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Measuring the Creativity of Architecture Students

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MEASURING THE CREATIVITY OF ARCHITECTURE STUDENTS

BY

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OF

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Abstract

Creativity research is an underdeveloped area of educational psychology, particularly in higher education. For example, few studies have examined the validity of product creativity assessment at this level. Research examining creativity and the combination of cognitive, personality, and motivational aptitudes in higher education is lacking. This study explored the creativity of freshmen students' final projects in a studio architecture class. The study used a systems theoretical framework supporting the idea that creativity occurs within an interaction of the environment and the individual. The study used correlation and regression to examine the relationship between creativity and individual aptitudes which can be supported by education within the architecture domain. To support the use of pedagogy in creativity intervention, factor analysis revealed the strong validity and reliability of a creativity assessment, namely the Consensual Assessment Technique. The most important individual aptitude for creativity was intrinsic motivation. This research further examined the impact of instructor grading, social dimensions of intrinsic motivation and implications for supporting creativity in higher education.

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Finally, since creativity requires inspiration, I would like to acknowledge my promoters on this long journey: my dear confidante and cousin, Dr. Joanne Marien, and Robin and Ian, my family. I often felt I could not have taken a single step without your patience and support.

Dedication

For my mother and father, as always, the wind beneath my wings.

~ con la pazienza, arrivano le rose...

TABLE OF CONTENTS

Chapter 3

List of Figures

List of Tables

Chapter 1

Introduction

Whereas some understanding about creativity and its importance in education exists, many obstacles remain. For example, while individual aptitudes have been explored as academic outcome predictors (Alloway & Alloway, 2010; Noftle & Robins, 2007), their relationship to creativity lays at the fringes of academic research (Plucker, Beghetto, & Dow, 2004). These individual aptitudes are important because they are defined as phenotypical attributes which are influenced not only by genetic but by environmental influences, including education. Many argue that the current emphasis on the standardized testing and curriculum, and rote learning has fostered an education system in which creativity is underemphasized (Kim, 2011). Although creativity is considered a higher-order cognitive skill (McWilliam & Dawson, 2008; Perkins, 1990; Sternberg, 2006 Yang, Wan, & Chiou, 2010), recent studies and creativity theorists suggest that creativity is declining among students of all ages (Kim, 2011; Plucker, 1999; Robinson, 2011). While creativity and innovation are considered among the top priorities for a 21st century workplace and economy (Florida, 2004; Florida & Goodnight, 2005; McWilliam & Dawson, 2008), many contemporary views of education deemphasize the development of creativity. Traditional classroom environments concentrate on progress measurement, accountability and standardized testing (Beghetto, 2005; Kim, 2011). The increased emphasis on standardized testing may have shifted the emphasis in schools toward drill exercises and rote learning, and away from critical, creative thinking. Citing

xi

1

the impact of such a singular emphasis, Beghetto (2005) states, "Efforts aimed at promoting student creativity are often marginalized and overshadowed by a myriad of other demands placed on teachers' instructional time (p. 254).

Need for the study

The consequences of a society in which creativity is declining may not seem dire. Creativity is often associated with negative characteristics by educators (Furman, 1998), and the general population (Plucker et al., 2004). Particularly in education, the current emphasis has been placed on standards, curriculum proficiencies, and accountability, while creativity as a learning outcome has not been emphasized, particularly in the post No Child Left Behind (NCLB) era (Robinson, 2011).

There are several ways in which the dismissal of creativity as a learning outcome puts our society at a distinct disadvantage:

First, the misconception that creativity is innate and reserved for the select few has marginalized an important educational competency that everyone can access, regardless of socioeconomic status, race, or gender (Kaufman, 2016). Rather than requiring high intelligence or elite academic discipline, creative potential seems to require exposure to a) "diversifying experiences that help weaken the constraints imposed by conventional socialization and b) challenging experiences that help strengthen a person's capacity to persevere in the face of obstacles" (Simonton, 2000, p. 153). Such requirements highlight the role that education can have in promoting creativity for all.

Second, diversity in the college admission population has been hamstrung by dominant measures of college readiness that include standardized test scores on the

Scholastic Achievement Test (SAT) or ACT (Hein, Smerdon, & Sambolt, 2013). Yet research has shown that less than 25% of the variability in college success is explained by such measures (Komarraju, Ramsey, & Rinella, 2013). Since higher education has recognized creativity as an important 21st century learning outcome (McWilliam & Dawson, 2008; Perkins, 1990; Sternberg, 2006 Yang, Wan, & Chiou, 2010), alternate measures of college readiness such as creativity tests have been explored (Kaufman & Agars, 2009). Sternberg's measures of successful intelligence (analytical, practical and creative intelligence) predicted college success more accurately than standard admissions tests, and differences by ethnicity were significantly reduced (Sternberg, 2006, 2008). A recent study by Pretz and Kaufman (2015) found that creativity test results are not stratified by the ethnic and gender differences evident in standardized tests used for college admissions. Therefore, capturing creative competency among underrepresented college populations, education and assessment in creativity is crucial and may be an "equalizer."

Finally, there has been an emphasis on the importance and promotion of STEM (Science, Technology, Engineering, and Mathematics) fields in education (DeJarnette, 2012). President Obama's administration made STEM education a priority, acknowledging that it was essential to strengthen America's role as the world's leader in scientific and technological innovation (The White House, 2009). We have made great progress in achieving the goals of preparing STEM educators and improving the numbers of engineering graduates in America (The White House, 2016). Yet to make innovators in these fields, it is essential that innovators understand both the STEM domain and how to create and innovate within it. A greater understanding of creativity in multi-domain

design areas such as media production or architecture would contribute to a better understanding of the combination of STEM's innovation and technical skills, which require creativity and technical expertise working in tandem.

To explore understanding of academic creativity in the individual student, the following sections introduce pertinent subject areas. First, the important potential and realized role of education in nurturing creativity is presented. Since creativity misconceptions have had a major impact on its sustainability in education, this section is presented next. To address two major misconceptions, that creativity is undefinable and immeasurable, the definition of creativity and assessment of creativity sections follow. Finally, the last two sections examine important unanswered questions relevant to student creativity, namely whether creativity is domain-specific, (i.e, a creative artist is unlikely to be creative in another domain such as mathematics) or as domain-generic as in the proverbial "Renaissance person". This question of domain is further examined through study of a multi-domain creator such as the architect.

Education's Role in Developing Creativity

Recent research has emphasized education's critical role in developing creativity (Fasko, 2001; Scott, Leritz, & Mumford, 2004; Sternberg, 2006). Within the field of education, creativity is considered a significant characteristic of cognitive development and has been identified as the highest cognitive process in Bloom's Revised Taxonomy (Krathwohl, 2002). Some psychologists look at the development of creativity as a higher-

level process that develops along with critical thinking (Perkins, 1990) and post-formal operations in a Piagetian framework (Wu & Chiou, 2008; Yang, Wan, & Chiou, 2010).

E.P. Torrance (1987) observed that creativity could be taught and originally designed his TTCT (Torrance Tests of Creative Thinking) as a method of individualizing instruction for teaching creativity. Studies have shown that creativity training does have a strong effect on creativity. In a quantitative analysis of 70 training techniques, Scott, Lertiz, and Mumford found that specific educational strategies were important in developing creative thinking. "Techniques that provide structures for analyzing problems in terms of relevant strategies, or heuristics, typically more structured techniques, can therefore be expected to have a relatively powerful impact on performance…Apparently, creativity training requires structured directed practice in the application of relevant techniques and principals" (2004, p. 377).

For these reasons, creativity is, and should be emphasized in higher education. For example, the Association of American Colleges and Universities (AACU) includes creative thinking as one of its core values and encourages institutions of higher education to assess creative thinking as a student learning outcome among undergraduates (Association of American Colleges and Universities, 2015). However, difficulties in teaching and assessing creativity are associated with various misconceptions about the construct.

Creativity Misconceptions

     Not Innate but Teachable. While studies have examined creativity's importance in education, misconceptions and problems with its definition have kept it outside the purview of educational research (Plucker et al., 2004). Misunderstandings about the nature of creativity, for instance that it is innate and cannot be taught or that creativity is too loosely defined a construct to be measured accurately have exacerbated the problem. Unfortunately, such misconceptions have hindered the path to a concise and empirically testable assessment of creativity.

     In the latter part of the 20th century, creativity theorists believed that creativity was not an innate ability but rather a cognitive ability that could be taught with the appropriate educational environment and methods (Guilford, 1980; Torrance, 1987; Kharkhurin, 2012). Numerous theorists have suggested myriad educational techniques and environments can develop creativity such as modeling creative behavior, questioning assumptions, defining and redefining problems, encouraging sensible risks, tolerating ambiguity and mistakes, teaching metacognition and providing frequent formative feedback (Fasko, 2001; Sternberg, 1999). One important area of inquiry is the importance of nurturing aptitudes, such as divergent thinking (McCrae, 1987; Runco, 1991) and motivation (Hennessey & Amabile, 1987), and cultivating personality factors, such as openness (Feist, 1998; McCrae, 1987), all of which are known to be correlated with creativity.

Not Definable, Not Measurable. Many psychologists have viewed creativity as a nebulous construct, lacking a concise definition (Plucker et al., 2004). Without a clear definition of creativity, it is correctly believed that assessment is challenging; the quality of an assessment depends on the validity and reliability of the assessment (Huck, 2012). Construct validity first rests on the evidence that the construct being measured is clearly defined (Fraenkel, Wallen & Hyun, 2012).

Definition of Creativity

To address ambiguity in the definition of creativity, recently creativity theorists have centered on a more distinct definition. Groundbreaking work began with Simonton's (2003) perspective that creativity must be regarded through the three unifying views of the creative person: (1) individual aptitudes that are influenced by environmental factors such as experience and education, (2), creative processes, and (3) creative products. Plucker et al. (2004, p. 90) analyzed definitions in over 90 prominent creativity research journals and determined that many articles supported the definition of creativity as "the interaction among aptitude, process and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context." The creative product is therefore viewed as an idea, conceptual model or tangible object that is both novel, useful and appropriate within the social environment.

With Simonton's (2003) assertion of creative aptitude, process, and product comes the underlying assumption that a) certain creative aptitudes and processes are necessary for creative product manifestation and b) creative product is evidence that creative aptitudes and process were present. For instance, when the architect creates a

design that is considered creative, it is likely that creative aptitudes such as divergent thinking, openness or motivation supported its creation (Runco, 2007). It is likely that s(he) used one or some of many creative processes such as remote association (Mednick, 1962) or directed creative cognition (i.e., Geneplore model) (Finke, Ward, & Smith, 1992). With evidence of a creative product, we assume that creative aptitudes and processes were used to create it. Since the mid-20th century, E.P. Torrance (1963; 1966; 1972) stressed the importance of education in nurturing aptitudes that were necessary for creativity (see also Feist, 1999; Plucker et al. 2004; Sternberg, 1999).

Perspectives on the Assessment of Creativity

Historically, creativity definitions have varied, particularly in its relationship with individual aptitudes. Creativity has been measured as a function of an individual's aptitude (i.e., potential) toward being creative, as creative process, or alternately as creative product. However, the existence of creative product is the only evidence that creative process has occurred (Plucker et al., 2004; Simonton, 2003). Moreover, the potential to be creative and the ability to exercise creative processes do not always result in creative outcome (Kaufman, 2016; Runco, 2007).

Inconsistent definitions of creativity have resulted in inconsistencies in correlations between not only individual aptitudes and creativity, but also educational creativity interventions and creativity. Understanding the relationship between aptitudes improves educational support (Sternberg & Lubart, 1991). Many creativity researchers support the idea of multiple measures of creativity, citing the shortfalls of single creativity assessments (Silvia et al., 2012). Interventions that try to improve student

creativity must have a valid measure to determine their effectiveness (Fraenkel et al., 2012).

The Domain Debate

Knowledge acquisition within the creative domain is an important component of creative production. To be creative in a domain, the creator must have sufficient knowledge of the field of study to discover a problem and make a creative contribution to the domain (Sternberg & Lubart, 1991).

The importance of knowledge within the domain touches on a great debate in creativity research: whether creativity is domain-generic or domain-specific. Advocates of domain-generic creativity claim that one who is creative possesses the aptitude to be creative in any domain. Advocates of domain-specificity suggest that underlying individual aptitudes are different from one domain to another. For example, someone creative in mathematics is unlikely to be a famous movie actor (Kaufman, 2016). It is important for education to know whether creativity can be taught similarly across domains or whether different aptitudes for creativity must be supported depending on the creativity domain.

Researchers debate whether creativity is domain-generic (i.e., creative in any or multiple disciplines) or domain-specific (Baer, 1998; Kaufman & Baer, 2005; Plucker, 1998; Sternberg et al., 2005). These researchers ask whether general creativity can be investigated or how creativity should be addressed in different domains. They posit that support for a domain-generic creativity comes from high correlations between creative

aptitudes across domains, and evidence for a domain-specific creativity is exhibited by relatively low correlations among the creative aptitudes across domains (Ivcevic, 2007).

Support for domain-generic creativity is demonstrated in evidence that all creativity is consistently correlated with openness and divergent thinking (Baer, 1993, 1994a; Dollinger, Urban, & James, 2004; Feist, 1998; Kousouas, 2010; McCrae, 1987; Runco, 1991; Silvia et al., 2008). In contrast, other researchers support domain-specificity with findings that individual aptitudes correlate with creativity differently depending on the domain of creativity explored (Baer, 2012; Feist, 1998; Ivcevic, 2007). Per Baer (2012, p. 20), "the crucial test for the generality-specificity question requires looking at the correlations of creativity ratings of products in different domains."

Architects are relevant to the domain debate in creativity. They are able to be creative in two or more domains, combining artistic and scientific creativity (MacKinnon, 1962; Simonton, 2009). Researchers have explored whether the architect's aptitudes are most like Feists's (1998) domain-specific scientific or artistic subjects or whether they represent a new combination of aptitudes. If there is domain-generic creativity, architects' aptitudes would follow the pattern of correlation with high creativity, high openness and divergent thinking. If there is a domain-specificity quality to creativity, architects aptitudes might be more correlated with those of artists, those of scientists or a hybrid of both (Feist, 1998) .

Purpose of the Study

Creativity has not been explicitly mentioned as part of the goals, objectives, or measured outcomes of K-16 education. This is largely due to the perceived difficulty in assessing it (Westby & Dawson, 1995), even though education acknowledges the importance in influencing individual aptitudes necessary for creativity (Plucker et al., 2004) and supporting creativity process development (Sternberg, 2006). With current definitions of creativity focusing on creative product (Plucker et al., 1999), assessments of creative product provide insights into creativity measurement. The Consensual Assessment Technique (CAT) has become increasingly prominent in the field of creativity research (Carson, 2006).

This research focuses on increasing understanding of specific aptitudes in multi-domain individuals such as architects. It provides additional understanding of the domain-generic/domain-specific debate within an academic setting. It also examines validation of the CAT, a creativity assessment known to have been used in several academic settings examining the effect of motivation and knowledge skills on creativity (Baer, 1994b; Baer & McKool, 2009). While CAT discriminant validity has been established (Hennessey, Amabile, & Mueller, 2011), few, if any, studies have examined its validity in an educational context.

Research Questions and Hypotheses

This dissertation examines the following research questions and corresponding hypotheses:

RQ1: Which individual aptitudes predict the higher creativity of architecture students? The hypothesis is multi-domain creative subjects' aptitudes are related either to scientific, artistic, or a new aptitude pattern variant.

RQ2: How well does the CAT measure architectural design project creativity? To determine the ability of CAT to measure creativity, two outcomes were examined,

1. Does CAT discriminate creativity from other product qualities such as technical goodness, comprehensiveness and neatness (when judged subjectively by subject matter experts)? The hypothesis is that creative product qualities will be discriminated from technical qualities by CAT.

2. Does creativity in CAT correlate with consistent aptitude predictors of creativity (divergent thinking and openness)? The hypothesis is that creativity will correlate with divergent thinking and openness.

Chapter 2

Literature Review

Creativity Defined

Myths and misconceptions about creativity have impeded the progress of creativity research. While some progress has been made, deep-seated problems with creativity understanding persisted as recently as 1999, when Sternberg and Lubart identified major roadblocks to the study of creativity, including: (1) viewing creativity as an innate phenomenon, (2) focusing only on eminent creativity, (3) elusive or trivial definitions, and (4) an overemphasis on divergent thinking and other such narrow unidisciplinary approaches. Winner (1997) provides support for the perception of creativity as an innate phenomenon with the claim that only innately talented individuals will strive to achieve creatively. Other creativity theorists have put forth the claim that creativity is only eminent creativity, or "big-C" creativity whereby importance is focused on works that will last forever (Simonton, 1994). Creative greatness may be studied by examining the lives of great creators or interviewing renowned innovators to understand their creative ability (Kaufman & Beghetto, 2009). Plucker, Beghetto and Dow (2004) examined over 90 peer reviewed creativity research journals from 1999 to 2002, finding that only 38% of the articles provided an explicit definition of creativity. Guilford (1950) focused on creativity as divergent thinking. Torrance (1966) developed his Torrance Tests of Creative Thinking (TTCT) as a measure of four dimensions of creativity viewed as divergent thinking (originality, elaboration,

resistance to closure and tolerance for ambiguity). Guilford (1950) and Torrance (1962) focused on exercises designed to enhance divergent thinking.

Recent interest in innovation and creativity have contributed toward a more positive outlook for creativity as a potential contributor in educational psychology (Plucker et al., 2004), leading to a distinct operational definition of creativity. Plucker et al. (2004) defined creativity as generating a novel and useful product through the interaction between individual aptitude, process, and environment. Historically, creativity research focused on creative aptitudes (Gough, 1979; MacKinnon, 1962) and process (Guilford, 1950; Torrance, 1966). More recently, prominent creativity journals have emphasized creative product as judged by experts (Plucker et al., 2004). Sternberg and Lubart (1999) stressed product adhering to task constraints, and Glăveanu's (2013) sociocultural perspective stressed appropriateness.

Many researchers have investigated individual aptitudes which have an influence on creativity (Amabile, 1983; Baer, 1993; Feist, 1998; Jauk, Benedek, Dunst & Neubauer, 2013; Wolfradt & Pretz, 2001). The aptitudes are defined as phenotypical attributes which are influenced not only by genetic but by environmental influences. These individual aptitudes can be expressed during a creative process whose evidence is in product creativity. This study uses the Plucker et al. (2004) definition, defining creativity as an interaction between individual aptitudes, process and environment by which a novel, useful and appropriate product provides evidence of creativity as judged by expert observers.

Theoretical Framework

Given the complexity of defining creativity, it is understandable that creativity has been viewed through several different theoretical lenses, including behaviorist, developmental, and systems theories (Starko, 2005).

