

INCREASING CREATIVITY IN DESIGN EDUCATION:
MEASURING THE EFFECT OF COGNITIVE EXERCISES ON STUDENT CREATIVITY

by

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B.S., Brigham Young University, 2006
M.L.A., Kansas State University, 2009

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Environmental Design and Planning
College of Architecture, Planning and Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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Abstract

Creativity is vital to the design professions although there is not a common understanding among designers about the nature of creativity. Designers need a model of creativity that helps place the importance of creativity in the design process and informs educators about how to better enhance creativity in their students. Merrill's Model of Creativity in Design (Merrill & Rolley 2012) was developed by the researcher and served as the framework for exploring the effect of an academic intervention on the creativity of college freshman design students in order to answer the question: Does participating in an academic intervention affect the creativity of first-year, three-dimensional design students, as measured by the Figural Torrance Test of Creative Thinking?

A mixed methods approach allowed development of a rich field of data for analysis as well as a body of student work and experiences. Design students were taught creativity techniques in addition to completing short exercises during a one-hour weekly seminar class, Design Thinking and Creativity. These students were compared to a control group of students utilizing a modified Solomon four-group non-equivalent control group quasi-experimental research design, adapted from Campbell and Stanley (1966). A paired t-test compared post-test scores between the treatment group ($n=70$) and the control group ($n=18$). Qualitative data was also collected including a demographic survey, a Creative Self-Assessment, and interviews.

The treatment group, on average, ($M=113.53$, $SE=1.82$) scored significantly higher than the control group on the post-test administration of the FTTCT ($M=104.78$, $SE=3.41$), $t(84)=-2.22$, $p<.05$, $r=.06$). An analysis using Spearman's Rho determined a significant correlation between individual participant's scores on three assessments of individual student creativity, which focused on the individual's creative cognitive abilities; however, there was no significant correlation with the final creativity project. These findings show that deliberate creativity education coupled with creativity exercises allowed students to slightly raise their creativity while the creativity of their peers dropped. Analysis of qualitative data revealed high student confidence and commonalities in defining creativity. This study demonstrates that an academic intervention can improve the creativity of beginning design students and provides a theoretical framework for future creativity research and teaching.

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Dedication

To my boys.

Chapter 1 - Introduction

Overview

This dissertation investigates the effects of a semester-long academic intervention on the creativity of beginning three-dimensional design students. An overview of the relevant literature surrounding creativity in three-dimensional design is presented along with a model of creativity in design students that offers a new way to understand creativity in design. The research methodology for studying creativity in design students is outlined, and the findings of the research reported. A discussion of the findings of the research and potential future research is offered.

Definition of Terms

For the purposes of this research the following definitions were used:

Creativity: Creativity is the process that results in novel and appropriate solutions that are judged to be tenable and high in quality (Merrill & Rolley, 2012).

Three-dimensional designer: The design fields of architecture, interior design [architecture], product and industrial design, urban and landscape design [architecture], all which require the designer to produce beautiful and also practically useful and well-functioning end products (Lawson, 2006).

High in quality: The term high in quality deserves specific attention. According to Geraldine Craig, the term “high in quality” was used as by the white privileged male as criteria to exclude women and African American artists out of shows (personal conversation, December 5, 2013). This negative connotation is not common among designers. For the purpose of this dissertation High in Quality refers to work that demonstrates depth of thought, application of skill, and cultural resonance (G. Craig, personal conversation, December 5, 2013).

Background

Early in my doctoral studies I had the opportunity to teach a beginning design studio. I had just completed my Master’s degree in landscape architecture and was excited to share that knowledge. As a person transplanted to the field of landscape architecture after receiving a

degree in psychology, I went into that beginning design classroom with the presumption that freshman students who had self-selected a design major would be creative bundles of rebellious angst, hungry to prove how far they could push the envelope. Instead of reining the students in, I was the one cajoling them to test the boundaries of the assignments. I was amazed that the students would quickly settle on a single idea; refuse to explore varying options; and not demonstrate any imagination in their work.

In conversations with students it became apparent that the work they arrived expecting to do was simply that of a draftsman. They wanted me to dictate exactly what to do for each design problem. To become proficient designers the students would need to learn to do more than just follow instructions. Designers frame problems, generate multiple solutions, explore the reach of the possibilities of the various solutions, select the option to pursue, and work out the details—all the while making adjustments to fit the emerging or changing constraints of the project. A major missing link between the draftsman mentality many students had and that of a designer, was creativity. It was at this point that I became interested in creativity as the subject for my doctoral studies.

In the early stages of my research into creativity, I approached a well-known psychology professor on campus to discuss creativity. When I mentioned that I was interested in studying creativity, he responded, “You can’t measure creativity.” I was surprised to realize that there may not be universal agreement on what creativity was nor how to measure it. Upon further inquiry, I found a longitudinal study of the creativity of American children using the Torrance Test of Creative Thinking. This research recently reported that the creativity of elementary students in the United States is declining (Kim, 2011). Long time, experienced professors have lamented “No Child Left Behind” policies that had changed the educational environment for the newest generation of students, with education expert Sir Ken Robinson asserting that current educational practices stifle creativity (2011). It was in this atmosphere that I began to envision the unnerving possibility of a generation of students who were not only incapable of creativity but had no motivation to do so. I wondered if it was already too late, or could these students be taught to be creative?

Creativity and Design

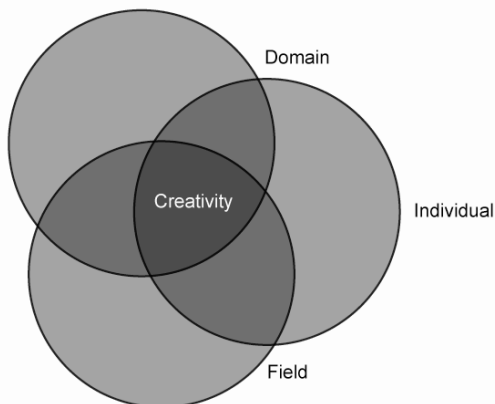
There is a tacit understanding, within the practice of design, that creativity plays an important role. However, though creativity is acknowledged as essential there is no common definition of creativity nor an understanding of how to teach creativity in the design studio. While some psychologists believe that creativity cannot be taught, defined, measured, nor understood, others claim that creativity is a mystic process, spontaneous inspiration, or a number of other creativity myths (Sawyer, 2006), and it is not within the realm of educators to address creativity.

Psychologists have tackled these ideas for a number of years, generating many theories and models of creativity but, unfortunately, they are not adapted specifically to design education. Some United State's universities have begun to implement academic programs focusing on creativity in undergraduate education (Berrett, 2013), but design educators need effective models and techniques for teaching creativity specifically to design students.

Theoretical Framework

The psychologist Mihaly Csikszentmihalyi changed the nature of creativity research when he changed the question from “What is creativity?” to “Where is creativity?” (2004). Csikszentmihalyi proposes that creativity lies at the intersection of three interrelated but distinct constructs: the domain, the field, and the individual as illustrated in Figure 1-1.

Figure 1.1 Author's interpretation of how creativity occurs within the interactions of the domain, the field, and the individual, based upon the work of Csikszentmihalyi.



In brief, the domain is the set of symbols and procedures used to communicate the individual's product to others within that individual's field. The field is composed of the other

individuals using the same set of symbols. The individual is the person who is striving to create something. As Csikszentmihalyi explains, the members of the field are the “gatekeepers” (2004, p. 28) of the domain. They are also the people who judge an individual’s product as creative or not. Creativity is a subjective judgment given to a product, at a certain point in time, by other individuals (Csikszentmihalyi, 2004). All three constructs (domain, field, and individual) are necessary for creativity to occur and be recognized. The three do not sit in isolated compartments; there is constant overlap between them.

Purpose Statement

The purpose of this research is to investigate the effects of a semester-long academic intervention on the creativity of first year three-dimensional design students.

Research Questions

The primary research question for this dissertation is: **Does participating in an academic intervention intended to teach creativity affect the creativity of first-year three-dimensional design students?**

This question is followed by secondary research questions:

What are the correlations between different measures of creativity?

How do first-year design students perceive their creativity?

How do first-year design students define creativity?

How does the definition of creativity differ between the researcher, student participants, and the field?

Design of the Study

Participating students enrolled in a course that was specifically intended to introduce concepts of creativity and how they directly relate to design. Over the course of the semester students became aware of various concepts and techniques related to creativity in design through direct instruction. Each week a different concept was presented to the students. Students gained an understanding of applying the concepts taught by completing short creativity exercise in class. Each week the products from the creative exercises were collected and assessed. At the end of the semester students completed a final design project. The weekly exercises and final exercise were used as a measure of the students’ creativity. The Figural Torrance Test of Creative

Thinking (Torrance, 2006) was administered to students at the beginning and the end of the semester and used to compare the creativity of students in the class with a control group.

Significance of Study

The significance of this research lies in its contribution to the literature of creativity through the lens of three-dimensional design. Since for the most part creativity research is conducted within the discipline of psychology.

Creativity is declining at the moment in history when it is needed most, especially in the realm of three-dimensional design. Designers are faced with the challenges of designing in a world of dramatic ecological change, limited resources, and dynamic social contexts. There is a need for a richer literature, more research, and a new model of creativity to help guide researchers, educators, and designers.

Chapter 2 - Literature Review

Introduction

This review of the literature begins with a look at creativity as defined by researchers from psychology and the design fields. The importance of creativity and design expertise is introduced followed by a more in depth look at the systems theory of creativity and how it applies to the fields of design. The systems theory of creativity proposed by Csikszentmihalyi is specifically applied as a framework for understanding creativity in design. The three systems defined by Csikszentmihalyi: the domain, field, and individuals are explored in the context of design. Finally, a new model of creativity for three-dimensional design is proposed based on analyzing and synthesizing different existing models of creativity through the lens of a designer.

Definitions

Defining “Creativity”

Review of contemporary literature across design and psychological disciplines reveals an active debate regarding the definition of creativity. Psychologists have been the most active in seeking definitions of creativity, having developed multiple definitions over the past sixty years. Their definitions are most often based on theoretic constructs that change between theoretical frameworks and even between researchers. In contrast, while the act of creativity is central to their work, whether implied or expressed, the design disciplines are remarkably silent on the definition of creativity. For this reason, this dissertation looks to other disciplines, primarily psychology, for an operational definition of creativity, as well as factors influencing creativity. Psychological literature provides the foundation for a model of creativity for three-dimensional designers.

As John F. Feldhusen concluded in his summary of various proposed definitions, “It can be seen that creativity is an extremely complex phenomenon that manifests itself as a set of processes within individuals” (1995). While the process of creativity is seen as a complex phenomenon, the fundamental definition is simple. A point of consensus in contemporary

literature is that in order for something to be judged as creative, it needs to be both novel and appropriate.

R. E. Mayer, in his review of definitions of creativity in the *Handbook of Creativity*, summarized that “there appears to be consensus that the two defining characteristics of creativity are originality and usefulness...” (Mayer, 1999, p 450). Mayer then concluded that creativity is the ability to produce work that is “both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)” (Sternberg & Lubart, 1999). In later years, Sternberg changed the Mayer definition to read: “Creativity is the ability to produce work that is both novel, (that is, original, unexpected), *high in quality*, and appropriate (that is, useful, adaptive concerning task constraints)” (Sternberg, 2003, pg. 89) (emphasis added by author). The addition of ‘high in quality’ speaks more directly to the end result of creative activity.

Theresa Amabile uses the following theoretical definition of creativity in her book, *Creativity in Context*. She states, “A product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic” (1996, p. 35). Amabile’s definition is useful to designers in two important ways. Firstly, Amabile’s definition of creativity includes the provisions that a creative product be both novel and appropriate. This emphasis on the creative product is especially relevant to the design fields, where a key aspect of design is the development of novel solutions to design problems. In addition to developing new ideas, designers must also judge the appropriateness of their solutions. Simply put, if one’s creative idea is not going to function in a particular situation, or if it will not solve a problem in a plausible way, then it is not valuable. Secondly, Amabile’s definition of a creative product introduces the idea that the problem, addressed by creativity, needs to be heuristic, meaning the path to the end solution or goals is not straight forward, rather than algorithmic. This is an important distinction because there is rarely a problem in design where there is a known and simple solution to a design question.

The term high in quality deserves specific attention. Accordingly to Geraldine Craig, the term “high in quality” was used as by the white privileged male as criteria to exclude women and African American artists out of shows (personal conversation, December 5, 2013). This negative connotation is not common among designers. For the purpose of this dissertation High in Quality

refers to work that demonstrates depth of thought, application of skill, and cultural resonance (G. Craig, personal conversation, December 5, 2013).

This dissertation applies the following definition of creativity synthesized from the definitions of Feldhusen, Mayer, Sternberg, and Amabile: **Creativity is the process that results in novel and appropriate solutions that are judged to be tenable and high in quality.**

Defining “Designer”

The definition of creativity used in this dissertation could apply to a wide range of practicing individuals and professions who use creativity in their work as designers. In a review of the literature on designers, Nigel Cross sought to define a designer by what they do. He states that designers “produce novel and unexpected solutions” and “apply imagination and constructive forethought to practical problems” (1990, p. 130). Bryan Lawson, an architect turned researcher, adopts Cross’s functional definition of a designer and narrows the scope to focus on a certain group of designers who operate in “the three-dimensional and environmental design fields of architecture, interior design, product and industrial design, urban and landscape design” (2006, p. 4). For the remainder of this dissertation, the term **“designer” will refer to a three-dimensional designer.**

The emphasis on three-dimensional designers is necessary because much of the research on creativity in design is gathered from the disciplines of architecture, landscape architecture, product design, industrial design, and urban design. These disciplines share similar creative processes due to the environment in which they work, the tools they use, and how they do their work. These disciplines also have specific commonalities in the nature of their professions, including using drawings as their primary communication tool, applying design procedures or methodologies to guide their work, having similar qualities and traits of expert designers, relying on the individual as their source of creativity, and in their definitions of design expertise.

Design expertise is critical to a meaningful discussion of creativity in design as it provides a common basis for discussing how designers operate. The literature on design expertise has focused on comparing the behavior and traits of novice designers to expert designers through the use of protocol studies (Cross, 2001). It is generally accepted that in order to be a design expert, one needs to spend time practicing within a specific domain. Cross emphasizes this point by stating that “Expertise is not simply a matter of possessing ‘talent’, but

is the result of a dedicated application to a chosen field” (2004, p. 428). Lawson asserts that success in design depends on “considerable technical knowledge and expertise, as well as being visually imaginative and [having the] ability to design” (Lawson, 2006, p. 4) Acknowledgement of the need for both creativity and expertise is relevant to this discussion because all the aspects of design that students need to succeed must be considered.

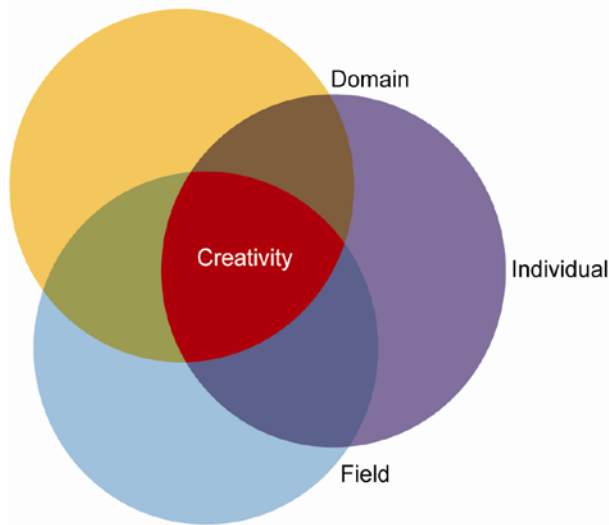
It is important to note that these theories are being analyzed and synthesized through the lens of one who has been trained as a three-dimensional designer. This translation of theory from the domain of psychology into three-dimensional design lends legitimacy to the model within the domain of three-dimensional design and is in line with the creation of theory that is uniquely design oriented. Julia Robinson describes this process in her paper, “Architectural Research: Incorporating Myth and Science” where she warns that, “The methods for doing this however, cannot be transplanted from other fields; they must become specifically architectural” (1990). Designers need to adopt and adapt outside methods of scientific inquiry to study architecture this adaptation is how outside methods become specifically architectural. She argues that there is more validity when a designer researches, studies, measures, and draws conclusions about designer.

Theoretical Framework

Systems Theory of Creativity

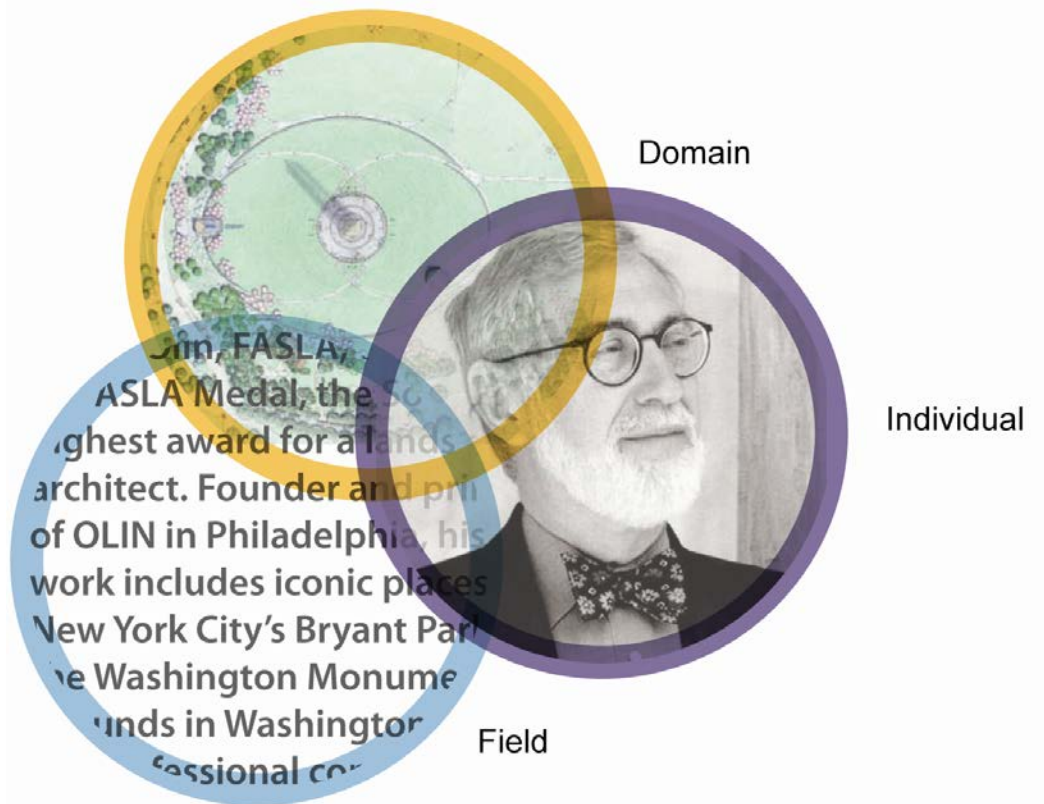
The psychologist, Mihaly Csikszentmihalyi changed the nature of creativity research when he changed the question from “What is creativity?” to “Where is creativity?” (2004). Csikszentmihalyi proposes that creativity lies at the intersection of three interrelated but distinct constructs: the domain, the field, and the individual as illustrated in Figure 2.1

Figure 2.1 Author's interpretation of how creativity occurs within the interactions of the domain, the field, and individual, based upon the work of Csikszentmihalyi (1996).



The domain is the set of symbols and procedures used to communicate the individual's product to others within that individual's field. The field is composed of the other individuals using the same set of symbols and procedures. The individual is the person who is striving to create something. As Csikszentmihalyi explains, the members of the field are the "gatekeepers" (2004, p. 28) of the domain. The members of the field are also the people who judge whether an individual's product is creative or not. Creativity is then a subjective judgment given to a product, at a certain point in time, by other individuals (Csikszentmihalyi, 2004). This interaction of the three components can be illustrated by using an example of a prominent contemporary designer, Laurie Olin. As illustrated in Figure 2.2, Laurie Olin is an individual landscape architect who produces designs. Olin uses the symbols and procedures of the domain of landscape architecture to communicate his designs. Figure 2.2 shows a rendering of landscape architectural improvements to the grounds surrounding the Washington Monument in Washington D.C., completed by Olin. The field of landscape architecture has recognized his work as being appropriate, novel, and high in quality. This recognition has reached the point where Olin has become a member of the field and is privileged to comment on the creativity of other urban designers.

Figure 2.2 Laurie Olin is an individual designer who works within the domain of landscape architecture to create places, which are seen as creative by design critics and other people. Images © Olin.



All three constructs (domain, field, and individual) are necessary for creativity to occur and be recognized. The three do not sit in isolated compartments; there is constant overlap and dynamic relationships between them. The following examines each of the three components separately to illustrate that component operates within designs.

Domain

As defined by Csikszentmihalyi, a domain is a set of symbols and a set of procedures used to communicate with others. This approach is of particular value to understanding creativity in designers because it allows one to understand both how a designer communicates and operates. This dissertation asserts that the symbols designers use fall into three categories: representations, design vocabulary, and finished products. The procedures used in design include professional practice procedures and design procedures.

Symbols

Representations

Designers use many different symbolic sets including drawings, model building, a shared vocabulary, and others introduced below. Of all these symbolic sets, the most familiar is representations. The act of creating representations that illustrate design intent as well as process is a defining role of three-dimensional design. Traditionally, designers have relied heavily upon drawings and models as the primary modes of communication.

It is hard to imagine a designer without visualizing the stereotypical caricature of an individual at the drafting board, pen in hand and an ever-mounting stack of drawings. There are of course multiple methods of approaching design such as computer aided drafting, pasted collage, and modeling with clay to name a few. Each individual discipline within the three-dimensional design domain is guided by a large collection of texts defining the purpose and conventions of drawings specific to their domain. Drawings are such an important part of the profession of design, that schools spend considerable amounts of time teaching students the standard conventions used in drawing.

Although there may be different drawing conventions within discrete three-dimensional design disciplines, they share the tenet that drawing is a way of thinking through problems in order to arrive at a solution and a means of communicating the solution to others. Drawing, as a thinking tool, will be visited again in a later discussion of the process of design. One strategy for understanding the place of drawings in the domain of three-dimensional design is to understand that there are a number of different kinds, or classifications, of drawings used by designers.

The first method for understanding the classification of drawings is to look at the different methods and theories of constructing drawings. This procedure is used by many textbooks intending to introduce the student to different types of drawings as well as how to construct them. For example, R. Yee and Francis Ching take the type and method approach to classifying drawings (Yee, 2007; Ching, 2004). Iain Fraser and Rod Henmi take another approach to classifying drawing in their book, *Envisioning Architecture, An Analysis of Drawing*. These authors attempted a classification system based on construction technique, as well as the intent of the drawing. Their classification system includes orthographic drawings, axonometric drawings, perspective drawings, referential drawings, diagrams, design drawings,

and visionary drawings. (Fraser and Henmi, 1994) Lawson (2004) eliminated construction technique from the list and based his classification solely on the intent of the designer. Lawson's classification system includes presentation drawings, instruction drawings, consultation drawings, experiential drawings, diagrams, fabulous drawings, proposition drawings, and calculation drawings (2004). Lawson's classification of drawings based on the intent of a drawing is utilized in this dissertation when discussing models.

Another type of representation used by designers is the model. Often models are implicitly included in the representation category of drawings, such as in Michael Brawne's book, *Architectural Thought*, where he combines "...marks on a two-dimensional sheet or screen and making exploratory three dimensional models" (2003, p. 83). For the purposes of this discussion, the category of models can be subdivided into two subgroups: the study model and the presentation model. The materials and size of these models can vary greatly depending on the intent of the designer. The study model is a model constructed by the designer in order to understand a design problem or to test a design solution. These study models are created with the intent of exploration on the part of the designer. The study model can also act as a communication tool to others. It is understood that the design exploration is unfinished or still in progress and that the model represents ideas being considered. The study model, as per the terminology of Donald Schön, facilitates a "conversation" with the design situation in three-dimensional space (1983). In contrast, the presentation model is intended to communicate the completed design solution or a portion of it.

Design Vocabulary

Another set of symbols that designers employ is the specific vocabulary they use in their written and spoken communication. It is not the purpose of this dissertation to explore and catalog the vocabulary specific to the three-dimensional designer, but to recognize that there is such a vocabulary and it may be employed when designers discuss and critique. This specialized vocabulary is used in evaluating the finished product and as a basis for considering creativity. Examples of design vocabulary texts are *Archispeak: An Illustrated Guide to Architectural Terms*, by Tom Porter (2004), as well as *Architecture: Form, Space, and Order*, by Francis Ching (2007).

Finished Products

The final category of communication symbols used by designers is the finished products resulting from a designer's efforts. Finished products include built works, final drawings, final models, and other products that present the culmination of design effort. Finished products are full of meaning. Therein other designers see nods to history, solutions to problems, and specific details and aesthetics. Designers use the finished products of others as inspiration for their own work. The attention given by various design journals and magazines to lavish, full-color photographs of finished products demonstrates how precious the finished product is to designers.

Procedures

Design employs a range of procedures that operate under different conditions to accomplish specific tasks. The first set of procedures is in place to protect public health, safety, and welfare, and is referred to in this dissertation as professional practice procedures. The second group of procedures is used to solve design problems and is referred to in this dissertation as design procedures.

Professional Practice Procedures

Practicing designers are required to pass licensure exams to ensure that individuals practicing within the various disciplines understand the legal, design, and other standards required of practitioners within the United States of America. For example, licensure exams for landscape architects are administered and managed by the Council of Landscape Architectural Registration Boards (CLARB). There are other criteria that designers adhere to including local, state, and federal regulations, and additional procedures depending upon the type and size of the professional practice. These procedures constitute the functional and technical protocols of expertise in designers.

Design Procedures

Perhaps the singular defining procedure for designers is the design process. This procedure both determines how designers work and, to a greater extent, how designers think. The entire design process consists of three components proposed by Lawson: the design problem, the design process, and the design solution (2006). See Figure 2.3. These components will be examined separately.

Figure 2.3 The author's illustration of the design process as explained by Lawson (2006).



The whole procedure of design begins with a problem. Typically, a client presents this problem to the designer. Quite often these problems are ‘wicked problems’ described by Horst Rittel and Melvin Webber as having no clear mission and no clear stopping point (1973). Lawson refers to ill-defined problems and wicked problems as design problems since they are the most commonly encountered problem designers face (2006). This inability to adequately solve a design problem until it is completely understood can be a daunting challenge. When a solution is proposed, often there are no objective criteria with which to judge its fitness to the design problem, and the solution is left to subjective interpretations. The nature of the client-designer relationship necessitates that there be a deadline for producing a design solution. Thus, frequently designers find themselves working through a problem while simultaneously learning about the problem and seeking a solution without clear measures of success, all on a tight deadline. This is the environment in which designers work, and this environment can be a catalyst for creativity. In an empirical study of creativity in design Bonnardel, asserts that constrained cognitive environments are necessary for creativity in design, (2000). Bonnardel describes constrained cognitive environments as constraints that designers work within. These constraints can originate from limitations that are internally based, such as lack of experience, or externally based such as budget constraints or the physical environment. Lawson provides anecdotes of famous designers explaining that their creativity usually is driven by the specific nature of the problem they face (2006). Design problems are full of uncertainty and designers have to understand and define the problem before they can generate options for solving the problem. Design problems are assessed using subjective interpretation and are time sensitive.

As a general definition, the design process can be described as “a series of events, stages, phases or states of energy which must be experienced before completing the entire journey” (Koberg & Bagnall, 1973, p. 16). Some designers argue that the design process is beyond observable study. This sentiment is summarized in the statement: “We believe that design is a mysterious and individual activity which is beyond description; it happens but is not amenable to

analysis” (Brawne, 2004, p. 19). All designers, however, do not share this belief as various designers and other researchers have attempted to articulate the design process.

While some designers and theorists articulate distinct phases in their process where creativity is necessary (Jones, 1963; Archer, 1984), other designers see the process as a way to guide creativity (Brand, 2008; Cross, 2004; Christiansen, & Dorst, 1994; Sasaki, 1950; Halprin, 1969; Koberg & Bagnall, 1973). Rather than presume when and where creativity is a part of design expertise, this dissertation recognizes that each individual applies creativity in his or her own way. The author assumes that creativity is needed in all phases of the design process, from understanding and properly framing the design problem, throughout the design process, and into the creation of presentation drawings. It is important again to note that the design process is not a guaranteed “recipe” (Harfield, 1999), which will always produce creative results. A creative design process is, therefore, that process which results in a novel and appropriate design solution.

Design solutions are the most straightforward pieces of the design procedure model. Design solutions are the resolution of design problems. There is an almost tacit requirement that design solutions be creative, appropriate, novel, and high in quality. If the solution fails to solve any of the client’s concerns, then the prescribed solution will never be realized. Likewise, if the solution is prohibitive in cost or detrimental to the community, it will not be realized and is, therefore, not appropriate. If the solution is not novel to the client or is simply a copycat version of a previous work, there is a good chance the solution will not be realized. In addition clients generally frown upon completed design solutions that are not high in quality. The design solution might be the most straightforward piece of the design procedure to articulate, but it is definitely not the most straightforward to produce.

This chapter identified representations, design vocabulary, and built works as the sets of symbols used to communicate in the domain of design. The specific design procedures used by designers, especially drawing as a problem-solving process, are unique to designers. Because the design process defines the functional and technical protocols of design, any attempt to understand creativity in design must include elements of design process.

The Field

The field consists of the experts or ‘gatekeepers’ of the domain; individuals who decide what new additions to the domain are adopted into use (Csikszentmihalyi, 2004). In design, these

individuals can be educators or practitioners. One of the important aspects of the field is that members are respected enough to be able to persuade others that ideas should be included in the domain. As described previously and illustrated in Figure 2.2, Laurie Olin is a member of the field in design.

