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The Efficacy of Teaching Creativity: Assessment of Student Creative Thinking Before and After Exercises

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The Efficacy of Teaching Creativity: Assessment of Student Creative Thinking Before and After Exercises

Abstract

As the global environment becomes increasingly more turbulent and competitive, creativity becomes the focus when preparing current students and future citizens to deal with uncertainty and to adapt to continuous change both personally and professionally. The purpose of the study was to understand how student creative thinking could be increased in a university classroom. Creativity exercises that can be incorporated in various courses were developed. The exercises formed four learning modules: (a) what is creativity, (b) recognizing and identifying opportunities, (c) generating ideas, and (d) evaluating creative ideas. Four instructors administered the exercises in five courses. To evaluate effectiveness of the training, figural format of the Torrance Test of Creative Thinking (TTCT) was used to assess student creative thinking before and after completion of the exercises. Creative thinking, which was operationalized as the composite Creativity Index measured by the TTCT, was significantly higher for the total group of participants after completion of the creativity exercises than before the training. Individual class analyses showed that students in four of the five participating classes had significantly higher creative thinking after completion of the exercises. The study demonstrates that by incorporating creativity exercises into existing courses, instructors can help students develop creative thinking — a critical aspect of one's professional development.

Keywords

creativity, Torrance Test, teaching, exercises

Disciplines

Art Education | Fashion Design

Comments

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The Efficacy of Teaching Creativity:**Assessment of Student Creative Thinking Before and After Exercises¹**

To imagine is everything,

To know is nothing at all.

Anatole France

6 The global environment is becoming increasingly more turbulent and competitive. It is
7 critical to prepare students to live, to work, and to be successful in this setting (Ford & Gioia,
8 2000). The ability to recognize and creatively exploit opportunities has become an essential skill
9 (Florida, 2002). Creativity becomes the focus when preparing current students and future citizens
10 to deal with uncertainty and to adapt to continuous change both personally and professionally.

11 Definitions of creativity have developed and evolved over several decades and have
12 encompassed (a) concepts of the creative process or the mental routines that are operative in
13 creating ideas, (b) the creative person when he or she demonstrates certain creative
14 characteristics in personality, traits, attitudes, or behaviors, (c) the creative product or tangible
15 object, and (d) the creative environment that fosters the creative person (Cropley, 2000;
16 McIntyre, Hite, & Rickard, 2003; Warr & O' Neill, 2005). While a conclusive definition of
17 creativity is elusive, its importance is undeniable. Creative thinking has been linked to well-
18 being and successful adaptation to the demands of daily life (Cropley, 1990; Reiter-Palmon,
19 Mumford, & Threlfall, 1998). Creative ideas are invaluable contributions one can make to an
20 organization (Brabbs, 2001) and are the ultimate source of all intellectual property (Farnham,

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1 1994). Moreover, creativity is stressed as a necessary requirement for United States prosperity
2 and security by the National Science Foundation (“Engineering Research and America’s Future,”
3 2006; Schunn, Paulus, Cagan, & Wood, 2006). The plethora of political, economic, and social
4 challenges experienced on a global scale in the 21st century necessitates new creative solutions.

5 In the ever-changing world of the fashion industry, creative skills are imperative. Despite
6 the recognized importance of “creative, non-programmed thinking, ...our formal educational
7 system and culture do not teach or nurture such cognitive skills” (Basadur, Wakabayashi, &
8 Graen, 1990). While in recent years, educators have incorporated more active, participatory
9 methods of instruction, industry, popular press, and educational establishments continue to stress
10 the need of teaching and facilitating creative thinking in the classroom (Katz, 2009; Shepherd,
11 2009). The Association of American Colleges and Universities cautioned that college graduates
12 were not prepared to compete in the global economy and urged colleges and universities to focus
13 on developing student creative thinking skills (Vance, 2007). However, teaching and assessing
14 creative thinking poses a challenge for instructors because it is a complex phenomenon and a
15 multi-faceted skill that is not easily taught “by showing slides and talking about theory”
16 (Armstrong, 1999; Coomber, 2008, p. 13; Gow, 2000).