Skinner (1972), a behaviorist, viewed all human actions as response to stimulus. Creative responses or actions are the result of reinforcing consequences. As creativity is rewarded, the more likely it will occur and that creative products will be formed (Starko, 2005). Mednick (1962) viewed creativity as a series of stimuli and responses, asserting that creativity resulted from connecting unrelated ideas. He found that individuals who had diverse prior experience with a stimulus were more likely to connect remote ideas about the stimulus, which in turn generated more creative thought.

Developmental theorists viewed creativity as a part of successful human development. For example, Maslow (1968) believed that self-actualization is at the highest level of his hierarchy of human needs, and could be achieved by fully functioning human beings. Further, self-actualizing creativity resulted from good mental health and the process of acquiring self-actualization. Maslow believed people would do everything creatively, if they had a high level of self-actualization.

Other theorists have supported developmental theories of creativity. For example, Vygotsky (1960) used three stages to distinguish creativity occurring during: (1) childhood, where creative imagination begins; (2) adolescence, where imagination and thought are brought together; and (3) adulthood, where mature creativity is controlled and used in a purposeful manner. Education, inner reflection, and thinking in concepts

15

influence the development of mature creativity. Vygotsky believed creativity was a consciously-developed mental function that requires adults to alter and merge ideas within specific environments to generate creative products such as art, inventions or scientific discoveries. Creativity research has also been viewed through a systems theory, which is similar to the developmental theory in that the individual and the environment influence each other.

Systems approaches suggest creativity cannot be identified in a vacuum but rather as an interaction between the environment and the person (Starko, 2005). Systems theories suggest there is interaction between cognitive, affective, motivational, and social and personal factors (Cropley, 2003). They also suggest the impact of the environment upon creative output (Starko, 2005). The environment can determine the type of novelty produced and thus is an active recipient of creative product (Cropley, 2003). Csíkszentmihályi (1996) also developed a systems model of creativity that included three aspects: the person, the domain, and the field. Thus, creativity is an interaction between product, person and environment (Starko, 2005). Csíkszentmihályi's "field" includes people who influence knowledge within a domain. With its emphasis on environment and domain experts, this theoretical framework highlights the critical role of educators in nurturing and supporting creativity.

Many educational scholars including Cropley (2003), Robinson (2011) and Sternberg (2003) acknowledge the importance of creative thinking in education. Given the complexities of knowledge and technology in the modern world (Florida, 2004), the creative imperative for education has increased in importance.

Creativity Predictors

Extensive research provides rationale for study predictors. Increasing consensus among creativity researchers suggests that creativity in the individual will be dependent on multiple aptitudes (Batey & Furnham, 2006; Runco, 2004). Evidence exists for components such as cognitive ability (Sternberg, 1997), personality factors (Feist, 1998), and motivation (Amabile, 1996).

Regarding cognitive factors, much of the research has focused on creativity's relationship with divergent thinking and intelligence. Divergent thinking has been shown to be a most consistent predictor of creativity, with supporting research in numerous studies (Baer, 1993, 1994a; Kousouas, 2010; Runco, 1991; Silvia et al., 2008). It has also been argued that a basic level of general intelligence is a necessary requirement for creativity (Silvia, 2008; Sternberg, 1997).

Feist (1998) investigated creative personality in a meta-analysis of 83 research studies, finding a consistent relationship between openness to experience and creativity, and a strong relationship between extraversion and creativity, as well. Central to two theories of creativity, including the investment theory of creativity (Sternberg & Lubart, 1999) and the intrinsic motivation principle of creativity (Amabile, 1996) is the important relationship between motivation and creativity. Other studies have supported the importance of both intrinsic motivation (Greer & Levine, 1991; Zhou, 1998) and extrinsic motivation (Shalley, 1995; Yoon, Sung, Choi and Kim, 2015) in creative production. These three factors and associated predictor aptitudes are examined in further detail in the following sections. See Figure 1 for detail of the creativity model of predictors used within this research.

Factors	Creativity Predictors
Cognitive Abilities	General intelligence (g)
	Divergent Thinking (DT)
Personality	Openness (O)
	Conscientiousness (C)
	Extraversion (E)
	Agreeableness (A)
	Neuroticism
Motivation	Intrinsic Motivation (IN)
	Extrinsic Motivation (EX)

Influences → Creativity
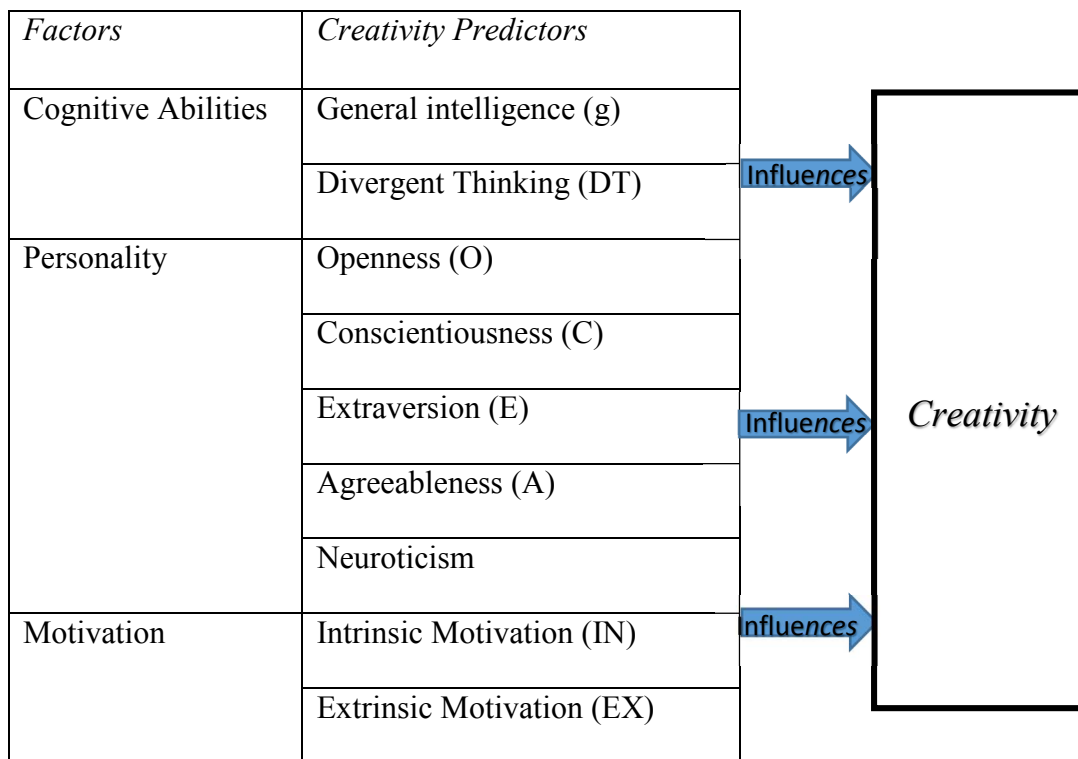
Figure 1: Creativity Model of Predictors

Cognitive Abilities. In the field of cognitive abilities, there is also an intense debate over the definition of intelligence. The Cattell-Horn-Carroll (CHC) theory of intelligence, frequently associated with psychometric measurement (Kaufman & Plucker, 2011), combines Horn and Cattell's (1966) theory of fluid (Gf) and crystallized intelligence (Gc) with Carroll's (1993) theory of a hierarchy of cognitive abilities, with general intelligence "g" at the top of the hierarchy and various broad and narrow specific abilities below it (Carroll, 1993). In a recent CHC presentation, some narrow abilities have centered on divergent thinking (DT) abilities (McGrew, 2009). Definitions for g, and DT may be found in Appendix A.

Research has shown a relationship between intelligence and creativity (Silvia, 2008; Sternberg, 1997). Early investigations (Getzels & Jackson, 1962) found very modest correlations (r = .22). Threshold theory argued that intelligence is a necessary but not sufficient condition of creativity and that creativity and intelligence are positively correlated only up until an IQ of approximately 120 (Yamamoto, 1964). Above this threshold, there is great variability in the relationship (Getzels & Jackson, 1962). Further research has contested threshold theory by showing a different creativity-intelligence relationship depending upon the type of creativity assessment used (Runco & Albert, 1986). While Jauk et al. (2013) confirmed threshold theory with an assessment of creative potential, they found a consistent positive correlation of intelligence with an assessment of creative achievement at all levels. Kim (2005) performed a meta-analysis of 21 studies using several different measures of intelligence and creativity and found a small positive correlation between creativity and all levels of intelligence.

Guilford (1950) and Hunter, Cushenbery, and Friedrich (2012) determined creativity required the ability for divergent thinking (DT). DT's importance was corroborated by other scholars using self-reporting inventories (Plucker, 1999; Runco, 2007; Torrance, 1972). Most creativity theorists believe that while DT is not a sole predictor of creativity (Kaufman, 2016), it is a strong and consistent predictor of creative potential (Runco, 2007). In a meta-analysis of 274 studies examining the relationship between divergent thinking and product creativity in the form of creative achievement, Kim (2008) found a significant correlation with a mean value of $r = +.306$. Kousoulas (2010) found a greater relationship between DT and creativity self-assessments than

between DT and product creativity. Such inconsistencies emphasize the importance of the creative measurement variant.

McCrae (1987) found that individuals who were creative in artistic careers and those who were in so-called "investigative" careers such as research scientist, anthropologists and sociologists were higher in divergent thinking.

Personality. The Five-Factor Model (FFM) of personality (McCrae & Costa, 1985) asserts that there are five factors in personality: openness, conscientiousness, extraversion, agreeableness, and neuroticism. FFM is a lexical approach to personality in which personality factors are viewed as phenotypical attributes accounted for by *both* genetic and environmental influences (Wiggins, 1996), which opens the door to pedagogical intervention. Most research on personality and creativity uses the FFM (Kaufman, 2016). Definitions for each of the five factors may be found in Appendix A. Each of the five personality factors represents a range between two extremes. For example, extraversion represents a continuum between extreme extraversion and extreme introversion. In the real world, most people lie somewhere in between the two polar ends of each factor (McCrae & Costa, 1985).

Although conflicting results are found in the relationship between creativity and personality factors**,** three consistent themes emerge. First, the correlation between creativity and openness is consistent, positive, and one of the most robust findings in the literature (Dollinger, et al., 2004; Feist, 1998; McCrae, 1987, Silvia et al., 2009). Creativity is strongly associated with being open to new experiences and ideas. Second, the relationship is influenced by whether creativity is measured as creative potential (DT

tests, Runco Ideational Scale, self-reporting), as creative process (creative metaphor production, Barron-Welsh Creativity test), or as a creative product (employer expert rating, distinguished works, creativity ratings by experts). Third, the relationship between personality and creativity is influenced by the domain in which one operates. Domains exist in diverse areas such as architecture, physics, education, mathematics, science, communications, and finance. Feist (1998) performed a meta-analysis of over 80 empirical studies examining the relationship between personality and motivation in two broad domains, art and science. He found significant differences in FFM personality characteristics among artists and scientists and while openness to experience was common among creative artists and scientists, scientists were less neurotic and more conscientious than creative artists. See Appendix B for research result details.

Motivation. Extrinsic and intrinsic motivations are defined in Appendix A. Ryan and Deci's (2000) review found task performance varied depending on motivational type. Amabile's (1983), intrinsic motivation hypothesis of creativity, stated: "the intrinsically motivated state is conducive to creativity, whereas the extrinsically motivated state is detrimental" (p. 91). Many research studies support the finding that intrinsic motivation benefits creativity, while extrinsic motivation does not (Amabile, 1985; Greer & Levine,1991). Amabile, Hill, Hennessey, and Tighe (1994) defined two intrinsic motivational sub-dimensions: enjoyment and challenge, which were included in WPI secondary scales. Ryan and Deci (2000) included interest and choice within a self-deterministic construct of intrinsic motivation. Considering goals, intrinsic motivation involves the desire to learn or understand something new (Barron & Harackiewicz, 2001; To, Fisher).

Casakin and Kreitler (2010) introduced a nuanced analysis of intrinsic and extrinsic motivation in their factor analysis study contrasting creativity in architecture and engineering design students. They learned that architecture students were intrinsically motivated through a desire to satisfy inner needs for creativity and self-development. Conversely, engineering design students felt more extrinsically motivated, outwardly innovating in response to their environment and contributing on a social level.

Little work has been done in this area of domain and motivation. Amabile (1984) examined preschool children's collages and managed intrinsic motivation by allowing some of the students a choice of art medium. Children who could choose their art medium were more creative than those who had no choice. CAT was used to evaluate students' work.

Interestingly, high extrinsic motivation in creativity is sometimes supported in empirical research. In the Shalley (1995) and Yoon, Sung, Choi, Lee and Kim (2015) studies, an extrinsic motivation in the form of an employer evaluation positively affected creativity. This positive relationship contrasted with Amabile's findings (1984, 1985).

These studies highlight the complexity of creativity research and the importance of the creativity assessment to provide insight into the nature of the creative individual. Measuring creative potential has value, but within the context of nurturing creativity in classrooms, measuring creative product to indicate whether the creative potential has been actualized is crucial.

Architects

Creativity researchers debate whether creativity is domain-generic (i.e., creative in any/multiple disciplines) or domain-specific (i.e., creative in only one discipline) (Baer, 1998; Kaufman & Baer, 2005; Plucker, 1998; Sternberg et al., 2005). These researchers ask whether we can investigate a general creativity or whether creativity should be addressed separately in different domains. They posit that support for a domain-generic creativity would come from high correlations between creative aptitudes and support for a domain-specific creativity would be exhibited by relatively low correlation among the creative aptitudes across domains (Ivcevic, 2007).

Arguments for both sides can be made. Support for domain-generic creativity is demonstrated in evidence that all creativity is consistently correlated with openness and divergent thinking (Baer, 1993, 1994a; Dollinger, et al., 2004; Feist, 1998; Kousouas, 2010; McCrae, 1987; Runco, 1991; Silvia et al., 2008). Support for domain-specificity in creativity is shown by other researchers who found that individual aptitudes correlate with creativity differently, depending on the domain of creativity explored (Baer, 2012; Feist, 1998; Ivcevic, 2007). According to Baer (2012), "the crucial test for the generality-specificity question requires looking at the correlations of creativity ratings of products in different domains."

Architects are of great interest in this debate because they are creative in two domains/multi-domains, combining artistic and scientific creativity (MacKinnon, 1962; Simonton, 2009). Researchers have studied whether the architect's aptitudes are most like Feists's (1998) domain-specific scientific or artistic subjects or a new combination of aptitudes.

Prior to 1984, studies of architects focused on personality and motivational aptitudes (Hall & MacKinnon, 1969; Dudek & Hall, 1984). While Hall & MacKinnon (1969) chose to study architects under the assumption they are "typical of the creative person", findings from their regression analysis were inconclusive and indicated a poor to no correlation between industry ratings of architects' creativity and personality or motivational aptitudes. Dudek and Hall (1984) researched motivation and personality among prominent architects and found a positive relationship between creativity and motivation. Among the five personality factors, they found creativity was negatively correlated with conscientiousness (risk-taking). Additionally, research on the cognitive aptitude of architects is lacking.

Assessment of Creativity

Several creativity assessments have been developed based on product definition. The Test for Creative Thinking-Drawing Production (Urban, 2004) showed parallel test reliability of $r = .62 - .70$ and low discriminant validity when compared with Raven's matrices ($r = .21 - .44$). Based on their Creative Product Analysis Matrix (CPAM) model using three conceptual dimensions of product creativity—(1)novelty; (2) resolution; and (3) elaboration and synthesis—Besemer and O'Quin (1986) developed the Creative Product Semantic Scale (CPSS), which uses a static rubric of conceptual dimensions with dichotomous items containing opposite adjective tags. Reliability values for CPSS are good (novelty $\alpha = .69 - .84$; resolution $\alpha = .83 - 85$; elaboration $\alpha = .81 - .86$). The CPSS dichotomous items do not change for each creative product. For example, dichotomous item measures such as "workable…. unworkable" and "operable …inoperable" are

appropriate in a new computer tablet design, yet irrelevant in a comic strip caption. Such ambiguity in item relevance may result in variability of judges' scores (Caroff & Besançon, 2008).

Amabile's Consensual Assessment Technique (CAT) (1983, 1996) for assessing product creativity is widely used (Kaufman, Plucker, & Baer, 2008), and considered the "gold standard" of creativity assessment (Carson, 2006). Applying Amabile's (1983) and Plucker, Beghetto and Dow's (2004) operational definition of creativity, product creativity is determined within a social context. CAT expert judges use subjective opinions to score comparative single product creativity. Amabile (1996, p. 73) stated the judges are people, "who have at least some formal training and expertise in the target domain." These judges mirror, albeit on a small scale, the experts in the real world who act as gatekeepers, deciding what is considered creative.

Finding experts can be challenging, but Dollinger and Shafra's (2005) study found that novice and expert judges performed scoring in a similar fashion. Newer data support using quasi-experts knowledgeable in specific domain, but who are not considered "experts" (Kaufman, Lee, Baer, & Lee, 2007; Kaufman & Baer, 2012). Kaufman (2016) termed quasi-experts as those having graduate degrees in a specific domain.

Assessing creativity and making conclusions about the assessment results are as effective as the instruments used in assessment. It is critical to examine instrument quality, validity and reliability. Construct validity is tied to the construct definition. One way to establish construct validity is to provide correlational evidence that creativity has a strong relationship with consistent predictors of creativity (Huck, 2012).

Another way to establish construct validity is to use factor analysis on scoring to examine correlations with elements of the definition. Within the same analysis, discriminant validity is established by determining lack of correlation with elements which are disparate from the definition (Huck, 2012).

Amabile (1983) performed factor analysis using the CAT to assess the creativity among girls aged 7-11. Amabile asked her judges to measure the collages on 23 different criteria dimensions, which were clustered into three areas: (1) creativity; (2) technical goodness; and (3) aesthetic appeal. Two factors were revealed: creativity and technical goodness. Her study's findings showed that the subjective judgements of creativity could be distinguished from judgements of technical goodness. Figure 2 (Factor Analysis on 23 Dimensions of Artistic Creativity Judgement) shows the dimensions and factor analysis results (factor loadings) from the study.

Amabile's (1983) factor analysis determines the instrument's strength in measuring the defined creative elements of novelty, complexity, and detail in contrast to the non-creative technical elements of neatness, planning, and technical goodness to establish discriminant validity of the CAT. Optimally three-dimension clusters would consistently load on the two factors, isolating technical goodness from creativity. Best practice in factor analysis recommends removing factors with no item loadings above .30 (Osborne & Costello, 2009); the aesthetic appeal cluster appears to contribute little to the model, with all items loading significantly less than .30.