According to the Oxford English Dictionary (1894), an expert is “1. One who is expert or has gained skill from experience. 2. One whose special knowledge or skill causes him to be regarded as an authority; a specialist.” A hundred years later, expertise is defined as, “The quality or state of being expert; skill or expertness in a particular branch of study or sport” (OED 1993). A particular branch of study, game activity, or athletic endeavor could also be stated as a “domain” to reflect the vocabulary of Csikszentmihalyi (2001, p. 464). In essence, expertise is the demonstrated ability of an individual in his or her particular domain. The study of experts and expertise will help others within a specific domain understand how experts perform. This, in turn, can help others within the specific domain to identify the skills or characteristics needed to become experts. It can also help educators identify what underlying skills and characteristics need to be taught while students are learning the basics of any domain. How best to undertake the study of experts is a question that is still open to debate. In the essay, *Two Approaches to the Study of Expert’s Characteristics*, researcher Michelene Chi outlines approaches to the study of expertise: absolute expertise and relative expertise (2006).

Absolute Expertise

The absolute expertise approach identifies experts as exceptional individuals who do not think or behave like the majority of people within their domain. The thrust of this method is to identify those individuals who qualify as experts. Assessment can be done by comparative means referencing a ranking system, measuring performance on exams, or by measuring how well an expert performs a task. There is also the option of measuring the products of experts and identifying a ‘break point’ in which experts distinguish themselves from the pack. An example in the three-dimensional design world would be to count how many times an individual’s work is featured in design magazines or placed in design competitions. An additional method of identifying experts would to rely on an independent index (Chi, 2006). This independent index would not directly measure the expertise of the individual but would act as an indicator of expertise. These approaches focus on operationalizing expertise and then identifying those

individuals who differ significantly from their peers. The absolute expert approach has the limitation of presenting expertise as a quality that defies description and is absolute; you are or you are not an expert with most designers classified as merely competent.

Relative Expertise

The relative expertise approach identifies all members of a domain along an expertise continuum and those who are defined as experts are merely further along in the process. This approach benefits from the idea that expertise is attainable and that by learning the traits and characteristics of experts, one can advance along the continuum towards becoming an expert. Cross, in his overview of design expertise, states: “Expertise is not simply a matter of possessing ‘talent’, but is the result of a dedicated application to a chosen field” (2004, p. 2). The first task in using the relative expertise approach is to define the proficiency levels along the expertise continuum.

A more specific model of design levels of expertise using the relative approach is presented by Kees Dorst and Isabelle Reyman and is based on the work of the philosopher Hubert Dreyfus. Although Dorst and Reyman (2004) argue that the model should be adjusted to reflect actual design expertise level, the model provides a good starting point for differentiating behavior at various levels of expertise, see table 2.1.

Table 2.1 Levels of expertise in design education used by Dorst and Reyman (2004, pg 3).

Level of Expertise	Approach to Problems	Design Process	Typical Design Behavior
Novice	Considers the objective features of a problem	Follow strict rules given by the experts	Reliance on rules
Advanced Beginner	Identifies situational aspects of the problem are important	Maxims are used for guidance through the problem	Sensitivity to exceptions to the 'hard' rules of the novice
Competent	Selects the elements in a problem that are relevant and chooses a plan to achieve specific goals	Employs a trial and error approach to problem solving	Emotional attachment to the problem, a sense of responsibility, and a clear need for learning and reflection

Level of Expertise	Approach to Problems	Design Process	Typical Design Behavior
Proficient	Immediately sees the most important elements in the problem	Approaches the solution based on identified elements identified within in the problem	Problem-solving and reasoning
Expert	Responds to specific situations intuitively	Performs appropriate actions straightaway	Problem-solving and reasoning stages merge into a single process
Master	An uneasiness with the standard ways of working that experienced professionals use is not seen as natural, but as contingent	Performs more nuanced appropriate actions than the expert	A deeper involvement in the professional field as a whole revealing an acute sense of context, and openness to subtle cues
Visionary	Strives to extend the domain in which he/she works	Develops new ways things could be, defines the issues, opens new worlds and creates new domains	Operates more on the margins of a domain, paying attention to other domains as well, and to anomalies and marginal practices that hold promises for a new vision of the domain

Once the levels of proficiency have been identified, it is necessary to define the characteristics of those who occupy each level. Chi has researched and summarizes the two most commonly used methods in her article, *Two Approaches to the Study of Expert's Characteristics* (2006). One method is to use gross assessments. Some examples of this definition of expertise include but are not limited to academic qualifications, years of practice, and peer judgments. Finer-tuned assessments include domain-specific knowledge exams, performance tests, or protocol studies. In her review, Chi has also identified seven ways in which experts excel. These exceptional areas include generating the best, detection and recognition, qualitative analyses, monitoring, strategies, opportunistic, and cognitive effort (Chi, 2006). The caveat is that these exceptional areas do not necessarily coincide with specific areas in which design experts excel.

In the closing remarks of a paper summarizing design expertise experiments, Cross states: "Conventional wisdom about the nature of problem-solving expertise seems often to be contradicted by the behavior of expert designers. In design education we must therefore be very

wary about importing models of behavior from other fields” (2004, p. 12). Expert design behaviors identified by Cross include proper problem scoping, personal problem framing (Akin & Akin, 1996), solution- focused problem solving, attachment to early ideas, and frequent switching of cognitive activity. Cross explains that these behaviors do not coincide with the problem- solving behaviors of experts in more well-defined problem- solving situations. The fact that designers deal with ill-defined problems, by definition, requires thinking that differs from other domains.

The field, as we have seen, is important to grasp in order to understand how creativity is judged in design. It begins by identifying those individuals who are capable of whether or not something new should be included in the domain. In order to make this judgment, these individuals should be experts in their respective domains. There are many different ways to attain this expert status. The identification of design expert behaviors helps design educators to focus on those approaches to design that result in high- quality design. It also helps the design educator to identify those traits that need bolstering in design students. Design experts act as a model for design students. With this understanding of both the domain and the field of three-dimensional design in place, the individual is the final component of Csikszentmihalyi’s model to address.

The Individual

The focus on individual creativity in the psychological community has produced a number of different theories regarding how creative individuals operate. In the following section, different theoretical approaches are reviewed, beginning with cognitive theories, metacognition, and social contextual theories. The theories are then synthesized into a model of the individual operating in the domain of design.

Cognitive Theories

A cognitive approach to creativity is focuses on the internal mental processes that result in creativity. Psychologists have discovered that instead of a single process of creativity, there are many processes seeming to operate parallel to one another. There are many different mental processes involved with creativity and research reflects this. Some theorists suggest that there is only one process that results in creativity; others suggest that there are multiple processes.

Researchers Thomas Ward and Yuliya Kolomyts have combined these processes under the term creative cognition, which “is concerned with explicating how common cognitive processes, available to virtually all humans, operate in stored knowledge to yield ideas that are novel and appropriate for the task at hand” (2010, p.93). Among the processes suggested in creative cognition are divergent thinking, convergent thinking, and knowledge.

Divergent thinking has received particular attention in psychological research and is related directly to the design process. It is defined as the ability to produce a variety of solutions to a given situation. It can be thought of as the generative process of creativity: the mind is able to conceive several ideas that spawn from a single source. This ability is linked to any generative phase of the design process where the designer proposes a possible design solution. When speaking of design process, Laurie Olin calls this “invention: what to bring to a place and insert, that’s new and never there before” (Olin, McGlade, Bedell, Weiler, Rubin, & Sanders, 2008, p. 12). Divergent thinking ability allows designers to generate a number of potential new objects or environmentally-shaping elements. There have been numerous psychological studies of divergent thinking and many of the current creativity tests focus on divergent thinking. This focus began with the body of work from J. P. Guilford, who, in his 1950 American Psychologists Association presidential address, stated that creativity should garner more attention from researchers. He proposed that creativity tests could be easily administered with paper and pen tests. In his own test, the *Unusual Uses Test*, Guilford asked participants to list all of the uses they could think of for a common object (Sternberg & Lubart, 1999, p.7). This template later served to inspire Torrance in his own instrument, the Torrance Test of Creative Thinking (Sternberg & Lubart, 1999, p.7). The Torrance Test of Creative Thinking is still in use and is one of the most widely- used and researched measures of creativity (Kim, 2006). Originally the test relied upon written responses to measure creative thinking, but a figural version of the test was developed. This figural version is useful when the nature of a person's writing skills may confound the validity of the test. The Torrance Test of Creative Thinking enjoys a high level of reliability (Kim, 2006), but researchers disagree about the test’s predicative validity and discriminate validity (Plucker and Makel, 2010). With the increase of tests focused on divergent thinking, critics began to argue that divergent thinking was not the only mental process at work.

The opposite of divergent thinking is convergent thinking or associative thinking. Convergent thinking is defined as the forming of associative elements into new combinations,

which either meet specified requirements or are in some way useful (Mednick, 1962). Researchers have also argued that divergent thinking alone does not result in true creativity and that convergent thinking is needed to sift through and evaluate the confusion created by divergent thinking. If divergent thinking is like a shotgun blast where thousands of ideas come bursting forth from a single point, convergent thinking is like rummaging through the shot and finding which pieces can be fit together to make a new, better bullet. Mednick (1962) created a test that focuses on convergent thinking. Participants are asked to arrive at a single word that associates three given words, for example: blue, mouse, and Swiss. The correct answer is cheese. Although Mednick argues that creativity happens only with convergent thinking, other theorists have created models that combine divergent and convergent thinking. Convergent thinking is important in the synthesis phase of the design processes of J. Christopher Jones (1963) and Hideo Sasaki (1950), but fits into the creative phase of L. Bruce Archer (1984). Fink, Ward, and Smith proposed the Geneplore Model, which consists of two phases: the generative phase and the exploratory phase (Sternberg & Lubart, 1999, p.7). The generative phase is when one generates new ideas and retrieves pertinent information. It is generally referred to as the 'brainstorming' phase. The explorative phase is when all the previous bits of information and ideas are sifted and used to solve the problem. Olin draws attention to the importance of the generative and evaluative phases to designers when he finishes the previous quote, "invention: what to bring to a place and insert that's new and never there before what's appropriate and why" (Olin et al., 2008, p. 12). Some researchers contend that the evaluative and the generative processes do not follow a fixed order and are interchangeable (Pike, 2002, Lawson, 2006).

Knowledge, the third process involved in creative cognition, is also an important component of creativity. Too much and too little pre-existing knowledge may be detrimental to effective novelty. If someone lacks sufficient knowledge in a given realm, they will not be able to be creative. Conversely, if a person is too familiar with the precedents of any given realm, they could become entrenched and rely upon old solutions rather than generating new ones (Mumford & Gustafson, 1988; Martinson, 1995). Figure 2.4 places divergent thinking, convergent thinking, and knowledge together as a set of internal cognitive processes that the designer uses when working towards creativity.

Figure 2.4 Author's illustration of internal cognitive functions introduced by Guilford (Sternberg & Lubart, 1999, p.7) and Mednick (1962) as important to creativity.



Psychometrics

The cognitive approach to creativity is linked to psychometric approaches to creativity. Psychometrics is a branch of psychology that is concerned with the reliability and validity of psychological measures. When approached from a psychometric point of view, creativity is a construct that can be measured, and these measures should be reliable and valid. Traditionally, psychometrics has employed paper and pencil tests similar to intelligence tests. Intelligence testing has in fact been one of the achievements of psychometric approaches and are the best examples of how psychometric testing operates. Table 2.2 summarizes commonly used cognitively- based measures of creativity.

Table 2.2 Commonly used cognitively-based measures of creativity.

Psychological Construct	Brief Explanation	Instrumentation	Example
Divergent Thinking	Individual's ability to generate multiple ideas from a single source.	Structure of the Intellect test (year) Torrance Test of Creativity (year)	How many uses can you think of for a paper clip?
Associative Thinking	Individual's ability to connect seemingly disparate ideas	Remote Associates Test (1962)	What is the one word that connects: paint, doll and cat? House.
Personality	Individual's personality supporting the idea that certain personality types are more predisposed to creativity	Myers-Briggs Big 5 personality test	Are you an introverted, intuitive, feeling, judging person?
Past Creative Activities	Creative people do certain things, or have been creative in the past.	Cataloguing an individual's past experiences	What have you done creative in the past?
Attitude	Focus on an individual's attitudes toward creativity	Attitudes toward creativity, in general, as well as how individuals view their own ability to be creative	Do you feel that you are capable of creativity?
Creativity Product	Focus not on the person but on the product that the individual produces	The Consensual Assessment Technique (1996) Creative Product Semantic Scale (1989) Diana Horn and Gavriel Salvendy (2009)	Could a non-creative person produce something creative?
Domain Specific Talents	Talent assessments focus on talents Talents that are particular to a given domain	CLARB AIA	Can you do what A professional architect needs to do what?

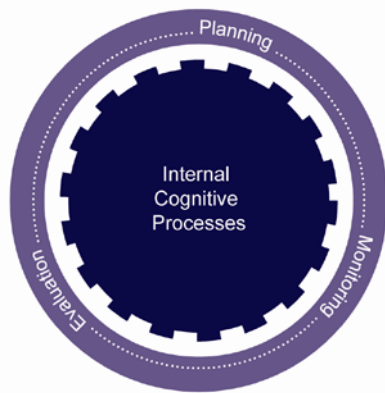
Metacognition

Metacognition is often explained as how we think about thinking. Lawson describes metacognitions as the processes that guide our internal processes, or “productive thinking” (2006, p. 140). If creativity really is a set of internal cognitive processes, it stands to reason that

if we can become more aware of these processes, we can implement them more often in our thinking, which in theory should be able to boost our own creativity (Hargroves, 2002). Being aware of how we are thinking falls into the realm of metacognition. Metacognition deals with strategies that help people be cognitively aware of their own mental processes and is composed of three major phases: planning, monitoring, and evaluation (Schraw & Moshman, 1995).

See Figure 2.5.

Figure 2.5 Author's illustration of the metacognitive phases of planning, monitoring, and evaluation used (Schraw & Moshman, 1995) to guide internal cognitive processes.



During the planning phase, an individual will determine how they are going to attack a problem. Activities during this phase include goal setting, developing a strategy, and identifying obstacles. Next is the monitoring phase, where one is actively checking on their thought processes to see if they are making progress towards their goal. In doing so, one is aware of one's own mental activity. If they are daydreaming, they can put themselves back on task; if the person is stuck, they might acknowledge the block and take a break or daydream to get past the block. The last phase deals with evaluation and includes assessing outcomes and gauging progress. It is in this phase that an individual can recognize a train of thought as potentially fruitful or a waste of time. Appropriate action can then be taken. Knowledge of metacognition, or thinking about how we think, can guide the processes of creativity and make creativity more efficient (Hargroves, 2002). There are several methods for improving metacognitive ability, including synetics (Gordon, 1961), thinking hats (deBono, 1999), brainstorming and mind-mapping. In many instances the design processes or design methodologies can be considered metacognitive in nature.

Social Contextual Theories

While many researchers support a cognitive approach to describing and understanding creativity, there are a number of theories that argue against focusing on any internal processes and are more interested in the context in which an individual works. These theories can be organized under the heading of social contextual theories. As presented previously in the chapter during the definition of creativity, Amabile and Sternberg both speak to an individual working within a social context that judges the novelty and usefulness of the final product.

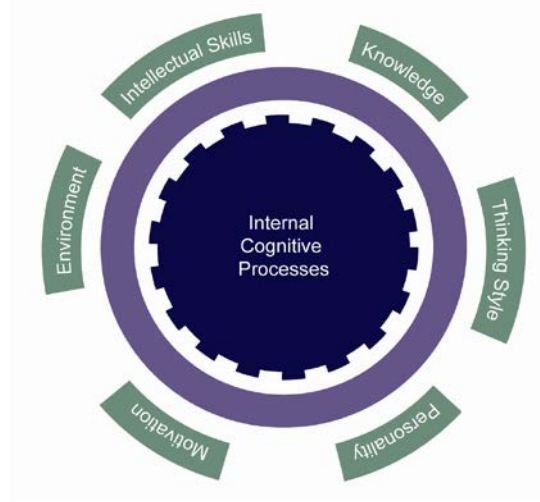
“A product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic” (Amabile, 1996, p. 35).

“Creativity is the ability to produce work that is both novel, (that is, original, unexpected), *high in quality*, and appropriate (that is, useful, adaptive concerning task constraints)” (Sternberg, 2003, pg. 89).

These definitions address the specifics of a designer’s creativity, using the internal mental processes of the individual as data. Theresa Amabile proposed a theory, known as the social psychology theory, that focuses on the conditions surrounding an individual and the creative product that individual produces. She asserts that “Given the current state of psychological theory and research methodology, a definition based on process is not feasible” (1996). Amabile theorizes that a person will be judged as creative if they produce creative products, rather than if they score high on a test that measures an internal mental process. Amabile argues that judging the creativity of a product is a completely subjective process and, therefore, needs to be treated as one.

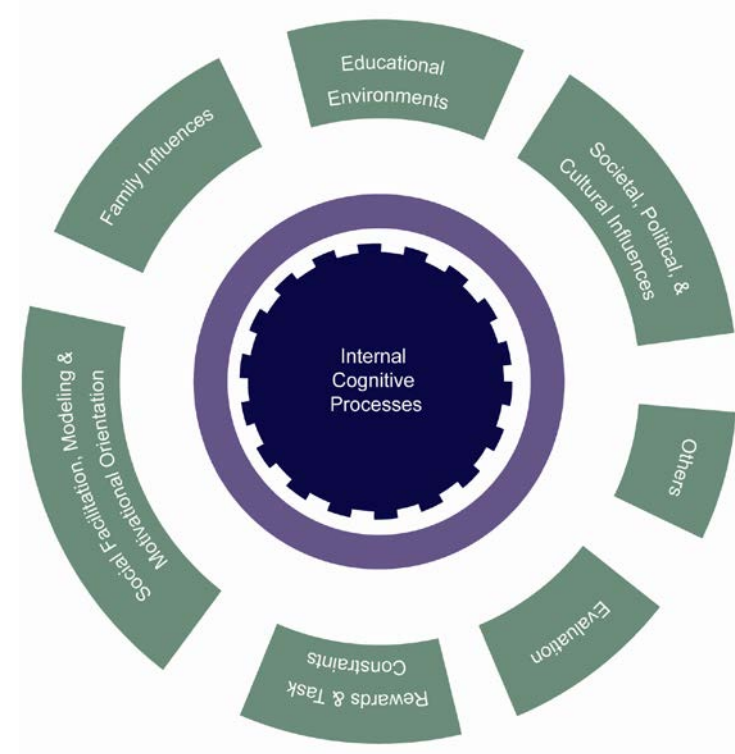
Amabile argues that rather than look at what is inside an individual, we should look at the environment surrounding an individual. She proposes that there are multiple social factors that affect creativity and set the context of an individual’s internal cognitive processes. See Figure 2.6. These social factors include: personality, thinking style, intellectual skills, educational environment, social facilitation, modeling, motivational orientation, reward and task constraints, evaluation, family influences, and societal, political, and cultural influences (Amabile, 1996).

Figure 2.6 Author's diagram of Amabile's social-contextual factors.



The Confluence Model proposed by Sternberg (Sternberg and Lubart, 1999, p. 10) supports the idea that although an individual may have creative thoughts, true creativity does not occur without “six distinct but interrelated resources” and that all six must be in place. He defines these six components as: intellectual skills, knowledge, thinking style, personality, motivation, and environment, as illustrated in Figure 2.7.

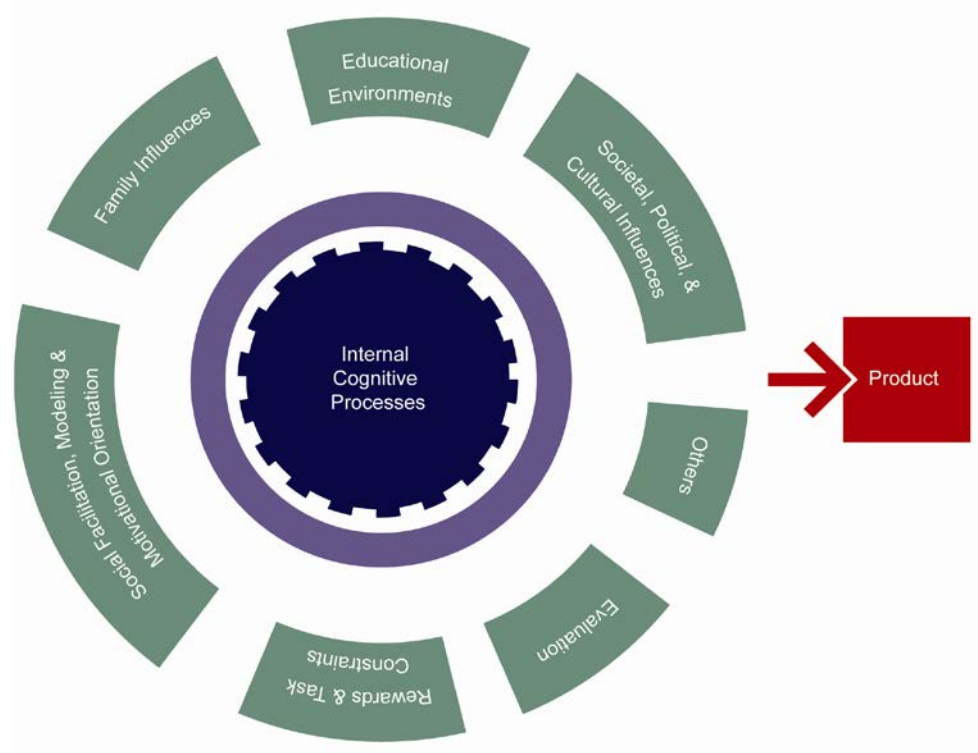
Figure 2.7 External factors identified by Sternberg (1999) that influence an individual's creativity.



Although Amabile’s model of creativity includes social-contextual factors, the most salient addition to her model is product itself (Amabile, 1996). Amabile’s model focuses on measuring the creativity of the product, specifying that it must be both novel and appropriate. The product, in addition to the social factors surrounding the internal cognitive processes of the individual, is illustrated in Figure 2.8. This is an important addition for designers, as by definition we produce something at the end of our design process.

Up to this point individual factors affecting creativity have been presented in isolation. The next step is to synthesize the various theories into a holistic model that design educators will be able to use. This model, in turn, provides the theoretical framework for a proposed research project.

Figure 2.8 Author’s diagram of Amabile's social factors with the addition of the product.



Theoretical Framework

Synthesis

Psychological theories are not typically combined. However, the synthesis of the models that embody the key characteristics of the domain, field, and individual in design produces a model that provides insights into methods for enhancing student's creativity. This modification is encouraged by the writings of Aaron Kozbelt, Ronald A. Beghetto and Mark A. Runco who offer a comprehensive view of creativity theories in the *Cambridge Handbook of Creativity*. Kozbelt, Beghetto, and Runco propose that future theorists critically examine creativity theories and, where appropriate, combine components of different theories in light of new research. They do not suggest a wholesale combination of all creative theories but offer this advice: "Rather, we are suggesting that scholars better situate their theories in the broader theoretical and empirical landscape of the domain, acknowledging and, when possible incorporating the plurality of perspectives that have taken root and flourished" (2010, p 40).

A synthesis of the different models, through a process of diagramming, resulted in a new model of creativity for designers and serves as the theoretical framework for this dissertation. The process began by mapping elements from the different creativity theories: cognitive, metacognitive, and social-contextual. The identification of redundancies illustrates where the different theories agree, see Figure 2.9. The overlapping constructs were removed to create a more streamlined model, see Figure 2.10.

Figure 2.9 Elements from metacognition, and social contextual theories (Sternberg, 1999; Amabile, 1996) are overlaid. Elements outlined in red are elements addressed by both authors.

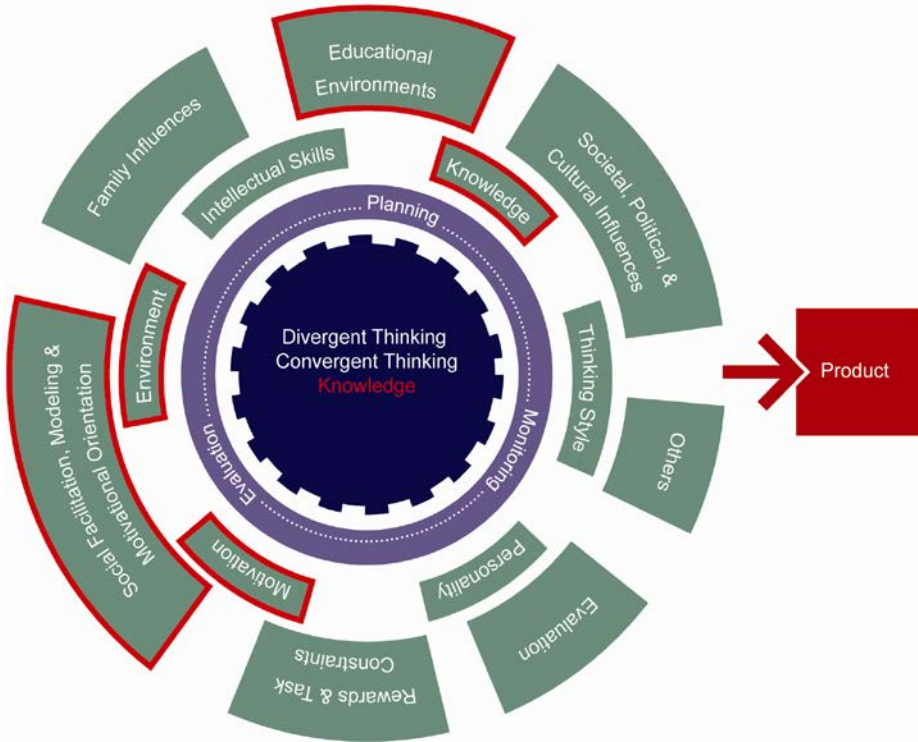
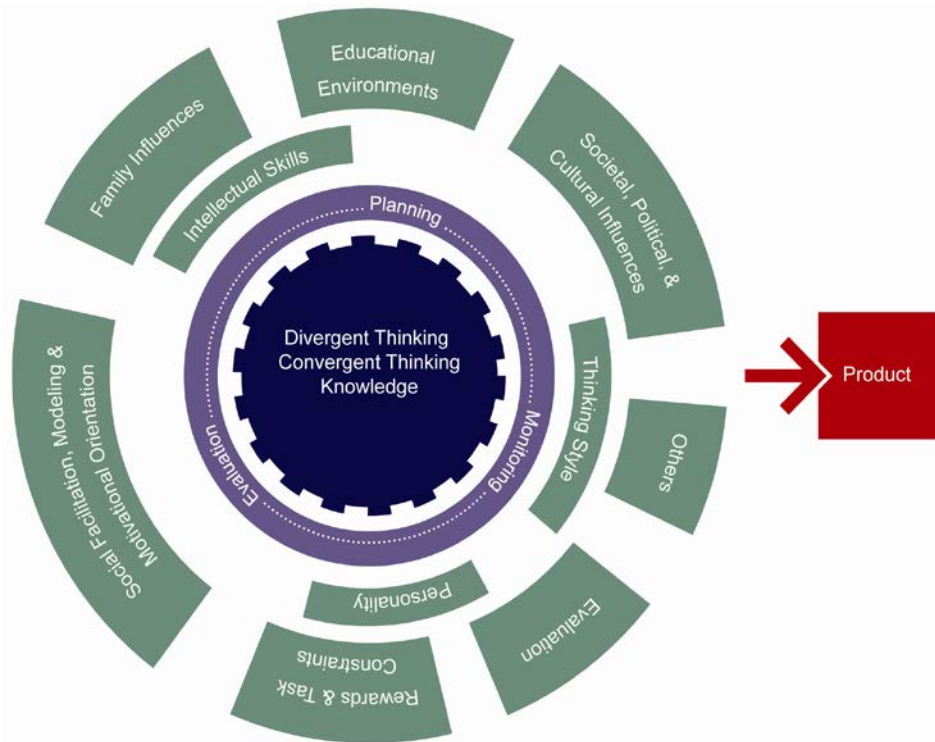


Figure 2.10 Illustrates the elements from Sternberg (1999) and Amabile (1996) overlaid with repetitive elements removed.



The next step in this synthesis is to identify those social factors that are outside of the direct influence of the educator. It is unlikely that educators will impact family influences and (societal), cultural, and political influences, so these factors have been moved from the center of the model and grayed out in Figure 2.11. Focusing on the product, the next phase of the synthesis adds the defining characteristics of a creative product: novel, appropriate, and high in quality. See Figure 2.12.

Figure 2.11 Illustrates peripheral role of elements less under the control of educators with those elements moved to the outside edge of the diagram and faded.