17 In 2006 to 2007, the authors were actively involved in a university-wide initiative at a
18 large Midwestern university to identify strategies for enhancing student creative thinking.
19 Faculty from diverse disciplines discussed opportunities and challenges in teaching and learning
20 creativity in search for best practices. Specifically, it was agreed that developing creativity
21 exercises that could be incorporated into a variety of courses was a more promising approach to
22 creativity training than developing special courses within different disciplines. This study was
23 one of several outcomes of the initiative supported by the Pappajohn/Kauffman Foundation

1 Entrepreneurship Grant Awards. The purpose of the study was to understand how student
2 creative thinking could be increased in a university classroom. The objectives of the study
3 included: (a) to develop and implement creativity exercises and (b) to measure effectiveness of
4 the exercises by assessing student creative thinking before and after the training.

5 **Literature Review**

6 **Creative Thinking**

7 Although creativity may be specifically linked to fields in which it is easily observed,
8 such as the fashion industry, researchers propose general conceptions of creativity applicable
9 across domains, disciplines, and fields (Feldhusen & Goh, 1995). While creativity is a complex
10 phenomenon that includes an individual's cognitive skills, personality factors, and motivations,
11 research suggests that there are a number of skills and strategies that may be developed to
12 increase one's creative thinking (Csikszentmihalyi & Epstein, 1999; Feldhusen, 1993). In their
13 meta-analysis of 70 studies, Scott, Leritz, and Mumford (2004) found the most effective
14 creativity training programs utilized a cognitive framework for developing creativity rather than
15 a social, personality, or motivational framework. A social framework described the environment
16 of the training; personality variables described the perception of freedom to explore inherent
17 creative ability within the training. A motivational framework described internal and external
18 measures employed to enhance creativity (Bull, Montgomery, & Baloché, 1995). Overall,
19 experts conceptualize creativity as a dynamic process of creative or divergent thinking (Basadur,
20 1994; Michalko, 2006; Mumford, 2003; Stamp, 2008). The most successful training programs
21 focused the development of training content on the core practices of opportunity recognition,
22 idea generation, and idea evaluation (Scott et al., 2004).

1 Available evidence indicates that skill in opportunity recognition, or the identification of
2 existing problems in the market place, is one of the most important influences on individual and
3 organizational creative performance (Mumford, 2003). Jay and Perkins (1997) note that the kinds
4 of problems that elicit creative thought tend to be problems that must first be identified and
5 defined by the individual before being creatively solved. Opportunity recognition is also the first
6 major step in any entrepreneurial or creative venture (Morris, 2006). Identifying more, rather
7 than fewer, possible opportunities increases the chances of finding appropriate ideas to pursue
8 (Dellabarca, 2002).

9 Ideation, or idea generation, is also considered a critical component of creative thinking
10 since it is a predictor for creative problem solving abilities (McAdam & McClelland, 2002;
11 Milgram, 1990). Research suggests that persistence in generating ideas increases the chances of
12 developing a preferred solution to a problem (Clapham, 1997). According to *Fortune* magazine,
13 as quoted by creativity expert Robert Epstein (Csikszentmihalyi & Epstein, 1999), it takes
14 10,000 ideas in business for one marketable, “good” idea to emerge. Epstein expounded upon
15 this information, stating, “If you get two ideas from each of your 25,000 employees, that gives
16 you only five good ideas to work with” (1999, p. 61). Creativity experts Csikszentmihalyi and
17 Epstein (1999) concluded that the problem of a glut of ideas within U.S. society would be a
18 refreshing and wonderful problem to exist; primarily, for purposes of fueling the U.S. economy
19 and encouraging personal and artistic creativity.

20 Literature suggests that in terms of innovation, or the development of marketable
21 products and services stemming from creative ideas, idea evaluation may be just as important as
22 idea generation (Lonergan, Scott, & Mumford, 2004; Osborn, 1963). Evaluation and testing of
23 ideas against market demand is the mechanism that allows for idea and product implementation

1 and marketing (Morris, 2006). If only one idea emerges from every 10,000, selection
 2 mechanisms need to be present to ultimately know which ideas are feasible (Csikszentmihalyi &
 3 Epstein, 1999). Furthermore, the evaluative process itself may be highly creative, in that ideas
 4 are reshaped and reformed to ensure their successful introduction into the market place
 5 (Franwick, Walker, & Ward, 1994).