Dimension	Factor Loading Factor 1: Creativity	Factor Loading Factor 2: Technical goodness
Creativity Cluster		
Creativity	.68	-.23
Novel use of Materials	.78	-.21
Effort Evident	.85	-.18
Variation in shapes	.72	.23
Detail	.95	-.04
Complexity	.91	.09
Novel Idea	.55	-.3
Technical Cluster		
Technical goodness	.16	.54
Organization	-.08	.67
Neatness	-.34	.51
Planning	.10	.83
Representation	.00	.95
Symmetry	-.34	.48
Expression of Meaning	-.01	.92
Aesthetic Judgement		
Liking	.22	-.04
Aesthetic Appeal	-.04	.14
Would you display it?	.22	.28

Figure 2: Factor analysis on 23 Dimensions of Artistic Creativity Judgement
(Amabile, 1983, p. 1004)

Inter-rater reliability quantifies the closeness of the scores assigned by the same

raters to the same study participants. Cronbach's α is recommended for reporting inter-

rater reliability (Amabile, 1983). Hennessey, Amabile & Mueller (2011), report that a

Cronbach's α reliability coefficient of .70 or higher can be considered evidence of an

acceptable level of agreement between judges. The higher the reliability coefficient, the

higher the reliability of the data collection method (Gwet, 2008). Regarding CAT,

"reliability is measured in terms of the degree of agreement among raters as to which

products are more creative or more technically well done" (Hennessey et al., 2011, p.

253).

Using CAT methods, it is recommended that all raters provide ratings for every

subject's product (Hennessey, Amabile & Mueller ,2011). These raters are considered a

random sample representative of the population of all possible raters. The subjects are

also a random sample representative of the population of creative products. The goal of

the inter-rater reliability is to determine how well their ratings correlate. For example, if

one rater consistently rated "high", their ratings would still be lower than usual in cases in

which all other raters gave a low rating. Cronbach's α reliability coefficient captures this

idea and measures how reliably a group of raters agree. Another measure, the intra-class

coefficient (ICC) measures both this rater agreement ("average measures") and how

reliable it would have been to use a single rater ("single measure") (Shrout & Fleiss,

1976).

Inter-rater reliability is crucial to the claim of the usefulness of the CAT in

classroom student work. If experts believe that student work cannot reliably be assessed

because of inconsistency or poorly-defined concepts, then inclusion of creativity into a

curriculum creates problems for goal-setting and accurate measurement. If creativity can

be assessed, then education and curriculum can meet the objective of successfully encouraging creativity in the classroom.

Example CAT studies are included in Appendix C. CAT is sensitive to changes in motivation (Amabile, 1996; Hennessey, Amabile, & Martinage, 1989) and increases in knowledge and creativity skills (Baer, 1994b), implying that CAT is sensitive to education instruction in creativity. Baer and McKool (2009) recommend the use of the CAT in higher education to compare the creativity of students at the course start and end.

Questions remain about pedagogy's role in creativity, the influence of individual aptitudes on creativity, and the influence of the domain on creativity production. Education is important to creativity because we understand that parents, teachers, individuals, peers, and employers can nurture aptitudes that can grow creativity (Sternberg, 2012). If creativity is to be a central outcome in education, a greater understanding of the effectiveness of our activities is required. A major goal of this study is to provide greater understanding of the validity and reliability of a measure of creativity.

Finally, the overall purpose of this study is two-fold. First, a greater understanding of aptitudes that support creativity across domains is required for educators to provide support for all students across academic disciplines. Second, if educators want to improve creativity, they must be able to measure the results of their interventions in creativity improvement accurately.

CHAPTER III

METHOD

This chapter presents the research methodology used for this study. It begins with an introduction of the research design and rationale, followed by a description of the sample, the variables of interest, the specific research procedures that were employed, data analysis and finally a section on ethical considerations. This chapter examines the methods used to answer the two research questions:

RQ1: Which individual aptitudes predict higher creativity in architecture students? The hypothesis is multi-domain creative subjects' aptitudes are related either to scientific, artistic or a new aptitude pattern variant.

RQ2: How well does CAT measure architectural design project creativity? To determine the ability of CAT to measure creativity, two outcomes were examined: (1) performing a factor analysis on the scores from the measurement; and (2) providing correlational evidence that the measurement shows a strong relationship between the dependent variable and known highly-correlated explanatory variables.

Research Design and Rationale

To address RQ1, a quantitative methodology is utilized to determine which aptitudes are correlated with creativity. A correlational research design and multiple regression is used to discover the existing relationship between the dependent variable creativity and explanatory variables, the aptitudes of the subjects (Fraenkel et al., 2012).

To address RQ2, the methodology determines the validity and reliability of the CAT in creativity measurement. To establish construct validity of a new measurement, Huck recommends that the researcher ought to perform "one or a combination of three things" (2012, p. 84). These include (1) performing a factor analysis on measurement scores; (2) providing correlational evidence that the measurement shows a strong relationship between the dependent variable and known highly correlated explanatory variables; and (3) determining that expected low and high performing groups performed logically on the measurement (Huck, 2012).

The researcher used items (1) and (2). For the first test, a factor analysis was performed on the six CAT rating dimensions provided by 7 expert judges for the 90 student creativity projects. For the second test, regression was performed to demonstrate the relationship between creativity measured by the CAT and known positively correlated predictors of creativity, namely divergent thinking and openness (Dollinger, et al., 2004; Feist, 1998; McCrae, 1987, Silvia et al., 2009).

An overview of the method of analysis and explanatory variables for the two research questions is in Table 1.

Table 1. Analysis Breakdown by Research Question

Research Question	Analysis	Variables	
		Dependent	Independent
RQ1-The hypothesis is multi-domain creative subjects' aptitudes are either related to scientific, artistic or a new aptitude pattern variant	Hierarchical/ Block-wise Regression: All Creativity = [Openness + DT] + [IM + EM] + [g] + [E + C + N + A]	All Creativity	1) Openness 2) Divergent thinking 3) intrinsic motivation 4) extrinsic motivation 5) g 6) extraversion 7) conscientiousness 8) neuroticism 9) agreeableness
RQ2 -It is expected that consistent aptitude predictors of creativity (divergent thinking and openness) will be correlated with creativity.	Bivariate Correlation: All Creativity = DT All Creativity = Openness	All Creativity	DT, Openness
RQ2-Factor analysis will reveal discriminant validity among the two major dimensions of judgment (creativity and technical strength), appearing as two distinct factors, each having eigenvalues greater than 1.0.	Factor Analysis CAT Factor loading on 2 factors: (a)Creativity & (b) Technical Goodness	Factor Analysis: (a)Creativity items: 1)CAT Novelty, 2)CAT Usefulness, 3)CAT Appropriateness and Technical Goodness items:, 4) CAT Technical Correctness, 5) CAT organization, 6) CAT neatness	

Variables of Interest

For research question 1, this study used existing research regarding aptitudes influential in creativity (see Figure 1). Multiple regression was used to clarify explanatory variables in architecture students. Nine variables were examined as explanatory variables: two cognitive aptitude measures (g, DT), five personality aptitude measures (O, C, E, A, and N) and two motivational aptitude measures (intrinsic, extrinsic). The dependent variable was the mean of the three creativity cluster ratings of freshman architecture design projects rated by quasi-expert architects using CAT.

Reflecting the definition of Plucker, Beghetto and Dow (2004), the creativity cluster consisted of a subjective judgement by raters of the (1) novelty; (2) usefulness; and (3) appropriateness of the architecture student product. Freshman architecture design project information assigned by faculty is given in Appendix D.

Research question 2 explores CAT's validity by examining the correlation between the RQ1 mean creative cluster ratings of (1) novelty; (2) usefulness; and (3) appropriateness of the architecture student product and three predictor variables (intrinsic motivation, divergent thinking and openness). Factor analysis was also performed examining the relationship between underlying factors and the six CAT items of rating (novelty, usefulness, appropriateness, technical correctness, organization, and neatness).

Sample

A convenience sample was drawn from full-time architecture students (18-25 years old) currently enrolled in a private university in the northeastern United States. Students younger than 18-years old were excluded in interest of maintaining expedited status with the University of Rhode Island Internal Review Board (IRB). The sample was primarily white (74%). The remaining 26% of students were Asian (1%), African American (2%), and Hispanic (6%), and 14% were foreign nationals. The gender ratio was approximately 42% female to 58% male. Architecture students were chosen because they are more likely to represent individuals who are creative in two domains.

Ninety-eight students were solicited for the opportunity to participate in the study. Of the ninety-eight students solicited, 90 submitted informed consent forms. With sample size = 90 for projects to be evaluated by the CAT, the subject-to-dimension variable size (10:1) was sufficient for factor analysis as required for research question 2 (Costello,

2009; Huck, 2012). Of the 90 submitted student assessments, only 78 assessments contained usable SAT scores. Of the 12 unusable scores, some students reported ACT, some omitted an entry and some put in unrealistic values.

Instruments for Explanatory Variables

This section discusses the measurement instruments used for each of the 9 explanatory variables. Reliability values for each of the instruments is discussed and tabulated in Appendix G.

General Intelligence. Combined SAT verbal (SAT-V) and quantitative SAT (SAT-Q) scores measured the general intelligence construct g. Students were asked to self-report SAT scores. Studies have shown the appropriateness of using the SAT as a test of intelligence (Brodnick & Ree, 1995; Frey & Detterman, 2004; Park, Lubinski & Benbow, 2007). Frey and Detterman (2004) showed that the SAT was correlated with measures of general intelligence at $r = .82$ (.87 when corrected for nonlinearity). The reliability of the SAT is given as .88 for SAT-V and .91 for SAT-Q (King, Huff, Ewing & Andrews, 2005). Though there is concern about the accuracy of self-reported test scores, the literature reports relatively high correlations between self-reported and actual test scores. For example, Cassady (2001) found the correlations between actual and self-reported SAT scores to be .73 for the SAT-V, .89 for the SAT-Q, and .88 for the total score.

Divergent Thinking(DT). The Alternate Uses Task (AUT) was used to measure DT. Used for over 40 years, the AUT has high internal reliability (with 3 scorers, $r = .87$ --Silvia et al., 2008) and validity, established in studies with children (Kogan, 1983;

Runco, 1991). Each participant was asked to think of as many uses as possible for two separate objects (See Appendix E). Objects used for these two tasks were a paper napkin, and strong adhesive such as electrical tape.

DT tests can be scored with different criteria involving ideational fluency, i.e. the quantity of ideas produced, and originality (i.e. ideational fluency). These scores are commonly found to be correlated to an extent that their discriminative validity has been questioned (Silvia et al., 2008). This is especially true when a summative originality scoring is employed where originality increases with the number of ideas (i.e., ideational fluency). Alternative scorings of ideational originality, (e.g., the Snyder scoring protocol), which control for fluency by considering the number of original idea categories as well as the number of ideas, no longer exhibit this problem (Snyder et al, 2004; Silvia et al., 2008).

The researcher and two trained assistants scored the tests. The Snyder scoring protocol (Snyder et al., 2004) in a was used after a 45-minute training session was provided. Scorers examined all AUT results in random order, and their ratings were compared. For input to the regression model, the six (2 tasks x 3 raters) AUT scores were averaged to one score.

Personality Aptitudes. FFM measures use self-descriptive adjective items or sentences to develop scores in each of the five dimensions (Goldberg, 1992). Measures include the 50-item International Personality Item Pool, the 60-question NEO-Five-Factor Inventory (NEO-FFI) and the 240-question NEO-Personality Inventory (NEO-PI-R) (Boyle, Matthews, & Saklofske, 2008).

This study used the shorter 44-item Big Five Inventory (BFI) developed by John, Donahue, and Kentle (1991) in response to concerns over time constraints and subject fatigue (see Appendix F). Questions are on a 5-point Likert-type scale that ranging from: (1) disagree strongly; (2) disagree a little; (3) neither agree or disagree; (4) agree a little; and (5) agree strongly. The 44 questions are grouped by 5 personality factors. Each of the personality factors is measured by several questions as follows: openness (ten questions), conscientiousness (nine questions), extraversion (eight questions), agreeableness (nine questions), and neuroticism (eight questions). Some items are reverse scored. The subject receives a value for each of the 5 personality factors ranging from 1 to 5.

Reliability values are $\alpha = .81$ for openness, $\alpha = .79$ for agreeableness, $\alpha = .82$ for conscientiousness, $\alpha = .88$ for extraversion, and $\alpha = .84$ for neuroticism (John, Donahue & Kentle, 1991). Validity evidence includes substantial convergent and divergent relation with other FFM instruments (John et al., 1991). BFI Scoring employed the John, et al. (1991) public domain document.

Motivation. The Work Preferences Inventory (WPI) survey student version (Appendix H) is a 30-question survey measuring intrinsic and extrinsic motivation. Intrinsic motivation refers to an individual's state of self-determination, competence, task involvement, curiosity, enjoyment, and interest in a task. Extrinsic motivation occurs when the individual is concerned with competition, evaluation, recognition, money or other tangible incentives, and constraint by others. The WPI is designed to assess individual differences in intrinsic and extrinsic motivational orientations (Amabile, 1994). Both versions (college student and working adult) of the WPI capture the major elements of

intrinsic motivation and extrinsic motivation. Both intrinsic and extrinsic

motivation can be present. Intrinsic motivation does not denote the lack of

extrinsic motivation or vice versa. The intrinsic motivation orientation is divided

into two secondary scales, challenge and enjoyment. The challenge scale is

related to an individual's interest in mastery and challenge in a task, while the

enjoyment scale is the interest and personal appeal of the task. The extrinsic

motivation orientation is divided into two secondary scales as well, outward and

compensation. The outward scale is related to the public approbation and

accolades expected from the task; the compensation is related to tangible reward.

The 30-question instrument is scored on primary and secondary scales of extrinsic

and intrinsic motivation. Questions are on a 4 point Likert-type scale that range from: (1)

Never or almost never true of you (N-1); (2) Sometimes true of you (S-2); (3) Often true

of you (O-3); and (4) Almost or almost always true of you (A-4). Some items are reverse

scored.

Fifteen questions each are dedicated to each of intrinsic and extrinsic motivation.

The 1-4 scores were summed and averaged for the intrinsic and extrinsic motivation

questions; thus, each subject received a score for each of the two motivation scales from

1-4. The intrinsic secondary scales (enjoyment and challenge) were scored because

research supports the importance of intrinsic motivation to creativity (Amabile, 1985;

Greer & Levine,1991). The 1-4 scores were summed and averaged for the intrinsic and

extrinsic motivation questions; thus, each subject received a score for each of the two

motivation scales from 1- 4.

The WPI has meaningful factor structures, adequate internal consistency, good short-term test-retest reliability, and good longer term stability (Amabile, 1994). Reliability values are $\alpha = .78$ to .79 for internal reliability, $\alpha = .84/.94$ (intrinsic/extrinsic) for test-retest reliability, and $\alpha = .67$ to .85 for long term stability. Rating factors were scored for intrinsic and extrinsic motivation on a 4-point Likert scale.

Consensual Assessment Technique (CAT). Freshmen design projects were assessed using the CAT. These design projects involved students creating a series of architectural design drawings for development of a pavilion and landscape on the grounds of a publicly accessible 100+ acre historic estate. The new pavilion is to be designed as a multi-purpose venue: an art gallery, event hall, contemplative space, various support spaces and an outdoor function area.

CAT shows good IRR using Cronbach's alpha and intra-class correlation methods ($\alpha=.70$ to.93) (Amabile, 1996; Baer, 1993, 1998; Baer, Kaufman, & Gentile, 2004; Baer, Kaufman, & Riggs, 2009). Creativity researchers regard correlation coefficients between .70 and.80 as strong IRR (Amabile, 1996). Strong IRR is considered evidence of construct validity when creativity is defined as an attribute evaluated by experts and when experts agree, the assessment is measuring the construct (Kaufman, Plucker & Baer, 2008). Amabile (1983) evaluated CAT discriminant validity, finding creativity wasn't confounded with technical goodness, neatness or correctness in expert's evaluation of paper collages. Runco, McCarthy, and Svenson (1994) examined concurrent validity, finding creativity self-ratings and that CAT shows moderate relationships and similar product rank. Baer found good long-term stability (1994b).

Procedure

IRB approval of this research as an expedited study was provided by the University of Rhode Island, Office of Research Integrity. Permission was granted to offer college architecture students the opportunity to participate in the study. Students were offered the opportunity to request feedback on their personality, motivation and creativity potential scores as an incentive to participate. Instructors did not receive any information regarding individual student survey responses, or whether students had participated in the research.

Data Collection. All eight classes of freshmen architecture students were scheduled to attend a studio art information session on the university campus once per week in a common auditorium-style classroom with desktops. During the first week of the research study, a short verbal script was read to the students to describe the intent of upcoming study, time commitment, consent procedure, the nature of the assessments, and confidentiality.

One week later, the freshman architecture students met in the studio art information session classroom. At the beginning of the class, two architecture professors were in the room, but departed as assessments were distributed. The researcher invited students to participate, and those who chose to participate signed informed consent forms, provided student ID numbers, and completed the study assessments. During the 40-minute assessment session, participants completed AUT/BFI/WPI assessments and recorded their SAT scores. They also recorded their student ID numbers as identifiers to retain student anonymity and to provide an identifier to match with final creative projects. Completed assessments were hand-delivered to the researcher, and all were completed

during the 40-minute period. Thereafter, the professors returned to the classroom. AUT/BFI/WPI assessments are included in Appendices E, G, and H.

Access to final projects for ARCH113 students were electronically-provided to the researcher by the studio project coordinator. The final projects were tagged by student ID number only. Projects without corresponding informed consent signatures were not downloaded in the analysis. These projects were made available electronically to the judges.

CAT Procedures. Recommended procedural requirements for CAT were met (Hennessey, Amabile, & Mueller, 2011). Judges were paid graduate students experienced in the architectural domain ("quasi-experts") with at least five years of study. The CAT judges were a diverse group of graduate students from another graduate school of architecture. Two were U.S. citizens, and five were international students, three from China and two from Latin America.

Judges were given training and instruction in a 45-minute videoconference call. Instructions given to judges were: (1) rate projects in random order; (2) rate projects on six rating dimensions with a score ranging from 1 (lowest) to 7 (highest) on each dimension; (3) rate projects independently, and (4) rate projects relative to one another instead of to an absolute standard. Clarification and definition of each of the six rating items--novelty, usefulness, appropriates, technical correctness, organization and neatness—were given. The judges were given three example projects to examine and reflect upon. Then they were given the opportunity for further questioning and group discussion. The scoring sheet is shown in Appendix I.

Data Analysis

All statistical analysis was performed using IBM's SPSS Version 24 statistical software via the researcher's cloud access to this software at SW University.

Research Question 1

RQ1: Which individual aptitudes predict higher creativity in architecture students?

RQ1 used hierarchical multiple regression to examine the relationship between the specified explanatory variables and the dependent variable, creativity as measured by the mean creativity cluster of rated items: novelty, usefulness, and appropriateness.