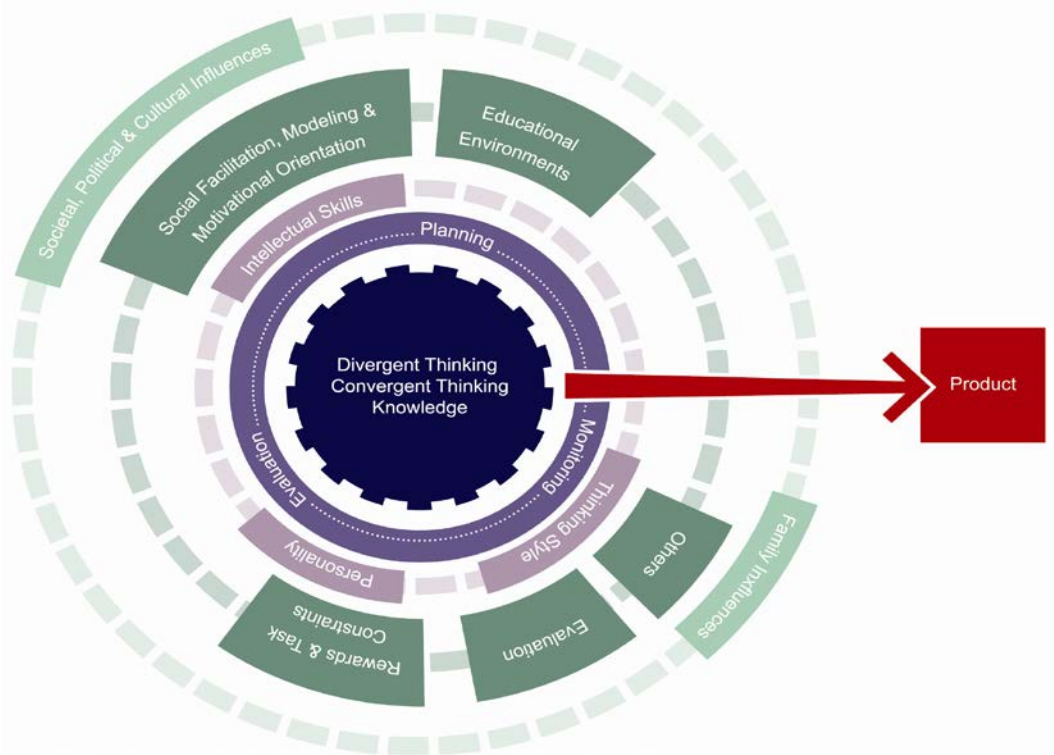
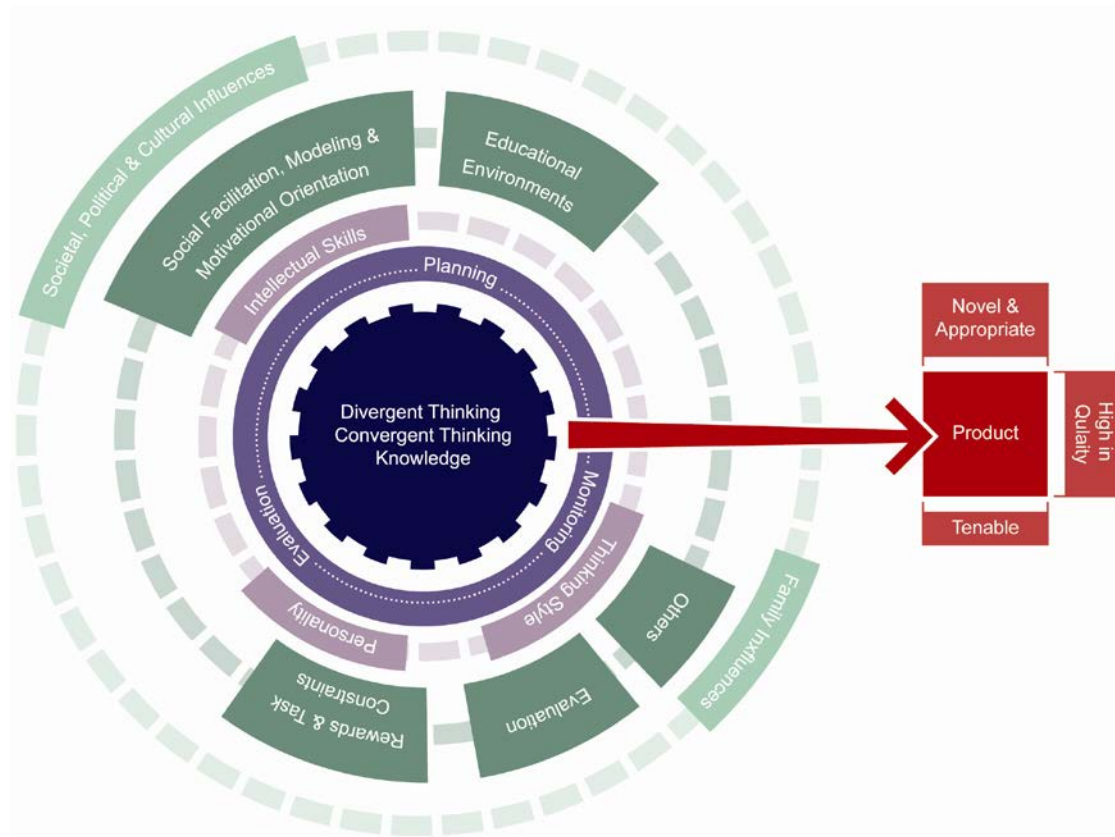
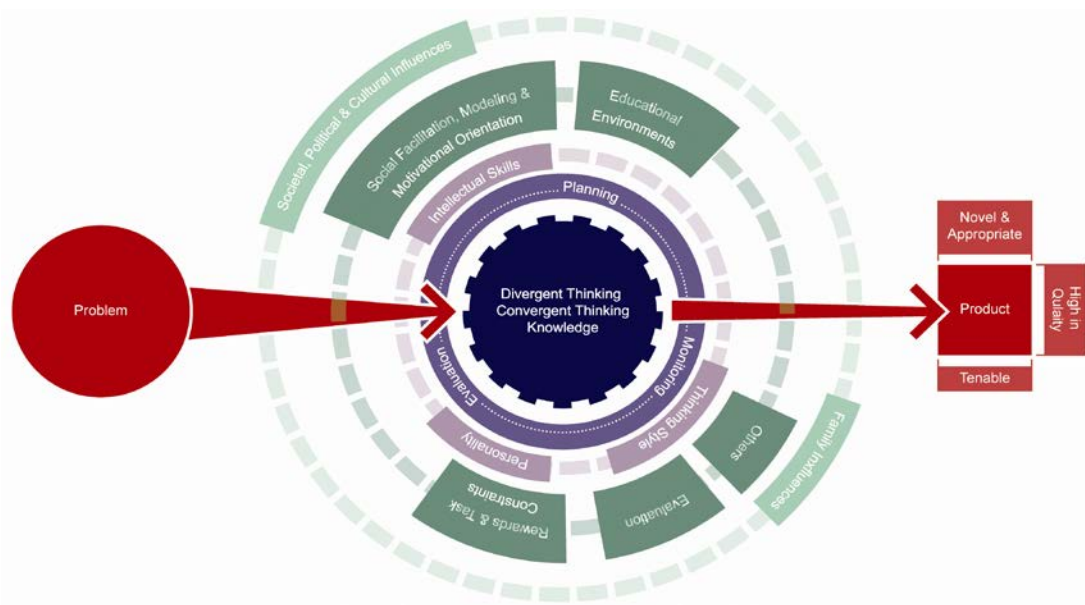


Figure 2.12 Illustrates the addition of parameters necessary for a creative product as identified by Amabile (1996) and Sternberg (2003).



It is also fitting to add a design problem to the diagram of the model as the generator of both the design process and the creative process for designers. This addition overlays the design process onto the creative process. At this stage of the synthesis, the model is unintentionally deceptive in showing that the product originates from family influences. In actuality the design solution comes from the individual and not from the context surrounding the individual. The social context is constantly influencing the individual but is not the generator of the design solutions. A third dimension is required to illustrate this relationship and is illustrated in Figure 2.13. Now that the individual is situated within the design process, it is appropriate to add the domain and the field from Csikszentmihalyi to the diagram. See Figure 2.14.

Figure 2.13 Illustration adding initial introduction of the problem and the final product.



The domain encompasses the problem, process, and solution, whereas the field envelops much of the contextual situation surrounding the individual and the product. We now have a complete diagram of the systems theory of creativity as it applies to three-dimensional design. The Merrill Model of Creativity in Design, illustrated in Figure 2.14, serves as the theoretical framework for understanding creativity in designers.

Figure 2.14 The Merrill Model of Creativity in Design



The domain provides researchers with an understanding of the type and nature of creativity needed in design. It is also important to note that the primary method for communicating this creativity is through drawings. These drawings can also be used as artifacts that can be studied and measured. The field provides both the criteria for judging the procedure and the symbols of design. Design expertise offers a standard for judges to measure the quality of design solutions and a language to use in describing that quality. The field and design expertise also provides criteria for selecting individuals who are design experts and are qualified

to make subjective judgments about design artifacts. Design expertise also gives us the criteria for selecting these experts. The individual provides the artifacts from the design process to be measured, as well as the internal cognitive efforts to work through the design process. This process occurs within a social climate. An encouraging and supportive social climate encourages creativity (Hunt 2006). We can focus on the individual or the immediate physical or social environment of the individual when seeking variables to manipulate and measure creativity.

Based upon this model, it appears that educators can influence creativity through direct intervention dealing with cognitive abilities, teaching metacognitive techniques, manipulating the immediate educational environment, and introducing appropriate design problems. The success of a few studies in raising the creativity of three-dimensional designers (Karpoval et al. 2011, Hargrove, 2007) is encouraging.

Creativity Exercises

The use of creative exercises is a method of direct intervention that allows students to practice the creativity process. Creativity exercises offer a design problem, which is often nonsensical, that must be solved in a short amount of time. Creativity exercises have been used in multiple studies as a way to increase creativity (Karpova, E., Marcketti, S. B., and Barker, J. 2011; Hargrove, 2007; Torrance, 1972). Scott, Leritz, & Mumford found from a meta-analysis of seventy studies, that successful creativity training programs “were likely to focus on development of cognitive skills and the heuristics involved in skill application, using realistic exercises appropriate to the domain at hand” (2004). The following is an example of an appropriate creativity exercise.

Take an ordinary red wagon, a simple toy that most children love, and “pimp it out” with whatever luxuries and additions you can think of. Create your ultimate urban- inspired, pimped-out red wagon. Sweeeet! (Mumaw & Oldfield, 2006).

These creativity exercises are important because they allow students the time and space to practice creative processes without the pressure of being graded. In essence, creativity exercises contain all the elements of a design process and require cognitive and metacognitive processes within a social context that is non-threatening. Some creativity exercises are linguistic in nature while others require drawing to communicate. Given the graphic nature of the domain of design, most creativity exercises should not be limited to writing. There are many sources for

creativity exercises. Potential sources of creativity exercises include but are not limited to: Thinkertoys (Michalko, 2006), Creativity Workout: 62 exercises to unlock your most creative ideas (Edward de Bono, 2008) and IDEO Method Cards: 51 Ways to Inspire Design (IDEO 2003).

Conclusion

The literature on creativity is mostly populated by the writing of psychologists who offer numerous theories about the nature of creativity. There are several opposing theories and models of creativity that contain elements that are important to the creativity inherent in three-dimensional design. Csikszentmihalyi's systems theory of creativity provides structure for synthesizing these relevant elements into a working model of creativity specific to three-dimensional design. This model offers design educators a framework for improving creativity in their students as well as identifying possible variables for research.

Other researchers interested in creativity and design education who have reviewed the literature have come to the conclusion that creativity can be enhanced by teaching and “[t]he task in the coming years is to enhance the development of such teaching and assessment practices through the application of research-led teaching” (Williams et al., 2010). Based on new insights gained from the model, the next step is to verify aspects of the model through deliberate scientific experimentation.

Chapter 3 - Methods

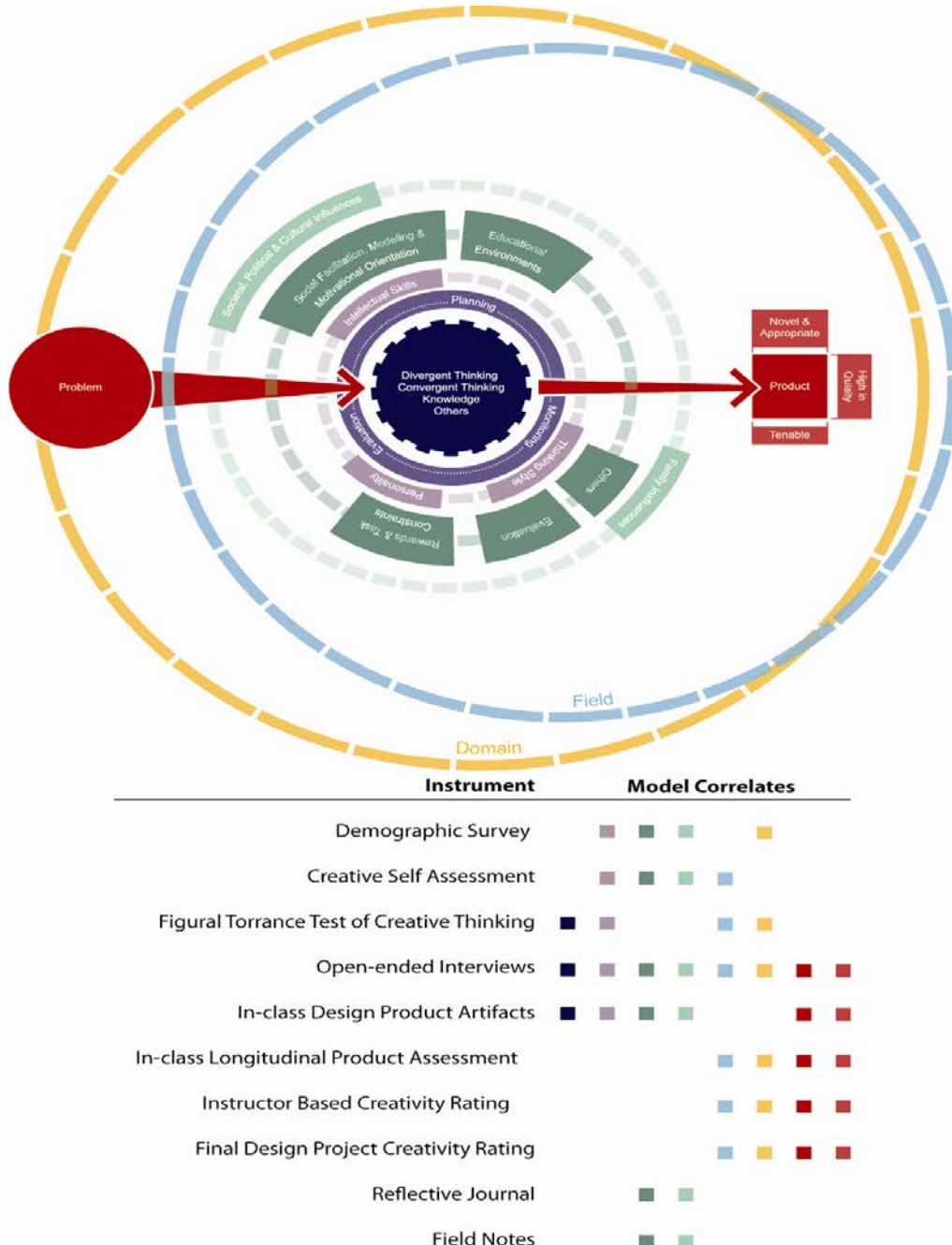
Introduction

The Merrill Model of Creativity in Designers (Merrill and Rolley, 2012) as presented in the previous chapter and shown again in Figure 3.1 provides a framework for understanding creativity in designers. With this framework, one can begin to identify factors within the model that can be measured which allows us to focus attention on specific variables that can be manipulated and measured.

The research utilized a mixed-methods approach in order to collect a rich field of data. This, in turn, aided the researcher in triangulating and answering the research questions below. The full range of data collection techniques and their accompanying analysis techniques utilized in the study are shown in Figure 3.1. The first column lists the instruments used in the research, while the second column illustrates the portion of the Merrill Model of Creativity in Design targeted by the instrument.

In this chapter the research questions are presented, followed by an in-depth description of the research design, the rationale for selected data collection methods, a description of the study, population, and sample, data collection, and the analysis and recording of the data.

Figure 3.1 Merrill Model of Creativity in Design along with the instruments employed in the research, and the specific areas that are targeted by the instrument.



Research Questions

The purpose of this study was to explore creativity in first-year design students at the College of Architecture, Planning & Design at Kansas State University in Manhattan, Kansas.

The research focuses on answering the primary research question: **Does participating in an academic intervention intended to teach creativity affect the creativity of first-year three-dimensional design students?**

This question is followed by secondary research questions:

What are the correlations between different measures of creativity?

How do first-year design students perceive their creativity?

How do first-year design students define creativity?

How does the definition of creativity differ between the researcher, student participants, and the field?

Hypothesis

The major null hypothesis tested in this research was: No significant difference in creativity, as measured by the Figural Torrance Test of Creative Thinking, will be found between those first-year three-dimensional design students participating in an eighteen-week long seminar who received specific training in creative problem solving, and those first-year design students who did not participate in the seminar.

Design of the Study

This research utilized a modified Solomon Four-Group non-equivalent control group quasi-experimental design adapted from Campbell and Stanley (1966). Non-random pre-existing classroom clusters were used to populate the different treatment groups. The experimental groups were drawn from students enrolled in a 1-credit seminar/workshop titled: Design Thinking and Creativity, at Kansas State University, College of Architecture, Planning & Design which was offered during the Fall 2012 Semester. There were three sections of this class, which met on different days of the week and at different times of the day in order to make the course available to a wider range of students. See Table 3.1. The classes were randomly selected to experience treatment type 1 or treatment type 2. The control group was solicited from students enrolled in the same program as the experimental group.

Table 3.1 The experiment pulled from three different sections that met once per week over the course of a 15-week semester.

Section Number	Day and time of class section
1	Monday 2:30-3:20 pm
2	Wednesday 9:30-10:20 am
3	Friday 12:30-1:20 pm

Sampling Population

The Environmental Design Studies course, entitled ENVD 299: Design Thinking and Creativity, served as the treatment group for the proposed investigation. There were three sections of ENVD 299. These classes are pre-existing classroom clusters, meaning that the classes were formed prior to the research and were then maintained together as distinct clusters of participants. Each pre-existing classroom cluster was randomly assigned to one of two-treatment types see Table 3.2. A control group was recruited from Environmental Design students not enrolled in ENVD 299, see Table 3.2, Demographic data from all participants who took the pretest, including the control group, was collected, by way of a demographic survey, to determine how comparable the different non-random clusters are.

Table 3.2 Modified Solomon four-group nonequivalent control group quasi-experimental design, adapted from Campbell and Stanley (1963).

	Experimental Groups	Pretest	Treatment	Posttest
Non-Random Pre-existing Classroom Clusters	(R) Treatment Type 1	O	X	O
	(R) Treatment Type 2		X	O
	Control Group	O		O

Rationale for the Selected Research Design

The proposed modification of the Solomon four-group research design controls for threats to internal validity presented by history, maturation, and the interaction of testing and

maturation. The research was conducted concurrently ensuring that all participants experienced the same day-to-day events, such as project due dates, tests, or holidays as well as larger, national or international events. All data collection was completed during the same time period for all groups. Assuming that the groups were all comparable in age and experience, they should have matured in roughly the same manner.

Strengths of Internal Validity

Testing effects are one of the greatest strengths of internal validity presented by the modified research design. By not giving the pretest to a single treatment group, the researcher was able to compare the mean scores between groups that had a pretest and those that did not. This allowed the researcher to identify if pretest sensitization occurred. Pretest sensitization represents, in this research, an increase in creativity scores due to exposure to the pretest and not necessarily due to the treatment. Therefore, the research is better poised to support the hypothesis that the treatment is attributable to any actual changes in creativity. The instrumentation for this research was constant between all participants. Participants were exposed to the same instruments, and all effort was made to ensure that the presentation of instruments was constant between groups.

Strengths of External Validity

This research design effectively controls for the interaction of testing and creativity and multiple treatment interference. In many research designs there is a chance that being exposed to the pretest will have an affect on how participants respond to the treatment. Using a treatment group that does not receive the pretest but does receive the treatment controls this variable and will support the hypothesis that any changes will be due to the treatment. The research design also controls for multiple-treatment interference by having all groups receive the treatment at the same time. This reduces the chance that external factors coupled with the treatment will produce different results between the groups. There was a single application of the education intervention, ruling out the possibility that multiple exposures to the treatment are responsible for any significant change in creativity; thus, the extent of generalizability is strengthened as participants could then be assumed to be equivalent across all treatment groups.

Threats to Internal Validity

There are a number of threats to the internal validity of the research, including threats to regression, selection, and the interaction of selection, maturation, and drop-out rate. Threats to regression are especially troublesome to research where the participants are selected because of their high or low scores (Gay, Mills and Airasian 2009). The classes were made up of first-year ENVJ students. This research did not select participants based on their scores or perceptions of high levels or low levels of creativity. Research that focuses on populations expected to have high or low levels of creativity runs the risk of finding a change that is not caused by the treatment but by the extreme groups regressing towards the population mean. In other words these extreme groups would become more normal. Participants were selected in such a way as to obtain a sample of the population that accurately reflected the entire first-year design student body. This research used creativity scores derived from different groups, but participant group assignment was determined by enrollment in class sections, representing a non-random classroom cluster selection method. It is assumed that each group was more similar to one another rather than being significantly different before any measurement took place. However, there is the possibility that students sorted themselves into sections based upon their level of creativity. These differences could be interpreted as differences between the groups due to the treatment when the groups were significantly different to begin with.

Another consideration is that due to the nature of taking non-random classroom clusters, there is a chance that the treatment groups and control group are already significantly different in their levels of creativity. There is the possibility that students who are already significantly more creative than their peer group will all have enrolled in the class. There is also the possibility that students who are creative do not see the need to enroll in the class and were represented more significantly in the control group. Instruments administered during the pretest identified to what extent the groups were similar. Complete experimental control would allow each member of the population an equal and random chance of being selected for the research and an equal and random chance of being assigned to the treatment group or the control group. This randomization would neutralize the differences between the groups. Such experimental control was not available to this research.

The control group and treatment groups were presented with different incentives to participate in this research. Due to the fact that the control group was not required to take the

posttest as a required component of a class for credit, there was the possibility that the control group would have a higher drop-out rate when compared to the treatment groups. This higher drop-out rate would have had the potential to skew the mean of the control group to the point that it was not truly comparable to the treatment groups. The researcher strove to control this variable by gathering a large control group using attractive incentives such as free pizza.

Threats to External Validity

There were a number of potential threats to the external validity of any findings from the research. This research only took place at the Kansas State University, Manhattan Campus. The culture or other factors (socio-cultural, demographics, environmental) unique to Kansas State University could have been contributing factors to any change in a participant's creativity. Due to the nature of the setting, it becomes difficult to generalize the findings of this research to other university programs to the extent that other universities may be different from the Kansas State University environment.

Also known as 'participant effects' (Gay, Mills and Airasian, 2009), external threats address how the participants react to the fact that they participated in research. These responses include the Novelty Effect, the Hawthorn Effect, and the John Henry Effect. The nature of this research did not allow complete control over these effects; the researcher was aware of potential threats to external validity and employed the measures outlined in Table 3.3 to control for them.

Table 3.3 Possible extraneous effects, their threats to external validity and how they are addressed (Gay, Mills and Airasian, 2009).

Name of effect	Threat to validity	Measures taken to diminish effect
Novelty Effect	Change is attributable to the novelty of the situation and not to the treatment	Novelty should fade over the course of the semester
Hawthorn Effect	Participants behave differently than normal because they know they are being observed	Participants will be in a classroom setting where the fact that they are being observed and assessed is expected
John Henry Effect	Participants behave differently than normal because they are competing with other groups	The presence of a control group and other treatment groups was minimized
Experimenter Effect	Any change may be attributed to the presence of the experimenter and not the treatment.	The presentation of the treatment and testing was standardized and delivered by the same person.

Research Environment

The research was conducted in the Environmental Design Program, ENVD, housed within the College of Architecture, Planning & Design on the Manhattan campus of Kansas State University. The data collection of this research took place during the Fall 2012 Semester, from August 27 through December 17, 2012. The sampling population for this research consisted of students enrolled in the first-year ENVD design studio.

The class took place on the Manhattan Campus of Kansas State University within Seaton Hall room 104 (Seaton 104). Seaton 104 is a seminar classroom used by multiple departments in the College of Architecture, Planning & Design. The room has no windows to the outside. The room is equipped with the following teaching technology: projector screen, projector, a laptop

computer with Internet connection, a whiteboard, a selection of whiteboard markers. The room was furnished with detached chairs and folding tables that could be arranged in any configuration according to the needs of the class. See Figure 3.2 For most of the semester the tables were arranged in a “U” shape with the students sitting around the perimeter of the room and the instructor at the front of the room, near the computer. See Figure 3.3. Often the class instruction and creativity exercises necessitated that participants work in small groups. In these cases the instructor rearranged the classroom so that tables and chairs were scattered throughout the room. See Figure 3.4.

Figure 3.2 Photographs of Seaton 104 where the seminar took place. The photograph is looking at the front of the room where the instruction took place.



Figure 3.3 Diagram of Seaton 104 during normal teaching conditions.

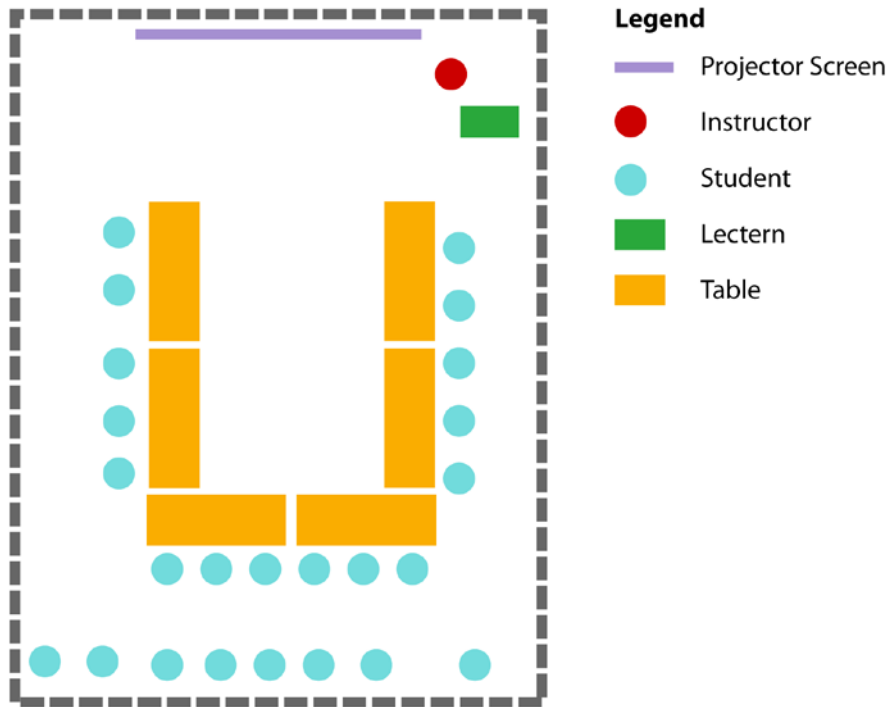
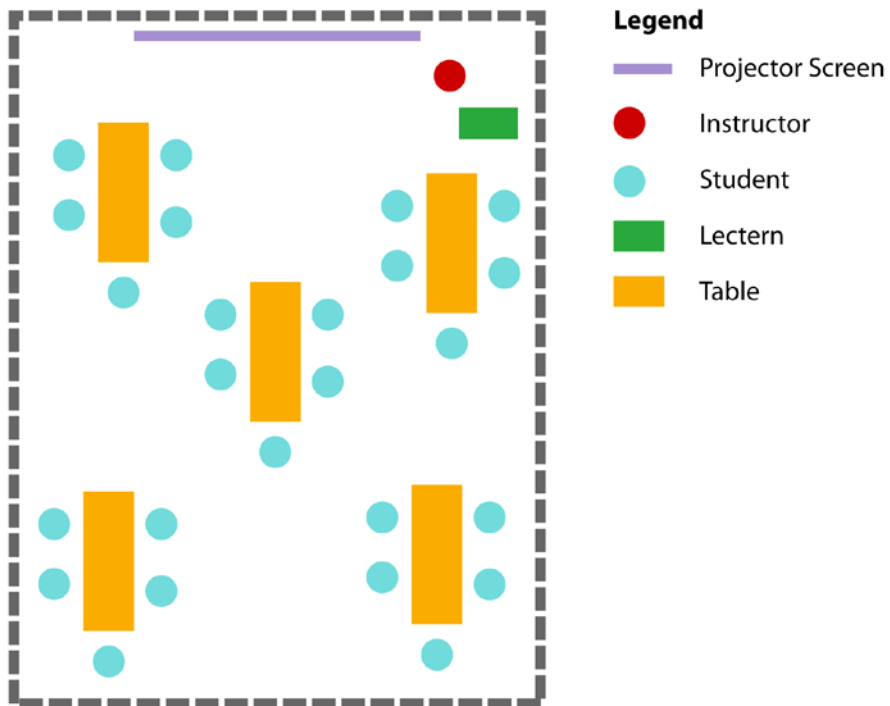


Figure 3.4 Diagram of Seaton 104 arranged for small group instruction and exercises.



Participant Recruitment

This research utilized two different recruitment procedures: one for recruiting participants for the experimental groups and another for recruiting participants for the control group. The recruitment procedure for the experimental groups focused on students enrolled in ENVD 299: Creativity and Design Thinking. Students were invited by the researcher to participate in the class via posters. These posters were distributed to the college's academic advisor before the beginning of the fall semester. Remaining posters were posted in Seaton Hall. Incentives to participate in the experimental groups included learning creativity techniques, and a passing grade in ENVD 299 for one credit (85% participation in class resulted in a passing grade).

The recruitment procedure for the control group focused on individuals not enrolled in ENVD 299. During the second week of the 2012 fall semester the researcher was able to visit the Survey of the Design Profession class, a required class for all first-year ENVD students. The researcher invited students to participate in the research. The incentive of a free dinner at the time of the pretest was offered. Of the control group participants who took the pretest (n=14), only five (n=5) participants returned to take the scheduled posttest. This necessitated additional recruitment of additional ENVD students to form a large enough control group to compare with treatment groups. Again the researcher visited the Survey of the Design Profession class to invite students to participate. The specific reward of free pizza was again offered as an incentive. After this invitation, one (n=1) control group participant returned. In a final attempt to raise the number of control group participants, the researcher worked with Dr. Wayne "Mick" Charney. During the History of Design final exam, Dr. Charney announced that the researcher would be outside the lecture room, with pizza, for anyone willing to take the FTTCT. Twelve (n=12) students responded to the invitation and took the FTTCT.

