

EFFECTS OF DIVERGENT TEACHING TECHNIQUES UPON
CREATIVE THINKING ABILITIES OF COLLEGIATE
STUDENTS IN AGRICULTURAL SYSTEMS
MANAGEMENT COURSES

by

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ABSTRACT

J.P. Guilford (1950) asked in his inaugural address to the American Psychological Association why schools were not producing more creative students. It has been this researcher's experience that courses at institutions of higher education are geared to teaching knowledge, themes, concepts, or measures, and do not allow time for the students to develop original ideas. While current practice transfers a great deal of information to students, it hinders the ability of students to be creative in the disciplines. In agricultural education teacher certification programs, this method of teaching is not only hindering the ability of future teachers to think creatively, but their future students' ability to think creatively.

Baker, Rudd, and Pomeroy (2001) purported that educators must prepare a specific curriculum to increase students' creative thinking ability. In a critique of Baker, Rudd, and Pomeroy (2002), Wingenbach (2002) asks, "What is the best approach for including the creative thinking process in agricultural education courses? (p. 1)" The purpose of this study was to increase the creative problem solving skills of undergraduate students at Texas Tech University in a mechanized agriculture classroom by utilizing divergent teaching techniques.

The researcher utilized the Torrance Test of Creative Thinking for the data collection tool in this repeated measures design. The following constructs were addressed in the raw data: (1) fluency- the ability to develop substantial amounts of ideas and drawings; (2) originality- the quality of newness that exists in something not done before;

(3) abstractness- the ability to create good titles and to fully capture the events of what the information is dealing with; (4) elaboration- thought out or organized with thoroughness and careful attention to detail and; (5) resistance to premature closure- the ability to keep an idea open long enough to build upon each idea. A measure of the students' overall creativity based on the subjects' grade level and gender has also been assessed.

The population consisted of undergraduate student at Texas Tech University whose major course of study requires a course in welding and metalworking and/or students who have a special interest in welding and metalworking. A convenience sample (n= 18) was utilized for this quasi-experimental design. The researcher has described in detail the data collection schedule, and has laid out step-by-step instructions for administering three treatments designed to increase a person's ability to think in a divergent manner. These treatments consisted of The Sensory Connection, Brainwriting, and Brainsketching.

Following the data analysis the researcher concluded that the results from this study showed a wide spectrum of results when looking at the examined constructs and three teaching techniques. Three of the examined constructs showed significant difference between the baseline measurement and the intervening treatments. It is recommended that alternate divergent teaching techniques be studied to determine their affects upon creative thinking, student satisfaction, and cognitive performance.

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CHAPTER I

INTRODUCTION

Introduction

J.P. Guilford (1950) asked in his inaugural address to the American Psychological Association why schools were not producing more creative students. It has been this researcher's experience that courses at institutions of higher education are geared to teaching knowledge, themes, concepts, or measures, and do not allow time for the students to develop original ideas. While current practice transfers a great deal of information to students, it hinders the ability of students to be creative in the disciplines. In agricultural education teacher certification programs, this method of teaching is not only hindering the ability of future teachers to think creatively, but their future students' ability to think creatively.

Agricultural educators have several methods to deliver knowledge, skills and abilities students need to gain in their courses. The term Agri-Science has been used to describe the variety of subjects, such as the life sciences and mathematics, agricultural educators can include in their curriculum courses. Due to the increase of subject matter, teaching mechanized agriculture course has been thought by many to have been removed from agriculture education to vocational education programs. Rosencrans and Martin (1997) found that many agricultural educators still see the value of production agriculture applications in agricultural mechanics as a very important part of their programs, but state that "instruction in agricultural mechanization should focus on developing general knowledge and skills that are transferable to a wide range of job clusters rather than

specific knowledge and skills that focus on a specific job in a job cluster (p.260).”

Mechanized agriculture courses should be offered, but they should be utilized to teach more than just basic production-related skills required for the course.

Statement of the Problem

Agricultural education is constantly changing. Swanson (1991) has stated that “it is imperative for the future of agricultural education to identify and hone the creative talents of people and to direct these toward elevating human possibilities” (p. 7).

Development of creative talents has been something that has been neglected in many of the courses required for agricultural education certification. “The pressures mount to cram more and more information into each course, educators find it increasingly hard to do any thing but cover the syllabus” (Felder, 1987, pg. 222). Baker, Rudd, and Pomeroy (2001) purported that educators must prepare a specific curriculum to increase students’ creative thinking ability. In a critique of Baker, Rudd, and Pomeroy (2002), Wingenbach (2002) asks, “What is the best approach for including the creative thinking process in agricultural education courses?(p. 1)” The problem of not knowing the best method of increasing undergraduate students’ ability to think in a creative manner needs to be addressed.

Purpose and Objective

The purpose of this study was to increase the creative problem solving skills of undergraduate students at Texas Tech University in a mechanized agriculture classroom by utilizing divergent teaching techniques. The findings of this study will increase our

understanding of the effects of divergent teaching techniques. Very little research has been performed on creative thinking in a mechanized agriculture context. This study will add to the body of literature regarding creative thinking and teaching creative problem solving. University faculty will be able to use this study to help guide them to incorporate creative problem solving in their curriculum. It has been hypothesized by the researcher that by utilizing divergent thinking tools and techniques, undergraduate students at Texas Tech University will increase their creative thinking ability.

The objective of this study was to:

1. Determine if the use of divergent thinking tools and techniques used in an undergraduate welding and metal fabrication course at Texas Tech University has an effect on an undergraduate student's ability to think creatively.

Definition of Terms

For the purpose of this study, the following terms and definitions will be used.

Divergent Teaching Techniques- Activities that spark creative thinking, and may follow many lines of thought. Divergent teaching techniques tend to generate new and original solutions to problems for those involved in the exercises.

Teaching divergent thinking is a five step systematic approach that should be followed (Kvashny, 2005). In step one, the subjects must rule out all judgments. This first step should allow the topics to be placed in a context that anything is possible; nothing should harness their ability to think the most abstract of thoughts. Step two involves seeking numerous ideas. The more ideas the subjects can generate the more

chance of acquiring a quality thought. In step three, the subjects will build on alternative options. This step requires thoughts that build on and resist closure on a topic. In step four, the subjects need to seek novel associations, finding connections between each idea and to bridge these thoughts in order to develop new thoughts. In step five, the thinker should allow time for incubation. Allowing time to completely let these thoughts develop will allow the best possible thought to surface.

The first divergent thinking teaching technique used in this study was Sensory Connection. This is a tool that takes the mind away from the problem at hand. The objective of this activity was to build a wealth of unrelated thought or observations which could be utilized to create novel ideas which may assist in obtaining new solutions to problems or challenges (Kvashny, 2005).

The second divergent thinking teaching technique was Brainwriting. This activity required the participants to write down their ideas on a teacher-provided form which allowed participants to build on each others thoughts without having to speak out loud, thus allowing openness in a group (Mycoted Ltd., n.d.). The students had six positions on the brainwriting form to generate their ideas.