6 **Development of Creativity Exercises**

7 The creativity and creativity training literature suggests that the three skills of opportunity
 8 recognition (or the ability to observe and see things from different perspectives), idea generation,
 9 and idea evaluation are essential elements of successful creativity training (Clapham, 1997;
 10 Csikszentmihalyi & Epstein, 1999; Lonergan et al., 2004; Milgram, 1990; Morris, 2006). Using a
 11 systematic approach to help students practice creative ways of thinking, we developed four
 12 learning modules, each containing three to seven distinct exercises. Based on the review of
 13 literature, the content of the four learning modules was organized as follows: (a) what is
 14 creativity, (b) recognizing and identifying opportunities, (c) generating ideas, and (d) evaluating
 15 creative ideas (Table 1). To help students discover and engage in creative, unconventional ways
 16 of thinking, the exercises were adapted from various sources to utilize interactive and
 17 experiential learning approaches. Some exercises were individual activities, while the majority
 18 included a team-component. The time required to complete the exercises varied from 5 to 20
 19 minutes per activity.

20 "Insert Table 1"

21 According to creativity experts, human creative potential is a virtually limitless resource
 22 that defies racial, social, economic, and gender categorization (Florida, 2002; Michalko, 2006).
 23 Because creativity is a natural, human trait, it may be cultivated and developed (Florida 2002;

1 Michalko, 2006). The goal was to create exercises that (a) were general and not content-specific
2 and therefore could be incorporated in various courses that teach diverse subject areas, (b) were
3 appropriate for students studying at different academic levels (from freshmen to seniors); and (c)
4 could be administered by instructors who did not have any special training in teaching creativity.
5 Examples of two of the exercises are presented below.

6 An opportunity recognition exercise, “bug report” (Table 1), could be administered as an
7 outside-class assignment or in-class activity, individual or team-based. The main idea of this
8 exercise was that everyday life problems represent opportunities for creative people, and great
9 ideas often come out of frustration when something does not work as it should, or something
10 does not yet exist. In the “bug report” activity, students were asked to note everything that
11 irritates or “bugs” them when people design, make, sell, select, buy, wear, store, care for, or
12 dispose of garments and accessories. Students then brainstormed, initially alone and then in
13 small groups, possible solutions to the identified bugs. This exercise encouraged students to draw
14 on personal knowledge and experiences to identify problems and then generate and develop
15 ideas to innovatively solve these problems.

16 In one of the idea generation/evaluation exercises, “dynamic framing”, situations were
17 de-contextualized, encouraging students to think creatively. Students were instructed to create
18 three columns on a piece of paper. The first column titled “theme,” the second column
19 “material,” and the third column “audience.” Underneath each column students were instructed
20 to list 5 themes or events, (i.e., a formal party), 5 types of diverse materials, (i.e., metal plates)
21 and 5 target markets or audiences, (i.e., senior citizens). After each student created a list, they
22 were instructed to work in groups of two to read across themes, materials, and audiences and
23 draw/sketch/talk about as many different types of ideas that they could create fitting the theme,

1 material, and audience. For instance, in the above example, students would think about garments
2 made of metal plates designed for senior citizens to wear to a formal party. After students
3 discussed their concepts and ideas, they were instructed to take one of their ideas and rate the
4 concept using the following questions as a guide. How was the idea dramatically different from
5 those that already exist? What is the overt benefit of this particular material used for this theme
6 and target audience? Would this idea be practical? Why or why not? What would make the idea
7 more feasible? For example, one of the more practical ideas developed was glow in the dark
8 fabric for use by children while camping, whereas duct tape worn by teenagers to a pool party
9 represented a less feasible product. Regardless of the quality of the idea, the exercise taught
10 students a useful technique for producing new ideas, and walked them through a critical
11 evaluation of their ideas.

12 **Assessing Creativity**

13 Because creativity is a “multi-faceted and complex entity” it may be demonstrated and
14 measured in an infinite number of ways (Daniels, 1987, p. 163). Measurements of creativity are
15 complex and difficult to compare. They include tests of divergent thinking or the capacity to
16 generate multiple alternative solutions (Cramond, Matthews-Morgan, Bandalos, & Zuo, 2005;
17 Torrance & Goff, 1989), attitude and interest inventories (Clapham, 2004), personality
18 inventories (Gough, 1979), biographical inventories (Amabile, 2001), and self-reported creative
19 activities and achievements (Fleenor & Taylor, 1994), as well as multidimensional inventories
20 (Kelly, 2004).² While tests of divergent thinking do not necessarily correspond to creative
21 production or creative eminence, these tests, particularly the Torrance Tests of Creative