Nonparticipating Students

Participation in the research was completely voluntary. Students enrolled in ENVD 299 were given the option to not be assessed as part of this research. If any student chose not to participate they were still required to participate in all class activities in order to receive class credit. The researcher did not collect data for students who did not consent to participate in the investigation. There was no penalty for any student who chose not to participate in the investigation. There were three students who chose not to participate in the research.

Consent and Confidentiality

Before participating in this research, all participants were required to read, understand, and sign a consent form that granted the researcher permission to collect and use data from that individual. These consent forms employed a template provided by the Internal Review Board at Kansas State University.

Each participant was assigned a random four-digit number during the pretest. All student work relating to the research was identified with this four-digit number. The master list of numbers and student names was not available to the researcher during the duration of the research. The master list was stored in a secure location, in the Department of Landscape Architecture, Regional and Community Planning office, 302 Seaton Hall. Students were informed in the class syllabus that they could go to the departmental office and ask for their identification number if they ever needed it.

The researcher will maintain physical copies of all data and informed consent forms from the investigation until 2015 in a secure location. The researcher is also maintaining electronic copies of all records, data, and informed consent forms from the investigation, and will do so until 2015 after the data collection is finished. Any participant wishing to access their personal information will need to contact the researcher directly. All records regarding scores will only be recorded using the student's assigned four-digit identification number.

Debriefing

The debriefing portion of this research was conducted immediately following the presentation of the posttest. The researcher explained the purpose of the research, how the research was going to measure creativity, and answered any questions that the participants presented. All participants were reminded that their copy of the consent forms that they signed contained the researcher's information and that if they had any questions they should feel free to contact him.

Research Schedule

Prior to the treatment, a pretest was administered, using a number of instruments. See Figure 3.5. The treatment took the form of a 1-credit class that focused on principles of design thinking and creativity. After the treatment there was a posttest that was given to both treatment

types and the control group. Concurrent with the treatment the researcher conducted a number of interviews with research participants and studio instructors.

Figure 3.5 Timeline of the research illustrating the specific assessments for the research schedule.



Pretesting

The pretest was composed of two different instruments: a Creative Self-Assessment, developed by the author, in consultation with committee members (Stephanie Rolley, Blake Belanger, Anne Beamish and Sheryl Hodge), and the Figural Torrance Test of Creative Thinking (FTTCT). The Creative Self-Assessment was given to all participants after students had enrolled in the class but before any of the treatment had begun. The FTTCT was administered to the Wednesday class section and the control group.

Creative Self-Assessment

The Creative Self-Assessment measures the extent to which participants believe that they are creative as well as providing a rationale for their belief. The creative self-assessment was composed of two questions: “Are you creative?” and “Why?”. Participants were given 15 minutes to answer both questions. This assessment accomplished three purposes. It helped the researcher to understand how the participants defined creativity and to what extent participants conformed to their own definition. It also demonstrated the confidence that students had in their own ability to be creative.

It was important to identify the definition of creativity used by the population and to assess whether it differs from the definition of creativity used by the field, or the operational definition of this research. Comparisons between the pretest and posttest revealed any changes in the participants’ definitions or levels of self-confidence.

Figural Torrance Test of Creative Thinking

In contrast to other creativity measuring instruments which use words to test creativity, the FTTCT measures creative thinking through drawings. The FTTCT was selected because design students use drawings as the primary method of communicating design ideas. The FTTCT measures creativity by giving scores to participants on five subscales:

1. Fluency: the quantity of ideas presented in the drawings
2. Originality: the degree to which the ideas presented in the drawings are unique
3. Creativity of Titles: the creativity of the titles given to drawings
4. Elaboration: the enrichment of ideas within each drawing
5. Resistance to Closure: the degree to which drawings demonstrate a willingness to continue working

These five subscales are combined to produce an Average Creativity Score. Thirteen criterion-referenced measures that Torrance (2006) called creative strengths are also included in the scoring. The creative strengths are emotional expressiveness, storytelling articulateness, movement or action, expressiveness of titles, synthesis of incomplete figures, synthesis of lines or circles, unusual visualization, internal visualization, extending or breaking boundaries, humor, richness of imagery, colorfulness of imagery, and fantasy. These creative strengths scores are

later combined with the average creativity score to produce the Creativity Index, which is recommended as the best measure of an individual's creative thinking (Torrance, 2006).

The FTTCT is fitting to a pretest /post-test research design as the instrument has two versions, A and B, which allow for pretesting and post-testing with comparable but different problems. The FTTCT is also standardized in its administration (Torrance 2006). An instructional packet is provided with the test that prescribes how the instrument is to be administered to all participants. A written script for instructing participants was provided to ensure consistency between different groups. The script was also printed for participants to read along with the instructor.

For this study, version A of the FTTCT was used for the pretest. Each participant received a standardized booklet that included instructions and space for the participant to finish all the required tasks. The instrument is divided into three separate segments each with a separate set of instructions that was read to the participants. A printed copy of each set of instructions was included with each segment in case participants wanted to read along. Participants were given 10 minutes to complete each section of the instrument. After the pretest was administered, the treatment portion of the research began.

Treatment

The treatment consisted of an educational intervention, which took the form of a semester-long seminar/workshop consisting of creativity instruction and creativity exercises. Participants purchased their own small sketchbook for recording their creativity exercises. This sketchbook was labeled with each participant's four-digit number printed on a sticker and attached to the cover. At the end of each class period, the researcher collected the notebooks and stored them between classes. Participants were able to retrieve their notebooks at the beginning of each class session.

The seminar/workshop focused on concepts identified in the literature as being important to creativity in design. The concepts addressed in class include: divergent thinking (Sternberg and Lubart 1999), convergent thinking (Mednick, 1962), brainstorming, metacognition (Hargroves 2007), framing the problem (Akin and Akin 1996), metaphor, mind mapping, random input, recombination, and the attitudes, motivation, personality traits, and behavior of design experts (Lawson and Dorst 2009). The creativity exercises were and presented by the

researcher and consisted of simple design problems that were not specific to any one of the three-dimensional design disciplines represented in the College of Architecture, Planning & Design. These creativity problems were figural in nature and had an enforced time deadline for completion. A list of the creativity exercises along with a brief description of each is provided in Table 3.4. The design exercises were selected in a systematic order based on the components of the Merrill Model of Creativity in Design. It was the intent of the researcher for participants to apply prior concepts to subsequent exercises. Whether this actually happened or not was not a variable measured by the research.

Table 3.4 In-class design exercises and brief explanation of the design activity.

Title	Explanation	Topic of Instruction
Buffalo in the Road	Students identified possible problems with a buffalo in the road.	Framing the problem
Little Red Wagon Redesign	Students redesigned the common red wagon (Mumaw and Oldfield, 2006).	Brainstorming
Minifigure You	Students designed a LEGO Minifigure ® in their own likeness.	Mind Mapping
Park(ing) Day	Students designed a park that would occupy a car sized parking stall for one day (Rebar, 2012).	Divergent Thinking
Metaphor Cities	Students designed three cities metaphorically based on an animal, a food, and an occupation (Brody, 2008).	Metaphor/Analogy
Chain Reaction Machine	Students designed a Rube Goldberg Machine (Goldberg, 2013) that was started by a burning candle and ended by setting off a mousetrap. Students had to use a randomly generated component in their machine.	Random Input
Movie-Themed Restaurant	Students designed a themed restaurant based on their favorite movie.	Recombination

Title	Explanation	Topic of Instruction
Office Raft	Students had to design a raft using common office supplies to survive a hypothetical dam break (Mumaw and Oldfield, 2006).	Associative Thinking
Design A Bottle	Students were divided into groups and to design a bottle for retail sales.	Metacognition
Hot Dog-Eating Logo	Students designed a logo for a imagined hotdog- eating league (Mumaw and Oldfield, 2006).	Metacognition
Totem Pole	Students designed a totem pole that represents their typical day (Mumaw and Oldfield, 2006).	Physical Environment
Box Office Fort	Students designed a fort using 4 cardboard boxes, 4 cardboard tubes, and supplies typically found in an office (Mumaw and Oldfield, 2006).	Attitudes, Motivation and Personality

Longitudinal Creativity Assessment

The method used for assessing the development of participants throughout the treatment period was important to this research. Throughout the semester, student work was assessed on both the novelty and the appropriateness of in-class design product artifacts produced by the students during each class session as recorded in the student notebooks. This longitudinal product/response assessment was conducted and recorded by three graduate-student graders, one per section, who were trained by the researcher. The graders received instruction from the researcher at the beginning of the semester. The graders and the researcher also held regular meetings throughout the semester to discuss questions and concerns, and to identify to the researcher any blatantly offensive material. Graders had access to a standardized Excel worksheet to use in the assessment of participant responses. Graduate-student graders were given one section per week to grade. The section assigned to them was rotated so that the graders would be less likely to develop biases toward certain students.

Graduate student graders rated a design solution as appropriate if the design solution indeed addressed and attempted to solve the design problem. Graders rated originality by identifying the top design solutions from that week and assigning them a ranking e.g. 1, 2, 3, 4. This identified the solutions which graders deemed to be the most creative within a section. This continual assessment built a composite score of creativity for each student. This longitudinal measure of creativity had the potential to identify creative individuals who may or may not score well on the FTTCT, or to support findings from other measures.

This assessment is patterned after elements from the Merrill Model of Creativity in Design presented in the literature review. Participants were also required to create a product that was then judged on its level of novelty and appropriateness. The criteria of tenable and high in quality were left off of this portion of the assessment, as many of the design problems were abstract and impractical, such as the exercise to redesign a child's wagon. The participants were given no constraints based on a budget or the laws of physics as the creativity exercises were intended to allow participants to play and have fun. Attempting to determine the tenability of products of absurd design exercises would have placed an impossible burden on the students and the graders. The longitudinal assessment had the capacity to track how well a participant improved over time, and it allowed the researcher to determine if there were any trends within a section, such as an overall increase in original products over the course of the semester. This "long view" was compared to the cross-sectional measurements represented by the FTTCT, and the final design problem.

Posttest

A three-part posttest was administered to all participants after the treatment. The posttest consisted of a final design project, a repeat of the Creative Self-Assessment, and the FTTCT. The researcher sent all completed FTTCT to Scholastic Testing Services Inc. who independently scored both the pretest and posttest administration of the FTTCT. The scores and original test packets returned to the researcher after grading was complete.

Final Design Problem

All participants in the ENVD 299 class were given a final design problem during the last week of the semester. The final design problem was figural in nature but success did not depend upon specialized knowledge of any single design discipline. The design problem was selected by

the researcher to insure it would not be above the capacity of the majority of participants. The final design problem consisted of a 50-minute design charrette, where individuals designed a gift-giving experience for a classmate. The charette was adapted from adapted from *An Introduction to Design Thinking* from the Hasso Plattner Institute of Design at Stanford University (2012). The gift giving experience is used because it is an experience that students are familiar with and includes the actions: of selecting a gift for, acquiring the gift, wrapping the gift, and presenting the gift. Participants were guided through the process of understanding the problem, framing the problem, generating multiple design solutions, selecting one solution for further development, and developing a final design. Participants presented their final design solution to the design problem on an 11" x 17" sheet of paper provided by the researcher. The final design problem represented, in essence, a compressed version of the participants' design process and allowed the researcher to analyze a final product of the participants' thinking.

A group of instructors ($n=10$) from the College of Architecture, Planning & Design were solicited as design experts to rate the creativity of the participants' final products using a system based on the Consensual Assessment Technique (CAT) (Amabile 1996). The design experts worked in isolation from each other and were not allowed to confer with any other individual during their assessment. The researcher was on hand to instruct and assist the raters, but did not give any advice on how the projects should be rated.

Each rater had the design products presented to them in a random order to account for any effects that the order of the products may cause. Each rater was instructed to rate the project on merits of creativity and not on artistic ability. Each rater ranked the design solutions on a continuum from most creative to least creative. After each design expert had assessed the design solutions, the researcher asked a series of open-ended questions about how the criteria used by the experts to judge creativity and the ranking process. All assessments were kept confidential until all raters had an opportunity to complete his or her assessment. The inter-judge reliability, or the extent to which the judges agreed, was calculated. This technique allowed the researcher to see how the field judges creativity, to what extent the experts share a common definition of what is creative, and which design projects are judged to be the most creative.

Interviews

Over the course of the treatment, interviews were conducted with students in the experimental group, students in the control group, and design studio instructors. The interviews created an opportunity to understand how the individuals were experiencing the course as well as gather data not readily available from the other means of data collection (LeCompte and Schensul, 1999). Additional data included attitudes and opinions about the course. The interviews gave individuals who did not feel that they could express their definition of creativity in writing, or graphic means, to do so verbally. The researcher also had the ability to ask additional questions for clarification.

A number of open-ended interviews were conducted with participants. All participants were invited to participate in a series of open-ended interviews but only a small subgroup of individuals from the experimental groups ($n=4$) and from the control group, ($n=2$) were interested in being involved. Participants were only interviewed if they were 18 years of age. These interviews took place once in October 2012, shortly after the treatment began, and again in December 2012, after the posttest. All students in the ENVD program are enrolled in design studio, which share a common curriculum but are led by individual design instructors. The design studio is important to the education of design students because it provides a space to experiment and synthesize knowledge into a design solution. Due to the unique position filled by design instructors in the lives and creativity of participants in this research, it was considered important to have a conversation with these design instructors about student activity.

Before the beginning of the Fall 2012 semester, the researcher emailed all first-year Design Studio instructors ($n=10$) to brief them about this investigation and to ask for volunteers who would be willing to participate in a number of open-ended interviews with the researcher. The researchers met with a number of interested studio instructors ($n=5$) and conducted open-ended interviews. The main purpose of these interviews was to investigate noted student behavior, design expertise, and the instructors' opinions. These interviews were scheduled throughout the semester based upon the studio instructor's availability.

Reflective Journal

The researcher kept a reflective journal throughout the investigation, where thoughts, observations, and biases as they related to the researcher's role as instructor and investigator

were recorded. The reflective journal allowed the recording of successes, insights, frustrations, and failures while instructing the seminar and was useful in the creation of a rich narrative of the investigation. The reflective journal was revisited at the end of the research in order to observe any patterns that emerged over time. It also provided an opportunity to make sense of relationships that were not initially apparent because of the researcher's focus on teaching the class. The research narrative can be found in Appendix C.

Field Notes

The researcher also kept a set of field notes for each class session, interview and group meeting. This acted as a record for all observations during any of these activities during the investigation and focused on the participants and the environment. These notes were referred to and analyzed throughout the research and helped in composing the research narrative.

Recording and Scoring of Data

The recording and scoring of data is an important component of the research design and is necessary for analysis. The method for recording and scoring varied slightly between the demographic survey, creative self-assessment, FTTCT, open ended interviews, in-class design artifacts, final design project creativity rating, reflective journal, and field notes. Figure 3.6 illustrates the different instruments used in this research with corresponding analyses. The colored boxes in the Model Correlates column indicate which portions of the Merrill Model of Creativity in Designers are being addressed by the instrument.

Figure 3.6 Summary of proposed data collection methods and accompanying analysis techniques.

Instrument	Model Correlates	Analysis
Demographic Survey	■ ■ ■ ■	Comparison of nominal data between groups
Creative Self Assessment	■ ■ ■ ■	Grounded Theory Content analysis, Comparisons made between pretest and posttest.
Figural Torrance Test of Creative Thinking	■ ■ ■ ■ ■ ■	Statistical Analysis by researcher
Open-ended Interviews	■ ■ ■ ■ ■ ■ ■ ■	Grounded Theory by researcher
In-class Design Product Artifacts	■ ■ ■ ■ ■ ■ ■ ■	Grounded Theory by researcher
In-class Longitudinal Product Assessment	■ ■ ■ ■ ■ ■ ■ ■	Statistical Analysis by researcher
Instructor Based Creativity Rating	■ ■ ■ ■ ■ ■ ■ ■	Grounded Theory by researcher
Final Design Project Creativity Rating	■ ■ ■ ■ ■ ■ ■ ■	Consensual Assessment Technique by design experts, and then analyzed by the researcher
Reflective Journal	■ ■ ■ ■	Investigation narrative
Field Notes	■ ■ ■ ■	Investigation narrative

The researcher collected all physical copies of the demographic survey and then entered the data into Microsoft Excel. All physical copies of the creative self-assessment were collected, divided into pretest and posttest categories, and then analyzed and hand coded for themes. Quotes supporting themes identified by the researcher were recorded in Microsoft Word.

The FTTCT is a copyrighted test of Scholastic Testing Services Inc. (STS) that offers professional scoring of the FTTCT, done by trained individuals. In order to increase the validity and reliability of the analysis and eliminate any researcher bias, the researcher elected to have STS score the FTTCT. All physical copies of the tests were mailed to STS for scoring, and the results were returned in report form to the researcher. Separate reports were generated for the pretest treatment section, the pretest control group, each posttest treatment group and the posttest control group. The reports show the scores for each of the five subscales measured by the FTTCT, as well as the overall Creativity Index of each individual test. Raw scores were reported along with standardized scores and percentiles that ranked the individual in comparison to national and local populations. The researcher used Microsoft Excel to record all scores.

All interviews were audio recorded using the Apple program “Garage Band” on a MacbookAir. The researcher arranged to interview members of each treatment group, members of the control group, and design instructors of the participants at their convenience. The interviews were analyzed and coded for themes by the researcher and selected quotes were transcribed into Microsoft Word. All names and any identifying information were removed.

The researcher retained all notebooks used by participants during the course. The researcher analyzed these notebooks in search of pertinent data. The researcher also rated each creativity exercise at the end of the semester. The researcher used a five-point scale: 0-not creative, 1-minimal creativity, 2-less creativity, 3-creative, 4-very creative. Individual exercise scores were combined to generate an Instructor-based Creativity Rating for each participant, which was entered into Microsoft Excel. The graduate student graders also recorded their weekly assessments in a Microsoft Excel spreadsheet.

The researcher recorded the ratings of the design experts in an Excel spreadsheet. The final design project that was judged most creative received a score of 1. The scoring then proceeded numerically until the last final design project was scored. These scores were then reverse coded for ease of analysis. The researcher also asked raters about their experience in rating the projects and recorded their comments.

The researcher recorded his own reflective journal entries in Microsoft Word, which were analyzed and coded for themes. The researcher recorded field notes during each class period, testing period, interview, the final design project creativity rating process, and throughout the research. All field notes were recorded in a small red Moleskin notebook, and the notes were analyzed and summarized in the project narrative.

Data Analysis

The Statistical Package for the Social Sciences (SPSS) was used for all statistical analyses of the data set. Descriptive statistics, including frequencies, measures of central tendency, and measures of variation were used to analyze the diversity of the sample in terms of age and home state with respect to the scores on the FTCTT. Analysis of the data included a determination of whether data were normally distributed. A Spearman's Rho Correlation between different measures of creativity was conducted to determine to which degree measures of creativity within this sample population were related. A Chronbach's Alpha analysis (Field, 2009) was conducted on the ratings of design judges to determine how similarly the different judges rated the final design problems.

Independent paired t-tests were used to determine the difference between groups pertaining to their scores on the FTTCT. Multiple one-way analyses of variance were conducted to determine if significant differences between groups existed. Because equal variance was not

assumed, Games Howell Post-Hoc tests (Field, 2009) were used to determine which groups were significantly different. This process was repeated for the following data from the FTTCT: Grade Based-Creativity Index, Fluency, Originality, Creativity of Titles, Elaboration, Resistance to Closure, and the Average Creativity Score.

A one-way analysis of variance was conducted on scores from the FTTCT to determine if there was an effect between pretest and posttest scores. This analysis was applied to participants who took both the pretest and the posttest, because equal variance was not assumed. A Games Howell post-hoc test was used to determine which differences were significant.

Chapter 4 - Findings

Hypothesis

The major null hypothesis tested in this research was: No significant difference in creativity as measured by the Figural Torrance Test of Creative Thinking will be found between those first-year three-dimensional design students participating in an eighteen-week long seminar who received specific training in creative problem solving, and those first-year three-dimensional design students who did not participate in the seminar.

Primary Research Question

The primary research question for this investigation is: Does participating in an academic intervention affect the creativity of first-year three-dimensional design students? A mixed methods approach allowed for the development of a rich field of data for analysis as well as a body of student work and experiences. Quantitative data determined if the intervention had an effect, whereas qualitative data helped to better describe the effect and context of the research.

Age of Participants

The three treatment groups and the control groups were similar in terms of age and geographic origin. See table 4.1. In terms of age, most students were between 18 and 20 years of age. The oldest student was a 25-year-old in Wednesday's section. The age composition of the three groups was very similar. Most of the students were 18 years old with a few older students scattered throughout.

Table 4.1 Age: Descriptive statistics including mean with standard deviation, median, and range for the age of participants at the beginning of this research.

Group	Mean (sd)	Median	Range
Treatment Groups	Monday (n=22)	18.91 (1.306)	19.00 5
	Wednesday (n=24)	18.87 (1.792)	18.00 7
	Friday (n=20)	18.46 (.721)	18.00 3
Control Group (n=14)	18.50 (.906)	18.00	3

Home State or Nation

Most of those enrolled in each of the three sections identified their home state as Kansas. Monday’s section was composed of students from Kansas (n=11), Missouri (n=6), and Texas (n=3). Students from other locations included South Carolina (n=1) and Colorado (n=1). Wednesday’s section was composed of students from Kansas (n=13), Missouri (n=4), and Texas (n=3). Students also came from other locations including Hawaii (n =1), Minnesota (n=1), Colorado (n=1), and Connecticut (n=1). Friday’s section was composed of students from Kansas (n =14), Missouri (n=3), and China (n=3). Students came from other locations including Hawaii (n=1), Minnesota (n=1), Colorado (n=1), and New Jersey (n=1). The only noticeable difference between the three treatment sections was that three Chinese students enrolled in Friday’s section. The pretest control group was composed of students from Missouri (n=1), and Kansas (n=4). Students came from other locations including Colorado (n=1), Illinois (n=1), Texas (n=1), and the United Arab Emirates (n=1). At first glance there are no red flags that would indicate that any of the groups were different in a significant way. Most of the students were from the Midwest and each class hosted a similar composition of students from across the United States as well as international students.

Table 4.2 Home State or Nation. Descriptive statistics including, counts for the home state or nation of participants at the beginning of this research.

Group		Kansas	Other Midwest States	Other Locations
Treatment Groups	Monday	11	9	2 (South Carolina, Colorado)
	Wednesday	13	8	3 (Hawaii, Colorado, Connecticut)
	Friday	14	4	6 (China, Colorado, Hawaii, New Jersey)
Control Group		4	8	2 (Colorado, United Arab Emirates)

Figural Torrance Test of Creative Thinking

Pretest Between Groups

Descriptive statistics were first obtained to determine what type of statistical analysis was appropriate for the FTTCT data. This preliminary tactical analysis determined if the treatment group and control data had the characteristics necessary to compare them. This does not mean that the two data sets should be identical. For example, apples and oranges can be compared because they are both edible, fruits, that fit in the palm of your hand. The nature of the fruit gives us a basis for comparison. However, if two data sets lack similar characteristics it would be like comparing an apple to the Boston Red Sox. When the two data sets are found to be similar, then parametric statistics can be used to analyze and compare them.

A Kolmogorov-Smirnov test was applied to the FTTCT Creativity Index pretest scores of both the treatment group and the control group to determine if the two data sets were normally distributed. The pretest scores on the FTTCT for the treatment group, $D(23) = .12$, ns, and the control group $D(14) = .14$, ns, were both normally distributed. Levene's test of homogeneity of

variance was conducted on both the treatment group and the control group to establish that both tests vary in similar ways. For the Creativity Index, the variances were equal for the control group and the treatment group $F(1, 35) = .82$, ns. Since none of these scores were significant, parametric statistics were used to analyze participant's pretest scores on the FTTCT.

A paired t-test was conducted between the treatment group and the control group, which determined if the two groups were different, on average. The pretest scores between the treatment group ($M=110.52$, $SE=2.32$) and the control group ($M=114.93$, $SE=3.48$) were not significantly different $t(35)=1.08$ $r=.03$. This is exactly what one would expect. The two groups should be very similar given that they have both just began the ENVD program. These scores paint a picture of equal creativity between the groups before any training.

Differences Within Groups

It is important to know if there was an increase in measured creativity between the pretest and the posttest within the treatment group and control group. This determination helps to establish if any measured effects are due to the treatment or if taking the pretest itself creates a difference. A dependent t-test was conducted only on participants who completed both the pretest and the posttest. On average there was no significant difference between the treatment group pretest ($M=111.43$, $SE= 2.43$) and posttest scores ($M=110.33$, $SE= 3.01$) $t(20) = .31$, $p>.05$, $r=.005$. On average, individuals within the control group who took both the pretest and the posttest performed significantly lower on the posttest ($M=106.67$, $SE= 6.91$) than on the pretest ($M= 121.00$ $SE= 3.97$), $t(5) = 2.61$, $p<.05$, $r=.08$. On the surface it appears that taking the pretest did not affect the creativity of either the treatment group or the control group. The data also suggests that that the treatment did not raise the creativity of the treatment group but that the creativity of the control group dropped significantly. Unfortunately, only four participants from the control group returned to take the posttest. The results, therefore, may be inconclusive.

Posttest Between Groups

Descriptive statistics were again conducted to determine what type of statistical analysis was appropriate for the posttest data set. A Kolmogorov-Smirnov test was applied to the FTTCT Creativity Index pretest scores of both the treatment group and the control group. The posttest scores on the FTTCT for the treatment group, $D(68) = .11$, $p<.05$ were significantly abnormal, meaning that they did not fit within the normal bell curve. This is most likely attributed to the

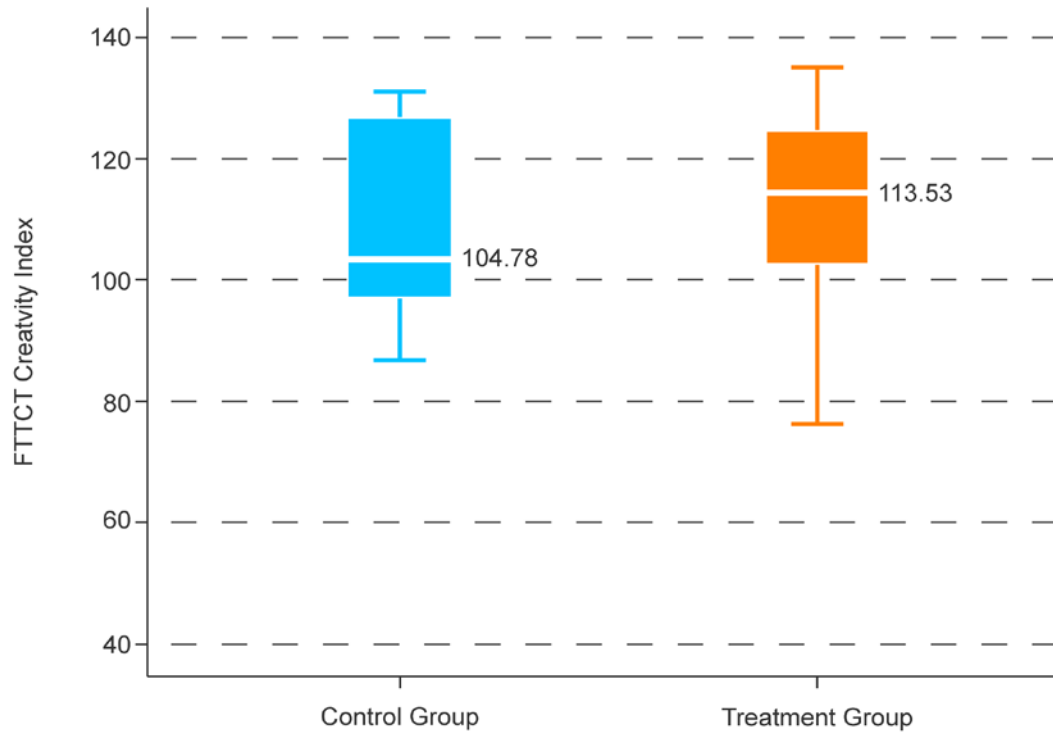
fact that the treatment group was significantly negatively skewed with a skewness of -1.03 (SE .29) and kurtosis of 1.68 (SE .57). Levene's test of homogeneity of variance was conducted on both the treatment group and the control group to ensure that the groups had a variance that was similar enough to be compared statistically. For the Creativity Index, the variances were equal for the control group and the treatment group $F(1, 84) = .18, ns$. Parametric statistics could be applied to the posttest data set.

The critical matter was to determine if there was a significant difference between the treatment group and the control group at the end of the semester. A paired t-test was again conducted between the treatment group and the control group. On average, the treatment group ($M=113.53, SE=1.82$) scored significantly higher on the posttest administration of the Figural Torrance Test of Creative Thinking than the control group ($M=104.78, SE=3.41$), $t(84)=-2.22, p<.05, r=.06$). Due to the fact that there was a significant difference between those first-year three-dimensional design students participating in an eighteen-week long seminar who received specific training in creative problem solving, and those first-year three-dimensional design students who did not participate in the seminar, one can reject the primary null hypothesis of this research.

Table 4.3 FTTCT Creativity Index Scores on both pretest and posttests for both treatment and control groups comparing the mean and standard error.