Regression analysis was used to determine the relationship between the dependent variable and the best combination of two or more explanatory variables (Fraenkel, et al., 2012). In this case, regression was used to examine the influence of these explanatory variable attributes measured by their respective instruments upon the dependent variable creativity, as measured by subject matter experts. See Figure 3 for the multiple regression model. Explanatory variables were entered using both the block and the stepwise method of regression analysis.

Factors	Creativity Explanatory Variables
Cognitive Abilities	General intelligence (g)
	Divergent Thinking (DT)
Personality	Openness (O)
	Conscientiousness (C)
	Extraversion (E)
	Agreeableness (A)
	Neuroticism
Motivation	Intrinsic Motivation (IN)
	Extrinsic Motivation (EX)

CAT Creativity Cluster Mean Score:

(Novelty)

(Usefulness)

(Appropriateness)

Dependent Variable
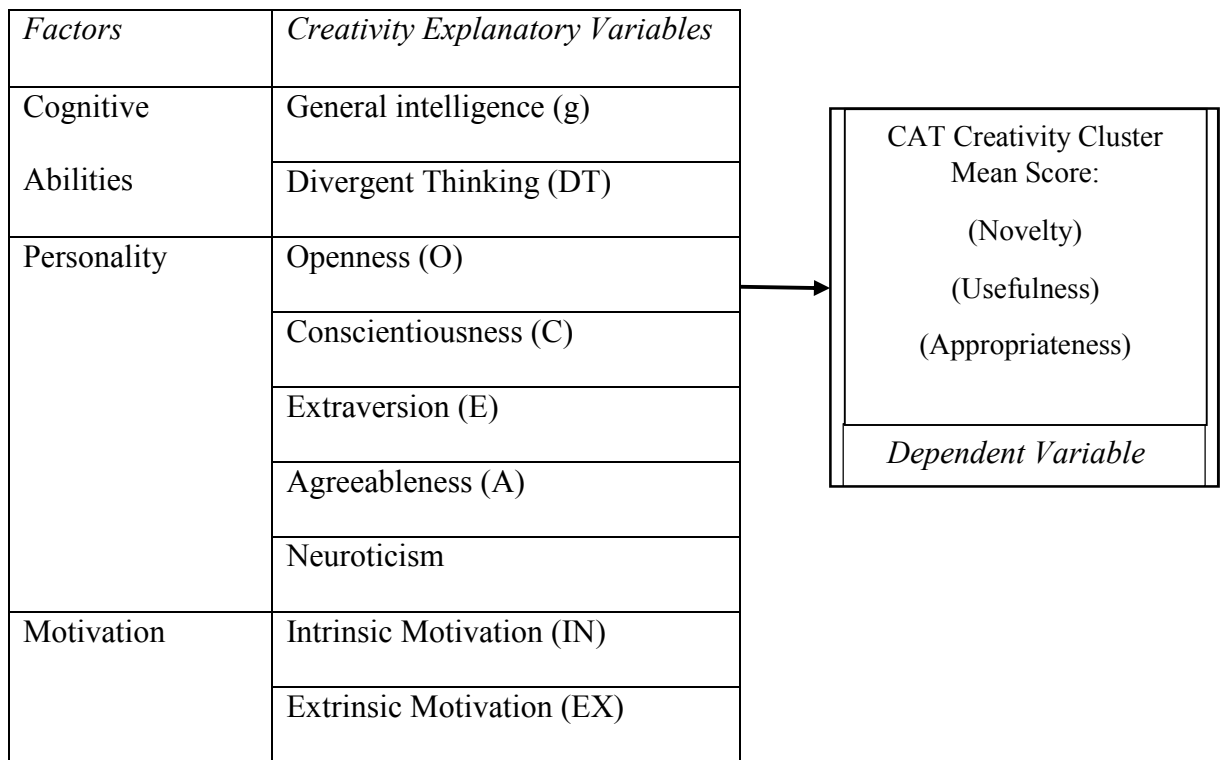
Figure 3: Multiple Regression Analysis of 9 Explanatory Variables with Creativity Dependent Variable

The SPSS "enter block" (or hierarchical method) of regression analysis was employed first. In this method, explanatory variables are entered in the multiple regression in stages with known explanatory variables with strong effect being entered first (Huck, 2012). With a known strong relationship between DT, openness, and intrinsic motivation with creativity (Amabile1996; Kaufman, 2016), the DT, openness, and intrinsic motivation variables were entered in the first block. We expected much creative product variability to be explained here. The second block added the remaining personality attributes (conscientiousness, agreeableness, extraversion, and neuroticism). Existing research suggests these variables are strongly correlated with creativity

(Chamorro-Premuzic, 2006; Feist, 1998; Furnham & Bachtiar, 2008; McCrae, 1987). SAT scores and extrinsic motivation were included in the final block. As additional blocks are added, change in R^2, changes in the standard error of estimate, and the significance of the explanatory variables within the models were observed (Huck, 2012). The alpha level of significance used was $\alpha < 0.05$.

For the explanatory variable "*g*" which was measured with the self-reported SAT scores, 12 of the samples did not report this data (n = 78). To manage this missing data, the missing SAT scores were replaced with the SAT mean. While this method has the disadvantage of reducing the variable standard deviation and correlation between the variable and other model variables (Widaman, 2006), the correlation on the obtained raw 78 SAT values with all other variables (dependent and explanatory) was low (-.119 to +.118). In this manner, the sample size was maintained at n = 90 to maintain a better sample size.

The SPSS stepwise method of regression analysis was employed as well. The stepwise method allows the statistical software to determine order of entry and include or exclude explanatory variables from the model based on the criteria of significance values set by the researcher ($\alpha < 0.05$) (Huck, 2012). If explanatory variables in the model under regression did not meet the significance standard, they were excluded from the model. This method begins with no explanatory variables in the model and attempts to insert variables until a suitable model is obtained. A partial f-statistic is computed for each variable as it is entered in the model and the algorithm stops when the new variable entered does not meet the criteria for the alpha significance value set by the researcher. It

is often employed as a preferred statistical technique to see the effect of including all the candidate variables (Montgomery, Peck & Vining, 2001).

The final sample size for the regression was 90. An a priori power analysis was conducted by the researcher to determine the power of the analysis, that is the probability of rejecting the null hypothesis when it should have been rejected because it is false (Huck, 2012). In this RQ1, the null hypothesis is that the explanatory variables neither influenced or predicted creativity. Therefore, the "power" is the probability of correctly rejecting the fact that the explanatory variables do not affect creativity. Removing the double negatives, this is the probability that we correctly determine that explanatory variables affect creativity. The "alpha level of significance" is the probability of rejecting the null hypothesis when it is true, (i.e. we decide that the explanatory variables affect creativity when in fact they do not influence creativity) (Cohen, 1988). The a priori effect size was determined by NCSS, LCC Pass15 power analysis tool, based on a sample size of 90, 9 explanatory variables and a desired power of 0.90 for multiple regression. The a priori effect size was determined by NCSS, LCC Pass15 power analysis tool, based on a sample size of 90, 9 explanatory variables and a desired power of 0.90 for multiple regression. A sample size of 90 achieves 90% power to detect an effect size (f^2) of 0.35 attributable to 9 explanatory variables using an F-Test with a significance level (alpha) of 0.011 and a beta of .10. For multiple regression, .35 is a large effect size (Cohen, 1988), indicating that it is likely that only stronger effects on creativity will be detectable by the model. With an alpha of 0.011, we have a 1.1% chance of erroneously deciding that the explanatory variables have no effect on creativity.

Tests for necessary assumptions for multiple regression were made for all variables. The explanatory variables were examined for multicollinearity and found satisfactory with variation inflation factor (VIF) values $(1.102 \leq VIF \geq 1.389)$. Satisfactory normality of residuals was found with a normal probability plot of values. Scatter plots were used to test for a good linear relationship between explanatory and dependent variables, and scatter plots were used to test for homoscedasticity by plotting the residuals against predicted values of the dependent variable. (Huck, 2012). No assumptions were violated in this sample.

Research Question 2

RQ2: How well does the CAT measure architectural design project creativity? To determine the ability of CAT to measure creativity, two outcomes were examined, namely:

1. Does creativity in the CAT correlate with consistent aptitude predictors of creativity (intrinsic motivation, divergent thinking and openness)?

2. Does CAT discriminate creativity from other product qualities such as technical goodness, comprehensiveness and neatness when judged subjectively by subject matter experts?

For the first part of RQ2, correlational analysis was used. This further measure of construct validity examined the relationship of consistent predictors of creativity, namely openness FFM personality measure (measured with the BFI) and divergent thinking (measured with the AUT) with the averaged creativity cluster items measured using the

CAT. The alpha level of significance used was α < 0.05 and the sample size was 90 for this portion of the analysis.

For the second part of RQ2, the goal was to examine the validity and reliability of the CAT. For construct/discriminant validity, factor analysis on CAT dimensions: novelty, usefulness, appropriateness, technical correctness, neatness and organization was performed. The creativity cluster consisted of novelty, usefulness and appropriateness dimensions, while the technical cluster consisted of technical correctness, neatness and organization (Amabile, 1983). See Figure 4 for the factor analysis model. The sample size was 90 for this portion of the analysis.
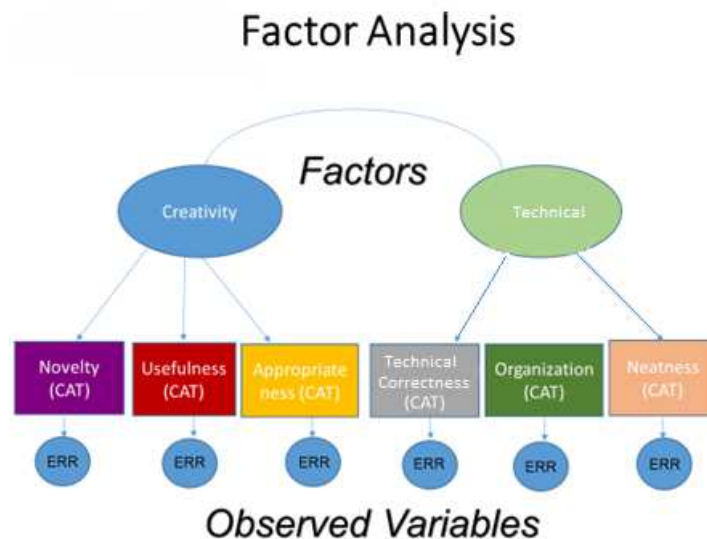
Factor Analysis

Figure 4. Factor Analysis Model

Factor analysis was chosen for this analysis because this method allows the researcher to examine relationships within a group of observed variables (Beavers et al.,

2013). Factor analysis is a procedure often used to assess construct validity (Huck, 2012). Principal component analysis with oblique rotation was used to identify common factors that explain the correlation between the means of the 6 rating variables of the subjective evaluation of product creativity (Huck, 2012). In this study, we were interested determining whether the creativity ratings of novelty, usefulness and appropriateness rating variables are "bound together" and distinguishable from technical goodness rating variables of technical correctness, organization and neatness. For this analysis, the sample size was on the smaller end of the spectrum for factor analysis, however with n = 90, the sample size meets the criteria of a minimum number of subjects (51 more than the number of variables = 51 + 6, n = 57) (Lawley & Maxwell, 1973) and subject to variable ratio of at least 5 (90 subjects/6 variables, n = 15) (Bryant & Yarnold, 1995). Whereas strong solutions made up of 3-4 item loadings of greater than .60 or higher make greater sample size less critical, a smaller sample size increases sampling error resulting in less stable solutions (Hogarty, Hines, Kromrey, Ferron & Mumford, 2005).

The requirement for adequate normal distribution of each of the 6 variables for factor analysis was made (Beavers et al., 2013) by performing a Kaiser-Meyer-Olkin measure of sampling adequacy using SPSS software (George & Mallory, 2009). Results of the Kaiser-Meyer-Olkin test were 0.840, indicating a "meritorious" rating for sampling distribution adequacy (George & Mallory, 2009). Oblique rotation is recommended when there is a high correlation between variables. If correlations exceed .32, then there is a 10% or more overlap in the variance among variables and oblique rotation is recommended (Tabachnick and Fiddell, 2007). All variable correlations exceeded .32.

As a further measure of construct validity, inter-rater reliability was analyzed. IRR is important to CAT because it is evidence of construct validity. Since creativity is recognized as an attribute that can be evaluated by CAT experts, when they agree, the assessment is measuring the construct (Kaufman, Plucker & Baer, 2008). CAT IRR is measured using the Cronbach's coefficient alpha (Baer & McKool, 2009). Reliability ratings of .70 or greater of Cronbach's alpha are considered sufficient agreement between judges (Hennessey et al., 2011).

For the CAT IRR, the averages for each rater's creativity cluster score and the averages for each rater's technical cluster score were used for each of the $n = 90$ sample projects. The Cronbach's alpha for all 7 raters was 0.746 for the creativity cluster and .846 for the technical cluster.

Ethical Considerations

Creswell (2014) states, "…all educational researchers need to be aware of and anticipate ethical issues in their research" (p. 22). The researcher has a responsibility to ensure safety, privacy, and honesty in the process of collecting and reporting research study data. The ethical considerations the researcher employed included IRB approval and maintaining participant confidentiality and anonymity.

This project was subject to IRB approval as it involved research using human subjects. All participant students were over 18 years old and were administered surveys that assessed their personality, cognitive and motivational aptitudes. The survey questions posed minimal potential physical, emotional, or mental harm. Participants were asked to complete an informed consent form, in paper form, and were signed by the students. They also provided their student ID number information on the informed consent form. Student ID

numbers were also provided by students on the survey forms. When a participant signed the consent forms and completed all the applicable surveys, the researcher separated the informed consent and survey forms to maintain participant anonymity and confidentiality.

Participation was voluntary, and all participants were provided with an explanation of the research. This included: a research study description, estimated time for survey completion, and an explanation of how anonymity and confidentiality was protected. All surveys were coded with a student ID number identifier that allowed matching with submitted end-of-semester creative projects. Participant survey data will be kept in a secure password protected file for five years. A designated staff member of the University's School of Education will be the only individual with access to these data.

Chapter 4

Results

This chapter describes the findings of the study. It presents the results of the data that were collected. Information is presented in a sequential order, with RQ1 quantitative data presented first, followed by RQ2 quantitative data.

Research Question 1 Data

RQ1: Which individual aptitudes predict higher creativity in architecture students? The hypothesis is that multi-domain creative subjects' aptitudes are related either to scientific, artistic or a new aptitude pattern variant.

Descriptive Statistics. All descriptive statistics for RQ1 are listed in Table 2.

Table 2 Descriptive Statistics for RQ 1

Descriptive Statistics

	Mean	Std. Deviation	N
Creativity	4.59	.61	90
Open	4.48	.57	90
IN	3.02	.36	90
AUT	7.84	2.55	90
Conscien	4.11	.64	90
Extra	3.11	.94	90
Agree	3.32	.63	90
Neurotic	3.33	.74	90
SAT	1246.46	158.89	78
EX	2.41	.38	90

General Intelligence or *g*.   *G* was measured with self-reported SAT scores. Since SW University is an "SAT optional" school, it was expected that some students might not recall SAT scores, have never taken the SAT in favor of ACT, or be reluctant to provide SAT scores. Of the 90 participants, only 78 reported SAT scores. Students were asked to provide the sum of their SAT math and verbal scores. The mean for this class ($\bar{x}$ = 1246.46, s = 155.8908) was significantly higher in the 1-tailed t-test (P ($t_{.05,77}$ = 13.285) < .00001) than the 2015 average of all SAT test takers u = 1006 (College Board, 2015). When values for skewness and kurtosis fall between the range of -1.0 to + 1.0, the data are considered normal (Huck, 2012); the distribution of SAT scores was normal (skewness = .56; kurtosis = .92).

Divergent Thinking (DT). Divergent thinking was measured with the Alternate Uses Task (AUT). The AUT was scored by 3 independent raters. The ratings were adjusted for inflated fluency by use of the Snyder protocol computation. High correlation was found between the raters for both the paper napkin test and the tape test. Test inter-rater reliability (IRR) for the AUT was quite high for the three raters for each of the two surveys respectively as follows: (rater1/rater2: .97 and .98, p < .001; rater1/rater3: .97 and 97, p < .001; and rater2/rater3: .99 and .96, p < .001).

AUT data were normal (skewness = .07; kurtosis = -.53). The mean for this class (n = 90) on the AUT was 7.84 with a standard deviation of 2.55. The lowest value for AUT was 2.98; the highest was 15.

Openness (FFM). The personality factor openness was measured using the Big Five Inventory (BFI). Possible scores on the BFI range from 1 to 5. FFM Openness data were normally distributed (skewness = .52; kurtosis = .62). The mean for this class ($\bar{x}$ = 4.48, s = .57, n = 90) was significantly higher (one sample t-test, P = .0185) than population norm for this factor (u = 3.92, σ = .66) (John & Srivastava, 1999) at the α = 0.05 level of significance.

Conscientiousness (FFM). The personality factor conscientiousness was measured using the Big Five Inventory (BFI). Possible scores on the BFI range from 1 to 5. FFM Conscientiousness data were normally distributed (skewness = -.74; kurtosis = -.01). The mean for this class ($\bar{x}$ = 4.11, s = .64, n = 90) was significantly higher (one sample t-test, P < .0001) than population norm for this factor (u = 3.45, σ = .73) (John & Srivastava, 1999) at the α = 0.05 level of significance.

Extraversion (FFM). The personality factor extraversion was measured using the Big Five Inventory (BFI). Possible scores on the BFI range from 1 to 5. FFM Extraversion data were normally distributed (skewness = -.10; kurtosis = -.77. The mean for this class ($\bar{x}$ = 3.11, s = .938, n = 90) was not significantly (one sample t-test, P = .1612) than population norm for this factor (u = 3.25, σ = .73) (John & Srivastava, 1999) at the α = 0.05 level of significance.

Agreeableness (FFM). The personality factor agreeableness was measured using the Big Five Inventory (BFI). Possible scores on the BFI range from 1 to 5. FFM agreeableness data were normally distributed (skewness = .27; kurtosis = .32. The mean for this class ($\bar{x}$ = 3.32, s = .63, n = 90) was significantly (one sample t-test, P < .0001) than population norm for this factor (u = 3.64, σ = .72) (John & Srivastava, 1999) at the α = 0.05 level of significance.

Neuroticism (FFM). The personality factor neuroticism was measured using the Big Five Inventory (BFI). Possible scores on the BFI range from 1 to 5. FFM neuroticism data were normally distributed (skewness = -.34; kurtosis = -.48). The mean for this class ($\bar{x}$ = 3.33, s = .74, n = 90) was not significantly different (one sample t-test, P = .8983) than population norm for this factor (u = 3.32, σ = .82) (John & Srivastava, 1999) at the α = 0.05 level of significance.