The third teaching technique that was utilized was known as Brainsketching (Mycoted Ltd., n.d.). This activity is similar to the brainwriting activity, but instead of writing down ideas and passing forms around, the participants were asked to sketch the answers to their problem statements.

Each group was placed at a workstation with a note pad, and then asked to sketch a drawing for two minutes. At the end of the two minutes, the students were asked to

pass their sketch to the right. When students worked on all the sketches, as a group they were to decide on the best sketch.

Creative Thinking - The term creative thinking used in this study was defined as the ability to create and generate new ideas. Torrance, Orlow, and Safter (1990) stated that the term “creative thinking abilities” as used in the Torrance Test for Creative Thinking (TTCT), refers to that constellation of generalized mental abilities that is commonly presumed to be brought into play in creative achievements.

When measuring creative thinking ability, participants in this study were asked to complete the TTCT four times during the course of the study. The students were asked to construct a drawing, create pictures from a series of incomplete drawings, and to complete a drawing from sets of parallel lines. This test assessed five mental characteristics of creativity: (1) fluency- the ability to develop substantial amounts of ideas and drawings; (2) originality- the quality of newness that exists in something not done before; (3) abstractness- the ability to create good titles and to fully capture the events of what the information is dealing with; (4) elaboration- thought out or organized with thoroughness and careful attention to detail; and (5) resistance to premature closure- the ability to keep an idea open long enough to build upon each idea. A measure of the students’ overall creativity based on the subjects’ grade level and gender was also assessed.

Assumptions

This study has four basic assumptions. First, the researcher assumed that all participants had the intrinsic motivation needed to think creatively, and wanted to

perform well on the instrument used to measure their creativity. Second, it was assumed that all participants in the study had no prior training or course work in creative problem solving. Third, it was assumed that there was no difference between TTCT scores and the days of the week which the treatments were administered. Fourth, it was assumed that all students were enrolled in this course on their own free will.

Limitations

This study possessed several limitations that may restrict the amount of inference that can be derived from the results. The mortality of the sample was at risk; several subjects were absent on days the treatments were administered. Additionally, students were very diverse in their areas of study, and students varied in terms of their interest levels in the course content.

Significance of the Study

A study of this nature is significant for several reasons. First and foremost, bringing creativity in the agricultural science classroom will adhere to Guilford's (1967) statement that creativity is the key to education in its fullest sense and to the solution of mankind's most serious problem. Second, it has been identified that agricultural educators feel that creativity should be integrated into the curriculum, but the problem lies in the fact that no one knows the most effective manner in which to do so. Finally, this study will break new ground for creativity research in agricultural education and mechanized agriculture based upon its design.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

Introduction

This review of literature has been developed in order to establish a theoretical framework, and to identify other bodies of research that have been key players in the fields pertinent to this study. This chapter has been broken down into sections to highlight the main points of research relevant to this study- creative problem solving, creative thinking, and divergent thinking.

The Osborn-Parnes Creative Problem Solving Model

The Osborn-Parnes Creative Problem Solving Model was developed by Alex Osborn and Sidney Parnes (Davis, 1986). Osborn is well known for his work originating the idea of brainstorming. Parnes, a professor at Buffalo State College, NY, worked with Osborn to develop a six step process known as the Osborn-Parnes Creative Problem Solving Model. This process described in Mitchell and Kowalik's Creative Problem Solving (1999) included: mess finding, data finding, problem finding, idea finding, solution finding, and acceptance finding. Mess finding relates to identifying a problem that presents a challenge. Data finding is an effort to find all known facts related to the situation at hand. Problem finding is set to identify a problem statement, and to isolate the most important problem identified in the mess finding stage. Idea finding is designed to identify as many possible solutions to the problem statement. Solution finding is performed by looking at the possible solutions and choosing the best solution for action.

Acceptance finding is the act of making every effort to gain acceptance for the solution.

This systematic model is illustrated in Figure 2.1.

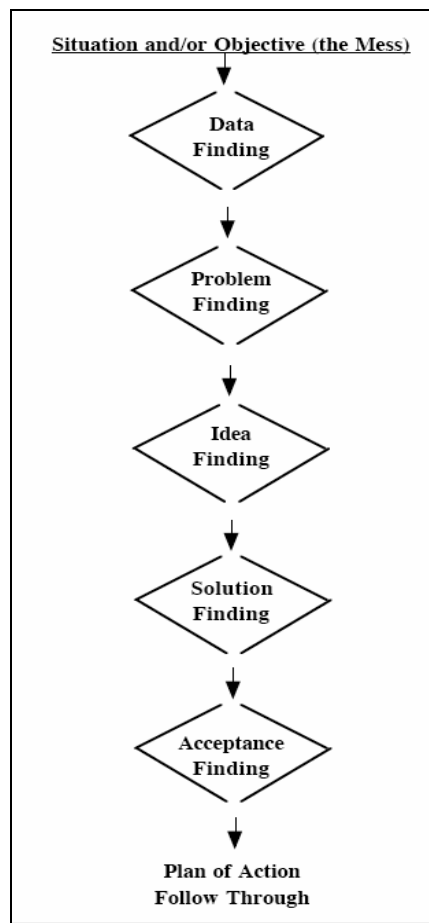


Figure 2.1 Osborn-Parnes Creative Problem Solving Model

Creative Thinking

E. Paul Torrance (1972) has for many years taught children to think creatively. He has investigated whether or not teachers can truly teach children to think creatively. Torrance looked at 142 studies that were designed to test different approaches to enhance creative thinking in children. Most of the experiments examined variables such as

teacher-classroom relationships, modifications to the Osborn-Parnes creative problem solving model, and complex problem packets of information. Torrance found that you can teach children to be creative, but motivation and facilitation play a key role in increasing a student's ability to think creatively.

Carroll (1978) has looked beyond younger children and has looked at teaching creativity as an academic subject at the university level. Carroll (1978), along with Sternberg and Lubart (1991) had recognized that both professors and students were afraid of creativity and did not value creativity as a good thing. In an attempt to change this perception, Carroll (1978) established a 16 week course that met twice a week for one and one-half hour. The course provided very little discussion over the recommend reading for the course; most of the course focused on activities that sparked creativity. Carroll not only wanted to teach about creativity, but he strived to make the students in the class more creative. A Torrance-like creativity test was used to evaluate the student (n=15) fluency. Carroll found that all but one student increased his ability to be more fluent, and the group members produced 100% more responses. Jackson and Sinclair (2005) have found that "like any teaching intervention, results vary according to group dynamics, and the personalities, capabilities, attitudes and interests of individuals" (p.6).

Felder (1987) has found that engineering educators have been teaching their students in a manner that gets the most information to the student in the shortest amount of time. Felder believed that his graduates not only needed the technical training in the field, but they should also have the ability to define problems, develop strategies, and solve the problems that they will face after graduation. Felder suggested that engineering

educators need to allow time within each course to provide opportunities to exercise both critical and creative problem solving. Sternberg and Lubart (1991) reiterated that in order to develop a student's ability to think insightfully, educators must allow students to have practical application of these skills in forms of ill-structured problems and projects. Felder (1987) stressed that giving these opportunities to students is one of the best contributions that teachers can make to the future of our society.