	Control Group	Treatment Group	
	Mean (Standard Error)	Mean (Standard Error)	Significance
Pretest	114.93 (3.48)	110.52 (2.32)	No $p>.05$
Posttest	104.78 (3.41)	113.53 (1.82)	Yes $p<.05, r=.06$

Figure 4.1 Box and Whisker Plots for FTTCT Creativity Index Posttest Scores between the control group and the treatment group. The FTTCT scores are standardized meaning that 100 is average for participants in relation to national norms for college freshmen.



Secondary Research Questions

Correlation Between Different Instruments

Another purpose of this research was to explore the level of correlation between different measures of creativity. In particular, how well do instruments that measure the cognitive process of creativity correlate with instruments that measure the creativity of a product? Performance on the FTTCT was significantly correlated with the Instructor Based Creativity Rating, $r_s=.43$, $p<.05$, and the In-Class Longitudinal Product Assessment, $r_s=.28$, $p<.05$. In-Class Longitudinal Product Assessment was significantly correlated with the Instructor based Creativity rating $r_s=.58$, $p<.01$. In contrast the final design project creativity rating was not significantly correlated to the other measures of creativity.

The fact that the score on the final design creativity rating did not correlate with the other measures of creativity is especially interesting given the fact that the experts agreed with each other. There was a high reliability between the 10 design experts rating the creativity of the final

design project, Cronbach's $\alpha = .85$. In other words the design experts agreed with each other, on average 85% of the time when rating the creativity of the students' final design projects. Table 4.4 presents the correlations between the different measures of creativity. A value of one indicates that the two measures correlate perfectly. The effect size estimates the level of the relationship between two correlated items. Field (2009) uses the benchmarks of .1 to be a small effect size, .3 is a medium effect size, and .5 is a large effect size.

Table 4.4 Spearman's Rho correlations coefficients between four different measures of creativity used in this research.

Test	FTTCT	Instructor Based	Longitudinal Score	Expert Rating
FTTCT	1			
Instructor Based	.43*	1		
Longitudinal Score	.28*	.58*	1	
Expert Rating	-.07	.13	-.14	1

* significant at the $p < .05$ level

Creative Self-Assessment

Pretest

During the pretest, all participants were asked the question: "Are you creative?". Responses were coded into seven themes. Most of the participants indicated that, yes, they are creative. Other participants expressed a belief that they were creative while others indicated uncertainty. Eight participants indicated that their creativity was conditional, two respondents expressed uncertainty, and two respondents answered the question with a no.

Selected quotes illustrate the themes from the Creative Self-Assessment is included in Appendix B. It is important to note that the researcher never shared with participants the operational definition of creativity employed in this research. Nor did the researcher share the

Merrill Model of Creativity in Design with participants during the instructional seminar because he felt responses from the students should be free from that particular influence.

Themes for the pretest question of “Are you creative?” include:

1. *Affirmative* ($n = 55$)
2. *Conditional* ($n = 11$)
3. *I believe/think I am* ($n = 9$)
4. *Desire to improve* ($n = 3$)
5. *No* ($n = 2$)
6. *Uncertain* ($n = 2$)

Posttest

After the treatment, and during the posttest, participants from the treatment group and the returning control group were again asked the question during the pretests: “Are you creative?”. Responses to the posttest question: “Are you creative?” were coded into two themes. Individual responses could be grouped into multiple themes.

Themes for the posttest question of “Are you creative?” include:

1. *Affirmative* ($n= 60$)
2. *Conditional* ($n=3$)

The confidence expressed by the participants increased after the treatment with no students expressing doubt in their creativity, see table 4.5. At the beginning of the semester, there were a number ($n=16$) of participants who questioned their creativity. Overall the tone of the responses was very straightforward and confident. The posttest indicated three conditional responses, no uncertainty, no negative responses, and no expressed desires to improve, indicating that most participants held the belief, after the treatment, that they are creative.

Table 4.5 Themes from the creative self-assessment question: Are you creative?

Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Affirmative	55	Affirmative	60
Conditional	11	Conditional	3
I believe/think I am	9		
Desire to improve	3		
No	2		
Uncertain	2		

Pretest - Additional Responses

It is interesting to note that apart from directly answering the primary question, many participants provided additional comments. These additional comments were grouped into six themes, which included:

1. *Drew a Picture (n = 17)*
2. *Everyone is creative (n = 5)*
3. *Desire for rules and boundaries (n = 5)*
4. *Artistic Reference (n = 2)*
5. *Imagination (n = 2)*
6. *Inspiration (n = 2)*

Posttest - Additional Responses

As with the pretest, students provided additional comments or sketches with their responses to the question, “Are your creative?”. These additional comments were grouped into six themes. Respondents' statements may be represented in multiple themes, including:

1. *Drew a picture (n=22)*
2. *Strategies/ Approach (n=6)*
3. *Class (n=5)*
4. *Different from others (n=5)*
5. *Everyone is creative (n=5)*
6. *Egotistic (n=3)*

These additional comments are especially interesting. The most common addition to an initial response was the inclusion of a picture, see Table 4.6. The researcher did not give explicit instructions on how to best respond to the questions and the students were free to answer the

question in any fashion they wanted. For the pretest most of the illustrations were decorative in the sense that they simply embellished their paper or included non sequitur images. See Figure 4.2.

Figure 4.2 Example of an illustrated response to the question “Are you creative?” during the pretest.

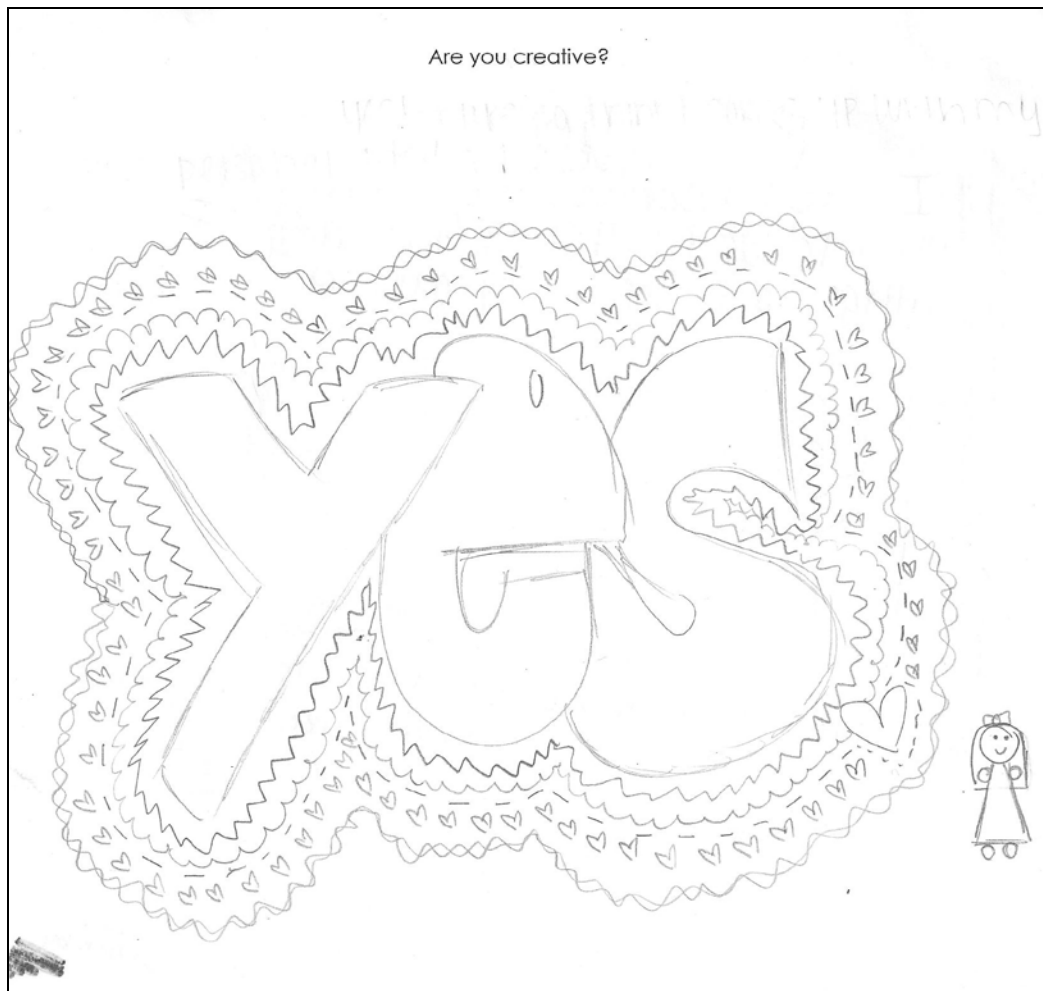


Figure 4.3 Example of a non sequitur illustrated response to the question “Are you creative?” during the pretest.



Drawing a picture was more common during the posttest. Another comment that was present during both the pretest and posttest was that everyone is creative. Statements regarding the relativity of defining creativity and how creativity is akin to a natural endowment often accompanied these comments. A selection of these comments is provided below.

- *Everyone is creative in [his or her] own right. There is no yes or no that can include or exclude one's own brand of creativity.*
- *It depends on someone's view of creativity because people have different perspectives on what is creative and what is not.*
- *Yes, everyone is creative in [his or her] own way. Nobody is wrong and everyone is right.*
- *Everyone contains some degree of creativity.*
- *It has everything to do with what is in your mind and how you express that to everyone else. So, yes I think that I am creative and so is everyone else.*

Artistic references, imagination, and inspiration both disappeared from the posttest, see table 4.6. The themes of Strategies/Approach, which mentioned the use of strategies in connection to creativity, and the theme of mentioning the Creativity and Design Thinking

Seminar, appeared during the posttest likely because of lessons learned in the seminar and other design courses.

Table 4.6 Themes from additional comments from the creative self-assessment question: Are you Creative?

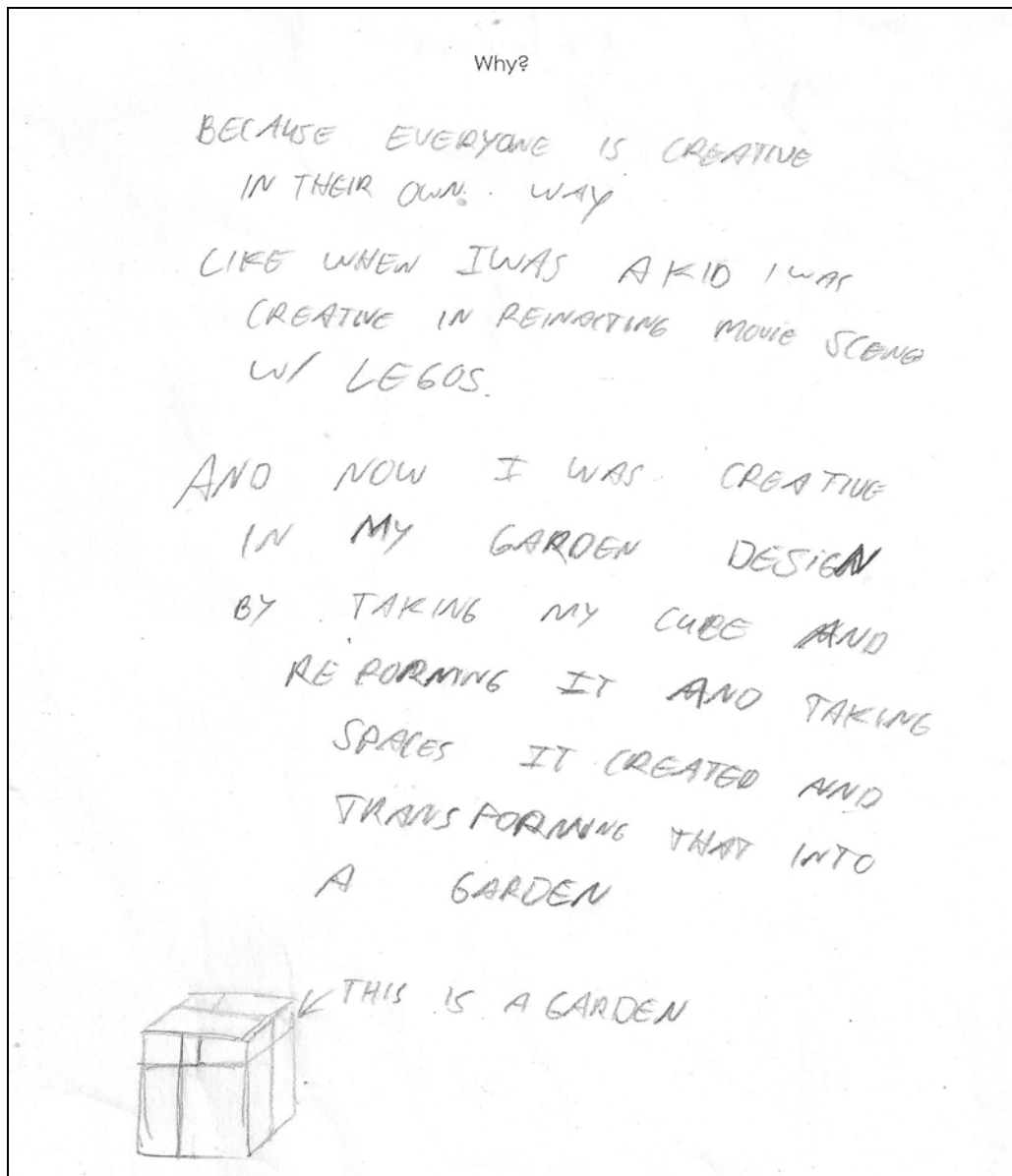
Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Drew a Picture	17	Drew a picture	22
Everyone is creative	5	Strategies/Approach	6
Desire for rules and boundaries	5	Creativity and Design Thinking	5
		Seminar	
Artistic Reference	2	Different from others	5
Imagination	2	Everyone is creative	5
Inspiration	2	Egotistic	3

One surprising theme that emerged in the posttest was the theme “egotistic”. These responses appear self-centered and are a reaction to other participants or the perceived expectations of the researcher. The responses are included below.

- *Also I don't think that creativity requires proving it to someone, so if you were expecting a picture or something as a response to this question: my apologies, but that isn't what's going to happen.*
- *I think that it is so subjective it's not even funny, and like pretty much everyone here, I could maybe just draw something or do some weird crazy visual thing to make a case to represent my creativity.*
- *Others might not find me creative because they have another definition, but to me I am creative.*

Drawing a picture for the posttest was not only more frequent, but the quality of the images increased. Fewer of the images were unrelated to the written response. The pictures usually directly illustrated the concept advanced by the written response, see Figure 4.4.

Figure 4.4 Example of an illustrated response to the question “Are you creative?” during the posttest. This example makes reference to a project in the design studio course outside of the seminar.



Why

As part of the pretest, students were asked the question: “Why?” in connection with the previous question about their creativity. Student responses were grouped into ten themes.

1. *Different than others* (n=25)
2. *Artistic reference* (n=17)
3. *Making* (n=14)
4. *Individual Expression* (n=8)
5. *Other People* (n=7)

6. *Problem Solving Ability (n=7)*
7. *Everyone is creative (n=6)*
8. *Drew a picture (n=6)*
9. *Generation of New Ideas (n=3)*
10. *Imagination (n=3)*

Posttest

After the treatment participants were again asked the question “Why?” along with the previous question, “Are you creative?” Responses were grouped into 12 themes. Themes include:

1. *Different than others (n=23)*
2. *Drew a picture (n=17)*
3. *Process (n=16)*
4. *Artistic reference (n=15)*
5. *Other People (n=10)*
6. *Creativity and Design Thinking Seminar (n=8)*
7. *Everyone is creative (n=6)*
8. *Problem Solving Ability (n=6)*
9. *Open-minded (n=5)*
10. *Making (n=3)*
11. *Heal the world (n=2)*
12. *Poetry (n=2)*

The main difference between the pretest and posttest responses was that there was more variety in the responses students gave at the end of the treatment. Themes present in the pretest that persisted through the posttest were: Different than others, artistic reference, drew a picture, making, other people, everyone is creative, and problem- solving ability. Themes that disappeared were: individual expression, generation of new ideas, and imagination.

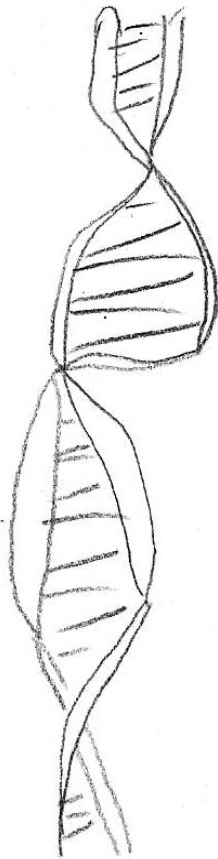
Table 4.7 Themes from the creative self-assessment question: Why?

Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Different than others	25	Different than others	23
Artistic reference	17	Artistic Reference	15
Making	14	Making	3
Other People	7	Other People	10
Drew a picture	6	Drew a Picture	17
Problem- Solving Ability	7	Problem- Solving Ability	6
Everyone is creative	6	Everyone is Creative	6
Individual Expression	8	Process	16
Generation of New Ideas	3	Creativity and Design Thinking	8
		Seminar	
Imagination	3	Open Minded	5
		Heal the world	2
		Poetry	2

From the pretest to the posttest, “different from others” remains the most dominant theme offered as evidence for a respondent’s definition of his own creativity. This theme references thinking differently than others, a desire to express oneself, and even the idea that being seen as weird and therefore different from others is an indication of creativity. More participants drew pictures for the posttest. This increase in drawing is encouraging as it suggests that the participants are incorporating the processes and communication methods of three-dimensional design. Although it is disquieting to see that design students do not value making things as a part of creativity. Again these images were less random but were combined with the written response as a composed sheet, see Figure 4.5. Respondents used principles introduced during the seminar in their pictures, see Figure 4.6. The increased frequency of drawing pictures is most likely a response to their design training.

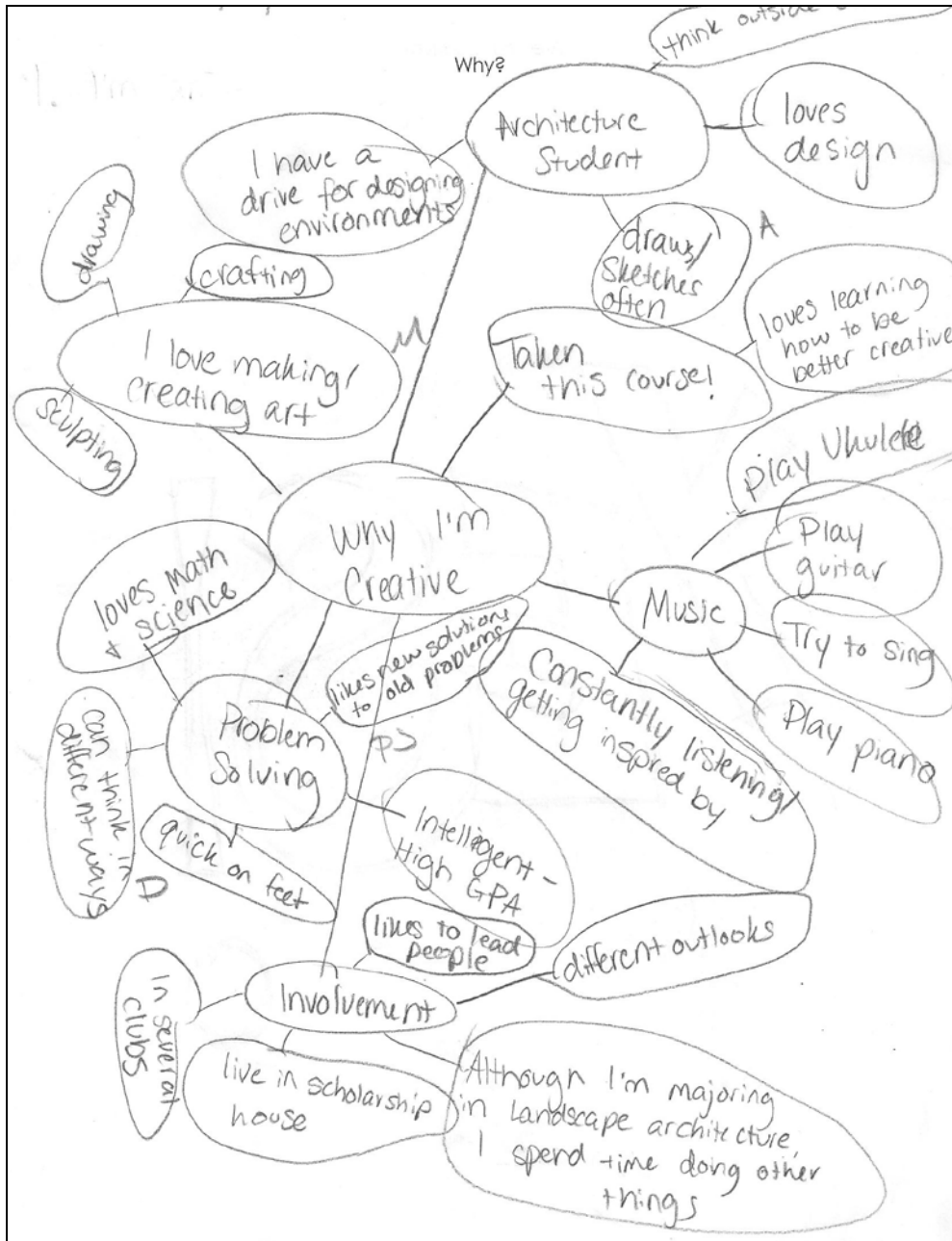
Figure 4.5 Image from the creative self-assessment question: Why? on the posttest. This is an example of less random combination of graphics and words. The written text reads “Genetics”.

Why?



Genetics

Figure 4.6 Image from the creative self-assessment question: Why? on the posttest. This example uses a creativity technique of mind mapping which was introduced in the creativity and design-thinking seminar.



Student Interviews

In addition to the written responses, the researcher conducted open-ended interviews with seven students in October, and six of the students returned for interviews in December. During these interviews the researcher asked the participant the following questions: Are you creative?

Why? How do you define creativity? The open interview format allowed the researcher to ask participants further questions about creativity.

Are You Creative?

The results of the interviews with the six students in December were similar to the creativity self-assessment. Generally students viewed themselves as creative. When students were asked if they are creative, they gave a range of answers. Participants tended to report affirmatively that they were creative ($n= 5$). No participant said that they were not creative whereas there was some uncertainty ($n= 2$). Most of the participants indicated that they were certain about their creativity, while two participants said that they were uncertain about their own creativity. Selected quotes from the interviews are provided below.

Affirmative

- *Yes, in my own way.*
- *I believe that I am creative.*
- *I like to think so.*
- *I think that creativity is something that I have been blessed with.*
- *I feel like I can be creative.*

Uncertain

- *I don't know.*
- *Debatable.*

Why?

When asked to explain why participants believe they are creative or not, there was again a variety of answers. Two themes emerged from the participants' comments: Conditional Creativity ($n= 5$) and the Importance of Ideas ($n= 4$). The conditional theme centers on the concept that creativity exists when certain conditions are met. The importance of ideas were specifically geared towards the generation of ideas. Neither one of these themes indicated that the students believed that creativity is a skill that can be taught. One student echoed the concept found in the creative self-assessment that creativity is an innate attribute, but that this attribute requires practice to improve. One selection of the participants' quotes is included below.

- *I believe that it's to some extent creativity has to do with what you are given, like your God given ability. And so I think that creativity is something that I have been blessed*

with, but its something like any other gift you have to develop, that you have to work at to make it better. So I can't just say I'm like super creative on my own there's been some sort of practice along the way like art classes that I have taken that have made me better at that as well.

Definition of Creativity

When asked to define creativity, the responses of participants were grouped into two themes: Subjective Definition ($n= 3$) and Problem Solving ($n= 3$). Selected quotes from the interviewees are included below.

Subjective Definition

- *I don't know if it has one definition. I think that it all depends on the people that you talk to like some people may think of it as like an artistic masterpiece is creative. Only you can do that. Whereas other people might just be like these ideas are creative even though multiple people came up with the same ideas.*
- *Being able to take something and make it your own. Creativity, I think, is very broad for different people. It's different between everybody.*
- *I feel like it's really hard to be creative with a bunch of other people that are trying to be creative. I mean everybody is just trying to think of something that no one ever thought of which is almost not creative because you are just doing the same thing that everyone else is doing; trying to think of something no one is thinking of. But you could be thinking of something that someone's is thinking of but in a different way and that is creative too, I mean different or I don't know.*

Problem Solving

- *I would probably say, taking information and using it to be innovative. For innovative I would say that it is building off of other ideas, or taking preexisting ideas, or theories, or concepts and altering them to fit what is necessary.*
- *I think creativity is problem solving. It is using thoughts to come up with solutions.*
- *Creatively is taking an uncommon approach to a certain task situation, that is like a collaborative event. I guess it also can kind of be an independent event. Yeah, taking different approaches, different strategies, something like that.*

Other Notable Responses

- *Creativity is being able to have an open mind. I mean an open mind that helps you. I guess that's it. ... Having an open mind, I guess, that generates good ideas.*

Five participants said that they were creative while two of the six said that they were uncertain about their creativity. The range of additional comments about creativity was similar to those found in from the creative self-assessment. The interviews allowed more time for the

students to reflect and to give an honest response to the questions posed that represented their true feelings. The students readily talked about themselves, their definition of creativity and frequently told stories that did not directly relate to the research. Naturally the students who volunteered to be interviewed were self-motivated by an expressed interest in the research and had already read about creativity or had questions about the research.

Design Expert Interviews

The Design Experts who participated in this research were questioned about their experience of measuring the creativity of participants on the Final Design Product. The seven following themes were derived from conversations between the researcher and each design expert. As an expert could make comments in several different themes, or multiple comments within a theme, the total number of responses is greater than the number of design experts. Italics indicate direct quotes from conversations with the design experts; observations by the researcher are marked in brackets. Themes from the design experts include:

1. *Not novel (n=12)*
2. *General attributes of higher scoring projects (n=10)*
3. *General attributes of lower scoring projects (n=10)*
4. *Humor (n=6)*
5. *Black Box (n=4)*
6. *Process (n=2)*

General Attributes of Higher Scoring Projects

Judges considered a number of attributes indicating greater creativity when they rated the different projects. The judges mentioned that evidence of a thought process, plausibility, and projects that built off of existing situations generally received a higher creativity score.

- *Depth of thought*
- *Interesting and different*
- *Engagement in the problem, participated in their solution*
- *Top ones were transformative specific to the situation*
- *Plausibility of the ninja one(ninja one?) is another reason it is creative*
- *Non traditional approaches*
- *Come up with something that solved the problem by requiring to put together common or uncommon methods and things to find a solution.*
- *Expression of the solution meant they had designed the idea, the action, it was fresh.*

General Attributes of Low Scoring Projects

In contrast, those solutions that simply restated the design problem, showed little evidence of thought process, and were interpreted as selfish, received lower scores. It is also important to note that the design experts considered it more difficult to judge the projects they considered less creative.

- *Illustration of problem statement = no good*
- *They did not design.*
- *[Projects identified as selfish within the gift giving scenario were scored lower]*
- *Predictable*
- *No evident connections*
- *Harder to judge the weaker projects*

In further conversations with the expert judges, five of the judges indicated that they could plausibly assign a zero cut off score for creativity. This means that there would be a point where they would say no creativity was evident. This is an important point as it contradicts the belief of some students that everyone is creative.

Results from Interviews with Studio Instructors

The researcher was able to meet with seven instructors throughout the course of the semester and ask them about the creativity they observed in their studios. Five of the instructors indicated that they felt the students at this early stage in their education are more concerned about achieving a passing grade on the assignment rather than exploring possible alternatives.

- *They want to know what to do to get the “A”.*
- *At this level they are very nervous about stepping outside of the requirements.*
- *I don’t know if they are creative or if they are trying to survive.*

During the interviews the instructors were more concerned with the specific challenges of teaching design to beginning students, such as the difficulty of teaching students how to handle criticism, share ideas one with another, and go beyond requirements.

One instructor observed that the group will come to a consensus over what is important and not make individual decisions, and that this may inhibit individual creativity. Three instructors commented specifically on the structure of the problems used in first-year during the Fall 2012 semester being problematic to fostering creativity.

- *When describing her own first-year experience one instructor said, “They said to us, you shall have a plan, maybe an elevation, and whatever else you need to explain your idea. Whatever else. Here, I feel you shall have the following things, and this is what you will be assessed on. So that’s something I feel hinders a lot of expressiveness because now, if you don’t have four sheets and each sheet will have two projections of this nature your project fails. You have to have these things and in order to have these things you have to have your design or instructional period half way through the project period over so that you can produce these things. I find that inhibits thinking.”*
- *Our course is so structured there is very little opportunity for them to be creative, really.*
- *They come into this school and they’ve got this pressure about grades and they suppress it. If they were creative people they don’t feel comfortable to express it because they think they are going to be punished for it and it’s because of the nature of the problems and the rule structure that is set up.*

Summary of Findings

The primary research question focused on the effect of an academic intervention on creativity, as measured by the Figural Torrance Test of Creative Thinking (FTTCT), of first-year three-dimensional design students. At the beginning of the semester there was no significant difference between the treatment group and the control group as measured by the FTTCT. At the end of the treatment period the treatment group on average scored significantly higher than the control group on the FTTCT posttest, but showed only a slight increase from their pretest scores, see Figure 4.7. There also appears to be little difference between the pretest and posttest scores of students in within the treatment group. At first glance it appears that the treatment did not increase student creativity, but when coupled with the fact that the control group’s creativity decreased, one can begin to speculate that the treatment counteracted factors in the students’ lives that negatively impact creativity. One way to imagine the effect is to think of it as an inoculation against a disease. The conditions for contracting the disease are favorable but your “shot” helps you from getting sick. Some of the negative factors could include: being away from home, grading structures that are different from high school, and the new rigors of design school. It is possible that by identifying and managing these factors could influence student creativity.