² For a comprehensive review of creativity assessments see Cropley (2000) and Scott et al. (2004)

1 Thinking, were developed to understand and nurture qualities that help people express their
2 creativity (Kim, 2006).

3 Divergent thinking produces multiple responses to a specific question or problem, thus
4 this cognitive skill is important to develop because the larger the number of ideas produced, the
5 greater the probability of achieving an effective solution (Taylor, Berry, & Block, 1958).
6 Evidence accrued over the last 50 years suggests that divergent thinking represents a distinct
7 capacity contributing to creativity and many forms of creative performance (Karnes et al., 1961;
8 Runco, 1999; Vincent, Decker & Mumford, 2002). Components of divergent thinking, including
9 fluency (the quantity of ideas), originality (the degree to which the produced ideas are unique),
10 elaboration (the enrichment of ideas), and the resistance to premature closure (the degree to
11 which one keeps an “open mind”) are quantifiable (Wechsler, 2006).

12 In the late 1950s, measurements of creative thinking initiated the psychometric approach
13 to the study of creativity and suggested that creativity could be studied in ordinary people with
14 scores arranged along a continuous score distribution (Rudowicz, 2004). Because creativity
15 exists along a continuum and is not a dichotomous measure, individuals can display differing
16 levels and degrees of creativity. This suggests creativity can be improved as a result of training
17 and education (Torrance & Goff, 1989). Both organizations and educational institutions have
18 invested considerable time and resources in the development and use of creativity training
19 (Fasco, 2000-2001). Various experiments and studies have supported and demonstrated that
20 creative abilities are enhanced as a result of training and practicing creative techniques
21 (Colangelo & Davis, 1991; Fontenot, 1992; Osborn, 1963).

22 **Hypothesis**

1 Past research suggests that perceptions about one's own level of creativity and creative
2 thinking can be increased as a result of training (Birdi, 2005; Clapham, 1997; Gilbert, Prenshaw,
3 & Ivy, 1992). For example, McIntyre et al. (2003) reported that after completing creativity
4 training, MBA students demonstrated improved scores on some dimensions of creativity, but not
5 others. The authors stressed that more research on creativity training and its effectiveness was
6 needed. Specifically, they argued that "[a]lthough the efficacy of developing a course to teach
7 creativity has been shown..., the ability to incorporate creativity training into an existing course
8 is still in question" (McIntyre et al., p. 148). Indeed, practically all of the studies that have
9 evaluated the effectiveness of creativity education did so when the training was in the format of a
10 stand-alone creativity course or program (e.g., Basadur et al., 1990; Birdi, 2005; Clapham, 1997;
11 Fontenot, 1992; Kabanoff & Bottger, 1991; Scott et al., 2004). In this study, we developed a
12 series of creativity exercises that would be incorporated into low- (freshman and sophomore) and
13 high-level (junior and senior) undergraduate courses; regardless of the content and the
14 instructors' background and experience with creativity training. To evaluate the effectiveness of
15 the developed creativity exercises, we tested the following research hypothesis:

16 H: Students will demonstrate higher creative thinking after completing the creativity
17 exercises than before the training.

18 Method

19 Instrument

20 To assess student creative thinking, the figural format of the Torrance Test of Creative
21 Thinking (TTCT) was used (Clapham, 1998; Torrance, 1966/1999). The test was developed
22 based on research of abilities required for creative thinking. The TTCT, translated into 35
23 languages, is the most widely used creativity test in the educational field and in the corporate

1 world (Clapham, 2004; Kim, 2006). The test measures creative thinking and is appropriate for
2 different ages, from kindergarten to adults. Median inter-rater reliability of the test range from
3 .90 to .97 (Cromptley, 2000) and test-retest reliability was reported between .60 and .70 (Treffinger,
4 1985). Forty years after its initial administration, longitudinal studies have demonstrated that the
5 TTCT has a good predictive validity for creative achievements (Cramond et al., 2005; Kim,
6 2006). The assessment was reported to be fair in terms of gender, race, and socio-economic
7 status (Kim, 2006; Torrance, 1977).