Kvashny (1982) investigated the practicability of improving creative thinking within his landscape architecture courses. Kvashny integrated creative learning activities in place of his normal academic curriculum in an experimental design. A pre-test was given to both groups at the beginning of the semester, and a post-test was administered at the end of the semester. Kvashny found that both groups made improvement in the four variables tested: fluency, flexibility, originality, and elaboration, but the treatment group doubled the control group's results in comparison of their originality and elaboration. As a result of this study Kvashny has recommended that the creativity variables such as fluency, flexibility, originality, and elaboration should be included as part of the curriculum in landscape architecture.

Jackson (2003) investigated teachers' and academics' views on creativity and curriculum integration. He found that academics recognize creativity as a personal innovation, working across boundaries of acceptability, and taking risk, doing things that have never been done before. Jackson stated that,

In summary, teaching for creativity requires a pedagogic stance that is facilitative, enabling, responsive, open to possibilities, and collaborative, and which values process as much as outcomes. Teachers operate in strong cultural and procedural environments that have significant impact on what they can do as teachers to

promote students' creativity. In spite of, or perhaps because of, these constraints, teachers who care about creativity are able to overcome these barriers to create through their pedagogy curricular spaces and opportunities for learning that encourage and reward students for their creativity. (p.5)

In Jackson's Designing for Creativity: A Curriculum Guide (2002) he discusses the relationship between student attitudes and creative performance. Positive attitudes, high levels of motivation, and willingness to work hard are all attributes to increasing a student's ability to think creatively. Jackson emphasizes that fostering and encouraging creativity is a way of reinforcing student self-motivation.

Divergent Teaching Techniques

As previously identified, divergent teaching techniques tend to generate new and original solutions to problems for those involved in an exercise. Kvashtny (2005) expressed that teaching divergent thinking is a five step systematic approach. In step one, the subjects must rule out all judgments. This first step should allow the subjects to be placed in a context that anything is possible; nothing should hinder their ability to think the most abstract of thoughts. Step two involves seeking a quantity of ideas. The more ideas students can generate the more chance of acquiring a quality thought. In step three students will build on alternative options. This step requires thoughts that build on and resist closure on a topic. In step four, the students need to seek novel associations, finding connections between each idea and bridging these thoughts in order to develop new thoughts. In step five, the thinker should allow time for incubation. Allowing time to completely let these thoughts develop will allow the best possible thought to surface.

There have been many activities and exercises that have been developed to enhance divergent thinking skills such as brainstorming, brainwriting, and use of formal analogies (Mycoted Ltd., n.d.). The basis of brainstorming is the act of generating ideas in a group situation, and allowing no judgments on the ideas that have been generated. Several other methods of brainstorming have been developed, but they all follow the same basic rules of classical brainstorming. Brainwriting is very similar to brainstorming, but the groups of people generating the ideas do not have to speak to one another. Writing ideas down on paper and building upon ideas other participants in the group have suggested allows openness within the group. This allows those that are inhibited of speaking out in front of others to express their ideas. The use of analogies has been identified by Mycoted Ltd. as a key feature of many approaches to creativity. When using analogies, you say that something is like something else, but not in the same way. Analogies are mostly used in informal settings, and can be very personal.

Divergent vs. Convergent

Guliford (1950) has recognized divergent thinking as one of the major steps involved in the creative process. Stokes (2000) has identified historical artists, such as Picasso and Matisse, which have displayed high levels of divergent thinking by incorporating multiple styles and media to develop some of the most innovative art works. In Coon's (1989) Introduction to Psychology, Exploration and Application, he presents numerous thinking modalities. The act of thinking refers to mental manipulation of concepts, rules, and precepts. Inductive reasoning, going from specific facts to general

principles, is much like divergent thought. Divergent thinking produces many ideas or alternative ideas. When thinking in a divergent manner, many possibilities are developed from one starting point.

Convergent thought is directly the opposite of divergent. Convergent thinking is directed towards finding one correct or best answer. Coon (1989) has referred to convergent thinking as conventional thinking in the problem solving process. Figure 2.2 is a subset of the Osborn-Parnes Creative Problem Solving Model, illustrating the complete model which begins with divergent thinking and concludes with convergent thinking. Even though these two types of thinking are quite opposite of each other (Coon, 1989), they both play a key role in the Creative Problem Solving Process (Jackson & Sinclair, 2005).

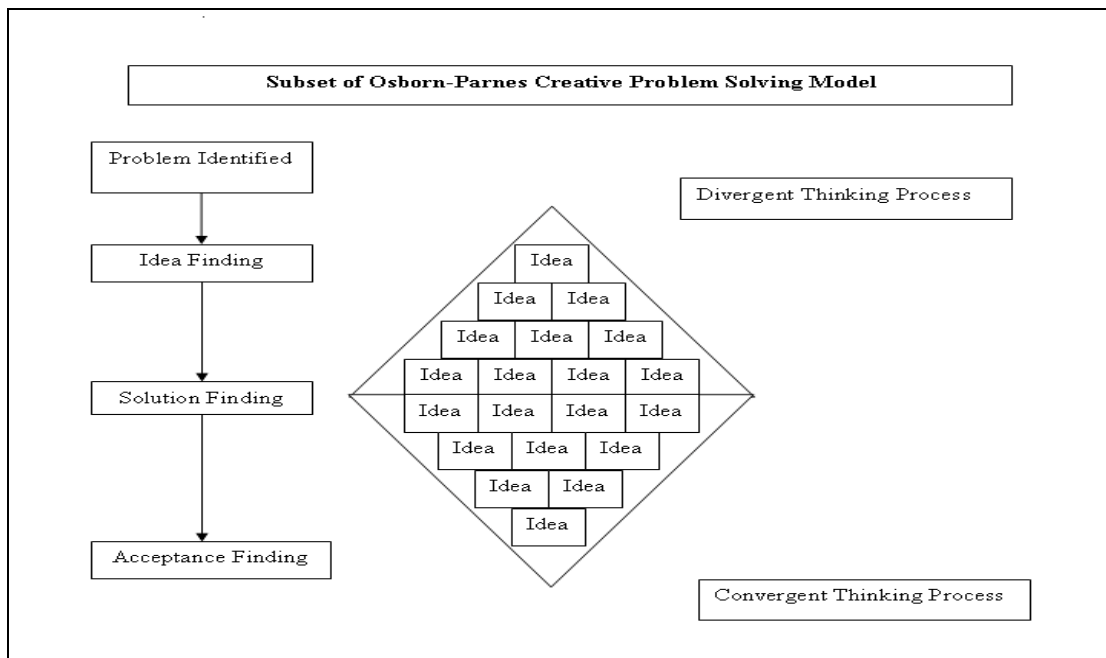


Figure 2.2 Osborn-Parnes Creative Problem Solving Model

Summary of Literature

The concepts of creative problem solving, creative thinking, and divergent teaching techniques have been reviewed thoroughly. The Osborn-Parnes Creative Problem Solving Process is a six step systematic process that includes: mess finding; data finding; problem finding; idea finding; solution finding; and acceptance finding. While reviewing literature on creative thinking, the researcher found that it is possible to teach people to be creative, but some variation can be expected due to participants' motivation and attitudes toward creative thinking. When teaching for divergent thought, many possibilities are developed from one starting point. Divergent thought, being just the opposite of convergent thought, has been identified as a key component to the creative problem solving process by being utilized during the idea generation stage.