Extrinsic Motivation. Extrinsic motivation was measured using the student version of the workplace inventory (WPI). Possible scores on each of the 30 items of the extrinsic portion of the WPI range from 1 to 4; the final score is averaged over the 30 items. Score data were distributed normal (skewness= -.02, kurtosis = -.81) The mean for this class for extrinsic motivation ($\bar{x}$ = 2.41, s = .38, n = 90) was significantly lower (one sample t-test, P = .0003) than the norm (u = 2.56, σ = .41) (Amabile, et al., 1994) at the α = 0.05 level of significance.

Intrinsic Motivation. Intrinsic motivation was measured using the student version of the workplace inventory (WPI). Possible scores on each of the 30 items of the intrinsic portion of the WPI range from 1 to 4; the final score is averaged over the 30 items. Score data were distributed normal (skewness= -.02, kurtosis = -.36). The class mean for intrinsic motivation ($\bar{x}$ = 3.02, s = .36, n = 90) was not significantly (one sample t-test, P = .4313) than the norm (u = 2.99, σ = .37) (Amabile, et al., 1994) at the α = 0.05 level of significance. On the secondary scales, the mean for enjoyment was higher ($\bar{x}$ = 3.295, s = .37, n = 90) than the mean for challenge ($\bar{x}$ = 2.49, s = .47, n = 90). An paired sample t-test showed that the mean difference between the scale rating for enjoyment was significantly higher than the rating for challenge; t(89) = 11.96, p < .0001.

Project Grades Given by Instructors. There were 8 different instructors for this sample of 90 students. Due to the possible varying perspective and grading criteria among the 8 instructors, this variable was not included in the regression model. Although not included in the regression model, project grades given by the instructor were included in the data set due to their potential to illuminate any correlation with creativity or student motivation. The freshman class average score on this project was 86.2 and the standard deviation was 3.85. The data were distributed normally (skewness= -.02, kurtosis = -.36) with a range of 16.

Required Multiple Regression Assumptions Checks. Statistical tests for

required multiple regression assumptions were made for all variables using SPSS

software. The explanatory variables were examined for multicollinearity and found

satisfactory with variation inflation factor (VIF) values ($1.102 \leq$ VIF ≥ 1.389.

Satisfactory normality of residuals was found with a normal probability plot of

standardized residual values and a plot of standardized predicted value vs. residual

values. Scatter plots were used to test for a good linear relationship between

explanatory/dependent variables, and scatter plots were used to test for homoscedasticity

by plotting the residuals against predicted values of the dependent variable. (Huck, 2012).

No assumptions were violated in this sample.

Correlational Statistics. Bivariate correlational statistics or the linear

relationship between creativity and nine explanatory variables were computed in SPSS.

Since the data met the criteria of required statistical assumptions (no multicollinearity,

normality of residuals, and homoscedascity), the Pearson product-moment computation

was appropriate (Huck, 2012). The complete correlation result table may be viewed in

Appendix K. Significant correlations with creativity and the explanatory variables are

tabled in Table 3.

Table 3. Significant Correlations (α = .05): Creativity and Explanatory Variables

	Pearson Correlation with Creativity	Significance (2-Tailed)
Openness (FFM) (n=90)	$r = .243$	$p = .012$
Intrinsic Motivation (WPI) (n=90)	$r = .433$	$p < .00001$
Divergent Thinking (AUT) (n=90)	$r = .266$	$p = .006$

These three variables' correlational results have the strongest relationships ($r > .2$, α= .05) to creativity among the nine variables. Intrinsic motivation was significantly and positively correlated ($r = .433$, $p < .00001$). Confidence intervals were computed using Fisher's 'z' transformation since the sampling distribution of r is not normally distributed (Glass & Hopkins, 1984). Confidence intervals at the 95% level were computed for the creativity-intrinsic motivation correlation (CI .343 to .516). Openness ($r = .243$, $p = .012$, 95% CI .0328 to .424) and divergent thinking (r = .266, $p = .013$, 95% CI .158 to .357) were positively correlated with creativity as well. These relationships are supported in the literature (Amabile, 1983; Dollinger, et al., 2004; Feist, 1998; McCrae, 1987, Silvia et al., 2009).

At the level of significance α= .10, five other explanatory variables were significant. Conscientiousness ($r = .207$, $p = .081$, CI .000 to .397) and neuroticism ($r = .201$, r = .09, CI -.006 to .391) were positively correlated with creativity. Extraversion ($r = -.197$, $p = .096$, CI -.388 to .01), agreeableness ($r = -.223$, $p = .059$, CI -.411 to -.017), and extrinsic motivation ($r = -.209$, $p = .078$, CI -.398 to -.002) were negatively correlated with creativity. The correlations must be viewed with caution, particularly

considering those confidence intervals spanned positive and negative values. Of interest are also the correlations between the explanatory variables, shown in Table 4.

Table 4. Correlations Between Explanatory Variables

Explanatory Variables	Conscientiousness	Agreeableness	Extrinsic Motivation
Openness	$r = .250$, p $= .01$	$r = -.250$, p $= .011$	NS
Intrinsic Motivation	NS	NS	$r = -.349$, p $< .00001$

Correlation with Project Grades. Every correlation between project grades given by instructors and intrinsic or extrinsic motivation was low and insignificant, ($r = .090$, and $-.004$, respectively, p $> .410$). The correlation between project grades and the creativity cluster of the CAT was low and insignificant ($r = .062$, p $= .568$). Every correlation between project grades and personality (openness, conscientiousness, extraversion, agreeableness, and neuroticism) was also low and insignificant, ($r = .191$, $.062$, $-.06$, $-.06$, and $.03$, respectively, p $> .10$). There was an insignificant correlation between project grades and the SAT ($r = .01$, p $= .49$) and the AUT ($r = .19$, p $= .11$).

Project grades correlated at the $\alpha = .10$ level with the technical correctness cluster of the CAT ($r = .213$, p $= .052$). The only significant correlation between project grades was with the combination of creativity and technical correctness, as scored by the CAT. This correlation was moderate ($r = .252$, p $= .021$).

Regression Analysis. Finally, a regression analysis was performed to determine how well the explanatory variables (9 variables from the AUT, BFI, WPI and SAT) are related to creativity (measured as the mean of the creativity cluster items from the CAT). The SPSS "enter block" (or hierarchical method) of regression analysis was employed first. In this method, explanatory variables are entered in the multiple regression in stages, with known explanatory variables with strong effect being entered first (Huck, 2012). Based on the correlational findings, the first block of explanatory variables entered were intrinsic motivation (IN), openness (Open), and divergent thinking (AUT). The second block of explanatory variables entered were agreeableness (Agree), conscientiousness (Conscience), and neuroticism (Neurotic). Finally, extrinsic motivation (EX) and g (SAT) were entered in the last block.

The ANOVA (analysis of variance) results are reported in Table 5. This table shows the f-values and significance values associated with each of the 3 blocks cumulatively. The f-value and the associated p-value tests the null hypothesis that none of the variance in creativity is explained by this collection of explanatory variables. The first block with intrinsic motivation (IN), divergent thinking(AUT), and openness (O) has an $F_{(3, 86)} = 12.295$, $p < .0001$, indicating a statistically significant model. With the addition of the second block (conscientiousness, agreeableness, extraversion, neuroticism), the $F_{(7, 82)} = 6.351$, $p < .0001$, statistically significant model is also indicated. With the addition of the third block g(SAT) and extrinsic motivation(EX), the $F_{(9, 80)} = 4.93$, $p < .0001$, the model is also statistically significant. With the known significance, we assume that some of the variability in creativity is explained by these nine variables.

Table 5 ANOVA Model Results for Hierarchical Regression

ANOVAᵃ

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.747	3	3.249	12.295	.000[b]
	Residual	21.932	86	.264		
	Total	31.679	89			
2	Regression	11.407	7	1.630	6.351	.000[c]
	Residual	20.272	82	.257		
	Total	31.679	89			
3	Regression	11.581	9	1.287	4.930	.000[d]
	Residual	20.098	80	.261		
	Total	31.679	89			

a. Dependent Variable: Creativity

b. Predictors: (Constant), AUT, IN, Open

c. Predictors: (Constant), AUT, IN, Open, Agree, Conscien, Extra, Neurotic

d. Predictors: (Constant), AUT, IN, Open, Agree, Conscien, Extra, Neurotic, SAT, EX

Table 6 displays the model summary of the 3 blocks of input data. For Model 1, there is a relationship between creativity with divergent thinking, intrinsic motivation, and openness ($r = .555$), with an $R^2 = .308$ and an adjusted $R^2 = .283$. This first model has 3 significant variables (intrinsic motivation, openness, and divergent thinking) and explained 30.8% of the variability in creativity. With addition of all the personality variables, (conscientiousness, agreeableness, extraversion, and neuroticism), the R^2 increases very little (by .052) with $R^2 = .36$, and there is a slight adjusted R^2 increase (.02) = .303. Very little change in the variability of creativity is explained by g as measured by the SAT and extrinsic motivation with an increase in the R^2 of .005 and an adjusted R^2 decline to .291. The third model with all nine explanatory variables explains 36.6% of the variability in creativity.

Table 6. Model Summary of Block-wise Input of Explanatory Variables

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.555[a]	.308	.283	.51404	.308	12.295	3	86	.000	
2	.600[b]	.360	.303	.50656	.052	1.618	4	82	.178	
3	.605[c]	.366	.291	.51089	.005	.333	2	80	.718	1.739

a. Predictors: (Constant), AUT, IN, Open

b. Predictors: (Constant), AUT, IN, Open, Agree, Conscien, Extra, Neurotic

c. Predictors: (Constant), AUT, IN, Open, Agree, Conscien, Extra, Neurotic, SAT, EX

d. Dependent Variable: Creativity

The contribution of each of these explanatory variables is illustrated in the coefficient data summary (Table 7). The coefficient information is provided for each of the 3 models. In the final model #3, both intrinsic motivation (IN) (beta = .532, p < .0001) and divergent thinking (AUT) (beta = .076, p = .001) were statistically significant contributing to 36% of the variability in creativity. In the first model, there are 3 significant contributing variables (open, IN, and AUT) and this is the only model in which openness is statistically significant (beta = .222, p = .028).

Table 7. Coefficient Data Summary – Hierarchical Models

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.525	.562		2.713	.008
	Open	.222	.099	.208	2.241	.028
	IN	.562	.127	.410	4.426	.000
	AUT	.071	.022	.300	3.262	.002
2	(Constant)	2.058	.733		2.807	.006
	Open	.170	.113	.159	1.505	.136
	IN	.509	.129	.371	3.949	.000
	AUT	.075	.022	.315	3.443	.001
	Conscien	.095	.089	.100	1.062	.292
	Extra	-.086	.062	-.133	-1.394	.167
	Agree	-.150	.093	-.155	-1.613	.111
	Neurotic	.057	.081	.069	.701	.485
3	(Constant)	1.640	1.068		1.536	.129
	Open	.151	.117	.142	1.298	.198
	IN	.532	.144	.388	3.694	.000
	AUT	.076	.022	.317	3.435	.001
	Conscien	.112	.094	.118	1.191	.237
	Extra	-.090	.062	-.140	-1.451	.151
	Agree	-.141	.095	-.145	-1.484	.142
	Neurotic	.060	.082	.072	.731	.467
	SAT	.000	.000	.080	.803	.424
	EX	-.018	.160	-.011	-.111	.912

a. Dependent Variable: Creativity

To further clarify the best model and the importance of each of the nine explanatory variables, the SPSS stepwise method of regression analysis was employed as well. The order of entry of each of the variables was determined by the computer to determine an optimal model. The optimal model is seen below in Table 8, with $R^2 = .308$,

3 significant explanatory variables, divergent thinking (AUT, p = .002), openness (Open, p = .028), and intrinsic motivation (IN, p < .0001). Regarding beta coefficients, the standardized beta coefficients (IN: β = .410; AUT: β =.300; Open: β =.208) are important in this model because the units of measurement for one of these three variables are different. This is evident in the range of values, which is from 1-5 for both intrinsic motivation on the WPI and openness on the BFI but from 2-15 for the divergent thinking instrument in the AUT.

This stepwise model selects model #1 (shown in Table 9 as Model #3) from the hierarchical regression method, confirming that the optimal model is that with three significant explanatory variables (intrinsic motivation, divergent thinking, and openness) and R^2 = .308.

Table 8. Coefficient Data Summary – Stepwise Model

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
3	(Constant)	1.525	.562		2.713	.008
	IN	.562	.127	.410	4.426	.000
	AUT	.071	.022	.300	3.262	.002
	Open	.222	.099	.208	2.241	.028

Research Question 2 Data

RQ2: How well does the CAT measure architectural design project creativity? To determine the ability of CAT to measure creativity, two outcomes were examined, namely:

Part 1. Does CAT discriminate creativity from other product qualities such as technical goodness, comprehensiveness and neatness when judged subjectively by subject matter experts? The hypothesis is that product qualities of creativity will be discriminated from technical qualities by the CAT.

Part 2. Does creativity in the CAT correlate with consistent aptitude predictors of creativity (intrinsic motivation, divergent thinking and openness)? The hypothesis is that creativity will correlate with intrinsic motivation, divergent thinking and openness.

RQ2 Part 1 Results

Descriptive Statistics

These results examine the ratings for six item variables which were made on the 90 projects by the seven quasi-expert raters. These judges were a diverse group of architectural graduate students in their 2nd year of graduate study. While two were US citizens (female), the rest were international students from China (3 females) and Latin American (2 males). Inter-correlations between compatriot students were insignificant.

The overall mean scores for each of the six item variables are shown in Table 9. Possible values for each item ranged from 1 to 7. All mean scores were above the mid-point of 3.5. The standard deviations ranged from .74 to 1.84 and the skewness and

kurtosis indices were within the recommended values of -1 to +1 respectively (Osborne & Costello, 2009). These values suggested that the data distribution was univariate.

Table 9. Descriptive Statistics for the 6 -item CAT

	Novelty	Useful	Approp	Technical	Organized	Neatness
Mean	4.78	4.47	4.58	4.27	4.33	4.46
Std Deviation	0.64	0.48	0.54	0.63	0.65	0.71
Kurtosis	-0.25	0.13	-0.12	-0.07	1.00	-0.37
Skewness	-0.02	-0.30	0.31	-0.05	-0.34	-0.16
Count	90.00	90.00	90.00	90.00	90.00	90.00

This data sample had 90 cases in the sample size. With six variables, the minimum sample size for factor analysis was satisfied (Bryant & Yarnold, 1995; Lawley & Maxwell, 1971). Initially, the factorability of the six items (novelty, usefulness, appropriateness, technical correctness, organization, and neatness) was examined. First, it was observed that all six of the items correlated with at least r = .3 with at least one other item, suggesting reasonable factorability (Osborne & Costello, 2009). Second, the Kaiser-Meyer-Olkin measure of sampling adequacy was .739, above the commonly recommended value of .6, and Bartlett's test of sphericity was significant (χ^2 = 384.64, df = 15, p < .0001) (Osborne & Costello, 2009). Finally, the communalities were all over .3 (see Table 10), further confirming that each item shared common variance with other items (Osborne & Costello, 2009). The communalities table (extraction column) shows the proportion of each item's variance that can be explained by factors extracted. Given these overall indicators, factor analysis was determined to be suitable with all six items.

Table 10. Principal Component Analysis Communalities

Communalities

	Initial	Extraction
Novelty	1.000	.790
Usefulness	1.000	.656
Appropriateness	1.000	.896
Technical Correctness	1.000	.874
Organization	1.000	.884
Neatness	1.000	.869

Extraction Method: Principal Component Analysis.

Principal component analysis was used because the primary purpose was to identify the two hypothesized clustered factors (creativity and technical correctness) underlying the composite scores for items of the CAT. A decision was made to use an oblique rotation, which is recommended when there is a high correlation between items. If correlations exceed .32, then there is 10% (or more) overlap in variance among factors and enough variance to warrant oblique rotation (Tabachnick and Fiddell, 2007). Almost every item had a correlation with other items > .32. Factor analysis was performed using a principal component analysis with an oblique rotation (SPSS Oblimin) and two factors. See Table 11 for information about the correlation between items.

Table 11. Correlation Matrix for the 6–item CAT

	Novelty	Usefulness	Appropriateness	TechnicalCorrect	Organization	Neatness
Novelty	1.000	.457	.741	.360	.468	.371
Usefulness	.457	1.000	.621	.541	.621	.539
Appropriateness	.741	.621	1.000	.302	.364	.357
TechnicalCorrect	.360	.541	.302	1.000	.817	.820
Organization	.468	.621	.364	.817	1.000	.830
Neatness	.371	.539	.357	.820	.830	1.000

After the factor extraction and rotation has taken place, an eigenvalue is associated with each factor. The larger a factor's eigenvalue is, the more it accounts for variance in the full set of our six variables (Huck, 2012). The researcher applied Kaiser's criterion such that factors are retained only if they have an eigenvalue greater than 1.0. The table of total variance explained is shown in Table 12. The factor analysis reveals two factors with an eigenvalue greater than 1.0, which together explain 82.8% of the variance in these variables. The decision to retain two factors is also revealed in the scree plot, shown in Figure 5. Reading the scree plot, the researcher determined that the number of useful factors would be two, since reading from left to right, the point where the scree line "levels" occurs after the second factor, creativity.

Table 12. Factor Analysis Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadingsa
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.763	62.717	62.717	3.763	62.717	62.717	3.363
2	1.206	20.107	82.824	1.206	20.107	82.824	2.708
3	.491	8.183	91.007				
4	.239	3.982	94.989				
5	.182	3.025	98.014				
6	.119	1.986	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Figure 5: Scree Plot of Factor Loadings
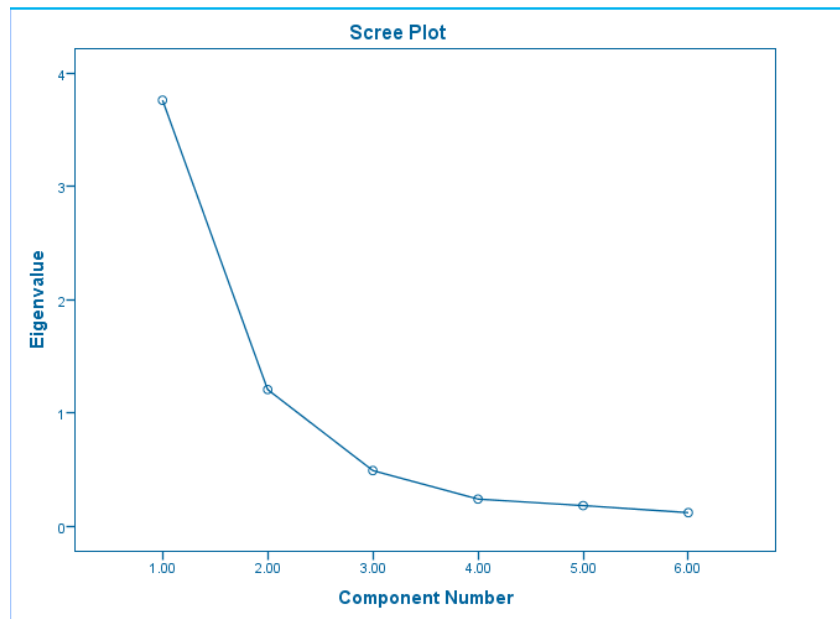
Five of the six items contributed to the factor structure and had a primary factor loading of .4 or above and no cross-loading of .3 or above. As can be observed in Table 13, one of the items, usefulness, loaded .435 on Factor 1 (Technical Goodness) and .515 on Factor 2 (Creativity). This was that item for which 34.4% (see Table 10 Communalities Extraction column) of the variance was unexplained by either of the 2 extracted factors. The complete two-factor loading is provided in Table 13.