8 The test is available in figural and verbal formats (Torrance, 1966/1999). The figural
9 format was chosen for this study to eliminate a possible effect of language on the results; English
10 was a second language for some of the participants. The figural format assesses quantity and
11 quality of creative ideas produced by a test-taker over a thirty-minute period. The assessment
12 consists of three ten-minute drawing activities (Picture Construction, Picture Completion, and
13 Lines/Circles). Participants are also asked to provide titles for their drawings. The test is
14 available in two forms (A and B) to assess participants' creativity at two different times
15 (Cramond et al., 2006). The TTCT was an appropriate measure for this study because it is
16 recommended for assessing "differential effects of educational materials, programs, curricula,
17 procedures and so on" (Torrance, 1966, p. 6).

18 **Procedure**

19 The creativity exercises were introduced in five classes at a large Midwestern university.
20 Because it is not recommended to administer the TTCT in a group of more than 35 students
21 (Torrance, 1990), the size of the class was one of the requirements when selecting classes for the
22 study. Another criterion was to have students of various academic classification (i.e., from
23 freshmen to seniors). And finally, the researchers wanted to include students that were majoring

1 in different subjects. One of the five selected classes was a freshman-level orientation course.
2 Another class was a senior-level veterinary practice entrepreneurship course. Three other classes
3 were apparel design courses: two sections of an introductory patternmaking course (sophomore-
4 junior level) and an advanced patternmaking course (junior-senior-level).

5 To investigate the effect of the creativity exercises on student creative thinking we
6 conducted an experimental study employing a repeated measures factorial design. The design
7 consisted of one within-subjects factor (Test when the creative thinking was measured) with two
8 levels (pre-test before administering the exercises and post-test after completing the exercises)
9 and one between subject factor (Class) with five levels (five different courses). The study was
10 approved by the university's Institutional Review Board.

11 All students enrolled in the five classes selected for administering the creativity exercises
12 were invited to participate in the study and complete the TTCT along with a short demographic
13 questionnaire. Instructors administered the twelve creativity exercises in the same order, as listed
14 in Table 1. Each instructor followed the same procedures for administering the exercises and the
15 debriefing following completion of each exercise. The exercises took between 8 and 12 weeks to
16 complete due to differences in the schedule of the classes (two vs. three times a week) and course
17 related activities. On average, students completed one to three exercises a week. Variations in
18 administering the creativity exercises due to differences in class schedules as well as instructors'
19 individual teaching styles was viewed as a strength of the experiment. The goal of the research
20 was to assess the effect of the exercises on student creative thinking in courses that teach diverse
21 subject areas, across different student populations, and delivered by instructors that did not have
22 special training in teaching creative thinking.

1 For the pre- and the post-test, the recommended standardized procedures were followed
2 (Torrance, 1990). Prior to administering the TTCT instrument, detailed instructions about the
3 assessment and procedures were read to the students from the test manual (Torrance, 1990). As
4 suggested in the manual, it was emphasized that the TTCT assessment was not an exam, but
5 rather a fun activity. Students were encouraged to give unusual and detailed responses to the
6 provided stimuli. Form A of the TTCT was administered in the pre-test before introduction of the
7 creativity exercises and form B—in the post-test after completion of the training. Students
8 received no extra credit or other compensation for participating in the creativity exercises and
9 completing the assessments. The creativity exercises were included in each of the five courses as
10 required in-class activities. Student performance in individual exercises was not assessed because
11 the study investigated the cumulative effect of the creativity training. Anonymous student
12 feedback on the creativity exercises and the assessments in the form of open-ended questions
13 was collected at the midpoint of the training and after completion of the study.

14 **Scoring and Interpretation of Data**

15 Collected booklets with student responses were mailed to the publisher of the assessment,
16 Scholastic Testing Services (n. d.), for scoring. Previous research indicates that reliability of
17 scoring TTCT is adequate when the procedure is done by novice assessors and is high when
18 completed by professional staff (Cropley, 2000; McInture et al., 2003). In this study, trained
19 raters from Scholastic Testing Services were used to assess the instrument to ensure high
20 reliability in scoring the participants' responses. Each booklet with responses was scored on five
21 separate norm-referenced assessments and thirteen criterion-referenced measures.³ Based on raw
22 scores, the Scholastic Testing Services provided a composite assessment of creative thinking, the

³ For a description of scoring procedure see Torrance (2008).

1 Creativity Index, which was derived from the five standard scores and the thirteen criterion-
2 referenced indicators. The standard scores were developed for three types of comparison groups
3 (i.e., national sample by grade, national sample by age, and local in-grade sample). The scores
4 were recommended to use for statistical procedures (Torrance, 2008). The Creativity Index
5 provided an overall assessment of an individual's creativity and was used to operationalize
6 creative thinking in this study.