CHAPTER III

METHODOLOGY

Introduction

Within this chapter, the researcher takes an in-depth look at the appropriate research design for this study, and discusses areas of concern when looking at internal and external validity. The researcher also identifies the population and sample of this study, as well as discusses the chosen instrumentation for measuring creative thinking abilities. The researcher has described in detail the data collection schedule, and has laid out step-by-step instructions for administering each treatment designed to increase a person's ability to think in a divergent manner. The researcher has also addressed the manner in which the raw data was analyzed, and discussed certain assumptions that were addressed when analyzing the data.

Research Design

According to Campbell and Stanley (1966), the research design for this quasi-experimental study is referred to as a time series experiment. In terms of threats to internal validity, failure to control history is a major weakness. To control for this threat, the researcher asked the subjects to identify alternative sources of information on creativity that they received during the course of the study. There was none identified by the participants. Instrumentation has been raised as another possible source of internal validity due to possible changes in the calibration of the measurement device. Since the

researcher used the same standardized instrument for measuring creativity, instrumentation was not problematic.

In terms of external validity, Campbell and Stanley indicate the major threat is in regards to the interaction of testing and the treatment. Consequently, the researcher generalizes no further than the study participants.

However, as Campbell and Stanley (1966) warn:

The prevalence of this design in the more successful sciences should give us some respect for it, yet we should remember that the facts of “experimental isolation” and “constant conditions” make it more interpretable for them than for us. It should also be remembered that, in their use of it, a single experiment is never conclusive... This too should be our use of it. But these [single studies] will not be regarded as definitive until frequently replicated in various settings (p. 42).

Population and Sample

The population consisted of undergraduate students at Texas Tech University whose major course of study requires a course in welding and metalworking and/or students who have a special interest in welding and metalworking. A convenience sample (n= 25) was utilized for this experiment. Students self-selected themselves in this study by registering for Agricultural Systems Management 2302- Welding and Metalwork, which was offered during the Fall 2005 semester at Texas Tech University. Students who enrolled in this course were not required to participate in the study. The students were not offered any incentives or disincentives for their participation in this study, and their grade in the course was not affected in anyway. Prior to the data collection, the students were presented with an Informed Consent Form (Appendix A),

and asked to participate in this study. All but one student agreed to volunteer for the experiment (n=24).

According to Campbell and Stanley (1966), mortality was not expected to be an issue in terms of internal validity. Due to the time of day that the course was offered and the extra-curricular activities that some students were involved in, mortality became an issue and six students dropped out of the experiment reducing the sample size to eighteen (n=18).

This sample was composed of twelve male students (66%) and six female students (33%), ages ranging between eighteen and twenty-four (M=21, SD=1.28). This sample contained one freshman (6%), four sophomores (22%), four juniors (22%), and nine seniors (50%). The students had a variety of major areas of study including: Interdisciplinary Agriculture (44%), Agricultural Communications (17%), Mechanical Engineering (17%), Theatre Arts-Design Technology (5.5%), Agricultural and Applied Economics (5.5%), General Business (5.5%), and an undecided major in the College of Business Administration (5.5%).

Instrumentation

The Torrance Test for Creative Thinking (TTCT) was used as the primary source of data collection. The researcher used this standardized instrument for measuring creativity throughout the entirety of the study in an attempt to control for internal validity. The TTCT was scored by the test developers, and the raw data returned in a

quantitative state. The following constructs were addressed in the raw data: (1) fluency- the ability to develop substantial amounts of ideas and drawings; (2) originality- the quality of newness that exists in something not done before; (3) abstractness- the ability to create good titles and to fully capture the events of what the information is dealing with; (4) elaboration- thought out or organized with thoroughness and careful attention to detail and; (5) resistance to premature closure- the ability to keep an idea open long enough to build upon each idea. A measure of the students' overall creativity based on the subjects' grade level and gender has also been assessed by the tests creators. Content and construct validity has been established by the TTCT developer (Torrance et al., 1990). Intra-rater reliability coefficients are above the .90 level (Torrance et al., 1990).

The TTCT is a timed, three part test, where students were asked to construct a drawing, create pictures from a series of incomplete drawings, and complete a drawing from sets of parallel lines (Torrance, n.d.). Each section has specific instructions that were read aloud exactly as written (Torrance, n.d.).

Data Collection

The data were collected during the fall semester 2005; in week one, baseline data were collected (August 31, 2005, 2:30 p.m.). Post-treatment data were collected in week five (September 28, 2005, 2:30 p.m.), in week eight (October 19, 2005, 2:30 p.m.), and in week fourteen (November 30, 2005, 2:30 p.m.). The data were collected in the same classroom with verbal directions given in the same manner on each collection date. The three treatments were administered one class period prior to the scheduled course exams.

The researcher had approximately 50 minutes to administer each treatment. A schedule of the data collection and treatment dates can be visualized in Table 3.1.

Table 3.1 Data Collection and Treatment Dates

Data Collection and Treatment Schedule	
TTCT 1 (Baseline)	Wednesday, August 31, 2005
Sensory Connection	Monday, September 26, 2005
TTCT 2	Wednesday, September 28, 2005
Brainwriting	Wednesday, October 19, 2005
TTCT 3	Wednesday, October 19, 2005
Brainsketching	Wednesday, November 30, 2005
TTCT 4	Wednesday, November 30, 2005

Lesson Content and Treatments

This section describes, in detail, each treatment administered to the sample.

Treatment 1

The first intervention the researcher conducted was a divergent thinking tool known as a sensory connection. This treatment was administered on September 26, 2005

at 8:00 a.m. This is a tool that takes the mind away from the problem at hand. The objective of this activity was to build a wealth of unrelated thought or observations which could be utilized to create novel ideas which may assist in obtaining new solutions to problems or challenges (Kvashny, 2005). The facilitator utilized a sensory connections worksheet and a variety of stimuli (Appendix B).

The participants experienced the stimuli and wrote down four different observations, impressions, reactions, words, or thoughts for each stimulus in the space provided on the worksheet. After all the stimuli were used, participants recorded the opportunity or problem statement currently under consideration in the space provided. Connections were then shared with the group. This option provided the opportunity for immediate clarification

The directions for the activity were administered in a classroom where students also received their sensory connection worksheet. The facilitator checked for comprehension of the directions.

The first stimulus the participants were exposed to was focused on their sense of sight. A picture of a visually-impaired man was displayed on an over head projector. The participants were allowed to view the picture and write down their observations for three minutes.