Table 13. Two Factor loadings based on a principal components analysis with oblimin rotation for 6 items from the Consensual Assessment Technique

	Component	
	Technical goodness	Creativity
Novelty	*.009*	.885
Usefulness	.435	.515
Appropriateness	*-.075*	.978
Technical Correctness	.963	*-.067*
Organization	.908	*.067*
Neatness	.942	*-.022*

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser
Normalization. a. Rotation converged in 5 iterations.

Factor loadings indicate strong loading on the first factor, the technical goodness factor, with loading values of .963 (technical correctness), .908 (organization), and .942 (neatness). These 3 items were distinguishable from novelty (.009) and appropriateness (-.075) in the technical goodness factor.   Factor loadings on the second factor, creativity,

were strong for novelty (.885) and appropriateness (.978). However, usefulness was cross-loaded almost evenly distributed among the 2 factors with a technical correctness loading of .435 and a creativity loading of .515. The component plot in Figure 5 shows the positioning of usefulness relative to the component 1 (technical correctness) and component 2 (creativity).
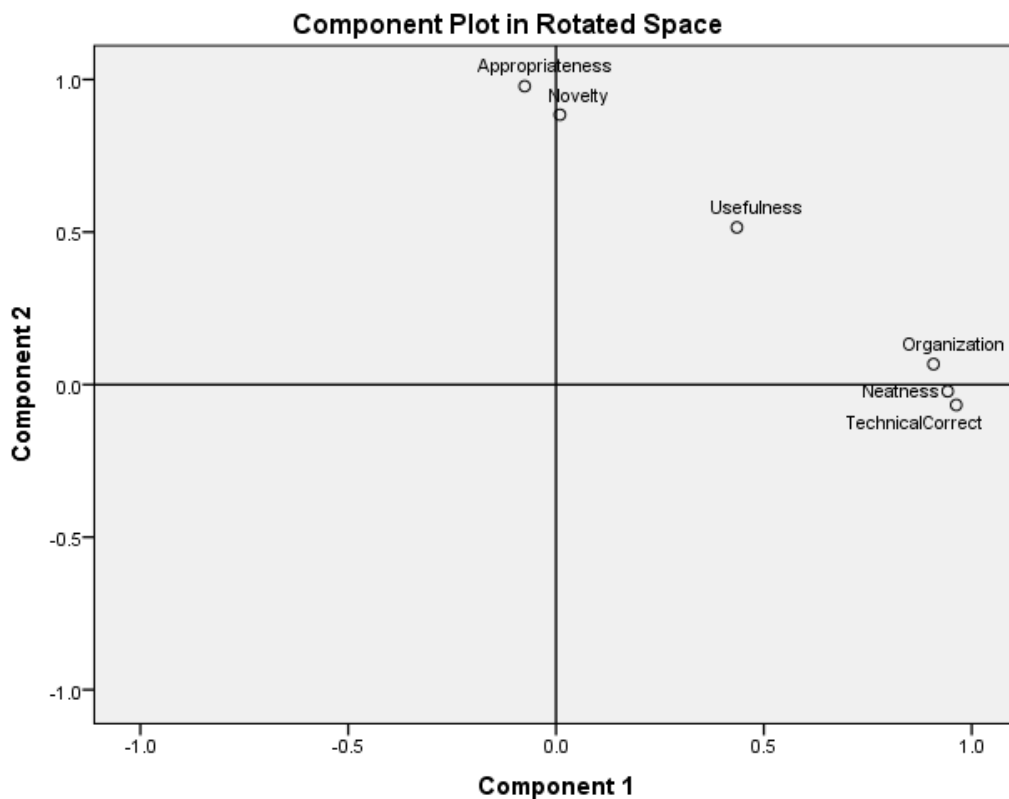
Figure 6. Component Plot of Creativity Factor (Component 2) and Technical Goodness Factor (Component 1)

RQ2 Part 2 Results

Does creativity in the CAT correlate with consistent aptitude predictors of creativity (intrinsic motivation, divergent thinking and openness)? The hypothesis is that creativity will correlate with divergent thinking and openness.

This part of RQ2 examines the relationship between creativity and known explanatory variables, namely, intrinsic motivation as measured by the WPI, divergent thinking as measured by the AUT, and the personality attribute of openness as measured by the BFI. All Descriptive statistics for RQ2, part 2 are listed in Table 13. As part of the analysis performed for RQ1, these variables meet the criteria of required bivariate correlation analysis assumptions. Satisfactory normality of residuals was found with a normal probability plot of standardized residual values and a plot of standardized predicted value vs. residual values. Scatter plots were used to test for a good linear relationship between explanatory/dependent variables, and scatter plots were used to test for homoscedasticity by plotting the residuals against predicted values of the dependent variable. (Huck, 2012). No assumptions were violated in this sample.

Table 14. Descriptive Statistics for RQ2 Part 2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Creativity	90	2.95	7.00	4.5950	.61
Open	90	2.86	6.00	4.0498	.66
AUT	90	2.93	15.00	7.8367	2.55
Intrinsic Motivation	90	2.27	3.13	3.02	.36

Both intrinsic motivation (measured with the WPI), DT (measured with the AUT) and openness (measured with the BFI) were significantly and positively correlated with

averaged values of the creative cluster measurement of creativity (measured with the

CAT). These results are shown in Table 15.

Table 15. Correlation of Creativity, Openness, DT (AUT) and Intrinsic Motivation (IN)

Correlations

		Creativity
Open	Pearson Correlation	.243[*]
	Sig. (2-tailed)	.012
	N	90
AUT	Pearson Correlation	.266[*]
	Sig. (2-tailed)	.013
	N	90
IN	Pearson Correlation	.433*
	Sig. (2-tailed)	<.0001
	N	90

*. Correlation is significant at the 0.05 level (2-tailed).

Scatter plots show the positive relationship between the personality characteristic

of openness and creativity in Figure 7, between divergent thinking and creativity in

Figure 8, and between intrinsic motivation and creativity in Figure 9.

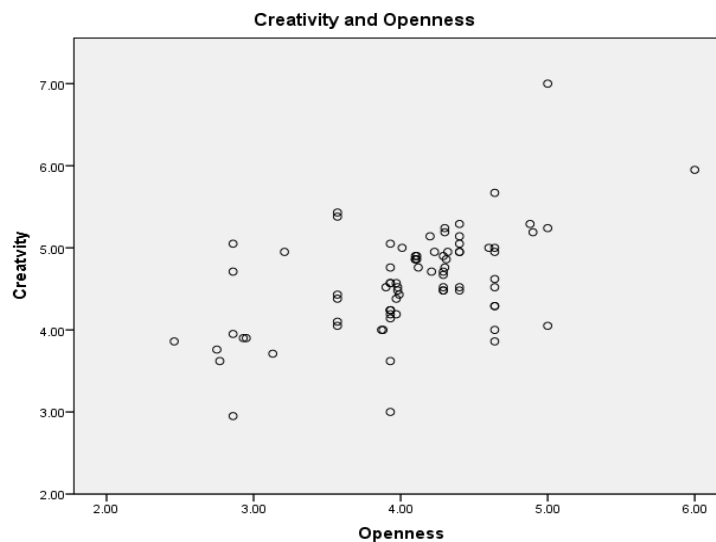Figure 7. Scatterplot of Creativity and Openness

Figure 8. Scatterplot of Creativity and Divergent Thinking
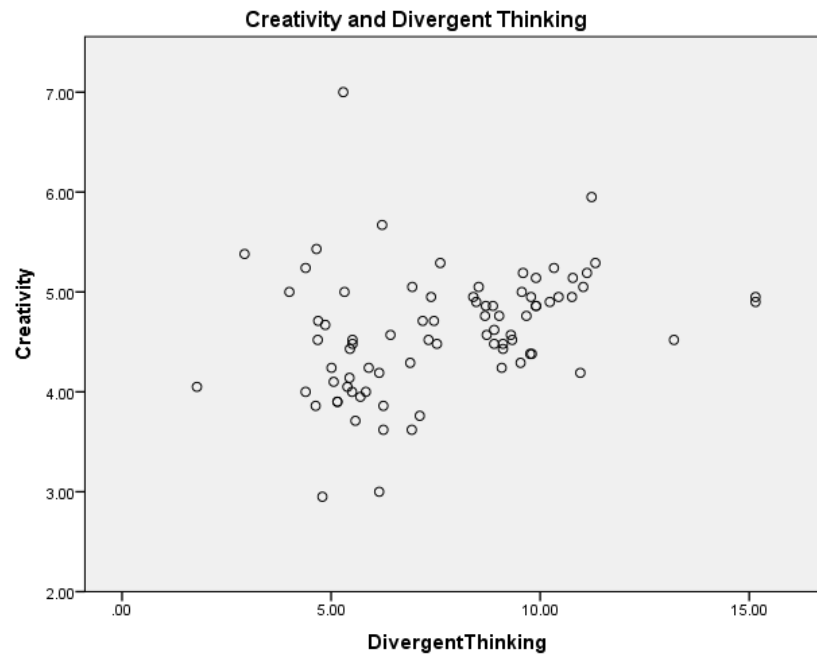
Figure 9. Scatterplot of Creativity and Intrinsic Motivation
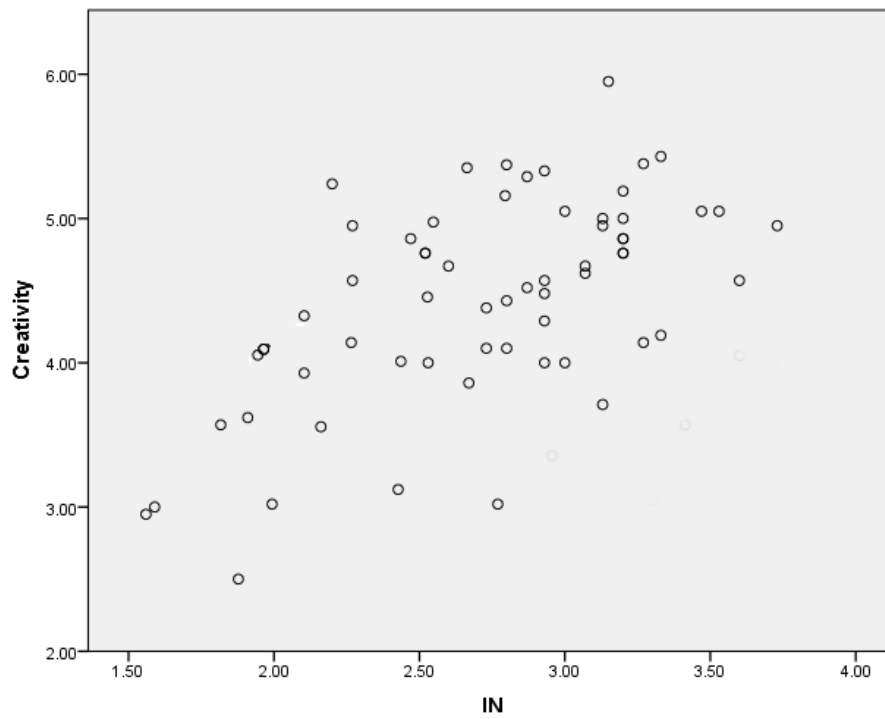
Summary of Results

Research Question 1. Overall, architecture students had significantly higher SAT scores than the 2015 mean, and were more open, conscientious, and less agreeable in personality factors than the norms for the FFM BFI. In terms of motivation, they were much less extrinsically motivated than the norm as measured by the WPI.

In terms of correlation, among the nine explanatory variables, creativity was most closely related to intrinsic motivation ($r = .433$, p < .00001), followed by divergent thinking ($r = .266$, p = .006) and openness ($r = .243$, p = .012). Regarding inter-correlations between the explanatory variables, intrinsic motivation was negatively and significantly correlated to extrinsic motivation.

The optimal regression model explained 30.8% of the variability in the creativity as measured by the creativity cluster of the CAT, with three significant explanatory variables. In order of influence upon creativity, these were intrinsic motivation, divergent thinking and openness.

Research Question 2. The first part of the second research question used factor analysis to examine the construct validity of the CAT by determining if expert judges could discriminate creativity from technical goodness in an architectural project. Factor analysis clearly identified the technical goodness factor as distinguishable from creativity, with significant loading on the technical correctness, organization, and neatness items. A creativity factor was identified with the novelty and appropriateness items, however usefulness loaded on both technical goodness and creativity factors, with (1- .636 = 34.4% of the variance in usefulness explained by an unknown latent factor.

Overall judge agreement among the seven raters is shown in Table 16. Each "Tech#" entry refers to one of the seven judges who scored the CAT. Inter-judge agreement ranged from .315 to .992. As recommended by Amabile (1983), Cronbach's alpha is recommended for reporting inter-rater reliability, with an acceptable level of agreement among judges set at .70 or higher (Hennessy et. al., 2011). Cronbach's alpha reliability statistics and intraclass correlation coefficient statistics are shown in Table 17. For the 7 judges, the alpha and the intraclass coefficient (ICC) statistic ("average measures") were in agreement and acceptable (α = .867). In addition, the intraclass correlation coefficient "single measure" was .542, indicating the reliability if a single rater had been used.

Table 16. Inter-Judge Agreement for 7-rater Factor Analysis

	Tech1	Tech2	Tech3	Tech4	Tech5	Tech6	Tech7
Tech1	1.000	.399	.465	.871	.417	.465	.321
Tech2	.399	1.000	.588	.399	.992	.588	.398
Tech3	.465	.588	1.000	.465	.599	.709	.315
Tech4	.871	.399	.465	1.000	.417	.465	.321
Tech5	.417	.992	.599	.417	1.000	.599	.417
Tech6	.465	.588	.709	.465	.599	1.000	.315
Tech7	.321	.398	.315	.321	.417	.315	1.000

Table 17. Cronbach's Alpha and ICC Correlation Coefficient Reliability Statistics for

CAT Factor Analysis

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.876	.884	7

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.542[a]	.452	.634	8.087	89	445	.000
Average Measures	.876	.832	.912	8.087	89	445	.000

Two-way random effects model where both people effects and measures effects are random.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

The hypothesis of the second part of the second research question was tested by determining the correlation between creativity and intrinsic motivation, divergent thinking (AUT) and openness (FFM BFI). The Pearson Product-moment correlations were positive and significant ($r = .433$, p $< .0001$; $r = .243$, p $= .012$; $r = .266$, p $= .013$) in intrinsic motivation, openness and divergent thinking, respectively.

Chapter 5

Conclusion and Recommendations

Introduction

This dissertation concentrated on increasing understanding of aptitudes in multi-domain individuals, such as architects, to provide additional understanding of the domain-generic/domain-specific debate within an academic setting. To address the question of creativity assessment, it examined validation of the CAT, a creativity assessment known to be sensitive to pedagogical intervention (Baer, 1994b; Baer & McKool, 2009).

This quantitative study collected data from currently enrolled architecture student personality, motivational, and cognitive assessments, as well experts' ratings of student end-of semester creative projects. This closing chapter presents conclusions, answers the research questions that bound this study, and offers recommendations for future research.

Conclusions

Research question 1 examined the aptitudes that are related to creativity in architecture students with the null hypothesis indicating no relationship between creativity and the nine explanatory variables, specifically in relation to those relationships found in previous research. It explored whether the aptitudes found were most like those of domain specific (artistic/scientific) or to domain generic creatives.

Analysis of Pearson-Product moment correlations and regression were used to explore this research question. The most significant finding from the correlation matrix

involved student motivation, wherein intrinsic motivation and creativity had a medium

correlation (r = .433, p < .00001) with 18.5% of the variability in creativity explained by

this motivational aptitude. Divergent thinking had a small correlation (r = .266, p < .006)

with 7.1% of the variability in creativity explained by this cognition variable. Finally,

openness had a small correlation (r = .243, p < .012) with 5.9% of the variability in

creativity explained by this personality variable. The aptitude pattern seen in past

research by creative individuals in either of two domains (artistic or scientific) or the

domain generic categories is compiled in Table 18.

Table 18 Aptitudes of Creative Individuals Across Domain

(Amabile, 1984, 1985; Feist, 1998; McCrae,1987)

Domain	Artist	Scientist	Domain-Generic
Personality	Openness (+) Conscientiousness (-) Extraversion (-) Agreeableness (-) Neuroticism (+)	Openness (+) Conscientiousness (+) Extraversion (-) Agreeableness (-) Neuroticism (-)	Openness (+) (Conscientious (-) Extraversion (-) Agreeable (-)
Motivation	Intrinsic (Amabile, 1984)		Intrinsic (**Amabile, 1985)
Cognition	Divergent thinking (+) (McCrae)	Divergent thinking (+) (McCrae)	Divergent thinking (+)

In previous research, the strongest discriminators between artists and scientists were seen in conscientiousness and neuroticism personality attributes. Unfortunately, neither of these attributes were significant at the α= .05 level in the model. Given the pattern of creativity's correlation with intrinsic motivation, openness and divergent thinking, this suggests support for either domain-generic theory, or more similarity to artistic creativity. However, at the α = .10 level, the pattern of correlations suggests that these architecture students are more conscientious, like scientists and more neurotic, like artists. Therefore, at this level of significance, there is a blend of artistic and scientific personality aptitudes.

The regression model supported the findings of the correlation model in which intrinsic motivation, divergent thinking and openness were the most influential explanatory variables in predicting creativity. The optimal regression model predicted 30.8% of the creativity in these students with significance in the three variables, leaving 69.2% of the variability unexplained. With inclusion of the less significant FFM explanatory variables (conscientiousness, extraversion, agreeableness, and neuroticism), 36.6% of the variability was explained.

The finding of positive and significant correlation between creativity and both openness and divergent thinking is not surprising and has been consistently supported throughout the research on individual creativity. The more interesting finding of these results centers on the significant positive relationship of creativity with intrinsic motivation. Relative to motivation, we found that overall, this class scored at or near the norm for intrinsic motivation, while scoring lower than the norm on extrinsic motivation. While intrinsic and extrinsic motivation are not exclusive motivations to one another,

there was also a significant negative correlation between intrinsic and extrinsic motivation. Therefore, those higher in creativity were significantly more intrinsically motivated and less driven by extrinsic motivation.