7 **Results**

8 **Sample Description**

9 The final sample size for data analyses consisted of one hundred and fourteen ($N = 114$)
10 usable responses and included participants who completed both of the TTCT assessments during
11 the pre- and the post-test. Forty-three percent of the research participants were enrolled in the
12 textiles and apparel program; 31% majored in veterinary medicine; 15% were hospitality
13 management majors; and the rest of the sample (8%) comprised students majoring in family and
14 consumer sciences. The majority of the respondents were female (80%). The average age of the
15 participants was 21.38 years ($SD = 3.17$). The majority of the participants were seniors (44%)
16 enrolled in advanced patternmaking (class 4) and veterinary practice (class 5) courses. Twenty-
17 four percent of the sample were freshmen enrolled in an orientation course (class 1). Juniors
18 represented 15% of the participants. Thirteen percent of the sample were sophomore students
19 enrolled in two sections of a introductory patternmaking course (classes 2 and 3). Detailed
20 descriptions of the participants are reported in Table 2.

21 "Insert Table 2"

22 **Hypothesis Testing**

1 The scoring agency calculated the Creativity Index based on the participants' age and
2 grade. In this paper, we present the Creativity Index data based on age for two reasons. First,
3 age- and grade-based repeated measures analysis of variance resulted in almost identical findings
4 in terms of significant increase of the Creativity Index in the post-test in comparison with the
5 pre-test. Second, because all participants from freshmen to seniors were recorded by the scoring
6 agency as grade 13, regardless of their year in college, analysis of data based on age would
7 provide a better discrimination of differences between the various academic classifications (i.e.,
8 from freshmen to seniors).

9 To determine the effect of the creativity exercises on student creative thinking, the data
10 were analyzed using a general linear model (GLM) repeated measures, which provided analysis
11 of variance when the same measurement was made twice on each participant. The Creativity
12 Index (measured twice: once before and once after the completion of the exercises) was a
13 dependent variable. Independent variables included: Test when the creative thinking was
14 measured and Class. Test was a within-subjects factor and had two levels: pre-test, when the
15 creative thinking was measured before administering the creativity exercises, and post-test, when
16 the creative thinking was measured after completion of the creativity exercises. Class was a
17 between-subjects factor and had five levels, according to five courses that were included in the
18 experiment. The results of the GLM repeated measures analysis of variance revealed that the
19 creativity exercises had a significant influence on the Creativity Index, $F(1,109) = 108.65, p =$
20 $.0001$. For the entire group of participants, the Creativity Index mean measured in the pre-test
21 was 109.48 ($SD = 13.80$). The Creativity Index mean measured in the post-test was significantly
22 higher, 123.53 ($SD = 14.44$). Test when the creative thinking was measured (pre-test before the
23 creativity exercises and post-test after completing the creativity exercises) explained half of the

1 variation in the Creativity Index, $\eta^2 = .50$. This result supported the hypothesis: students
2 demonstrated higher creative thinking after completion of the creativity exercises than they did
3 before the training.

4 The GLM repeated measures analysis of variance with Class as between-subjects factor
5 revealed a significant effect, $F(4, 109) = 7.61, p = .0001$. The Class factor explained 22% of the
6 variation in the Creativity Index, $\eta^2 = .22$. Because there is a statistically significant effect of the
7 Class factor, we can conclude that a statistically significant difference in creative thinking exists
8 between some of the classes, i.e., in this study, student creative thinking differed by Class
9 (regardless of the creativity training). Overall, students in junior- and senior-level courses had
10 higher scores in creative thinking than students in freshman- and sophomore-level courses, as
11 indicated in Table 3. Test factor by Class factor interaction was significant, $F(4, 109) = 5.12, p =$
12 $.001$, and explained 16% in the Creativity Index variability, $\eta^2 = .16$. This result indicated that
13 depending on the Class, there was a difference in the increase of the Creativity Index after
14 completing the exercises. To further explore what effect Class had on the results of the creativity
15 training, the Creativity Index means from the pre-test and the post-test were analyzed using a
16 paired sample *t*-test. The results indicated that the Creativity Index significantly increased after
17 the exercises in four out of the five participating classes (Table 3). Only in class 2,
18 Patternmaking, section 1, was the increase in the Creativity Index not significant, $t(1, 10) = -$
19 $1.13, p = .284$.