The next stimulus was designed to activate the participants' sense of hearing. The students were asked to place blindfolds on and sit quietly. The facilitator then played a song over the sound system of the classroom. This song lasted two minutes. Twenty seconds into this song, the facilitator then drastically decreases the volume of the song,

bringing it back to the original volume. Once the volume was back to the normal level, the facilitator then slowly decreased the volume to a dull sound over the sound system. By the end of the song, it was very difficult for the participants to hear the sound. The participants were then instructed to remove their blindfolds and record their observations regarding the experience. Five minutes were allotted for this activity.

For the third stimulus, the participants were exposed to their sense of touch. The participants were blindfolded and instructed to insert their hand into a container of soapy liquid. Once all the participants experienced the stimulus, they were instructed to remove their blindfold and record their observations about what they had just felt. This stimulus was allotted five minutes.

The last stimulus was designed to use the participants' sense of smell. The participants were once again asked to place their blindfolds on and sit quietly. The facilitator then took a book of matches and set it on fire. Once the fire was extinguished the facilitator walked around the room so that all participants could experience the smell of the smoldering matchbook. After all the students experienced the stimulus, they were asked to remove their blindfold and record their observations. Five minutes were dedicated for this activity.

Once all the stimuli were administered, the participants were reminded of their goal of synthesizing all of the stimuli. After they processed the information, the class was given a problem statement of, "Problems Agriculture Science Teachers Face in a High School Agriculture Mechanics Class." The participants were asked to find

connections that pulled all the stimuli together. The participants were allowed to work on the task individually for five minutes.

Once the participants reflected on these connections, the facilitator went around the room and asked the participants to share their statements with the group. The facilitator then clarified the students' connections, and the class was asked to build upon the ideas.

Treatment 2

The second intervention was a divergent thinking tool known as Brainwriting. This treatment was administered on October 19, 2005 at 8:00 a.m. This activity allowed the participants to write down their ideas on a teacher-provided form. This activity was closely related to brainstorming, but it allowed participants to build on the thoughts of others without having to speak out loud, thus encouraging openness in a group that may be hindered by speaking in front of others (Mycoted Ltd., n.d.). The students had six positions on the brainwriting form to generate their ideas. Once they supplied their first three ideas across the sheet, they placed their form in the middle of the table. The students who finished their form first, picked up the extra brainwriting form and filled it out. The participants worked on this activity until time was called or all sheets had been completed.

The facilitator arranged for the students to sit in groups of five. Each group of five received six different brainwriting forms on their table (Appendix C); one at each seat, and one in the middle. Each brainwriting form had a different problem statement

written at the top of the form. The problem statements consisted of: 1) “How can I get my 10th grade welding class to wear their safety glasses?”; 2) “How can I motivate my students to improve their workmanship on our project?”; 3) “What can I do to keep my students from horse playing in the shop?”; 4) “My students are not wearing appropriate clothing in the shop. What can I do?” ; 5) “My principal told me that my lab classes need to be more active in the community. How can I get my classes involved in the community?”; and 6) “I want to build a dunking booth for the fair in my senior Agricultural Mechanics class. I have never built anything like this. Where should I look for help?”

When the students entered the room, the facilitator randomly distributed the students to the different tables. The students were instructed not to look at the sheets in front of them until the activity was initiated by the facilitator. Once all the students were in their groups, the facilitator gave the instructions for the activity.

Once the students started working on the brainwriting forms, the facilitator played classical music over the classroom sound system. The students then had ten minutes to work on their sheets.

When time was called, the facilitator then asked the groups to go through each of the worksheets to clarify any ideas that were confusing to the group. While they were clarifying these ideas, the facilitator asked the groups to look for two things: 1) the one idea that will work the best for the problem and 2) the one idea that was the most unique and far-fetched. Five minutes were allowed for the groups to go through the worksheets.

After time had been called, each group was asked to select a spokesperson for the group to present the most practical ideas and most unique ideas for each worksheet. At the end of each presentation, the facilitator led a discussion on each idea.

Treatment 3

The third intervention was a divergent thinking tool known as Brainsketching (Mycoted Ltd., n.d.). This treatment was administered on November 20, 2005 at 1:00 p.m. This activity is similar to the brainwriting activity, but instead of writing down ideas and passing forms around, the participants were asked sketch the answer to their problem statement. The problem statement was, “Texas Tech is retiring the Double T emblem from the university. President Whitmore, has come to the Department of Agriculture Education and Communications and asked students to design a new emblem. President Whitmore is requesting that this logo be constructed out of mild steel and unpainted at the time of the presentation, therefore the Welding and Metallurgy course is a prime candidate to design and create the new logo.”

This activity was conducted in the welding laboratory. The students were divided into groups of three. Each group was placed at a workstation with a note pad for each student. The students were asked to sketch a drawing for two minutes. At the end of the two minutes, the students were asked to pass their sketch to the right. For another two minutes they were asked to add to the sketch that was just handed to them. Once again, after two minutes, they were asked to pass their sketch to the right. Then for one minute

they were asked to add to the last sketch that they have just received. As a group they were to decide on and alter the sketch that they deemed the most appropriate logo.

They then were asked to construct their group's logo out of mild steel. As they were working on constructing their logo, they were asked to designate one person in the group to present their logo to the instructor. The subjects had forty-five minutes to work on the logo and presentation.

Data Analysis

The data were analyzed using SPSS/PC v.13. Descriptive statistics were used to describe the sample. A general linear model repeated measures analysis was used to determine within-subject differences based upon the treatments. This analysis included Mauchly's test, which determined if the variances of differences between the conditions were significant. This tested the assumption of sphericity, or the relationship between pairs of experimental conditions (Field, 2005). When sphericity was not violated, a standard repeated measures F value was used to determine significance between the conditions. If sphericity was violated (i.e. Mauchly's test was significant), then a Greenhouse-Geisser corrected F was used to determine significance between conditions.

To determine how the conditions differed, the researcher used two approaches based upon recommendations by Gay and Airasian (2003) and Gall, Borg, and Gall (1996). The first approach involved the analysis of a graphic presentation of the results. To this end, the researcher used a normalization process recommended by Loftus and Masson (1994) to control for unsystematic variance. This process involved computing an average creativity score for each subject based upon the four creativity scores taken at

different intervals, then subtracting the grand mean from each individual's average score, and then adding these adjusted scores to the subjects' raw scores (Field, 2005).

Confidence intervals were then calculated at the 95% confidence level and error bar charts plotted to contrast the scores. This allows for visualization of the amount of spread between the sets of scores. If the visual inspection reveals a considerable overlap between the bars, these samples are unlikely to be different from the population, consequently the treatments would be deemed unsuccessful. Conversely, if the error bars are not overlapped, the treatments would likely be successful in influencing a change in creativity within the subjects.

For the second approach, the researcher calculated post-hoc analyses as part of the GLM ANOVA process. One of the concerns with post-hoc analyses is with controlling the overall family-wise error rate (Field, 2005, Clark, 2003). Consequently, the more conservative Bonferroni post hoc test was used. Although researchers have expressed serious reservations about this ultra-conservative approach (Garcia, 2004, Westfall, n.d.), the investigator decided upon the more conservative approach, risking a much greater likelihood for Type II errors.

