan Amanda McAfee** and Co-PI: **Bobby H. Hoffman**

Date: **June 25, 2014**

Dear Researcher:

On 6/25/2014, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	The Educational Psychology Beliefs of Pre-Service Teachers
Investigator:	Morgan Amanda McAfee
IRB Number:	SBE-14-10376
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 06/25/2014 01:05:19 PM EDT

IRB Coordinator

APPENDIX H: REVISED IRB APPROVAL LETTER 1

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Morgan Amanda McAfee** and Co-PIs: **Bobby H. Hoffman, Lihua Xu**

Date: **February 24, 2016**

Dear Researcher:

On 02/24/2016, the IRB approved the following minor modifications to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Bobby Hoffman and Lihua Xu are Co-Investigators and Lindsey Jackson has been added to the study as a Sub-Investigator. A qualitative data collection phase is being added to the study and 10 participants will be enrolled. New and revised documents include: protocol, recruitment e-mails, qualitative data collection protocol, and quan / qual instruments. Revised consent documents have been approved for use.
Project Title:	The Educational Psychology Beliefs of Pre-Service Teachers
Investigator:	Morgan Amanda McAfee
IRB Number:	SBE-14-10376
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/24/2016 11:00:42 AM EST

IRB Manager

APPENDIX I: REVISED IRB APPROVAL LETTER 2

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Morgan Amanda McAfee**

Date: **October 10, 2017**

Dear Researcher:

On 10/10/2017, the IRB approved the following activity as minor modifications to human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Modification Type:	Removing Bobby Hoffman, Lihua Xu, & Lindsey Jackson. Adding Stephen Sivo as a Faculty Advisor. Revised Protocol was uploaded in iRIS and both revised EOR were approved for use.
Project Title:	The Educational Psychology Beliefs of Pre-Service Teachers
Investigator:	Morgan Amanda McAfee
IRB Number:	SBE-14-10376
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Kamille Chap

Signature applied by Kamille Chaparro on 10/10/2017 10:26:38 AM EDT

IRB Coordinator

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