The themes of this research support the importance of fostering intrinsic motivation in promoting creativity. First, motivation is regarded as a phenotypical aptitude which can be taught and nurtured through education (Casakin & Kreitler, 2010). Secondly, the importance of intrinsic motivation found in this study calls into question the behaviorist framework in which creativity is a product of reward (extrinsic motivation) for creative behavior. Finally, systems theory acknowledges a more complex structure to creativity, in which creative training alone will not ensure creativity (Csíkszentmihályi, 1996; Starko, 2005). According to Torrance (1972), the most effective techniques for stimulating creativity involved creativity training, along with nurturing cognitive and affective factors.

As a final note on the exploration of creativity and individual aptitudes, the amount of variability unexplained (~69%) points to the complex nature of creativity. There is much work to be done in exploring the myriad of factors that influence creativity.

RQ2: How well does the CAT measure architectural design project creativity? To determine the ability of CAT to measure creativity, two outcomes were examined,

> 1. Does CAT discriminate creativity from other product qualities such as technical goodness, comprehensiveness and neatness when judged subjectively by subject matter experts? The hypothesis is that product qualities of creativity will be discriminated from technical qualities by the CAT.

This research sought to apply psychometric rigor to the construct and discriminant validity of the CAT in an educational setting. The factor structure was aligned with the results found by Amabile (1983) and demonstrated that the subjective judgements of creativity could be discriminated from technical goodness. Based on the results of the factor analysis, the judges were more able to distinguish the first factor, technical goodness, as "not creativity". Using "technical correctness", "organization", and "neatness" variables separated non-creative elements of the student's projects.

The second factor grouped novelty and appropriateness variables together as creativity. However, placement of usefulness was more problematic, with cross-loading over both factors, and almost equal correlations with all other variables (between .54-.62 except novelty. Descriptive statistics indicate the lowest standard deviation ($s = .476$) for usefulness indicting that, among the 90 rated projects, there was less variability in the usefulness scores assigned for the projects. The usefulness values were more clustered around the mean. There are two possible reasons for this anomaly in usefulness: (1) One might speculate that the assignment was vague in describing the purpose of the building to be designed by the students; it is difficult to design and judge the usefulness of a building if there is uncertainty about how it will be used or (2) since usefulness loaded on both creativity and technical correctness, the judges may view usefulness as both a creative and technical endeavor or (3) usefulness is viewed as part of another latent factor unrelated to creativity or technical goodness.

A reasonable conclusion is that discriminant validity was shown in this research; expert judges could discriminate creativity from technical goodness of the student's projects. Regarding construct validity, factor analysis showed that two of the 3 defining

elements of creativity (novelty and appropriateness) loaded on a creativity factor distinct from technical goodness. Further, Plucker and Baer (2008) also regard inter-rater reliability as a measure of construct validity. Since creativity is recognized as an attribute that can be evaluated by experts, when experts agree, the assessment has construct validity. With the high inter-rater reliability of these judges (α = .88), this is further evidence of construct validity of the CAT.

CAT reliability is also measured by the inter-rater reliability coefficient. The higher the inter-rater reliability, the higher the reliability of the data collection method (Gwet, 2008). With that inter-rater reliability coefficient (α = .88), good reliability of the CAT is established in this study.

2. Does creativity in the CAT correlate with consistent aptitude predictors of creativity (divergent thinking and openness)? The hypothesis is that creativity will correlate with divergent thinking and openness.

Analysis of Pearson-Product moment correlations were used to explore this research question. The most significant finding from the correlation matrix showed that both consistent aptitude predictors were correlated with creativity. Divergent thinking had a small correlation (r = .266, p < .006) with 7.1% of the variability in creativity explained by this cognition variable. Openness had a small correlation (r = .243, p < .012) with 5.9% of the variability in creativity explained by this cognition variable.

This part of this research question tested the hypothesis that consistent predictors (intrinsic motivation, openness and divergent thinking) of creativity would be correlated with creativity using the CAT instrument. Since these correlations were significant, this

correlational evidence of a relationship between intrinsic motivation, creativity and divergent thinking and openness show the construct validity of the CAT (Huck, 2012).

Limitations

The sample chosen for this study was a convenience sample from the researcher's university. It is likely that they were uniformly of higher socioeconomic status than the general population of college students and therefore of questionable generalizability to the general population of college students. As expected with higher socioeconomic status, SAT scores given indicated a higher g than the population norm, again a generalization limitation. While the population was chosen as a recent product of K-12 education, the population was of uniform age (18/19 years-old), and there is limited generalizability to other age groups in primary and secondary education or older groups in higher education.

Although the sample size was adequate for the number of variables in the regression and factor analysis, a larger sample would have allowed for more depth and additional/interaction variables, which might have added to the flexibility of the design.

The measure of general intelligence, g, was problematic. While the use of SAT as a measure of intelligence, and the efficacy of the self-reporting of SAT scores has been supported in the literature, there were missing and likely misreported scores in the sample. The participants were from an SAT-optional university, so students may have forgotten or dismissed the importance of their scores. An alternate measure of g such as Raven's Progressive Matrices or the Miller Analogies Test might have been better alternative, given a longer allocated assessment period.

While every effort was made to mitigate subject fatigue in test taking during the 40-minute session, this may have occurred during the last WPI assessment.

Although use of project grades assigned by the instructors was limited, the conclusions drawn from the grades were restricted by the fact that there were eight different instructors evaluating the student projects. Although there was a single architecture studio coordinator and there was an agreed upon common grading policy, grade uniformity was not guaranteed due instructor freedom in assigning grades.

Discussion and Recommendations

Since intrinsic motivation was a strong factor in the variability of creativity, this discussion naturally begins with motivation. A long-held view of motivation, embodied in B.F. Skinner's (1972) psychological hedonism, emphasized the human need for pleasure and the avoidance of pain. The need for pleasure establishes the importance of reward as a basis for human action. The behaviorists believed in the power of reward to influence many aspects of human performance. So, it seems natural to suppose that creativity, as with other human activities, can be enhanced by reward. Yet, creativity is different from behaviors or activities that are readily identifiable and occur frequently and therefore can be easily rewarded. By its nature, creativity involves the unusual. Sometimes a creative problem or goal has multiple useful solutions. But in either case, because the creative response is not in the individual's previous repertoire of experiences, behaviorist approaches offer limited information concerning the processes used to generate such behavior.

The students performing this activity received a strong extrinsic motivation in the form of a reward for the assignment, namely, a "high-stakes" grade on the project, which accounted for 35% of their semester grade. However, as seen in the low correlation between extrinsic motivation and project grades, higher extrinsic motivation failed to garner higher project grades.

In addition, project grades were not correlated with creativity. While the assignment instructed the students to be creative, the rated creativity cluster scores of the

CAT judges was not reflected in higher project scores. Projects which were graded higher by instructors were not more creative, as judged by experts using the CAT.

Project grades were somewhat correlated with the technical goodness cluster of the CAT. Moreover, when the creativity cluster was added to the technical goodness cluster, only a little more correlation was displayed. More of the project grade was dependent on technical goodness than creativity. This pattern of instructor scoring had been established by the time of this project, which was graded at the end of the semester. While the students were told to be creative, they did not expect that they would be graded on their creativity. The extrinsic motivator of the project grade affected technical goodness more than creativity.

The themes of this research support the importance of fostering intrinsic motivation in promoting creativity and particularly across domains. First, motivation is regarded as a phenotypical aptitude which can be taught and nurtured by education (Casakin & Kreitler, 2010). "Events that increase perception of competence or self-determination are assumed to enhance intrinsic motivation. Events that decrease perception of competence or self-determination will diminish intrinsic motivation" (Eisenberger & Cameron, 1996, p. 1155). Educators should be equipped to manage these events. Secondly, the importance of intrinsic motivation found in this study rejects the behaviorist framework in which creativity is a product of reward (extrinsic motivation) for creative behavior. High stakes testing, grading and accountability foster a system of extrinsic motivation which does little to support creativity and in this study, was found to be non-correlated with creativity. Finally, systems theory acknowledges a more complex structure to creativity, in which creative training alone will not ensure creativity.

Nurturing cognitive and affective factors such as motivation is important. When intrinsic motivation is overlooked, teachers and students concentrating on creativity tend to emphasize the mechanics of creativity rather than the motivation that triggers the stimulus necessary for getting involved in creative acts. Being unaware of the motivational disposition of students deters teachers from focusing on motivation in a systematic manner, and exploiting the potential creative capabilities of students to a maximum.

As evidenced by these results, motivation in creativity is an extremely complex area which has more recently been studied in ways outside the motivation construct of intrinsic and extrinsic motivation. Using a sample of college students, Grant and Berry (2011) examined how creativity (measured with the CAT) was positively influenced by the interaction of high intrinsic motivation and prosocial motivation, which is the desire to benefit others and look at the perspective of others. The effect of the desirability of the extrinsic reward on creativity was explored as well (Eisenberger & Byron, 2011). While much has been done, other areas of exploration in this area would enrich understanding of how motivation affects creativity.

The work of Grant and Berry highlights the importance of further investigation into the complex relationship between creativity and motivation. Beyond interactive effects, moderating and mediating variables should be considered, particularly in an academic environment. Moderator variables, such as gender or instructor grades, may strengthen a relationship between motivation and creativity. Males may prefer extrinsic motivators to express creativity; low instructor grades may inhibit the risk-taking behaviors necessary for creativity (Kaufman, 2015). Mediator variables, such as the

particular instructor or the type of project assignment may explain how motivation affects creativity. Some instructors may leverage intrinsic motivation better than others, yielding greater creative product; a service learning project may inspire greater creativity as it appeals as a prosocial motivation.

Beyond the "person" model variables (cognitive abilities, personality, and motivation), there is about 69.2% of the variability in creativity unexplained by our variables. While we have argued that education often nurtures our included variables, there are certainly other individual aptitudes whose effect on creativity has been studied. These include affective factors such as perseverance, grit, self-efficacy (Sternberg & Lubart, 1995; Zhang & Sternberg, 2011) and growth mindset (Csíkszentmihályi, 1996). The effect of education on such factors regarding creativity is unexplored, yet recent studies have called for exploration of how educational intervention can nurture such factors as perseverance and grit (Robinson, 2016; Rojas et al., 2012) and creative mindset (Karwowski, 2014). Knowledge proficiency in the domain of interest

Classrooms of all kinds would do well to create environments that allow for and foster students' intrinsically motivated creativity. Within the umbrella of intrinsic motivation, Amabile, Hill, Hennessey, and Tighe (1994) defined the dimensions of enjoyment and challenge, which were included in WPI secondary scales. Ryan and Deci (2000) included interest and choice within a self-deterministic construct of intrinsic motivation. Therefore, to support intrinsic motivation, the instructor must implement teaching and learning activities that are both stimulating and enjoyable, and that offer students a degree of personal control. Yet fostering intrinsic motivation can be slow to affect behavior and can require special and lengthy preparation. Students are individuals,

so a variety of approaches may be needed to motivate different students (DeLong & Winter, 2000). A current trend which meets the goals of interest, challenge and choice is the concept of "maker-spaces" (Sheridan et. al, 2014) and "genius hour" (Juliano, 2014) in schools where students can freely explore and create according to their own interests. Such spaces support creativity in both the arts and STEM areas.

Fortunately, as we have need for further understanding of how to nurture other factors important to creativity, we have a method that succeeds in measuring creativity in an academic environment. In our higher education venue, the reliability and validity of the CAT was strong. The difficulty in distinguishing the usefulness component of the creativity cluster may even provide needed direction in future research in creativity and motivation. Grant and Berry (2011) felt that intrinsic motivation encouraged a focus on novelty, and that prosocial motivation encouraged a focus on usefulness and called for further research in the area. CAT judges perceived the novelty component well, yet the usefulness component was not as well discriminated. Further research might use architectural assignments with a prosocial motivation such as: building designs for a cathedral destroyed by the 9/11 bombings, or for a living community for battered wives or Alzheimer's patients.

With the support of the CAT assessment tool to measure academic efforts in improving creativity, and deepening understanding of the qualities that contribute to creativity, we can make great progress in promoting creativity in education.

Appendix A

Definitions of Research Study Variables

Research Variable	Definition	Source
Divergent thinking (DT)/ Convergent thinking	DT – the process of generating multiple solutions to a problem CT – the process of deducing a single solution to a problem	Guilford (1950)
General Intelligence (*g*)	The general cognitive ability that consistently differentiates individuals on mental abilities regardless of cognitive task or test.	Carroll, 1993
Personality: Openness (O)	Active imagination, aesthetic sensitivity, attentiveness to inner feelings, preference for variety and intellectual curiosity	McCrae & Costa, 1985
Personality: Conscientiousness (C)	Tendency to show self-discipline, act dutifully, and aim for achievement against measures or outside expectations. It is related to the way in which people control, regulate, and direct their impulses. Preference for planned rather than spontaneous behavior	McCrae & Costa, 1985
Personality: Extraversion (E)	Tendency to obtain gratification from outside oneself, to be enthusiastic, talkative, and assertive.	McCrae & Costa, 1985
Personality: Agreeableness (A)	Preference for social harmony. Generally considerate, kind, generous, trusting and trustworthy, helpful, and willing to compromise their interests with others.	McCrae & Costa, 1985

Personality: Neuroticism (N)	Tendency to experience negative emotions, such as anger, anxiety, or depression; sometimes known as emotional instability	McCrae & Costa, 1985
Motivation: Intrinsic	Motivated by enjoyment and interest in the task; interest in understanding new material	Ryan & Deci (2000)
Motivation: Extrinsic	Motivated by external reward such as tangible rewards, positive evaluation, feeling of task mastery.	Ryan & Deci (2000)

Studies of Aptitudes and Correlation with Creativity

Aptitude	Authors	Assessment	Correlation with creativity measure
Personality O:	Jauk, Benedek, & Neubauer, 2014	Self-reporting of creative achievement/activities	positive
	Batey, Chamorro-Premuzic and Furnham (2009)	Runco Ideational Scale, self-reporting	positive
	Silvia& Beaty (2012)	Creative Metaphor Production	positive
	Wolfradt & Pretz (2001)	Creative ratings of stories production by experts, self-reporting of creativity & Creative Personality Scale scores	positive
	Furnham, Zhang, Chamorro (2006)	Self-reported Creativity Barron-Welsh Creativity Test	positive positive
E:	Furnham & Bachtiar, (2008)	Self-reporting of creative behavior	positive
	Silvia & Nusbaum, 2012	Creativity of college major (arts higher?)	positive
	Roy (1996)	Creativity of artist vs non-artists as profession	negative
	Chiang, Hsu, Shih (2015)	Employer creativity rating In workplace of R&D engineers	positive
	Furnham, Zhang, Chamorro (2006)	Self-reported Creativity Barron-Welsh Creativity Test	No relationship No relationship
	Feist (1998)	Product creativity – published / distinguished work of artists and scientists	Artists-Negative Scientists - Positive
N:	Furnham, Zhang, Chamorro (2006)	Self-reported Creativity Barron-Welsh Creativity Test -scoring of visual drawings -artistic creativity	No relationship No relationship
	Gelada (1997)	Based on occupation – UK creative advertising	Negative

		designer's vs managers of mainstream UK companies	
C:	Chamorro-Premuzic (2006)	Student Performance on Dissertations/projects/exams	Negative
	Wolfradt & Pretz, (2001)	Creative ratings of stories production by experts, self-reporting of creativity & Creative Personality Scale scores	Negative
	Furnham, Zhang, Chamorro (2006)	Self-reported Creativity Barron Welsh Creativity Test	Positive No relationship
A:	Feist (1998)	Product creativity – published / distinguished work of artists and scientists	Negative
	Furnham, Zhang, Chamorro (2006)	Barron-Welsh Creativity Test -scoring of visual drawings -artistic creativity	No correlation
Intrinsic/ Extrinsic Motivation	Amabile, 1985	Consensual Assessment Technique (tangible reward)	+ (Intrinsic Motivation)
	Greer & Levine (1991)	Consensual Assessment Technique (writing intrinsic motivation questionnaire)	+ (Intrinsic Motivation)
	Shalley (1995)	Consensual Assessment Technique (expert evaluation)	+ (Extrinsic Motivation)
	Dewett (2007)	Product Eval by Supervisor/	+ (Intrinsic Motivation)
		Self-report of creative accomplishments and public accolades	** No correlation with motivation
	McCrae (1987)	6 DT tests – (Christensen & Guildford: Ideational Fluency, Expressional Fluency, Word Fluency, Consequences & Obvious and Remote Consequences (1957/8)	+
Cognitive Divergent thinking	Plucker (1999)	TTCT/Public Creative Achievement Inventory	Positive
	Runco, Millar, Acar, & Cramond (2010)	TTCT/Personal & Public Creative Achievement Self-reporting	Positive

	Torrance (1972)	TTCT/Creative Achievement Self-reporting	Positive
	Runco (1986)	Wallach-Kogan Divergent thinking tests/ Creative self-reporting	High IQ + Non-gifted -
	Runco & Albert (1986)	5 different DT tests, including Wallach-Kogan	+ /Threshold effect
_g_	Yamamoto (1964)	DT tests (TTCT)	+ Threshold Effect
	Kim (2005)	Meta-analysis (Various)	+

Consensual Assessment Technique Studies

Study Authors/Year	Product Task	Incentive/Setting
Wolfradt & Pretz, 2001	Writing story about a Picture (Gf/Gc-creativity)	No incentive/Higher education
Silvia & Beaty, 2012	Writing creative metaphors (Gf/Gc-creativity)	Participation credit hour/Higher education
Shalley, 1995	Design solutions for human resource problems (motivation-creativity)	Creativity goal (intrinsic) or supervisor evaluation/ Workplace setting
Baer, 1993	Making collages (DT-creativity)	Intrinsic / 5th grade school setting with instructional intervention
Greer & Levine, 1991	Writing Haiku poem (motivation-creativity)	Guided imagery techniques of fantasy, intrinsic motivation, combined fantasy & intrinsic motivation/ Higher education

Freshman Architectural Design Project

SW University

School of Architecture, Art and Historic Preservation

ARCH 113: Architectural Design Core Studio 1

Fall 2016

Faculty: Aaron Brodejana

Dane Clark

Karen Hughes

Melissa Hutchinson

Kris Lawson

Anastasia Laurenzi

Anthony Piermarini [Coordinator]

BG Shanklin

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Project 5

A Field, An Object, A Ritual: Pavilion and Gallery at Mt. Hope Farm

Project Outline:

 The Trustees of the Mt. Hope Farm are seeking to develop a new Pavilion and Landscape on their historic grounds. The venue is intended to expand upon the existing operations of the facility as a cultural center and events destination for Bristol. Mt. Hope Farm has historical and architecturally significant structures, listed in the National Register of

Historic Sites and Places. Students are to read more about the history of the site on the website [www.mounthopefarm.org]

The new Pavilion and Landscape, will host a range of events and provide a new venue for local artist to display their work. The Mt. Hope Farm currently accommodates a Bed and Breakfast at the Governor Bradford Inn, a seasonal outdoor farmers market, and currently has three event locations within its historic grounds. They include the Barn, the Gardens, and Cove Cabin. With the addition the new facilities, the farm will be able to host events and celebrate the history of the site and expand its mission as patron of culture and architecture.