Figure 4.7 Diagram illustrating the pretest and posttest results on the FTTCT for the treatment group and control group.

Experimental Groups	Pretest	Posttest
Treatment Group	110.52	113.53
Control Group	114.93	104.78
Significant	no	yes

Regarding the different measures of creativity, this research found that scores on the FTTCT significantly correlated with instructor-based creativity rating and the longitudinal creativity rating. Surprisingly though, there was no significant correlation between the experts' rating of the students' final projects and any of the other creativity measures. The FTTCT measured creativity based on: the quantity of ideas, uniqueness of ideas, creativity of titles, enrichment of ideas, and a willingness to keep working (Torrance, 2006). The longitudinal measure of creativity was based on appropriateness and novelty. The instructor based his rating on appropriateness, novelty, the richness of the idea, and evidence of exploration. It appears the design experts rated projects based on depth of thought, novelty, engagement with the problem, a transformation of the problem, non-traditional approaches, and a degree of plausibility. The design experts were not shown any evidence of the design process. If they were they might have considered: completeness of ideas, wiliness to keep working, and evidence of exploration.

This research also sought to understand how students feel about their creativity. At the beginning of the research 66.26% of students affirmatively stated that they thought that they were creative. By the end of the semester this percentage rose to 85.71% of all the respondents indicated that they were creative. A Kendall's Tau correlation showed that there was not a significant relationship between students response on the creativity self-assessment and scores on the FTTCT, $r=.12$, $p>.05$. In general the students feel that they are creative and identified certain reasons to justify their belief. One of the most frequently cited reason respondents gave for their creativity is that they are different from others. This difference is sometimes described by respondents as being weird, or thinking in a unique way compared to others. The fact that they drew was also a common response. Another theme that reoccurred was the idea that

everyone is creative, and that in some cases; judgment about another's creativity was unjust. This theme was repeated in the interviews between the researcher and participating students. Students said that creativity is subjective and depends on the situation and how it is defined. Yet, when the design experts were asked to measure the creativity of the students' final design project they were able to do so with a high level of reliability. The ten judges agreed with one another 85% of the time.

The interviews with the instructors revealed that they felt that the students are too focused on getting good grades, which inhibits creativity. Suggested possible solutions included providing a course structure and writing design problems in a way that focuses more on encouraging design exploration. Assignments that reward quantity and quality of designs could help foster exploration. Changing the grading structure so that students feel that they can explore and be creative without being penalized would help students be less preoccupied with grades.

Chapter 5 - Summary and Discussion

Introduction

This research was motivated by a desire to explore and understand creativity in first-year design students at the College of Architecture, Planning & Design at Kansas State University in Manhattan, Kansas. A review of the literature on creativity sought to find a commonly held definition and model of creativity as it applied to the domain of three-dimensional design. Creativity is still a subject of active and dynamic debate and a commonly accepted definition and model for the design disciplines was impossible to find. The lack of a definition and model of creativity was viewed as a design problem for this author and an opportunity to develop a definition and model specifically tailored to three-dimensional design.

By analyzing the different contemporary theories of creativity through the lens of a designer, the similarities among the existing models of creativity were identified. These similarities allowed the researcher to synthesize the common elements of different models within an organizational system adapted from the work of Csikszentmihalyi (1996). This framework was coupled with the design process and resulted in the Merrill Model of Creativity in Design which provided a foundation for selecting methods and data collection instruments, and for understanding creativity in design students. See Figure 5.1. The 'Instrument' column in Figure 5.1 lists the instruments used in the research. The 'Model Correlates' column indicates the portion of the Merrill Model of Creativity in Design targeted by the corresponding instrument used to answer the primary and secondary research questions of this study.

getting a “good grade,” students received points for attendance and participation because it was more important to the researcher that students experiment in an environment free of the pressures of producing an excellent result or good grade. Students were expected to simply produce projects using concepts and strategies taught in the class.

The research found that design students enrolled in the seminar scored significantly higher than their peers who did not take the seminar. Their higher performance does not reflect a dramatic increase in the treatment group scores but rather a considerable drop in creativity in the control group. Deliberate creativity training coupled with creativity exercises allowed students to slightly raise their creativity while the creativity of their peers dropped.

The instruments used to measure creativity were intended to cover a wide range of quantitative and qualitative data. This broad scope of data collection provided opportunities to better understand and interpret findings. Quantitative instruments measured included the Figural Torrance Test of Creative Thinking (FTTCT), an in-class longitudinal product assessment, an instructor-based creativity rating, and a final product creativity rating. The FTTCT, in-class longitudinal product assessment, and the instructor-based creativity rating were all significantly correlated with one another. There was no significant correlation between the final product creativity rating and any other measure of creativity.

Students were also found to be unshaken in their opinions of their own creativity with most of the students responding affirmatively to the question, “Are you creative?”. This confidence was coupled with the sentiment that they were creative because they are different from others; possess artistic abilities; express themselves with drawings; and, have that creativity ratified by outside sources.

This research developed an operational definition of creativity that guided the seminar and provided the basis for generating the Merrill Model of Creativity in Design. Through the creative self-assessment and individual interviews the researcher was able extrapolate a definition of creativity shared by participating students. Through direct observation and discussion with design experts, the researcher identified concepts that they considered creative. A comparison of these three definitions uncovered common elements: the reality of the creative process, the importance of novelty, and the existence of the field as judges of creativity.

Discussion

Research Questions

The research focused on answering the primary research question: **Does participating in an academic intervention intended to teach creativity affect the creativity of first-year three-dimensional design students?**

This question is followed by secondary research questions:

What are the correlations between different measures of creativity?

How do first-year design students perceive their creativity?

How do first-year design students define creativity?

How does the definition of creativity differ between the researcher, student participants, and the field?

Effect of Academic Intervention

The primary research question for this study was: Does participating in an academic intervention affect the creativity, as measured by the FTTCT, of first-year three-dimensional design students? While there was no significant difference between participants in the treatment group and the control group on the pretest administration of the FTTCT, students in the treatment group, ($M=113.53$, $SE=1.82$) scored significantly higher on the posttest administration of the Figural Torrance Test of Creative Thinking than the control group ($M=104.78$, $SE=3.41$), $t(84)=-2.22$, $p<.05$, $r=.06$). This supports the claim that three-dimensional design instructors can positively affect the creativity of their students through exercises focused on the raising the cognitive abilities of design students. Such exercises can easily be integrated into existing studio courses and become a part of students' regular cognitive practice.

A notable finding was that the control group's creativity dropped considerably over the course of the semester. This finding is in support of the findings of Hargrove (2012) where the creativity of control group participants remained the same or decreased over a four-year time frame. It appears that, in general, creativity also decreases in beginning design students over one-semester, but that the academic intervention of this research helped safeguard the participating students from succumbing to factors affecting the control group.

There are many possible explanations for this decrease in creativity. For example, students are coming from a high school educational context that is completely different from the

college educational environment. The added stress of learning a new domain and the assimilation of these new rules could hamper a student's creativity. A major factor could also be the emphasis on and the importance of grades. This stressor will be revisited later in the chapter.

Correlation of Different Measures of Creativity

Regarding the different measures of creativity this research found that scores on the FTTCT significantly correlated with instructor-based creativity rating and significantly correlated with the longitudinal creativity rating. Surprisingly, there was no significant correlation between the experts' rating of the students' final projects and any of the other creativity measures.

The lack of consistency between the FTTCT and the expert creativity rating is disconcerting, especially since there was such a high level of inter-judge reliability (Cronbach's $\alpha = .85$) between the 10 design experts. The FTTCT measured creativity based on: the quantity of ideas, uniqueness of ideas, creativity of titles, enrichment of ideas, and a willingness to keep working (Torrance, 2006). The longitudinal measure of creativity was based on appropriateness and novelty. The instructor based his rating on appropriateness, novelty, the richness of the idea, and evidence of exploration. It appears the design experts rated projects based on depth of thought, novelty, engagement with the problem, a transformation of the problem, non-traditional approaches, and a degree of plausibility. The design experts were not shown any evidence of the design process. If they were they might have considered: completeness of ideas, willingness to keep working, and evidence of exploration. There is also the possibility that the cognitive aspects of creativity measured by the FTTCT do not translate into final products, or that the final project process needs to be refined. The latter would be the easiest to change.

A final design problem that was more similar to the creativity exercises used in class would be more familiar to students. This familiarity would need to be paired with a final design problem that challenged the participants. For the final design problem in this research, each participant was given a unique problem to define, frame, and solve in addition to a client. It is possible that this entire process was too difficult for the participants. The process could be reasonably simplified if the problem was already defined and framed for the students to solve. This simplicity could also make the task of rating the products easier for the design experts.

Another option that merits further experimentation is to change the design expert scoring system. Through conversations with the design experts after the projects were rated, the researcher found that half of the judges would be in favor of including a lower cut-off point in the rating system, in which all remaining projects were simply categorized as non-creative. This cut-off point might prove useful in more accurately comparing the final project with other measures of creativity. Ultimately, the design experts agreed with one another 85% of the time. This suggests that design experts, identified as 'the field' by the Merrill Model of Creativity in Design, share a common idea or definition of creativity. Further research is needed to explore to what extent design experts share a common definition of creativity. A larger pool of design experts that included practitioners, professors from other institutions, and critics would be advantageous and allow researchers to identify attributes that the field considers essential to creative design products. Such data could help refine the Merrill Model of Creativity in Design.

What Measure to Use

With any experiment, the instrument selection is important and the pros and cons of each instrument need to be considered. The strength of the FTTCT resulted from the provision of a standardized administration and scoring system. Experts from Scholastic Testing Services provided a double-blind relationship between the researcher and the participants. The testing booklet and the scoring of the test both carry a financial cost. The FTTCT also takes 30 minutes to administer. A broader selection of instruments was not employed in this study due to the scope of this research. More research is needed to identify, compare, and contrast the different instruments measuring creativity in order for design educators and researchers to understand what instruments are best suited for assessing their students.

How First-year Design Students Perceive Their Creativity

At the beginning of the semester, the results of the pretest indicated that 63.2% of the participants considered themselves to be creative. Another 10.3% gave responses of "I think/ believe I am." At the end of the semester 91.7% of the students indicated that they were creative with another 8.3% giving responses of "I think/ believe I am." Over the course of the semester, the participants' self-reported creativity rose to the point that all participants felt that they were creative, or could be under the right circumstances. This finding suggests that the students are confident in their potential to be creative or confident in their abilities to be creative. There is a

subtle difference between the statements “I am creative” versus “I am capable of being creative”. This could reflect recognition that they are not yet experts in their chosen domain and still need time and training to become so. One of the limitations for the creative self-assessment is that students were able to view one another as they responded to the prompts in the classroom. There were at least two respondents who referenced what others were doing and stated that they would not “be creative” in the same way as their peers. More in-depth questions and future interviews will help create more refined questions and instrument protocols.

To a certain extent creativity should be expected in design students. These students do not represent the average college student, as they have self-selected a three-dimensional design major. At the end of the semester, most of the participants in the treatment group were deemed creative as measured by the FTTCT. At the end of the semester the treatment group scored higher on average than the control group, and the national average for their grade level. For the most part the students were fairly accurate in their self-assessment of believing they were creative. Another question that would invite further insight from the participants might be, “Do you consider your self more creative than your classmates?” and “Why?”.

These questions could be posed during interviews with the researchers. For this study, the self-assessment findings correspond with the interviews in the sense that students come to the university with a predetermined definition of creativity and that students believe themselves to be creative.

How First-year Students Define Creativity

According to the self-assessment most students defined creativity as being different from others, possessing artistic abilities, expressing oneself with drawings and having that creativity ratified by outside sources. Participants in the pretest, and in the interviews, identified that they liked having rules or constraints around a problem. Bonnardel introduced the idea that constrained cognitive environments are necessary for creativity in design, (2000). The interviewed students defined creativity as subjective and related to problem-solving ability.

How Does the Definition of Creativity Differ Between the Researcher, Student Participants, and the Field.

The operational definition of creativity used for this research is: Creativity is the process that results in novel and appropriate solutions that are judged to be tenable and high in quality.

Design experts defined creativity as novel solutions that demonstrated a depth of thought and did not simply restate the design problem. Solutions that magically solved the problem without any effort from the student—a genie magically resolving the problem, for example—were considered uncreative.

There are common elements within these three definitions of creativity, including process, novelty, and the field. At the end of the semester, the students had begun to identify the importance of process. The students identifying creativity as a process was especially rewarding to the researcher and although the researcher never shared his operational definition with the students, the concept was most-likely emphasized in the teaching of the class. The emergence of this theme without explicit instruction supports the idea that students were internalizing ideas from the seminar.

The idea that being different from others defined one's creativity was the main theme that surfaced from the creative self-assessment. This theme can be interpreted in different ways. In certain responses the researcher observed that when participants stated they were different from others, that students meant that they could express their individuality. At other times, it was clear that respondents meant that they, personally, thought differently than others, making them unique. This importance of being different could also mean that the students recognize the value of novelty to being creative and have had limited avenues of expressing their creativity. This belief in their own uniqueness is encouraging as students may use that to build a desire to create work that is novel.

The students also included references to other people when assessing their own creativity. They either indicated that they had been told by others that they were creative or that they inherited these qualities from family members. Essentially, students are describing gatekeepers who have given their mark of approval, which is akin to the field described by Csiksentmihalyi (1996). These findings are promising as they reveal that the definitions used by the researcher, the students, and the field are similar and offer an opportunity for design educators to build on students' perceptions of creativity.

General Observations from the Seminar

The researcher often observed the stressor of grades while conducting the seminar class. Students constantly asked how each activity would affect their grades. When students knew

beforehand that they were going to miss a class, they would ask if their absence would bring down their grade. They never asked what material they would be missing. Interviews with studio instructors revealed that this was a common observation. A side effect of being overly concerned with grades is a devotion to the single correct answer. At the beginning of the semester the students were often concerned that there was one correct answer to the questions the researcher would ask. The following example illustrates this point.

During the pretest the researcher gave the students the creative self-assessment on an 8.5” x 11” sheet of paper with the question, “Are you creative?” printed on the top of the sheet. One student engaged the researcher in the following conversation?

Student: Isn't it a one word answer?

Researcher: Is it?

Student: Do you want a regular written answer?

Researcher: <no response>

The danger of the one right answer mindset is that students were reluctant to explore multiple ideas after they had produced a single response to a design question. The researcher was often alarmed at how quickly students would stop working on a problem. During the seminar students were given 10-15 minutes to respond to the daily creativity exercise. The researcher began to observe and record how long students would spend working on the problem. A small percentage of the students habitually stopped working after two minutes. As time progressed, more and more students would fade away with only two or three students in each class section working the full time allowed. This tendency to stop working may be because students ran out of ideas and had not internalized techniques introduced in class. The students who regularly took the whole time often produced sophisticated and more developed solutions. In general these were also the students who were more willing to draw their responses.

At the beginning of the semester students consistently chose to write out their answers to design challenges. There was a general preference against drawing solutions. For example, when asked to turn a parking space into a small park, many students produced a list of amenities and features. The willingness to draw increased over the course of the semester, but even towards the end students leaned towards written responses rather than graphic ones. This observation suggests that when beginning design students entered the design program they did not value drawing, or were unfamiliar with using drawing to communicate ideas. More research into these

topics will help design educators better understanding the nature of beginning design students and how to best approach their education.

Imagination

Imagination was not identified as a component of this research, it was not a part of the model of creativity and it was not measured. At the end of the research it became apparent that imagination should be considered an important component of creativity in design students. Many of the creativity exercises contained an element of using imagination in order to complete the exercise. Many of the frustrations expressed by the researcher and other design instructors towards the students can be interpreted as a lack of imagination. In a speech delivered in the Imagination Gallery in London, Sir Ken Robinson stated, “Creativity is putting your imagination to work. To be creative you have to do something. You can be imaginative all day long and never do anything, but to be creative you do things. It’s a very practical process.” “One short way of defining creativity is applied imagination” (London Business Forum, 2011). This definition of creativity and imagination should resonate with designers because designers produce things. It is the application of our cognitive functions that creates the design solution. Imagination and its role in creativity in design deserves further investigation.

Limitations of the Research Design of the Study

Using pre-existing classroom clusters introduced limitations to this research because there was a chance that the individuals self-sorted into groups. For example, all of the more highly creative students might have chosen to enroll in the seminar offered by the instructor, in which case the groups would not truly represent the target population. The researcher observed anecdotally that the Friday mid-day section as a group was more talkative and more apt to share work and ideas with each other. The control group showed an unanticipated attrition rate. The use of pre-existing classroom clusters was used because full experimental control over the entire sampling population was not feasible. Full experimental control over a sampling population would allow randomization to provide comparable groups. In addition to full experimental control a higher level of influence of the researcher among the student population could also reduce the attrition rate of the control group.

This research was conducted over the course of a single semester using a single cohort of students, and did not allow for multiple treatments to be conducted over a long period of time.

Repeating the experiment over a longer period of time, with participants of varying ages, and at different universities, would lend support to generalizing findings to a larger target population.

The researcher did not focus on modeling creativity as a method for creativity education nor did he share the Merrill Model of Creativity in Design or his operational definition with the participants. The researcher was more interested in discovering what definition would naturally develop from the participants. Due to the anonymity afforded participants during this research there was little opportunity for the researcher to share the creative work done in the course with the class. It would have been beneficial for the students to see what kinds of responses were rated as creative. In a sense they would see creative behavior rewarded and would interpret this as permission to be creative themselves. During a pilot study for this research students were given vocal permission to put “dragon wings” on their solutions. The researcher and other instructors observed that this permission translated into more creative solutions. The researcher feels that students were focused on their grade and were unwilling to trade the security of getting a good grade for creativity. Modeling of creative behavior, along with seeing creativity be rewarded could help students overcome the fear of being creative.

The pretest for this research was administered to a single pre-existing classroom cluster that was chosen at random. If the different classrooms had self-sorted into different levels of creativity then the pretest might not accurately represent the treatment group as a whole. The procedure was used because the treatment groups were assumed to be similar and that randomly choosing a classroom cluster would be an unbiased way of administering the pretest to a portion of the treatment group. If a selection of students from all the treatment groups were used as a group to take the pretest, then the pretest could better represent the treatment group as a whole. There is a danger that the individuals in each classroom who took the pretest may have had an effect on their classmates who did not take the pretest.

The control group suffered from a high rate of attrition. Only six of the original fourteen control group members returned to take the FTTCT posttest. This necessitated the recruitment of more students to have a substantial control group. Participants for the control group were recruited on the last day of the semester after sitting for a final examination. Willing participants signed a consent form and took the FTTCT there and then. Although the testing administration protocols were followed, the timing of the control posttest could have been influential on the resulting control group scores.

Suggestions for Future Research

There are some areas for future research that logically present themselves based on the outcomes of this research. They are: a shorter intervention, a cross-sectional study using multiple measures of creativity, an inventory of existing creativity building exercises, and the comparing different groups of students including: art students, engineering students, and education students.

This research could be repeated with a shorter intervention time. A four week course could potentially cover the same material. This would allow researchers to determine if a semester-long intervention is necessary or if similar results can be achieved in a shorter time frame. It would be fascinating to determine the shortest treatment time necessary to improve participant creativity.

A cross-sectional study using multiple measures of creativity in order to assess which instruments are correlated would provide researchers with information regarding which creativity test is most applicable to three-dimensional design. The use of different age and/or educational background groups would also inform researchers on how creativity changes as students advance in their studies.

A study that first identifies the different creativity exercises in existence could lead to research that compares and contrasts the effects of different training exercises. This would inform researchers and instructors which creativity exercises are best suited for three-dimensional design. This could alternately lead to the creation of a new battery of creativity exercises specifically for three-dimensional design education.

Research that directly modifies the immediate environment of three-dimensional design students could help researchers identify environmental factors that affect student creativity. This line of research could also help individual students understand their own optimal environmental setup for creativity.

Research could also be conducted to compare the creativity of design students with open major students, or students from specific alternate majors such as art students or business students. This might prove useful in determining whether or not students rated with higher creativity self-select into the domain of three-dimensional design.

Conclusion

Creativity will continue to be an important subject that design educators cannot afford to ignore. In order to best approach teaching creativity it benefits design educators to have tools and resources available to them. This research has contributed significant additions to the understanding of creativity among design students: a new model of creativity, a means of recording the internal definition of creativity as held by the students, and demonstrated methods for raising creativity in the classroom.

An important product of this research was the development of the Merrill Model of Creativity in Design. Where previously there had been no succinct model of creativity related particularly to the domain of three-dimensional design, this model synthesized the literature on creativity and the design process and put it into an accessible form. The Merrill Model of Creativity in Design is a tool that design educators can use to both understand and guide student creativity. The model served as the framework for this research and was a tool for understanding the results. The model can serve as the theoretical framework for future creativity research, as scaffolding for teaching design, and can identify specific factors affecting the creativity of specific groups of students. The potential to identify what specific factors will allow design educators to address those factors and result in more efficient teaching practices.

This research was able to articulate the commonly held definition of creativity shared by beginning design students, particularly their belief that creativity is equated with uniqueness. Simply being aware of that fact can help design educators in training design students. Realizing that students already value novelty as a part of creativity, educators can focus more on training students to create products that are appropriate, tenable, and high in quality to further increase their creativity.

The findings of this research support the idea that design educators have the ability to affect the creativity of their students. The methods utilized in this academic intervention of short directed instruction on creativity techniques coupled with short creativity exercises are effective. This knowledge can direct the development of courses in creativity. Alternately the methods are equally suitable to incorporate into existing design courses.

With the contemporary challenges of a national decline in creativity and an educational system that delivers uncreative design students to design educators it is important to understand the nature of creativity in three-dimensional design. This research provides a needed theoretical

approach, an applicable model, as well as successful methods for raising creativity. This new knowledge will help assist design educators in their task of producing the next generation of creative designers.

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Appendix A - Design Thinking and Creativity ENVD 299: Course Materials

Contents

The following items are included in this appendix:

- ENVD 299 Course Syllabus
- Informed Consent Forms
- ENVD 299 Information Poster
- Control Group Recruitment Poster
- Demographic Survey
- Creative Self-Assessment

ENVD 299 Course Syllabus



THE COLLEGE of
ARCHITECTURE, PLANNING & DESIGN

ENVD 299: Design Thinking & Creativity

Introduction

This course will focus on creativity as it pertains to the three-dimensional design professions, namely; planning, landscape architecture, urban design, architecture, interior architecture, and product design.

Course Objectives

This course introduces students to design thinking and creativity within the unique culture of three-dimensional design by using current research to:

- Introduce students to the concepts of design thinking.
- Introduce students to the concepts of creativity as they pertain to 3D design.
- Introduce students to the creative process through drawings, prototypes, and models.
- Expose students to the attributes of design experts.
- Introduce multiple strategies for creative problem solving.
- Provide a space for students to practice these strategies.

Learning Objectives

Upon completing this course you will:

- Begin to identify your personal creative process.
- Have an understanding of who designers are, how they think, and how they communicate.
- Practice different creative strategies used for problem solving.
- Identify strategies that you feel are helpful in your design process.

Fall 2012

Mon: 2:30 **Wed:** 9:30 **Fri:** 12:30

Instructor:
Jeremy Merrill
317 Seaton Hall, K-State
Manhattan, KS 66506
jmerrill@k-state.edu

Office Hours:

Mon: 1:30-2:15

Wed: 8:30-9:15

Fri: 11:30-12:15

Materials

Students will need to provide a notebook that is at least 4" by 8" but no larger than 8.5" by 11". Students will also need to bring a pencil or pen to each class.

Students will need to purchase a Figural Torrance Test of Creative Thinking Packet which is available through the instructor

There are no required texts for this class. From time to time the instructor will make additional readings available on K-state Online.

Course Structure

This course is scheduled for one hour each week. The instructor will devote the first half of each class time to lecture and the demonstration of material. The second half of class time will be set-aside for students to complete short assignments based on that day's material. Students will record their work in a notebook, kept specifically for this class. The assignments will require the students to practice the weekly assignments through drawing, prototyping, or modeling.

Students will record both their process and final product in the same notebook. These exercises will be graded pass or fail with 10 points recorded for each passed assignment. Any work that is not an honest attempt to complete the daily assignment will be given a "zero" and will not count towards the student's grade. Any work that is blatantly offensive will also receive a score of "zero".

This notebook will be retained by the instructor and distributed to the students at the beginning of each class session, and collected at the end of each class session. The notebooks will be used to mark attendance and to track students' progress in the course.

In addition to daily assignments each student will complete a final design project.

Course Conduct

1. Attendance and punctuality is required and professional demeanor is expected of each student.
2. Students are expected to refrain from using electronic devices during class.
3. If you will be absent from class for a verifiable illness or personal emergency you are expected to e-mail the instructor prior to the beginning of class. Failure to notify the instructor will result in an unexcused absence. If you have an unexcused absence you will not be allowed to turn in a late assignment. Late work will be accepted only with a real medical excuse or verifiable personal emergency.
4. In all cases communicate with the instructor

Evaluation

The total points available for this class is 200. Each daily assignment is worth 10 points. The final project is worth 50 points. Final grades will be determined as follows:

A	200-184	92-100%
B	183-166	83-91%
C	165-150	75-82%
D	149-134	67-74%
F	133 or less	0-66%

Statement regarding Academic Honesty

Kansas State University has an Honor System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor System. The policies and procedures of the Honor System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. The honor system website can be reached via the following URL: www.ksu.edu/honor . A component vital to the Honor System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

For more information, visit the Honor & Integrity System home web page at: <http://www.ksu.edu/honor>

Academic Accommodations for Students with Disabilities

"Any student with a disability who needs a classroom accommodation, access to technology, assistance during an emergency evacuation, or other assistance in this course should contact Disability Support Services and/or the instructor. DSS serves students with a wide range of disabilities including, but not limited to, physical disabilities, sensory impairments, learning disabilities, attention deficit disorder, depression, and anxiety .

For additional information, contact dss@k-state.edu;

Statement Defining Expectations for Class Conduct

All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article VI, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

Student Academic Creations

The ownership of student works submitted in fulfillment of academic requirements shall be with the creator(s). The student, by enrolling in the institution, gives the institution a non-exclusive royalty-free license to mark on, modify, retain the work as may be required by the process of instruction, or otherwise handle the work as set out in the institution's Intellectual Property Policy or in the course syllabus. The institution shall not have the right to use work in any other manner without the written consent of the creator(s).

Copyright Notification

"Copyright 2012- Merrill" applies to this syllabus, posted materials, lectures, and assignment samples. During this course students are prohibited from selling notes to or being paid for taking notes by any person or commercial firm without the express written permission of the instructor teaching this course.

Copyright of course readings, audio recording, and videos reside with the original author of these materials

ENVD 299: Design Thinking & Creativity



THE COLLEGE of
ARCHITECTURE, PLANNING & DESIGN

Course Schedule

(Subject to change)

Aug 20-24	<i>Intro to course, definitions/ myths of creativity, 3-d designers</i>
Aug 27-31	<i>Creative Thinking Assessment</i>
Sep 3-7	<i>Design Process</i>
Sep 10-14	<i>Design Problems: framing of design problems</i>
Sep 17-21	<i>Divergent Thinking: brainstorming</i>
Sep 24-28	<i>Divergent Thinking: mind-mapping</i>
Oct 1-5	<i>Divergent Thinking: metaphor, analogy</i>
Oct 8-12	<i>Divergent Thinking: random input</i>
Oct 15-19	<i>Recombination</i>
Oct 22-26	<i>Associative Thinking</i>
Oct 29-Nov 2	<i>Metacognition: recognition of cognition</i>
Nov 5-9	<i>Metacognition: regulation of cognition</i>
Nov 12-16	<i>Physical Environment</i>
Nov 19-23	<i>Attitudes, Motivation, and Personality</i>
Nov 26-30	<i>Design Expert Behavior</i>
Dec 3-7	<i>Creative Thinking Assessment</i>
Dec 10-14	<i>Final Design Problem</i>

Informed Consent Forms

KANSAS STATE UNIVERSITY STATEMENT OF INFORMED CONSENT

PROJECT TITLE: Raising Creativity in Design Education

APPROVAL DATE OF PROJECT: July 3, 2012 **EXPIRATION DATE OF PROJECT:** Dec 14, 2012

PRINCIPAL INVESTIGATOR: Stephanie Rolley

CO-INVESTIGATOR(S): Jeremy Merrill

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS:

Jeremy Merrill, ENVD PhD Candidate, 317 Seaton Hall, Kansas State University, Manhattan, KS 66506
E-mail: jmerrill@ksu.edu Phone: (785) 537-6856

IRB CHAIR CONTACT/PHONE INFORMATION:

Rick Scheidt, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

Jerry Jaax, Associate Vice President for Research Compliance and University Veterinarian, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

PURPOSE OF THE RESEARCH: This study explores the effects of a design studio course (ENVD 201) on design students.

PROCEDURES OR METHODS TO BE USED: Students will complete a short demographic survey. Students will participate in two design exercise sessions during the semester. The first session will last for one hour and will take place near the beginning of the semester. The second session will last for two hours and will take place near the end of the semester. You will be contacted with the exact dates. The exercises will include sketching, diagramming, and writing. All work will be recorded on paper provided by the researcher.

LENGTH OF STUDY: Your participation will begin August 27, 2012 and continue through December 14, 2012.

RISKS OR DISCOMFORTS ANTICIPATED: Risks will not be greater than those experienced during normal daily activities.

BENEFITS ANTICIPATED: By participating in the research you can expect to learn new techniques for enhancing your design process and final products.

EXTENT OF CONFIDENTIALITY: The identity of all participants will remain confidential. An outside party (department staff) will assign students a four-digit ID code. Each student will receive a printed ID label to affix onto paper for documenting his or her design exercises. All paper will be collected by the researcher at the end of each design exercise session. The key relating student names to ID codes will be kept in a locked location in a departmental staff member's office, restricted from investigators.