In discussing the two approaches for single case data, Gall, et al. (1996) concluded by stating, "In summary, researchers can be misled both by visual analysis and by inferential statistics in interpreting data from single-case experiments. Therefore, you need to exercise good judgment in using either or both of these techniques (p.531)."

CHAPTER IV

FINDINGS AND RESULTS

Introduction

The purpose of this study was to increase the creative problem solving skills of undergraduate students at Texas Tech University in a mechanized agriculture classroom by utilizing divergent teaching techniques. Eighteen undergraduate students, ages ranging between eighteen and twenty-four, enrolled in Agricultural Systems Management 2302- Welding and Metalwork, were studied in order to determine if the use of divergent thinking teaching techniques had an effect on a student's ability to think creatively.

The previous chapter described the research design for this experimental study, the population and sample, instrumentation, data collection, lesson content and treatments, and the means that were utilized to analyze the data. Chapter IV presents the results from the data analysis generated from the sample.

General Linear Model: Repeated Measures ANOVA

The data consisted of national percentile rank scores provided by the scoring agency. Torrance, et. al., (1990) states: "The national percentile rank scores indicate the ranking of a student's score when compared with scores of other individuals in the same grade in the norming group (p.5)".

Fluency

An inspection of Table 4.1 reveals that overall, there appears to be an increase in fluency scores between the baseline measurement ($M=60.72$, $SD=24.96$) and the

treatment groups. The greatest scores in fluency followed the brainsketching exercise (M=76.11, SD=26.49).

Table 4.1
Means and Standard Deviations: Fluency

	n	M	SD
Baseline	18	60.72	24.96
Sensory Connection	18	69.44	22.21
Brainwriting	18	64.83	27.51
Brainsketching	18	76.11	26.49

As indicated in Table 4.2, Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=2.03$, $p=.846$). The results show that significant within-subject differences existed between the baseline measurement and the three treatment groups ($F(3, 51)=3.13$, $p<.05$).

Table 4.2
General Linear Model Repeated Measures ANOVA: Fluency¹

	SS	df	MS	F	p
Within Groups	2352.11	3	784.04	3.126	.034
Error	12793.39	51	250.85		
Total	15145.50	54			

¹ Mauchly's $W=.88$, $\chi^2=2.03$, $p=.846$

A Bonferroni post-hoc analysis was conducted to determine if specific differences existed between the baseline measure and the treatments. The Bonferroni post-hoc analysis was unable to determine how the baseline and treatments differed. Figure 4.1 reveals a visual of the adjusted mean scores between the baseline and treatments.

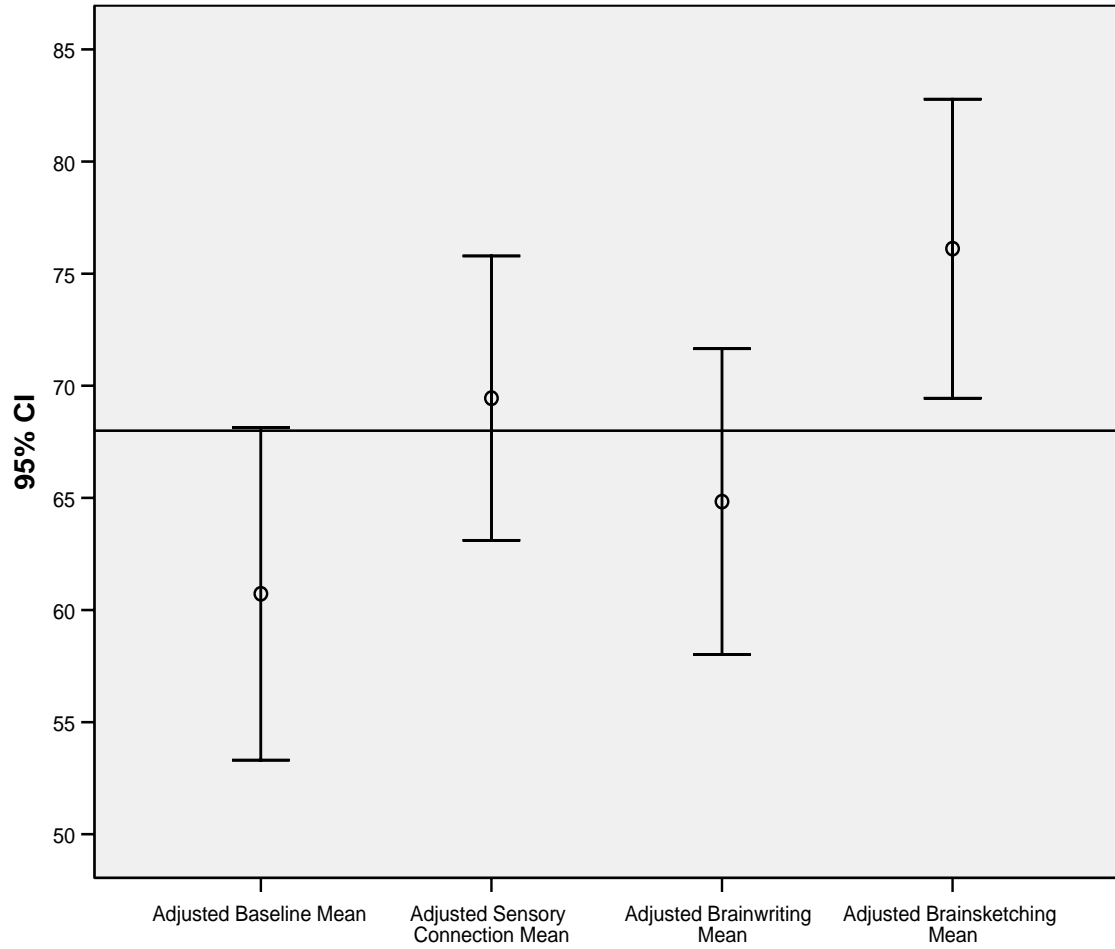


Figure 4.1: Adjusted Mean Scores: Fluency

Originality

An inspection of Table 4.2 reveals that overall there appears to be little difference in originality scores between the baseline measurement ($M=66.78$, $SD=21.48$) and the treatment groups. The greatest increase in scores were present after experiencing the sensory connection exercise ($M=75.94$, $SD=21.88$).

Table 4.3
Means and Standard Deviations: Originality

	n	M	SD
Baseline	18	66.78	21.48
Sensory Connection	18	75.94	21.88
Brainwriting	18	75.39	23.94
Brainsketching	18	75.67	26.12

As indicated in Table 4.2, Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=4.05$, $p=.543$). The results show that significant within-subject differences were not present between the baseline measurement and the three treatment groups ($F(3, 51) = 1.57$, $p > .05$). A visual of the adjusted mean scores is presented in Figure 4.2.