The pavilion will host a range of functions and as such will have certain spatial requirements, let's call this the program. The new facilities will have a new art gallery for local artists, a multipurpose hall for larger gatherings and performances and related supporting spaces. The relationships between spaces and approach to making for this project is to be informed by the investigations students have established in Projects 3 and 4. Students are not expected to start over, but to further refine their projects, through iteration to incorporate the new physical site and programmatic considerations.

Outline Program Requirements:

Gallery Space – 4 Season Space

Include ideas and spaces generated in project 4 – i.e. Observation Space, Contemplation Space, and Thresholds. This Gallery will host a changing venue of items, potentially including the Curious Object and its Display Device to educational purposes (lectures, seminars, yoga, etc…). The space should have a strong connection to the outdoor sculpture garden and ample diffuse natural lighting.

Multipurpose Space – 3 Season Space – hosts 250 people.

This is space is intended to host various events and performances, as such it must be fairly flexible in its configuration. The space should take advantage of the grounds, the landscape and connections to the outdoor spaces to allow for various types of celebratory rituals.

Outdoor Function Area(s) and Sculpture Garden

The new building is intended to take advantage of the magnificent setting of the Historic farmlands and provide places for people to gather socially. To promote various events, a Bon-Fire pit and Grilling areas are to be included for evening venues. Mt. Hope Farm also has the potential to be a great setting for the appreciation of art therefore a sculpture garden is to be provided for rotating exhibitions.

Support Spaces:

These spaces are critical to proper function of this event area, and as service and support spaces, they play a significant role in the organization of all buildings. However they do not necessarily need to be attached to the pavilion, they may be part of a separate structure that compliments the gallery and the multipurpose space. Interestingly, these are the spaces where staff and guests intermingle, the social and spatial relationships are often established through the dynamics between service and served spaces. Below is a list of support spaces that need to be accommodated.

Bathrooms – 200 sf (2)

Catering Kitchen – 1000 sf – convenient to the Gallery and Multipurpose Space Misc Storage Area – 500 sf

Loading Area – 500 sf – this must have delivery truck access and be convenient to the gallery storage/workshop and multipurpose spaces.

Process:

This project will work through a series of meta-projects or "stages" as outlined in the schedule below. The sequence is intended to guide students through the various considerations that a project of this complexity involves.

Project Schedule:

Week 1

T Oct 22   Final Review Projects 3&4

Issue Project 5 and Meta Project "Stage 1": Site Readings/Recordings

W   Nov 24 – No Classes Held – Thanksgiving Break

T Nov 25 – No Classes Held – Thanksgiving Holiday

Week 7

M   Nov 30 – Desk Crits

W   Dec 2 – Desk Crits

T Dec 3 – Desk Crits

Final Review Date has not been released - TBD

Definitions:

prefix: meta-; prefix: met-

: more comprehensive : transcending <metapsychological> —usually used with the name of a discipline to designate a new but related discipline designed to deal critically with the original one.

SW University

School of Architecture, Art and Historic Preservation

ARCH 113: Architectural Design Core Studio 1

Fall 2016

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PROJECT 5 – MASTER DRAWING

A drawing should be an investigative device, a voyage of discovery, a series of glances into the

future. 'Oh my God, was that what it was about?' seems to be a reasonable conclusion.

-Peter Cook

Cook, Peter. "Looking and Drawing." *Architectural Design – Special Issue: Drawing Architecture* 83.5(2013): 80.

Schedule:

Assigned: Monday, November 23

Due: Thursday, December 3 – Project 5 Final Review

Readings:

From <u>Architectural Graphics</u> – 5th <u>Ed.</u> by Francis D. K. Ching, read "Perspective Drawings," pages 101-140.

Objectives:

1. To examine architectural drawing techniques for representing experience, space, form, edge, light, shadow, color and depth.

2. To introduce varied media and techniques for architectural drawing.

3. To understand the power of drawing as a means for exploring and conveying experience in architecture.

Introduction:

To draw space is to inhabit space. The act of drawing is at once a leap into the unknown and an opportunity to define it. In order for the hand to make a mark the mind must make a decision. What happens here? How does the light get in? What is the texture of the surface? As the hand navigates the page the mind moves through the space. This is the making of architecture.

The drawing media we choose and the techniques we employ affect the way we understand the space being drawn. You will be inspired by the choices of master architectural drawings to explore the space of your pavilion with a large final experiential perspective drawing. From a set of inspiration drawings provided, you will choose one to analyze and to inspire the media and techniques used for this perspective drawing of your pavilion.

Process:

In class today, carefully analyze the media and techniques of the inspiration drawings provided and choose one that aligns with the design intent and desired experience of your pavilion. Discuss media and drawing surface options in relation to your chosen inspiration drawing with your instructor.

For Monday, November 30:

Complete the reading posted on Bridges. Acquire any media you need to draw in the spirit of your inspiration drawing. Final drawings shall fill a large sheet of paper – approximately 24" x 36" or similar size as available in your chosen medium. Purchase two sheets of paper - one for your final drawing plus another for analysis diagrams and experimentation with media.

Complete the following analysis diagrams by looking carefully at your inspiration drawing and reproducing its techniques *using your chosen media*:

- Draw an instance of transition between light and shadow from your inspiration drawing

- Draw an interior corner from your inspiration drawing, pay attention to tonal change

- Draw an edge with space behind it from your inspiration drawing, pay attention to tonal change

- Draw an achromatic value scale (grayscale) capturing the range of lights and darks in your inspiration drawing

- Draw a chromatic value scale capturing a color present in your pavilion and how your inspiration drawing's author would alter it based on intensity, light and shadow.

In your sketchbook, sketch three options for your final perspective view. At least one of the three views must be a section perspective. Consider the experience your drawing will explore and how your choice of view

and composition will convey your design intent. Carefully choose horizon line height, center of vision and vanishing point location(s) to enhance the sense of being within your project. All options are to be drawn *at eye level*. While these are reduced scale sketches, they should acknowledge the proportions of your final paper and explore how your drawing will inhabit the page.

In Class Monday, November 30:

Choose your final perspective view with your instructor's input. Draft your final view at full scale on trace paper or directly on your final drawing surface. Use a light hand for construction lines.

Re-draw your project's parti diagram at 4" x 4" using your final drawing media.

For Wednesday, December 2:

Invest completely in the experience of drawing your final perspective view. Be open to the influence of the media you use on your exploration of space. Take chances, make discoveries, draw with heart. Your drawing must be 90% complete before class begins on Wednesday.

In Class Wednesday, December 2 and for Final Review Thursday, December 3:

Complete your final perspective drawing and make adjustments based on the feedback of your instructor and peers. Prepare for and organize your final project presentation. Get some rest.

Alternate Uses Task

Student ID #_____

1. Take up to 15 minutes to think of as many uses as you can for strong adhesive tape such as electrical tape. (You pick color). Write each of your ideas in the space below.

2. Take up to 15 minutes to think of as many uses as you can for a paper napkin. Write each of your answers in the space below.

Big Five Inventory

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who *likes to spend time with others*? Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement.

Disagree strongly ~ Disagree a little ~   Neither agree or disagree ~ Agree a little   ~ Agree strongly

----------**1**----------**2**---------**3**-----------**4**-----------**5**--------

I see myself *as someone who …*

___ 1. is talkative

___ 2. tends to find fault with others

___ 3. does a thorough job

___ 4. is depressed, blue

___ 5. is original, comes up with new ideas

___ 6. is reserved

___ 7. is helpful and unselfish with others

___ 8. can be somewhat careless

___ 9. is relaxed, handles stress well

___ 10. is curious about many different things

___ 11. is full of energy

___ 12. starts quarrels with others

___ 23. tends to be lazy

___ 24. is emotionally stable, not easily upset

___ 25. is inventive

___ 26. has an assertive personality

___ 27. can be cold and aloof

___ 28. perseveres until the task is finished

___ 29. can be moody

___ 30. values artistic, aesthetic experiences

___ 31. is sometimes shy, inhibited

___ 32. is considerate and kind to almost everyone

___ 33. does things efficiently

___ 34. remains calm in tense situations

___ 13. is a reliable worker

___ 14. can be tense

___ 15. is ingenious, a deep thinker

___ 16. generates a lot of enthusiasm

___ 17. has a forgiving nature

___ 18. tends to be disorganized

___ 19. worries a lot

___ 20. has an active imagination

___ 21. tends to be quiet

___ 22. is generally trusting

___ 35. prefers work that is routine

___ 36. is outgoing, sociable

___ 37. is sometimes rude to others

___ 38. makes plans and follows through with them

___ 39. gets nervous easily

___ 40. likes to reflect, play with ideas

___ 41. has few artistic interests

___ 42. likes to cooperate with others

___ 43. is easily distracted

___ 44. is sophisticated in art, music, or literature

Please check: Did you write a number in front of each statement?

List of Instrument Reliability Scores:

Instrument	Reliability (α=)
AUT (Silvia et. al., 2008)	Based on number of raters(): (1):0.70 (2): 0.82 (3): 0.87 (4): 0.90 5(5): 0.92
WPI (Amabile et al., 1994)	Internal reliability:.78-.79 Test-retest reliability: (.84 intrinsic/94 extrinsic) Long term stability: (.67 to.85)
BFI – openness (John, Donahue, & Kentle, 1991)	.81
BFI – agreeableness (John, Donahue, & Kentle, 1991)	.79
BFI – conscientiousness (John, Donahue, & Kentle, 1991)	.82
BFI – extraversion (John, Donahue, & Kentle, 1991)	.88
BFI – neuroticism (John, Donahue, & Kentle, 1991)	.84
BFI – 3-month test-retest reliability	.80 to.90
Gf -SAT-Math (Frey & Detterman, 2004)	.82
Gc – SAT-Verbal	.87 (Coyle & Pillow, 2008).92 (Frey & Detterman, 2004)
CAT (Amabile, 1996)	.70 to.93

Appendix H

Work Preference Inventory
College Student Version
Teresa M. Amabile, Ph. D

Please rate each item in terms of how true it is of you. Please <u>circle</u> one and only one letter for each question according to the following scale:

N = Never or almost never true of you
S = Sometimes true of you
O = Often true of you
A = Always or almost always true of you

N	S	O	A		
N	S	O	A	1.	I am not that concerned about what other people think of my work.
N	S	O	A	2.	I prefer having someone set clear goals for me in my work.
N	S	O	A	3.	The more difficult the problem, the more I enjoy trying to solve it.
N	S	O	A	4.	I am keenly aware of the goals I have for getting good grades.
N	S	O	A	5.	I want my work to provide me with opportunities for increasing my knowledge and skills.
N	S	O	A	6.	To me, success means doing better than other people.
N	S	O	A	7.	I prefer to figure things out for myself.
N	S	O	A	8.	No matter what the outcome of a project, I am satisfied if I feel I gained a new experience.
N	S	O	A	9.	I enjoy relatively simple, straightforward tasks.
N	S	O	A	10.	I am keenly aware of the GPA (grade point average) goals I have for myself.
N	S	O	A	11.	Curiosity is the driving force behind much of what I do.
N	S	O	A	12.	I'm less concerned with what work I do than what I get for it.
N	S	O	A	13.	I enjoy tackling problems that are completely new to me.
N	S	O	A	14.	I prefer work I know I can do well over work that stretches my abilities.
N	S	O	A	15.	I'm concerned about how other people are going to react to my ideas.
N	S	O	A	16.	I seldom think about grades and awards.
N	S	O	A	17.	I'm more comfortable when I can set my own goals.
N	S	O	A	18.	I believe that there is no point in doing a good job if nobody else knows about it.
N	S	O	A	19.	I am strongly motivated by the grades I can earn.
N	S	O	A	20.	It is important for me to be able to do what I most enjoy.
N	S	O	A	21.	I prefer working on projects with clearly specified procedures.
N	S	O	A	22.	As long as I can do what I enjoy, I'm not that concerned about exactly what grades/awards I receive.
N	S	O	A	23.	I enjoy doing work that is so absorbing that I forget about everything else.
N	S	O	A	24.	I am strongly motivated by the recognition I can earn from other people.
N	S	O	A	25.	I have to feel that I'm earning something for what I do.
N	S	O	A	26.	I enjoy trying to solve complex problems.
N	S	O	A	27.	It is important for me to have an outlet for self-expression.
N	S	O	A	28.	I want to find out how good I really can be at my work.
N	S	O	A	29.	I want other people to find out how good I really can be at my work.
N	S	O	A	30.	What matters most to me is enjoying what I do.

Appendix I

Consensual Assessment Technique Scoring Sheet for Judges

(For each of your projects, rate them based on the following criteria on a scale
of 1 (Lowest) to 7 (Highest)

Dimensions of Creativity Judgement	Lowest (1)	Very Low (2)	Medium Low (3)	Medium (4)	Medium High (5)	Very High (6)	Highest (7)
Novelty							
Usefulness							
Appropriateness							
Technical correctness							
Organization							
Neatness							

Appendix J

Confirmatory Factor Analysis
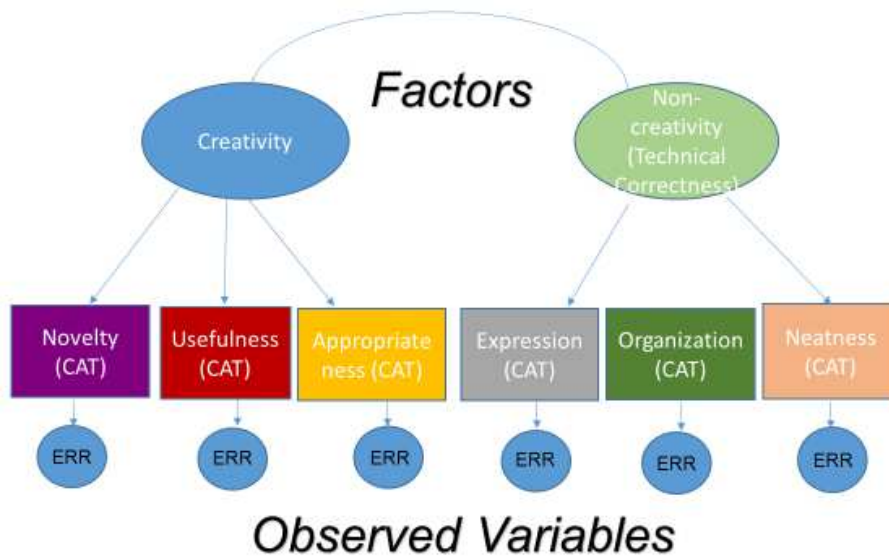
Complete Bivariate Correlation List for Explanatory and Dependent Variables

Correlations

		Creativity	Open	Conscien	Extra	Agree	Neurotic
Creativity	Pearson Correlation	1	.243*	.207	-.197	-.223	.201
	Sig. (2-tailed)		.012	.081	.096	.059	.090
	N	90	90	90	90	90	90
Open	Pearson Correlation	.243*	1	.261*	.199	-.271*	.272*
	Sig. (2-tailed)	.012		.027	.093	.021	.021
	N	90	90	90	90	90	90
Conscien	Pearson Correlation	.207	.261*	1	-.040	-.052	.100
	Sig. (2-tailed)	.081	.027		.737	.663	.404
	N	90	90	90	90	90	90
Extra	Pearson Correlation	-.197	.199	-.040	1	.044	.107
	Sig. (2-tailed)	.096	.093	.737		.716	.369
	N	90	90	90	90	90	90
Agree	Pearson Correlation	-.223	-.271*	-.052	.044	1	.134
	Sig. (2-tailed)	.059	.021	.663	.716		.260
	N	90	90	90	90	90	90

Neurotic	Pearson Correlation	.201	.272[*]	.100	.107	.134	1
	Sig. (2-tailed)	.090	.021	.404	.369	.260	
	N	90	90	90	90	90	90
EX	Pearson Correlation	-.209	-.178	.128	-.014	.118	-.081
	Sig. (2-tailed)	.078	.134	.285	.906	.323	.497
	N	90	90	90	90	90	90
IN	Pearson Correlation	.433[**]	.140	.132	-.173	-.012	.143
	Sig. (2-tailed)	.000	.236	.268	.146	.921	.231
	N	90	90	90	90	90	90
SAT	Pearson Correlation	-.068	.224[*]	-.005	.224	-.064	.039
	Sig. (2-tailed)	.536	.047	.968	.058	.595	.745
	N	90	90	90	90	90	90
AUT	Pearson Correlation	.266[*]	-.130	-.157	.024	.076	.069
	Sig. (2-tailed)	.013	.253	.187	.839	.528	.563
	N	90	90	90	90	90	90

Correlations

		EX	IN	SAT	AUT
Creativity	Pearson Correlation	-.209	.433[**]	-.068	.266[*]
	Sig. (2-tailed)	.078	.000	.536	.013
	N	90	90	90	90

Open	Pearson Correlation	-.178	.140	.224*	-.130
	Sig. (2-tailed)	.134	.236	.047	.253
	N	90	90	90	90
Conscien	Pearson Correlation	.128	.132	-.005	-.157
	Sig. (2-tailed)	.285	.268	.968	.187
	N	90	90	90	90
Extra	Pearson Correlation	-.014	-.173	.224	.024
	Sig. (2-tailed)	.906	.146	.058	.839
	N	90	90	90	90
Agree	Pearson Correlation	.118	-.012	-.064	.076
	Sig. (2-tailed)	.323	.921	.595	.528
	N	90	90	90	90
Neurotic	Pearson Correlation	-.081	.143	.039	.069
	Sig. (2-tailed)	.497	.231	.745	.563
	N	90	90	90	90
EX	Pearson Correlation	1	-.360**	-.011	.043
	Sig. (2-tailed)		.002	.925	.721
	N	90	90	90	90
IN	Pearson Correlation	-.360**	1	-.187	-.035
	Sig. (2-tailed)	.002		.102	.762

	N	90	90	90	90
SAT	Pearson Correlation	-.011	-.187	1	.064
	Sig. (2-tailed)	.925	.102		.560
	N	90	90	90	90
AUT	Pearson Correlation	.043	-.035	.064	1
	Sig. (2-tailed)	.721	.762	.560	
	N	90	90	90	90

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

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