20 “Insert Table 3”

21 Anonymous feedback asking students to evaluate the creativity exercises further
22 suggested that the exercises and the TTCT assessment were good learning opportunities.
23 Participants stated that the exercises allowed them to explore their own creative strengths and

1 weaknesses. As the quotes below (collected at the time of post-test) illustrate, overall student
2 feedback on the creativity training and assessment indicated that it was a positive and productive
3 learning experience:

4 The creativity exercises got me to challenge myself. I had to think outside the box,
5 and not just for one idea but to have more than one idea. (Student 6)

6 I realized that being creative has some to do with how you think and wanting to be
7 creative. (Student 51)

8 I learned that being creative can be challenging. I also learned that it takes time and
9 practice. (Student 29)

10 **Discussion**

11 In this study, we demonstrated that student creative thinking, which was operationalized
12 as the composite Creativity Index measured by the TTCT, was significantly higher for the total
13 group of participants after completion of the creativity exercises than before the training. This
14 indicated that student creative thinking increased significantly following implementation of the
15 creativity exercises. This result supported previous findings that creativity training increases
16 one's creative thinking skills (e.g., Clapham, 1997; Fontenot, 1992; McIntyre et al., 2003).
17 Individual class analyses showed that students in four of the five participating classes (classes 1,
18 3, 4, and 5) had significantly higher creative thinking after completion of the exercises (Table 3).

19 Only students in class 2, Patternmaking, section 1, did not report a significant
20 improvement in the Creativity Index (Table 3). A possible explanation for this result could be
21 that this was the only course scheduled at 8 a.m., three times a week, whereas the other four
22 courses met later in the morning or in the afternoon. In addition, a substantial portion of the
23 students in class 2 struggled with the course content. By the time of the second TTCT testing,

1 near the end of the semester, 22% of the students had dropped the course. Moreover, another
2 33% of students after completion of the course had either changed the area of concentration from
3 design to merchandising, or switched to another major. This result indicates that it is important to
4 account for personal and contextual characteristics which may influence the outcomes of
5 creativity training. Because a large portion of the class was not doing well in the course, the
6 students may have experienced a greater deal of stress and lower motivation to explore and
7 demonstrate their creativity. This result warrants further investigation.

8 Our findings indicated that students at different academic levels (from freshmen to
9 seniors) had improved creative thinking as the result of completing the creativity exercises. The
10 four classes that demonstrated significant increases in the Creativity Index scores (classes 1, 3, 4
11 and 5) had students enrolled in different levels in college. Only freshmen were enrolled in class
12 1, the orientation course (Table 2). Class 3 had a majority of students in their second year (55%).
13 Only seniors were enrolled in a veterinary practice course (class 5), and class 4, advanced
14 patternmaking course, had an equal number of juniors and seniors. Interestingly, classes 4 and 5,
15 where the majority of students were seniors, demonstrated greater creative thinking in
16 comparison lower-level classes.

17 Students majoring in different subjects and enrolled in courses traditionally perceived as
18 “highly-creative” (apparel design) and “less-creative” (e.g., veterinary practice) demonstrated an
19 increase in creative thinking after the training. Class 5, comprised of veterinary medicine
20 students had the same creativity thinking scores as students majoring in apparel with a
21 concentration in creative design (class 4). This result suggests that the creativity exercises are
22 general in nature and not content-specific and, therefore, can be used in a variety of courses and
23 with students majoring in diverse subjects to improve creative thinking.

1 The five courses in which the creativity exercises were introduced were taught by four
2 different instructors (Table 2). While the exercises administered in these classes were the same,
3 each instructor had a somewhat different approach to introducing the material due to (a) personal
4 teaching and communication styles; (b) diverse population of students (freshmen vs. seniors,
5 highly creative majors vs. more practice-driven majors); and (c) the content of the courses. Four
6 classes that reported an increase in creative assessment scores (classes 1, 3, 4 and 5) were taught
7 by different instructors (Tables 2). This implies that improvement in student creative thinking
8 may be independent of the teaching style of the instructor or the person administering the
9 creativity exercises.