Table 4.4
General Linear Model Repeated Measures ANOVA: Originality¹

	SS	df	MS	F	p
Within Groups	1069.44	3	356.48	1.57	.208
Error	11574.06	51	226.94		
Total	12643.50	54			

¹ Mauchly's $W = .77$, $\chi^2 = 4.05$, $p = .543$

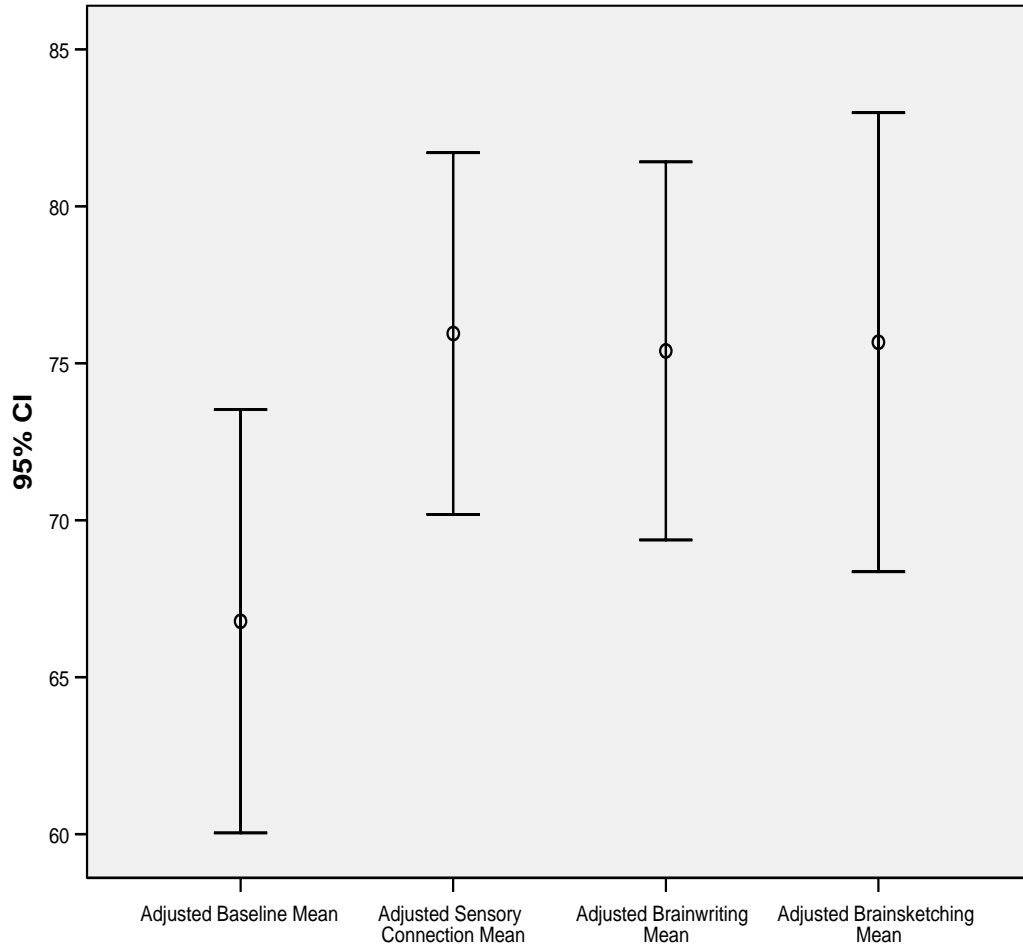


Figure 4.2: Adjusted Mean Scores: Originality

Abstractness

An examination of Table 4.5 reveals that in general there appears to be a slight fluctuation in abstractness scores between the baseline measurement ($M=29.39$, $SD=19.75$) and the treatment groups. The greatest increase in the scores were observed after students experienced the sensory connection exercise ($M=37.61$, $SD=28.20$). After this initial spike in scores, scores on both the brainwriting exercise ($M=31.94$, $SD=22.49$) and brainsketching exercise ($M=26.17$, $SD=17.38$) slowly decreased.

Table 4.5
Means and Standard Deviations: Abstractness

	n	M	SD
Baseline	18	29.39	19.75
Sensory Connection	18	37.61	28.20
Brainwriting	18	31.94	22.49
Brainsketching	18	26.17	17.38

As indicated in Table 4.6, Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=9.84$, $p=.080$). The results show that significant within-subject differences were not present between the baseline measurement and the three treatment groups ($F(3, 51)=1.09$, $p>.05$). Figure 4.3 reveals a visual analysis of the adjusted scores.

Table 4.6
General Linear Model Repeated Measures ANOVA: Abstractness¹

	SS	MS	df	F	p
Within Groups	1264.44	3	421.48	1.09	.364
Error	19807.06	51	388.37		
Total	21071.50	54			