NO COMPENSATION OR MEDICAL TREATMENT IS AVAILABLE IF INJURY OCCURS.

Last revised on June 25, 2012

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

Participant Name: _____

Participant Signature: _____ Date: _____

Witness to Signature: (project staff) _____ Date: _____

Last revised on June 25, 2012

KANSAS STATE UNIVERSITY
STATEMENT OF INFORMED CONSENT

PROJECT TITLE: Raising Creativity in Design Education

APPROVAL DATE OF PROJECT: July 3, 2012 **EXPIRATION DATE OF PROJECT:** Dec 14, 2012

PRINCIPAL INVESTIGATOR: Stephanie Rolley

CO-INVESTIGATOR(S): Jeremy Merrill

CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS:

Jeremy Merrill, ENVD PhD Candidate, 317 Seaton Hall, Kansas State University, Manhattan, KS 66506
E-mail: jmerrill@ksu.edu Phone: (785) 537-6856

IRB CHAIR CONTACT/PHONE INFORMATION:

Rick Scheidt, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

Jerry Jaax, Associate Vice President for Research Compliance and University Veterinarian, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

PURPOSE OF THE RESEARCH: This study explores the effects of a design thinking and creativity course (ENVD 299) on design students.

PROCEDURES OR METHODS TO BE USED: Students will participate in a series of interviews with the researcher about their experience in ENVD 299. These interviews will be audio recorded.

ALTERNATIVE PROCEDURE THAT MIGHT BE ADVANTAGEOUS TO SUBJECT: For students enrolled in ENVD 299 who do not want to participate in this research will complete all the design exercises but will not have their work studied.

LENGTH OF STUDY: Your participation will begin August 27, 2012 and continue through December 14, 2012.

RISKS OR DISCOMFORTS ANTICIPATED: Risks will not be greater than those experienced during normal daily activities.

BENEFITS ANTICIPATED: By participating in the research you can expect to learn more about your own design process and experiences in ENVD 299.

EXTENT OF CONFIDENTIALITY: The identity of all participants will remain confidential and anonymous. During the interviews names will not be used. The researcher will type out the interviews and substitute a false name for all participants.

NO COMPENSATION OR MEDICAL TREATMENT IS AVAILABLE IF INJURY OCCURS.

Last revised on Oct 09, 2012

TERMS OF PARTICIPATION: I understand this project is research, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

Participant Name: _____

Participant Signature: _____ Date: _____

Witness to Signature: (project staff) _____ Date: _____

Last revised on Oct 09, 2012

ENVD 299 Information Poster

ENVD
299

Design Thinking & CREATIVITY

1

CREDIT HOUR, PASS/FAIL

Monday
2:30-3:20

Wednesday
9:30-10:20

Friday
12:30-1:20

FALL 2012 SEMESTER

Instructor:
Jeremy Merrill,
ENVD PhD Candidate

ENVD 299 Design Thinking and Creativity
1 credit hour
Jeremy Merrill, Instructor

This class/workshop will focus on creativity as it relates to the three-dimensional designer. Students will be introduced to a variety of factors which influence an individual's creativity. Students will be instructed in numerous strategies used in the creative design process, and will have the opportunity practice these strategies in class.

Class will meet for one hour per week. All student work will be completed during scheduled class time and recorded in a notebook specifically designated for the class.

Control Group Recruitment Poster

A photograph of a student with curly hair, wearing a dark top, sitting at a desk in a design studio. The desk is cluttered with papers, a computer monitor, and a keyboard. In the background, there are whiteboards and a clock on the wall. The image is overlaid with a semi-transparent blue grid pattern.

Students Enrolled in ENVD Design Studio
Research Participants Needed
INFORMATION MEETING
4:00 PM, August TBD, 2012
Seaton Hall 106C
FREE FOOD PROVIDED

Demographic Survey

DATE

ID_____

Demographic Survey

Age:

Pre-selected Major:

Hometown:

Have you ever been to a foreign country?

If yes, for how long?

Please list any past creative activities? (classes taken, hobbies, experiences, problem solving, etc...)

Creative Self-Assessment

DATE

ID _____

Are you creative?

DATE

ID _____

Why?

Appendix B - Creative Self-Assessment Themes and Quotations

Creative Self-Assessment

Are you Creative?

Pretest

During the pretest, participants were asked the question: “Are you creative?” Responses were coded into seven themes. Quotations from responses are presented in support of themes. Most of the participants indicated that, yes, they are creative. Other participants expressed a belief that they were creative while others indicated uncertainty. Eight participants indicated that their creativity was conditional, two respondents expressed uncertainty, and two respondents answered the question with a no. Themes for the pretest question of “Are you creative?” include:

- *Affirmative (n = 55)*
- *Conditional (n = 11)*
- *I believe/think I am (n = 9)*
- *Desire to improve (n = 3)*
- *No (n = 2)*
- *Uncertain (n = 2)*
- *Other notable responses (n = 3)*

Affirmative

While most respondents simply wrote yes, some respondents responded in other affirmative ways.

- *I am extremely creative.*
- *I am pretty creative.*

Conditional

Eleven respondents indicated that their creativity was conditional on other criteria.

- *To some extent, I would say that I am.*
- *I can be at times.*
- *In some ways.*
- *Depends on context.*
- *When I want to be.*

I believe/think I am

Nine respondents indicated that they thought or believed that they are creative.

- *I like to think so.*
- *I believe I am.*

Desire to improve

A total of three of the respondents indicated a desire to become more creative.

- *I try to be.*
- *Not as creative as I want to be.*
- *I wish I were more creative.*

Uncertain

Two of the respondents indicated uncertainty about their creativity.

- *I don't know*
- *I am not sure.*

Other responses

Other responses included the idea that creativity is subjective, a definition of creativity that is based on comparisons with others, and innate ability.

- *Everyone is and it's subjective.*
- *Sure, but then I find someone who is more creative.*
- *Innately.*

Posttest

After the treatment, and during the posttest, participants were again asked the same two questions posed during the pretests: "Are you creative?" and "Why?" Responses to the posttest question: "Are you Creative?" were coded into five themes. Individual responses could be grouped into multiple themes. Quotes are included to illustrate the other responses.

- ***Affirmative (n= 60)***
- ***Conditional (n=3)***
- ***Other notable responses (n=7)***

Affirmative

These respondents responded affirmatively that they were creative.

- *I am extremely creative.*
- *Yes, I believe so, its hard not to be creative.*
- *Heck yes, I am.*
- *Yes, I am creative in a very subtle way.*
- *Yep, are you?*
- *Definitely, Yes.*
- *Yes, I would say I am. I have been going back to this question several times this semester to see if my answer would change, but I still see myself as creative.*

Conditional

Three respondents indicated that their creativity is conditional and dependent on certain outside circumstances including: desire, and pressure.

- *I can be when I want to be.*
- *It's hard to be creative under pressure.*
- *I feel I can be creative when I want to be. It all depends on the situation I am in.*

Other notable responses

The following responses were notable but not organized into any of the previous themes.

- *I would consider myself somewhat creative.*
- *I am more creative than I thought I was.*
- *[One student folded their response sheet into an origami flower.]*
- *Am I?*
- *Quite possibly.*
- *I would like to think that there are some awesome creative thoughts stored away deep inside my brain.*
- *The class helps me a lot in my creative thinking.*

Table B.1 Themes from the creative self-assessment question: Are you Creative?

Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Affirmative	55	Affirmative	60
Conditional	11	Conditional	3
I believe/think I am	9		
Desire to improve	3		
No	2		
Uncertain	2		

After the treatment the confidence expressed by the participants increased. There were three conditional responses, no uncertainty, no negative responses, or desires to improve indicating that most participants all held the belief, after the treatment, that they are creative.

Are you Creative? Additional responses

Pretest

It is interesting to note that apart from directly answering the primary question, many participants provided additional comments. These additional comments were grouped into seven themes. Quotes are included in support of the themes. Respondent's statement may be represented in multiple themes. Themes included:

- ***Drew a Picture (n = 17)***
- ***Everyone is creative (n = 5)***
- ***Desire for rules and boundaries (n = 5)***
- ***Artistic Reference (n = 2)***
- ***Imagination (n = 2)***
- ***Inspiration (n = 2)***
- ***Other notable responses (n = 3)***

Drew a picture

A number of respondents included a picture in addition to their initial response. See figures B.1-B.3 for examples.

Figure B.1 Example of an illustrated response to the question “Are you creative?” during the pretest.

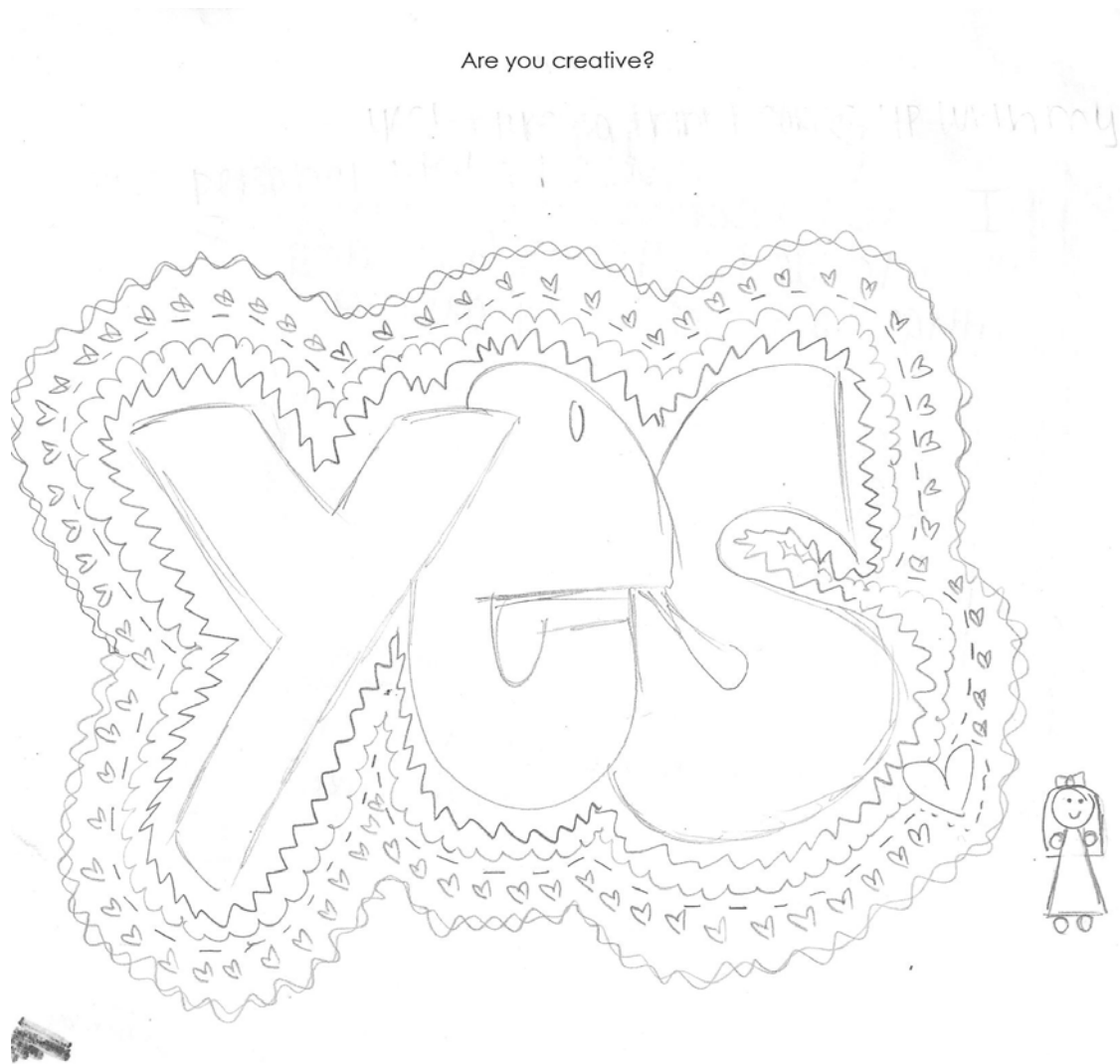


Figure B.2 Example of an illustrated response to the question “Are you creative?” during the pretest.



Figure B.3 Example of an illustrated response to the question “Are you creative?” from the pretest.



Everyone is Creative

Five of the respondents indicated that they believe creativity is subjective and that everyone is creative.

- *Everyone is creative in [his or her] own right. There is no yes or no that can include or exclude one's own brand of creativity.*
- *It depends on someone's view of creativity because people have different perspectives on what is creative and what is not.*
- *Yes, everyone is creative in [his or her] own way. Nobody is wrong and everyone is right.*
- *Everyone contains some degree of creativity.*
- *It has everything to do with what is in your mind and how you express that to everyone else. So, yes I think that I am creative and so is everyone else.*

Rules and Boundaries

Three respondents indicated that rules or boundaries, or “the box” were a component in their creativity.

- *Pretty logical person.*
- *I also really like rules.*
- *When it comes to thinking about things that don't exist it is hard.*
- *I tend to limit my thinking to just remain “in the box” I have a few moments where I come up with interesting “out of the box” ideas.*
- *When I am told to “be creative” I cannot be.*

Artistic Reference

Two respondents specifically mentioned art in their additional comments.

- *Does not have to be art.*
- *Creativity with artistry = spruce it up.*

Imagination

Two respondents specifically mentioned imagination in their additional comments regarding their creativity.

- *Imagination*
- *Imagine*

Inspiration

Two respondents specifically mentioned inspiration in their additional comments regarding their creativity.

- *I have to have some sort of inspiration to be most creative.*
- *I need inspiration.*

Other notable responses

Other responses made reference to making things better, outside influences, and an explanation of the creative process from one respondent.

- *Figure out how to make it better.*
- *Well at least that is what people tell me.*
- *I enjoy experimenting with ideas and if something doesn't work out, I don't spend long before I try a different route.*

Posttest

As with the pretest students provided additional comments or sketches with their responses to the question are you creative? These additional comments were grouped into seven themes. Quotes are included in support of the themes. Respondent's statement may be represented in multiple themes. Themes included:

- *Drew a picture (n=22)*
- *Strategies/ Approach (n=6)*
- *Class (n=5)*
- *Different from others (n=5)*
- *Everyone is creative (n=5)*
- *Egotistic (n=3)*
- *Other notable responses (n=03)*

Drew a picture

Respondents included pictures that either illustrated or added to their written response. See figures B.4- B.6 for examples.

Figure B.4 Example of an illustrated response to the question “Are you creative?” during the posttest. This particular example illustrates the concept the respondent expresses with words.

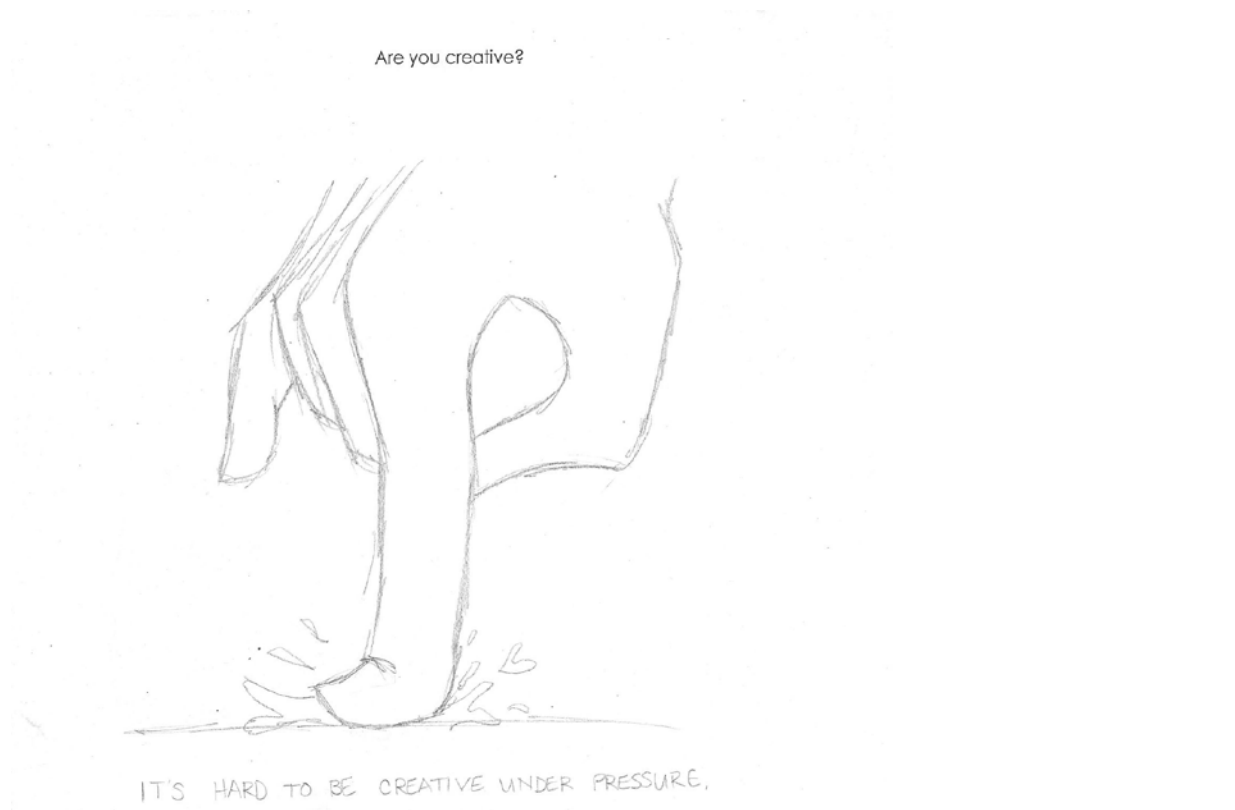


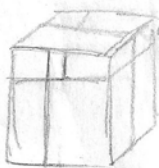
Figure B.5 Example of an illustrated response to the question “Are you creative?” during the posttest. This example makes reference to a project in the design studio course outside of the seminar.

Why?

BECAUSE EVERYONE IS CREATIVE
IN THEIR OWN WAY

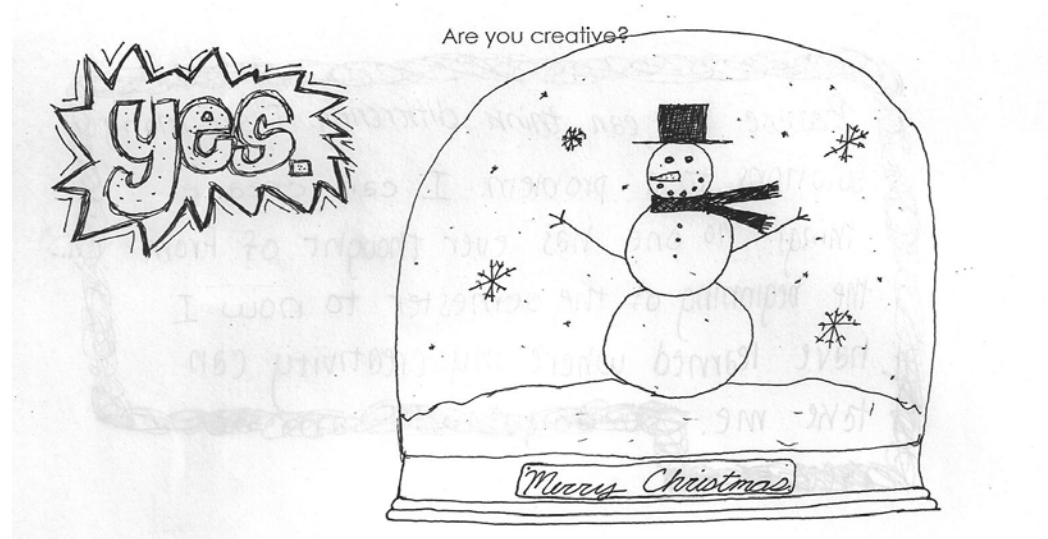
LIKE WHEN I WAS A KID I WAS
CREATIVE IN REIMAGINING MOVIE SCENES
W/ LEGOS.

AND NOW I WAS CREATIVE
IN MY GARDEN DESIGN
BY TAKING MY CUBE AND
RE FORMING IT AND TAKING
SPACES IT CREATED AND
TRANSFORMING THAT INTO
A GARDEN



THIS IS A GARDEN

Figure B.6 Example of an illustrated response to the question “Are you creative?” during the posttest that does not relate to the written response.



Strategies/ Approach

And six respondents mentioned an understanding of specific strategies and/or approaches to being creative.

- *I also believe this class has helped me be more creative by teaching me ways and processes to get out of my normal humdrum way of thinking.*
- *I understand more about what it means to be creative and how to think in certain ways to improve creativity.*
- *I have a better grasp on how to present my creative side and express my creativity in multiple ways.*

Creativity and Design Thinking Seminar

Five respondents specifically mentioned the creativity and design-thinking seminar as influential to their creativity.

- *However I think this class has made my creativity better.*
- *I would like to believe so, since starting this class I have gained more confidence in the fact that I am creative.*
- *I feel this class has caused me to become more creative than before.*

Different from others

Five respondents indicated that they believed that they are creative because they are different from other people.

- *I am capable of coming up with different ideas than others would, which makes me different and creative.*
- *I'm creative in the sense that I could think of things, objects, and ideas that no one will create.*
- *Yes, in my own unique way.*

Everyone is creative

Five of the respondents indicated that they believe creativity is subjective and that everyone is creative.

- *Every person has the ability to be creative. There are no levels of creativity. Most times if you think that you aren't being creative, you are. Creativity isn't defined.*
- *We are all individuals and are different from each other and that is what makes anything creative.*
- *Everyone is creative in his or her own way and in his or her own amounts.*
- *Also, I believe anyone can be creative given the right situation, so I must also be.*

Egotistic

Three respondents provided responses that they were beyond classification and that it could not be identified.

- *Also I don't think that creativity requires proving it to someone, so if you were expecting a picture or something as a response to this question: my apologies, but that isn't what's going to happen.*
- *I think that it is so subjective it's not even funny, and like pretty much everyone here, I could maybe just draw something or do some weird crazy visual thing to make a case to represent my creativity.*
- *Others might not find me creative because they have another definition, but to me I am creative.*

Other notable responses

Other responses made reference to being uncreative, difficulty in talking about creativity, and how one respondent find himself creative.

- *I can be wildly uncreative as well as over creative.*
- *I ramble. I think that is because it is hard to talk about a concept that doesn't seem to have a concrete definition.*
- *Yes, I find myself very creative.*

Table B.2 Themes from additional comments from the creative self-assessment question: Are you Creative?

Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Drew a Picture	17	Drew a picture	22
Everyone is creative	5	Strategies/ Approach	6
Desire for rules and boundaries	5	Creativity and Design Thinking Seminar	5
Artistic Reference	2	Different from others	5
Imagination	2	Everyone is creative	5
Inspiration	2	Egotistic	3

Drawing a picture was a common additional response that increased during the posttest. Other additional comments that were present during the pretest and posttest was everyone is creative. Artistic references, imagination, and inspiration both disappeared from the posttest. Strategies/ Approach, and the Creativity and Design Thinking Seminar all appeared during the posttest likely because of lessons learned in the seminar and in the other design courses.

Why

During the pretest students were asked the question: “Why?” in connection with the previous question about their creativity. Student responses were grouped into nine themes. Quotes are included in support of the themes. Respondent’s statement may be represented in multiple themes.

- *Different than others (n=25)*
- *Artistic reference (n=17)*
- *Making (n=14)*
- *Individual Expression (n=8)*
- *Other People (n=7)*
- *Problem Solving Ability (n=7)*
- *Everyone is creative (n=6)*
- *Drew a picture (n=6)*
- *Generation of New Ideas (n=3)*
- *Imagination (n=3)*
- *Other notable responses (n=2)*

Different than others

Twenty-five respondents indicated that they believed that they are creative because they are different from other people.

- *I want to be more creative in my life so I can stand out and be different.*
- *I found that a vast majority of people would do something one way; where I would do it another way.*
- *I believe that I am creative because I create and am capable of creating new unique things and answers that are unique to me/my brain.*
- *I am creative because I think differently from a lot of people I know*
- *It's also the lack of an intellectual society where people can truly understand the thought of a mind like mine.*
- *I feel I can think in different ways to solve something compared to my friends.*

Artistic reference

Seventeen respondents referenced artistic abilities or experiences as reasons and evidence for their creativity.

- *I enjoy creating my own art.*
- *Because while I can think of creative and peculiar ideas but I lack the drawing ability to make them a reality.*
- *I struggle specifically with music. With art I don't have great difficulty creating.*
- *Drawing is something I like to do to pass the time.*
- *I grew up taking art classes every year.*

Making

These responses centered on the concept that by making or building things was evidence of their creativity and were referenced by fourteen respondents.

- *Because I enjoy designing and making my own things.*
- *I have always loved the idea of making things with my two hands, wither it is sculpted or written.*
- *Because I enjoy making things and most of the time I am successful in my final products individualism.*
- *I like to make things.*

Individual Expression

Eight respondents indicated that creativity was important because it is a method of individual expression.

- *Because I like to come up with my own ideas for things*
- *Other I enjoy creating my own art.*
- *I have to be creative to make things look pretty and original.*
- *I like to express myself using colors!*

Other People

Seven respondents specifically included other people in their comments about their creativity. Other people included parents, friends, and the general public.

- *Levels of creativity are determined by the general reaction of the public to certain works and pieces of art.*
- *Overall I can recall friends and family saying that I am very creative.*
- *I think it's a gene I got from my Dad.*

Problem Solving Ability

Seven respondents used problem- solving ability as evidence for their creativity.

- *I always think of new things to do with my friends, different ways to solve problems and other things.*
- *I feel like I am good at problem solving.*
- *When given a problem I take all things into consideration when solving it: How can this be better? Who does it influence, or have to do with? What do they want from the solution? And can this be done!?*

Everyone is creative

Six respondents indicated that they believe that everyone is creative.

- *I think everyone is creative to a certain degree.*
- *Everyone is...*
- *When we [were] born in this world ourself is creative.*
- *Creativity is really a subjective thing though.*
- *Creativity HAS NO DEFINITE MEASURE.*
- *Because everyone is creative in his or her way. My creativity is might not be considered creative by someone else. I would like to think that I can come up with innovative ideas on my own, but that is my opinion.*
- *Creativity is anything YOU want it to be.*

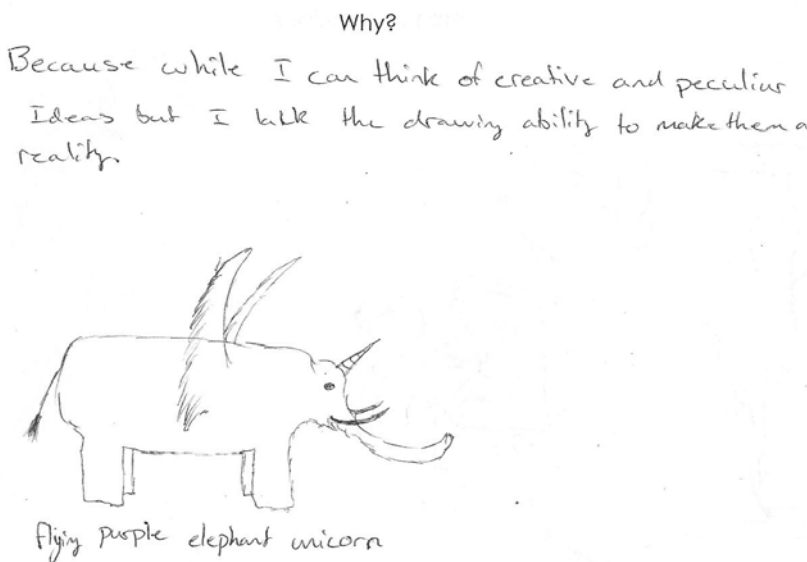
Included a drawing

Participants were not instructed that to only include written responses. Many of the respondents chose to include a picture. Most of the pictures make specific reference to the course, or illustrate and support the respondent's written answers. See figures B.7 and B.8.

Figure B.7 Themes from additional comments from the creative self-assessment question: "Why?" on the posttest.



Figure B.8 Themes from additional comments from the creative self-assessment question: "Why?" on the posttest. In this example the image does not relate to the written response.



Generation of New Ideas

The ability to generate new ideas was cited by three respondents.

- *Because I like to think of new ideas to try, and see if they work or not.*

Imagination

Three respondents indicated the imagination as important to their creativity.

- *Any kind of idea involves some imagination and with that comes along creativity.*
- *Because I have a crazy imagination.*

Other notable responses

There were a total of two notable quotes that are not grouped into themes.

- *I am creative because I don't hold myself back and I explore new opportunities every chance that I get! I also am not judgmental or have a pre-bias about things when I see them or I try to at least. It's like looking at things with a fresh set of eyes.*
- *Because I will think of solutions to certain situations.*

POSTTEST

Students were asked the question “Why?” along with the previous question, “Are you creative?” Responses were grouped into eight themes. Quotes are included in support of the themes. Respondent’s statement may be represented in multiple themes. Themes include:

- ***Different than others (n=23)***
- ***Drew a picture (n=17)***
- ***Process (n=16)***
- ***Artistic reference (n=15)***
- ***Other People (n=10)***
- ***Creativity and Design Thinking Seminar (n=8)***
- ***Everyone is creative (n=6)***
- ***Problem Solving Ability (n=6)***
- ***Open-minded (n=5)***
- ***Making (n=3)***
- ***Heal the world (n=2)***
- ***Poetry (n=2)***
- ***Other notable responses (n=10)***

Different than others

Twenty-three respondents indicated that they believed that they are creative because they are different from other people.