10 **Conclusions and Implications**

11 To successfully adapt to rapidly changing work environments and effectively compete in
12 the global economy, students must be prepared to think in different and more creative ways
13 (Florida, 2002). In the new millennium, creativity becomes critical to one's personal and
14 professional development and success (Vance, 2007). This research addressed the need in
15 helping students increase their creative thinking skills. To accomplish the goal, the authors
16 developed four learning modules that consisted of a series of creativity exercises that could be
17 incorporated into various courses. Four instructors administered the exercises in five classes. To
18 evaluate the effectiveness of the training, the figural format of the Torrance Test of Creative
19 Thinking (TTCT) was used to assess student creative thinking before and after completion of the
20 exercises.

21 The findings demonstrated that after the training, the composite assessment of creative
22 thinking, the Creativity Index, improved significantly. Even though previous research found that
23 creativity can be improved as a result of training, the majority of the studies assessed

1 effectiveness of stand-alone creativity courses or programs (e.g., Birdi, 2005; Clapham, 1997;
2 Fontenot, 1992; Kabanoff & Bottger, 1991). This research demonstrated the effectiveness of a
3 series of short creativity exercises administered by four instructors in five different classes.

4 While the majority of the participants reported significantly higher creative thinking
5 scores after completion of the exercises, there were some students whose scores did not improve
6 and, in some cases, even decreased in the second assessment. In one of the five classes that
7 participated in the experiment (class 2), there was no significant difference between student
8 creative thinking measured before and after the implementation of the creativity exercises (even
9 though there was an increase in the post-test Creativity Index in comparison with the pre-test
10 Creativity Index, the difference was not significant). It appears that contextual and situational
11 characteristics, such as time of day when the exercises and assessments were administered and/or
12 motivational predisposition of individuals taking the creativity test might influence the outcomes
13 of creativity training and assessment. There is some evidence that individual and contextual
14 characteristics may be an explanation for low creativity performance (Kabanoff & Bottger, 1992;
15 Vosburg, 1998). Further research is needed to understand what role contextual, situational and
16 personal characteristics play in the efficacy of creativity training.

17 A relatively homogeneous sample in terms of gender and age imposed certain limitations
18 in interpreting the results of the study. Even though there is some research evidence that gender
19 does not influence creative thinking, there is no agreement on relationship between age and
20 creativity (McIntyre et al., 2003). Because the post-test to measure student creative thinking was
21 administered within a week after completion of the creativity exercises, longitudinal effects of
22 this training are not known. It is possible that students may need to continually practice creative

1 thinking techniques to maintain their level of creativity. Further research can examine the effect
2 of creativity training over a longer period of time.

3 Based on the research findings, it is possible to conclude that the creativity exercises
4 were general in nature because they were effectively used to increase creative thinking of
5 students from freshman to senior standing, enrolled in different majors and courses that were
6 taught by four different instructors. After confirming their effectiveness, the creativity exercises
7 were incorporated in an introductory level course required for all students enrolled in the
8 authors' department which includes the three majors of apparel design and merchandising,
9 hospitality management, and family and consumer educational studies. Other departments in the
10 university, such as business management, veterinary practice, and journalism have expressed
11 interest in adding the creativity training into the curricula. Further testing of the effectiveness of
12 the exercises for increasing creative thinking of diverse student and non-student populations in
13 different regions of the United States is needed.

14 This study has implications for instructors who want to nurture student creativity. By
15 incorporating a series of short exercises throughout the courses they teach, instructors can help
16 students develop the important skill of creative thinking. Even though there are a variety of
17 creativity training programs currently available, research suggests the most effective programs
18 involve a cognitive framework centered on the core practices of opportunity recognition, idea
19 generation, and idea evaluation (Scott et al., 2004). The exercises adapted for this study utilized
20 this approach. As instructors develop creativity-enhancing curriculum, creativity exercises that
21 focus on these skills of opportunity recognition, idea generation, and idea evaluation can enhance
22 creative thinking in their students.

1 While the TTCT test has been widely used for many years and has been reported to
2 accurately assess participants' creative thinking, high creative thinking scores are not a guarantee
3 of creative performance. Additional factors such as motivation and determination are imperative
4 for a realization of creative potential (Torrance, 1990). Future research may explore relationships
5 between motivational and attitudinal characteristics and creative performance. In addition, it is
6 important to contextualize the TTCT within the fashion/apparel industry. Testing successful
7 apparel professionals can further the understanding of the role of creative thinking in the apparel
8 industry and the predictive quality of the TTCT to career advancement.

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