- *I try to think of ways most people wouldn't. When I do this, I find that I think of things that myself, or even others wouldn't normally think of. When I think of these things, I feel as if that's what being creative consists of.*
- *I feel like I think differently than others.*
- *I'm weird and creative people are weird people.*
- *Because we all have our individual way of thinking and producing things, and the way I do is easily defined as a more creative approach.*

Drew a picture

Participants were not instructed that to only include written responses. Many of the respondents chose to include a picture. Most of the pictures make specific reference to the course, or illustrate and support the respondent's written answers. Only four of the pictures are random and do not relate to the written response. See figures B.9-B.11 for examples.

Figure B.9 Image from the creative self-assessment question: Why? on the posttest. This example illustrates the written response.

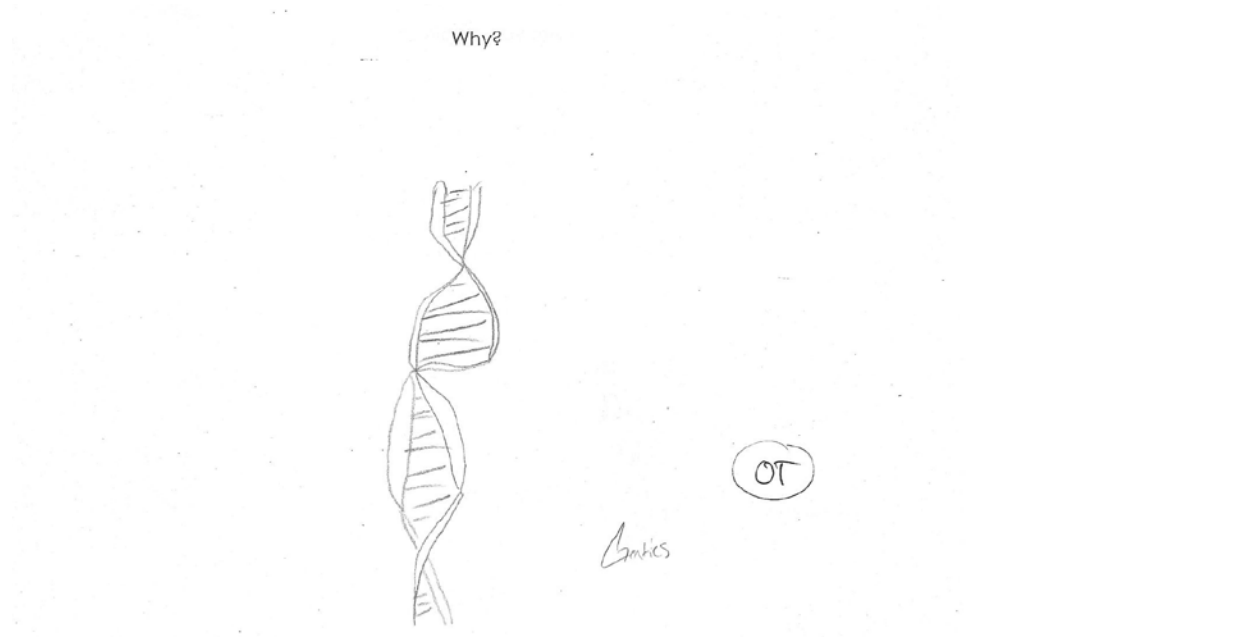


Figure B.10 Image from the creative self-assessment question: Why? on the posttest. This example illustrates the written response.



Figure B.11 Image from the creative self-assessment question: Why? on the posttest. This example uses a creativity technique of mind mapping which was introduced in the creativity and design-thinking seminar.



Process

Mentioned the creative process or a specific piece of the design process

- *Every idea that's new, inventive, or one that combines or adds to previous ideas is a part of, and goes through the creative process.*
- *I am able to come up with multiple ideas and solutions.*

Artistic reference

Respondents cited their artistic abilities as an evidence of their creativity.

- *I am able to express myself through design as well as through music and craft.*
- *Creativity is imaginative thinking used in art and design.*
- *There is something about people's brains that practice the arts that enjoy creativity.*
- *I took art and drawing courses.*

Other People

Responses within this theme specifically mention other people as an aspect of a respondent's creativity. Responses include other people as judges of creativity, collaborators, parents and past influences.

- *I am creative because I can process an idea completely different than anyone else. Whether others see my ideas as creative is another story.*
- *I would credit my upbringing. This includes but is not limited to my parents, siblings, friends, the input I received as a child and the collected variable of my education.*
- *I can take other's ideas and add on or recreate them.*

Creativity and design-thinking seminar

Respondents also made specific mention of the creativity and design-thinking course as an influence to their creativity.

- *Because I was able to come up with things in this class that no one else thought of as well as unique designs for studio and history assignments.*
- *This class has taught me that creativity is a tool to be used and sharpened.*
- *This class helped me further investigate different ways of sparking my creativity.*
- *I have learned ways to create things, in studio and in this class.*

Everyone is creative

Six respondents indicated that they believe that everyone is creative.

- *I believe that I am creative and so is everyone else. The degree to which we are creative I think, can be defined by how much we are able to apply it and use it.*

- *I think that everyone is creative in their own special way, analytically, artistically or even writing. There isn't anyone I can think of that wasn't creative in one way or another.*
- *Being creative is a part of who I am; it can't be taken or given. We are all born with it; it's just a matter of how we express it.*
- *Because creativity can not be measured. Everyone is creative in their own way*

Problem Solving Ability

Respondents made reference to their ability to solve problems as evidence of creativity.

- *I am confident that I can fix most things because I am creative and think of solutions.*
- *Finding odd ways to solve problems is a strong quality of mine.*

Open-minded

These respondents attributed their creativity to their ability to be open to possibilities.

- *I am open minded and willing to look at different views, as well as being open to being inspired by the things around me.*
- *I don't let limitations stop me in what I want to accomplish. I find ways around them. I guess you could call that creativity.*
- *The reason why I think that I am creative is because of the fact that I am not afraid to take unique ideas, thoughts etc. and apply them into ordinary processes.*

Making

These responses centered on the concept that by making or building things was evidence of their creativity.

- *I build things.*

Poetry

Two respondents provided poems to augment their response.

*I'm not going to even try,
To begin to explain why,
But I'd like to think I am,
And to go out with a bam,
I am writing this poem,
And that is all so, um...*

*There could be many reasons,
As one changes with the seasons,
To become creative.
It could be from a poem that rhymes,
Or from painting limes,
But yes, I must be creative.*

Heal the World

Two respondents indicated that their creativity would help make the world a better place.

- *Because the world needs creative people and that is my destiny. ... It's my turn to innovate, create, and help make the world a better place.*
- *When we get to the peak of creativity then we can use this to help people and change the world*

Other notable responses

There were a total of ten notable quotes that are not grouped into themes.

- *If it is something that I am forced to do many times I would not be able to be as creative as I know I can be.*
- *I feel as if I am creative because creativity is unique.*
- *Creativity helps me actualize my potential.*
- *Because I am an individual. Not a machine that's programmed for the same response every time.*
- *I am creative because I am in architecture.*
- *Because I create, and I read it online somewhere.*
- *But I like specifics. Working with specifics and making them right, in a creative way.*
- *Because I am a visual learner, as well as a visual teacher. I can explain things with pictures much more easily than I can with words.*
- *Because I want to be creative, so I am.*
- *I can create new designs that have never been seen before. Even if they don't work I have still created a new idea.*

Table B.3 Themes from the creative self-assessment question: Why?

Pretest		Posttest	
Themes	<i>n</i>	Themes	<i>n</i>
Different than others	25	Different than others	23
Artistic reference	17	Drew a picture	17
Making	14	Process	16
Individual Expression	8	Artistic reference	15
Other People	7	Other People	10
Everyone is creative	6	Creativity and Design Thinking	8
		Seminar	
Drew a picture	6	Everyone is creative	6
Problem Solving Ability	7	Problem Solving Ability	6
Generation of New Ideas	3	Open-minded	5
Imagination	3	Making	3
		Heal the world	2
		Poetry	2

From the pretest to the posttest “different from others” remains the most dominant theme offered as evidence for respondent’s creativity. “Artistic Reference” remained high for both the pretest and posttest. It is notable that 17 respondents drew a picture for the posttest compared to 11 for the pretest. At the end of the semester there were a greater variety of themes, further evidence that the respondents had picked up concepts from the seminar or their time as a design student.

Appendix C - Personal Narrative

The Creativity class ENVD 299 was intended to be a chance for students to take a class that would help to enrich their creativity and design process. The class was set up as a participation/ seminar where students would come to class each day be exposed to a new concept related to creativity and design thinking or a strategy for improving creativity and design thinking. The class would then end with short design exercises.

There were three sections, in order to offer the class to a large number of students. The classes were offered Mondays at 2:30 pm. Wednesdays at 9:30 am, and Fridays at 12:30.

Class Differences

Monday's class was generally more content to work quietly

Wednesday's class was the same

Friday's class was more talkative with me and with each other.

I noticed that the class would often share their work with one another without being prompted to do so. They would turn to their neighbor and talk about their design solution.

Physical Environment

The class took place on the Kansas State University campus in Manhattan, Kansas within Seaton Hall room 104 (Seaton 104). Seaton 104 is a seminar classroom that is used by multiple departments in the College of Architecture Planning and Design. The room has no windows to the outside. The room is equipped with the following teaching technology: projector screen, projector, a laptop computer with Internet connection, a whiteboard, a selection of whiteboard markers. The room was equipped with detached chairs that could be arranged in any configuration. The room was also equipped with a number of folding tables that again could be arranged according to the needs of the class. For most of the semester the tables were arranged in a "U" shape with the students sitting around the perimeter of the room and myself at the front of the room, near the computer.

The College of Architecture Planning and Design maintains Seaton 104 and would set up the class room according to the needs of different professors and faculty. For the purposes of this class, I would sometimes find the room devoid of chairs, or tables, and would have to set up the room while students were coming into the room. I do not know that if this had an effect on the students but it did make me feel as if I were unprepared and unprofessional when the room was in disarray. I felt that my credibility as an instructor was weakened.

During the semester Seaton 104 was unavailable to my class while the Department of Interior Architecture and Product Design were using the room for accreditation purposes. The students were not pleased by this break in routine. During these class periods, I found and scheduled rooms that were available and empty during my class period. The rooms changed since the classes met at different times on different days of the week. On one occasion I was not informed that Seaton 104 was needed right after my class. A staff member interrupted my class and told me that I was not supposed to be in the room and that it was needed. Since the class was a point where we were sharing our design solutions, and could easily move this activity into the neighboring Pierce Commons, we moved out of the room. I tried my best to be polite and accommodate other faculty and staff unfortunately I do not feel that this was reciprocated. One faculty member interrupted my class on two occasions without any apology. This too undermined my authority as an instructor and still pisses me off, and yet at this point I forgive him.

Curriculum

The class was not a predetermined set curriculum or already established design-thinking program. It was not a laboratory controlled, scripted instructional script delivered in a controlled setting. It was a living, dynamic classroom where I, changed my approach to the students from student to student and between class sections. I responded to the mood of the class, I tried very hard to maintain consistency between the different class sections, but this was field research and I was not able to control every aspect of the research environment.

Design Exercises

The design exercises were meant to not favor any one of the potential design disciplines. The design exercises were selected, and adapted from a variety of sources including: design exercises from a Pilot Study conducted in 2011, “Caffeine for the Creative Mind” by Mumaw, S. & Oldfield, W. L. 2006, and my own interests and expertise.

Students Academic Level

We chose first year students with the idea that they would have less cognitive baggage. Cognitive baggage can be thought of as predetermined processes, and design strategies that might be inherent from training in any of the related, but distinct design disciplines offered in the College of Architecture Planning and Design. Another consideration was the idea that they would be blank slates, tabula rasa and would be more receptive to any training.

Learning by Doing instead of by lecture

During the beginning of the semester I started by having 30 minutes of instruction and 20 minutes reserved for a design challenge. I felt that I was losing the students interest. Halfway through the semester I realized that shorter 15 minute segments worked better to retain the students’ attention and gave them more opportunities to practice the concepts and strategies introduced in the class. I then planned my lessons in 15 minute chunks and had more little mini exercises so that students could be writing and drawing during class become more hands on and experiential. This was a positive development in the class.

First I had the students sketch a chair from various vantage points. I thought that this would be a good experience for the students, so that they would look at objects.

There is nothing new under the sun.

I was trying to illustrate the idea that to be creative we need to reimagine things and recombine them. Look at things and that are familiar and recombine existing ideas, that this recombination of already existing ideas is an act of creation. The example that I gave to all the classes is Reese’s Peanut Butter cups. Chocolate and peanut butter were already in existence but putting them together made something new.

One class period I thought that I would have the students compete one with another. The students listed a number of vehicles, and then a list of mythical creatures. Students were put into pairs and assigned a vehicle and a mythical beast. Students were asked to imagine what would happen if their assigned vehicle and a mythical creature had a baby. Again it is the idea of recombining ideas to form something new. The students had a time limit and then they exhibited their designs. Students then voted on their favorite. The combinations were:

Unicorn + Chevy Camaro

Hippogriff + Yacht

Cockatrice + Moped

Dragon + Motorcycle

Pegasus + Jet-ski

Sphinx + Dodge Charger

The Unicorn/Chevy Camaro received the most votes. The aspect of the recombination that students identified as their favorite was the fact that the car would run on rainbows, a clean alternative energy source. One reason that I think that the unicorn car was successful was because it actually combined elements from the two prompts, for example the team attached the unicorn horn on the front of the car, and had the car seats lined with fur. The less successful combinations simply took the vehicle and made it look like the beast. The cockatrice moped was simply a moped in the shape of a cockatrice, not a recombination of elements.

While writing that last part I am aware at how important the social context is for the rainbow-powered car to be meaningful. The media is saturated with advertising for electric cars and the vilification of oil companies. Sustainability is a topic of concern for many of these students, and within the college at large. A nod to alternative fuels seems to be a response to the social context of the students that resonates with others outside of those who created the idea.

The point that I need to return to is that the students enjoyed the competition and I saw the value of having the students practice the creative strategy of recombination instead of having me

explain it to them. During the conversation after the exercise I was able to point to the exercise for examples. The final activity of the class period was to design a themed restaurant based on the students' favorite movie. This exercise was selected for two reasons, recombining a movie and a restaurant illustrates again the idea that existing ideas can be synthesized to create something new. The second idea is that I wanted the students to work on something that they liked. I had a lot of trouble with getting the students to show interest, or passion for the exercises done in class. I wanted them to care a little bit about what they were doing. If they could get excited about anything I supposed it could be about their favorite movie. I was still disappointed at how quickly they did one thing and then stopped. They typically would design the façade, or one view of the interior, or the costumes the waiter would wear, but few of them combined multiple views or tried to make a whole restaurant. Maybe it was too quick or maybe they can not shift quickly enough between scales.

My problems with students

One problem that I had during the semester was dealing with what I would call, student apathy. Little punks sitting there, not having any passion for design! I honestly would get pissed off at students who would not try and would give up and stop working on the design exercises during class. Often I would note that students would put down their pencils after 2 minutes of working on a design exercise. For most of the design exercises I announced that the students would have 15 minutes to work. The design exercises were selected to be interesting, to push the students to come up with ideas that would be exciting. The whole thing was supposed to be fun, and yet some of them refused to get into it. Perhaps they were too cool for school.

Quote on being cool:

“Cool is the highest accolade; the best a thing can be, But *cool*, as in “cool on a subject,” also means disinterested, aloof. Cool, actually, is a protective mask worn by the fearful. Cool is disenfranchised, dispassionate, alienated and frightened, Cool is non-committal for fear that to commit to an unpopular idea might make one uncool. Cool defined is cool dissipates, Like Dracula, cool can't know the light lest it wither. Cool is uncreative. It follows but it does not lead” (Cabarga, 2004, p. 13).

The other thing that pissed me off is when students would jot down one idea, one solution, one design, and only one picture to solve complex problems. I felt as if there was general lack of exploration on the student's part. They were so sure that their first idea was the best. This was especially frustrating since early on in the semester we focused on idea generation or divergent thinking, as one of the foundations of creativity and design thinking. I repeated over and over again, that there is no such thing as one solution.

This pursuit of one solution was referred to as a result of "No Child Left Behind" education that the students had received. So, perhaps in a class where there is no right answer, any answer would do. The intent was to allow student the opportunity to not fail. That they could come up with any solution and they would not be penalized for giving a solution that did not work. I meant to have this as a liberating atmosphere, try anything, free your mind, make mistakes without fear of reprisal, etc.... Instead students may have seen that since there was no reward for getting a good answer, or designing something fantastic, there would be no point in trying very hard. Since anything would do they produced anything. The incentive to try and succeed was lacking. This is supposition, which is supported by some of the interviews that I had with First Year Studio Instructors.

One example of this one answer fixation is illustrated in a conversation I had with a student Aug 31, 2012. I had given the students an 8.5" x 11" sheet of paper with the question, "Are you creative?" printed on the top of the sheet. One student asked me the following question?

Student: Isn't it a one word answer?

Me: Is it?

Student: Do you want a regular written answer?

Me: <no response>

The contrast is a particular student who consistently explored multiple ideas in his sketch book and took the entire allotted time for the design exercises working on his design solution. I see this individual's work as highly creative, and his approach as one that is the standard of excellence. He also had a nice hand.

Which brings me to another point. Perhaps the only reason that students would try one response or to give up after a couple of minutes is that they did not feel comfortable with their drawing skills. I often told students that will not be assessed on their artistry but on the quality of their ideas, but with no way to reinforce this statement, I feel it may not have inspired the students to just try.

I am also sad that there was not a better way to showcase the student's work. Due to the nature of confidentiality, necessary for this research I was not able to directly comment on students work as they were identified by a random four digit code and graduate research assistants graded the students work so that I would not be biased, or develop favorites over the course of the semester. I did develop favorites, nevertheless and was disappointed at the end of the data-gathering phase when a number of my favorite students did not perform as I had expected. C'est la vie.

There is some question in the interviews as to what is the most important motivating factor for design students. I have proposed in my model that motivation is an important factor in the creativity of an individual. I believe that intrinsic motivation is better at producing creative results. But is it? This research did not directly address what motivational style is better for encouraging creativity but the question that I have now is what is the better motivator to encourage creativity in design students? If you are creative you get a reward? Or if you are not creative you get a punishment?

It was the opinion of one studio instructor that the students would not perform tasks that did not have an assessment component attached to it. More simply stated, if there were no grades for doing an activity they would not do it. This is troubling in light that much of the design process is completed without any grades being given by instructors.

Maybe that is why I was so keen to talk about motivation at the end of the semester.

Is the freshman year the best time to offer a creativity and design-thinking course?

Bryan Lawson talks about moving students from one level of design expertise to more advanced levels. Are they just too young, and their cognitive functions too immature to handle creative thinking, and should such a course be offered later in their training so that they feel as if they have experience or some rudimentary level of design expertise. On the other hand is creative thinking important in the early years of design education, because it lays the groundwork for creative thinking in the future. So that when students acquire a certain level of expertise they are then able to respond to design problems in a novel way because they already have their mind trained to think creatively?

Grades

Students were concerned about their grades throughout the semester.

The students that did not attend or who were late were generally the ones who asked about their grades.

Creativity according to Kathryn Moore, is where she says that students use creativity instead of from making. I understand what she is trying to say, it's the students who try and come up with something wacky and zany and never move past the shock and awe stage of creativity. They need to apply themselves and actually make something in the end.

John Smith and his creativity, extra large tubes in his fort. The magic and machines in the final exercise, by giving control or using magic, they have something that is not really creative but lazy. This is the type of creativity that Kathryn Moore talks about in her book...

Chinese Students

I had a number of Chinese students in my class. These students presented two different challenges. The first being that sometimes they would not understand the cultural importance of a little red wagon.

They did not know what a little red wagon was. One student thought that the little red wagon was a tool used by workers and not a child's toy.

They would use their smart phones constantly to translate their ideas from Chinese to English. They would use their smart phones to look up words or concepts in the middle of design problems.

My Abrasive Creative Kid: John Smith

What should I call him?

He was seen by others as the creative one. Early on in the semester, after a design problem, I would hear students saying, “I want to see what John did.” It was interesting at this point early in the semester to see who the students, as a group, determined to be the creative one.

He was also the student who asked how offensive could he be on the FTTCT. The problem is that he was rather gifted at drawing but seemed more interested in arguing and causing contentions rather than creating anything useful. He might be that student for me who I think has potential but until he learns how to relate to humanity he won't have many clients.

Drawing

Why did they not want to draw?

What does this have to do with resistance to closure?

The ONE student who drew consistently, and looked like he enjoyed drawing, was successful on almost every in-class design exercise.

Preference of Problem Types

I gave the Figural Torrance Test of Creative Thinking to the Wednesday class and we talked about it a week later. As a class they reported that they liked the exercises that were one image, and where they had a longer time to develop their one idea. They did not like the exercise where they had the same prompt and then had to think of different ideas for the same prompt.

One prompt one idea= black blob

The same prompt for multiple ideas= pairs of parallel lines

The students also resisted coming up with options for design problems, favoring one answer as opposed to multiple options. This was especially frustrating since generating multiple ideas was

presented as an important component of creative thinking. I told them at one point that not generating multiple ideas would result in a zero for that day's assignment.

Convergent Thinking

Oct 19, and Oct 22 I had the students informally take items from Mednick's Convergent Thinking Test. The test is supposed to measure participants' ability to find the one word that bring together three multiple words. They loved this exercise. I believe that they are much more versed in word games and linguistic puzzles rather than physical/ spatial problems. It is also important to note that although Mednick's test only allows one answer there were several examples of answers that connected the three words but were incorrect according to the test. I also believe that the test is contingent on cultural training. One would have to know what blues music is in order to answer the three word pair, cheese, music, moon for example.

Appendix D - Suggestions for Future Creativity Classes

Introduction

The ENVD 299: Design Thinking and Creativity Course was a part of research. It was therefore under a number of constraints that do not apply to ordinary university courses. If given the chance, I would make changes based on my findings and personal experience. These changes are discussed below. It is our job as educators is to dismantle student perceptions of creativity and rebuild their knowledge of creativity.

Class Learning Objectives

This class will introduce concepts of creativity and how they directly relate to design. Over the course of the class students will become aware of the various concepts of creativity related to design through direct instruction and selected short readings. Students will gain an understanding of applying these concepts to design by applying the concepts to short creativity exercises, as well as outside of class activities. Students should become competent in developing their own creative strategies in their work.

Student Learning Outcomes

At the end of the class I want students to:

- Be more creative
- Become comfortable with ambiguity,
- Posses a wiliness to keep working,
- Possess a willingness to begin work even when the problem is not completely understood,
- Overcome the fear of failure

Students

On average I had about 22 students in each class section. There were not too many students for me to teach but there were too many students to comfortably fit in the room. I do not think that this class would do well in a large lecture hall.

I also do not think that the course should be limited to a single discipline. I believe that the cross-pollination of ideas from the design disciplines is extremely beneficial to students. If the class is composed of students outside of design I think that it would be interesting to incorporate the ideas and processes of outside disciplines but always focusing on design. Kind of egotistic of me, I know.

The age of the participants is a factor that I have not had much experience with understanding. There is the chance that more advanced design students will have a grasp of their discipline and will benefit from taking a new look at things, or by more easily placing themselves within the model of creativity they might be able to see the value in the creativity class. Unfortunately, I feel that a lot of students in my class valued the easy one credit more than the instruction. The opposite might be true as well. Older students might be more resistant because they think they know everything about their discipline and are certain that honing their AutoCAD and Photoshop skills is more important than creative thinking. There is the pressure they feel that if they do not have the technical ability they will not get a job. Or, students will see that the majority of students possess the similar technical aptitudes and they want to stand out. More important than age, and discipline is the attitude of students. The ones who wanted to be creative, and valued the course simply did better.

Class Setting

The classroom should have modular furniture that it can adapt to the needs of the class and the creativity exercises. A computer with a projector screen is good but students should not get the impression that they will be lectured to, this is a workshop, and they will learn by doing.

Tables with whiteboards or newsprint so that students can draw big and not feel like they are wasting precious resources. It was interesting how reticent students were to spend money on their education apart from tuition. I still think that students should have small notebooks would be beneficial for students to keep notes, and sketch, and keep reflective journals in. The experimental nature of my class called for anonymity of the participants, but being able to be more involved with individuals working, to be able to coach and guide them would have been a great help.

Materials

Personal Notebooks: For my research. I collected all of the notebooks from each class to look through and score. This was a time consuming process, and the notebooks were my responsibility. I would leave the notebooks up to the students, so that they are responsible for bringing them to each class. I believe that you can get a better sense of how the students are doing by observing their work in the notebooks during regular class sessions.

Pencils: I am beginning to hold a grudge against mechanical pencils, but that is a personal preference. I find that the fixed line weight is better for writing than drawing.

Required Text: I do not think that a text book is completely appropriate for the class. I would support short readings taken from multiple sources.

The Method Cards from IDEO are a great resource that can help students get through their creativity block. They are available for purchase a set of cards for \$49.00 new, or there is an app available from the iTunes store for \$4.99.

Model Supplies: During my research there was not enough time to explore designing with models. I did not have a protocol written for grading models, but I think that including physical making of prototypes would be beneficial to design students. Model making materials would include items typically associated with a kindergarten classroom: Tape, glue, pom-poms, popsicle sticks, cardboard, scissors, and other found materials.

Daily Class Procedure

As the first real run of this class we only met once a week per section. I honestly believe that this was too infrequent. I would advise that the class meet twice a week. There should be a short creativity exercise each time the class meets. There could be more than one exercise each day. I found that in the class that students responded well when the class was chunked into short segments:

Example of Class Session Schedule

5 min.	Introduce the concept of the day
10 min	short practice, or discuss with a classmate, group discussion
15 min	Follow up and deeper explanation of the concept
15 min	Creativity Exercise
5 min	Wrap up the class, reinforce the concept again.

One class per week could be the introduction of the project. The next class period could be about reflecting on that concept, how it applies to your big project, studio, or a workshop. This would also be a good time for students to reflectively write in their notebooks about what they are learning, and how they are applying creativity. Or this time would be a great time to share their work with one another.

Grading

I would say that keeping the class as a Pass/Fail is the best idea. The idea is that if students will come and participate, they should get a good grade. This should reduce their fear of failure. During the research project, the class was a graded A,B,C,D,F course. This made the grading more clunky than anything, and it was confusing. It was also hard for me to keep track of who was in class because their notebooks were coded for anonymity. At the end of the semester I had a lot of students who were trying to barter for a good grade. "I only missed four days so I should get a B." When in reality they missed a lot of the course content. I would suggest a grading policy that indicates that if a student misses four classes they fail the course.

Exercises

The selection of exercises is important. There are a number of books and sets of creativity exercises that already exist but you have to be careful which one to select, because a number of them are linguistic exercises. I feel that design students will benefit from exercises that can be solved with drawings. I would also suggest that the exercises be zany, or imaginative. The reason for this is that you need exercises that do not have an established, existing, or accepted correct answer or many students will latch on to the existing solution and stop working.

The desire for the single correct answer is an underlying problem for new design students. They want to give the right answer and I was surprised at how often students would lock up and stop working when given problems that have no right answer. I understand that there are certain personalities that do not think that they are creative. Do not let students use this as an excuse. There are certainly some people who would like to sleep all day, and others who would eat only chocolate, but we learn. Frankly, the student who comes to design school thinking he already knows everything were some of the most infuriating. To combat this, choose exercises that require the students to use their imagination and where there is no right answer.

I often got the impression that the students did not connect the lessons from earlier in the semester to later exercises. I think that they saw each class as a separate module that was distinct from the other classes. To combat this I would suggest two longer exercises, to be completed outside of class time, one due at Midterms and the other due at Finals. This lets the students have a connecting thread, between the classes, and allows them to incubate ideas. This would give the students an opportunity to make something three-dimensional models, which fits well into their design education. The model building also would give them a break from drawing and expose them to design thinking with models.

Midterm Creativity Exercise

Build an origami fort, out of copier paper, that will withstand a brutal Ping-Pong ball catapult attack. You may not use glue, tape, or any other adhesive. Also, build a Ping-Pong catapult that will decimate your opponent's puny origami fort. The catapult has to be constructed of drinking straws, tape, and powered by three rubber bands provided by the instructor. The midterm will consist of a single elimination tournament. Prizes will be awarded.

Final Creativity Exercise

Ryan Hargrove, who teaches a creativity class at Kentucky University, has his students build a three-dimensional model of their own creative process. I think this is a great exercise, but it is not the only type of end of the year project I offer it only as a suggestion.

Modeling Creativity

Show them how others do it. Bring in other students and have them present their work. Show them that people who are creative can succeed. Make short videos and reading available for the students. Time Lapse process videos are amazing when you understand what is happening and can observe the design process.

Definition of Creativity

I never shared my definition or model with my students because it was research and I did not want to introduce additional variables. I think it is extremely important for the students to be able to unpack their beliefs about creativity and understand what creativity in the domain of design is like. The Merrill Model of Creativity can help them situate themselves within the model and become aware of the different factors that influence creativity.

Testing

You do not have to test the students, but it sure is a nice laboratory setting. In a classroom setting you should share the scores with the students. I think that a lot of them would like to know their score, both pre and post. Budget accordingly.

Professor

As the instructor you need to be able to handle ambiguity, to be flexible enough to reinforce ideas other than your own. You also have to be firm about what behavior is unacceptable. I told my students that blatantly offensive material would not be tolerated, and I had to stand by that decision. I just don't think that putting profanity on a project makes it 20% more creative. These are constraints, and constraints can help guide creativity.

From the Institution

Be aware that some people will think that you are full of crap. That creativity cannot be taught; even really good designers that I know personally are skeptical about my research. Also realize that you are going to be asking students who just came out of high school and want to be mature grown ups that they need to be imaginative and play. You yourself will have to be energetic, and engaged with the class and up to date on pop cultural memes that the students will

constantly spew. Or you can create a constraint that their work only can reference the 80's. That is really cool right now.

Conclusion

Have fun.