¹ Mauchly's $W=.54$, $\chi^2=9.84$, $p=.080$

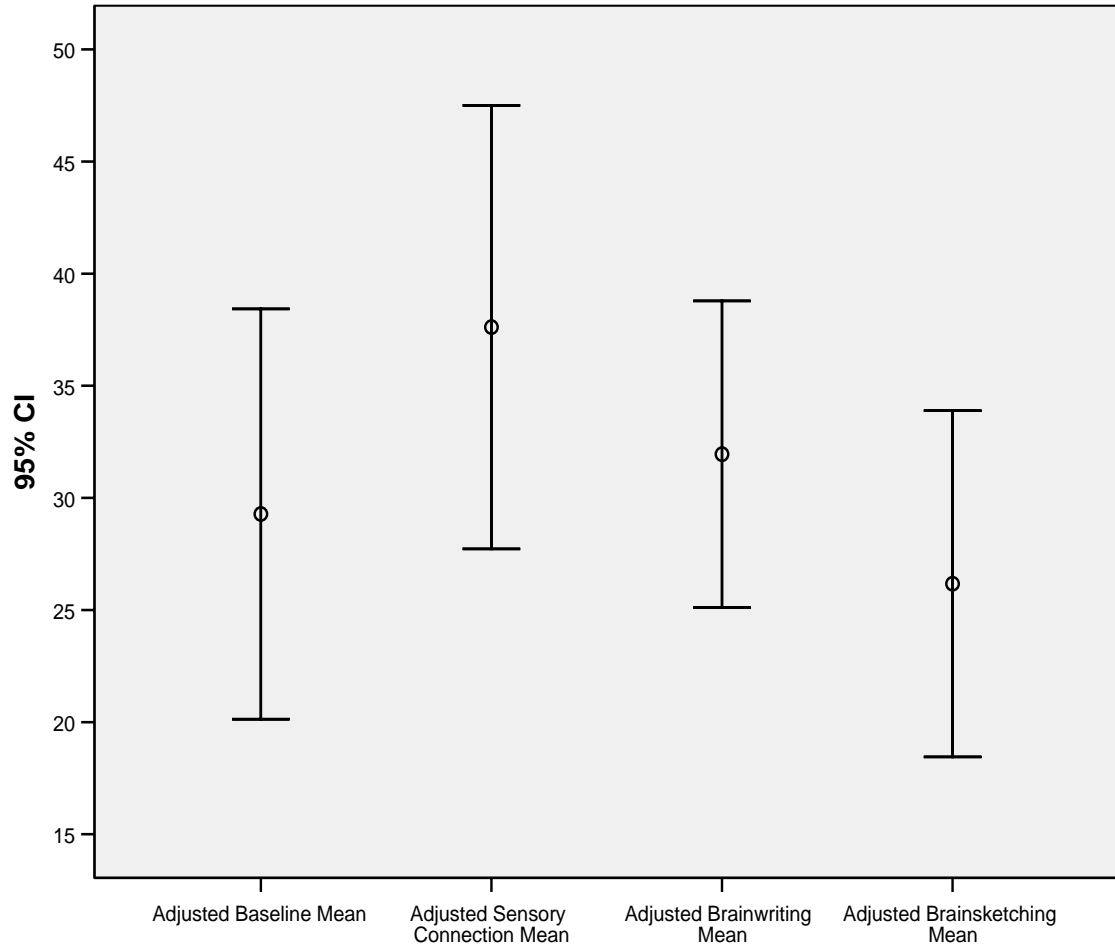


Figure 4.3: Adjusted Mean Scores: Abstractness

Elaboration

An inspection of Table 4.7 discloses that overall there appears to be a decrease in elaboration scores between the baseline measurement (M=29.22, SD=12.10) and the treatment groups. The largest decrease in scores appeared after the brainwriting exercise (M=21.56, SD=12.41)

Table 4.7
Means and Standard Deviations: Elaboration

	n	M	SD
Baseline	18	29.22	12.10
Sensory Connection	18	25.61	12.21
Brainwriting	18	21.56	12.41
Brainsketching	18	23.56	12.20

As specified in Table 4.8, Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=1.30, p=.936$). The results show that significant within-subject differences were not present between the baseline measurement and the three treatment groups ($F(3, 51)=1.77, p>.05$). Figure 4.4 reveals an overall negative linear trend in the data between adjusted baseline scores and the adjusted treatment scores.

Table 4.8
General Linear Model Repeated Measures ANOVA: Elaboration¹

	SS	df	MS	F	p
Within Groups	578.71	3	192.90	1.77	.165
Error	5565.04	51	109.12		
Total	6143.75	54			

¹ Mauchly's $W=.92, \chi^2=1.30, p=.936$

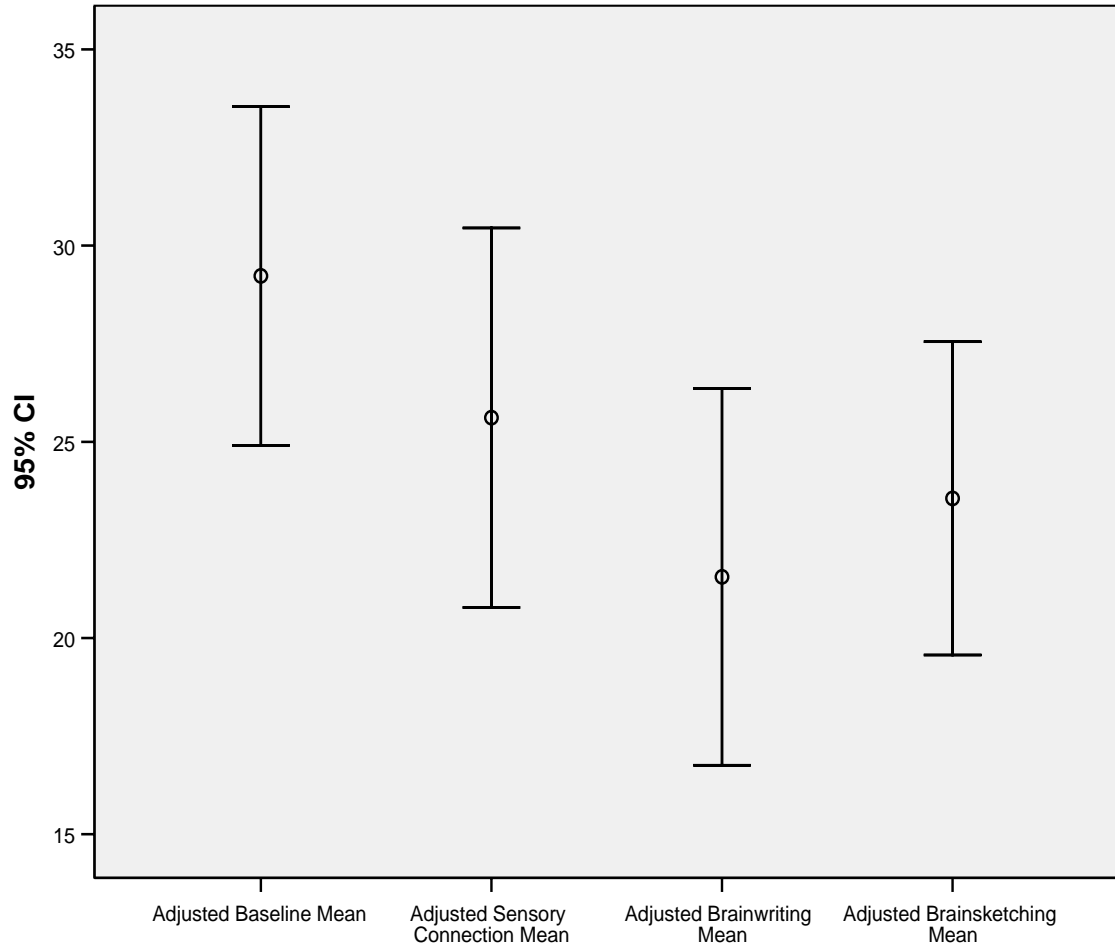


Figure 4.4: Adjusted Mean Scores: Elaboration

Resistance to Closure

An inspection of Table 4.9 reveals that overall there appears to be an increase in resistance to closure scores between the baseline measurement ($M=56.44$, $SD=25.08$) and the treatment groups. The greatest scores in resistance to closure were observed after the sensory connection treatment ($M=78.44$, $SD=19.76$).

Table 4.9
Means and Standard Deviations: Resistance to Closure

	n	M	SD
Baseline	18	56.44	25.08
Sensory Connection	18	78.44	19.76
Brainwriting	18	67.67	26.03
Brainsketching	18	73.27	24.43

As indicated in Table 4.10 Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=10.81$, $p=.056$). The results showed significant within-subject differences between the baseline measurement and the three treatment groups ($F(3, 51) = 4.11$, $p < .05$).

Table 4.10
General Linear Model Repeated Measures ANOVA: Resistance to Closure¹

	SS	df	MS	F	p
Within Groups	4804.38	3	1601.46	4.11	.011
Error	19860.88	51	389.43		
Total	24665.26	38.33			

¹ Mauchly's $W = .50$, $\chi^2 = 10.81$, $p = .056$

The Bonferroni post-hoc analysis was used to determine the significant differences between the baseline measure and the treatments. Using the adjusted alpha of .05, a significant difference was found between baseline mean resistance scores and resistance mean scores after the brainsketching activity. Figure 4.5 reveals the adjusted mean scores for the baseline and treatments.

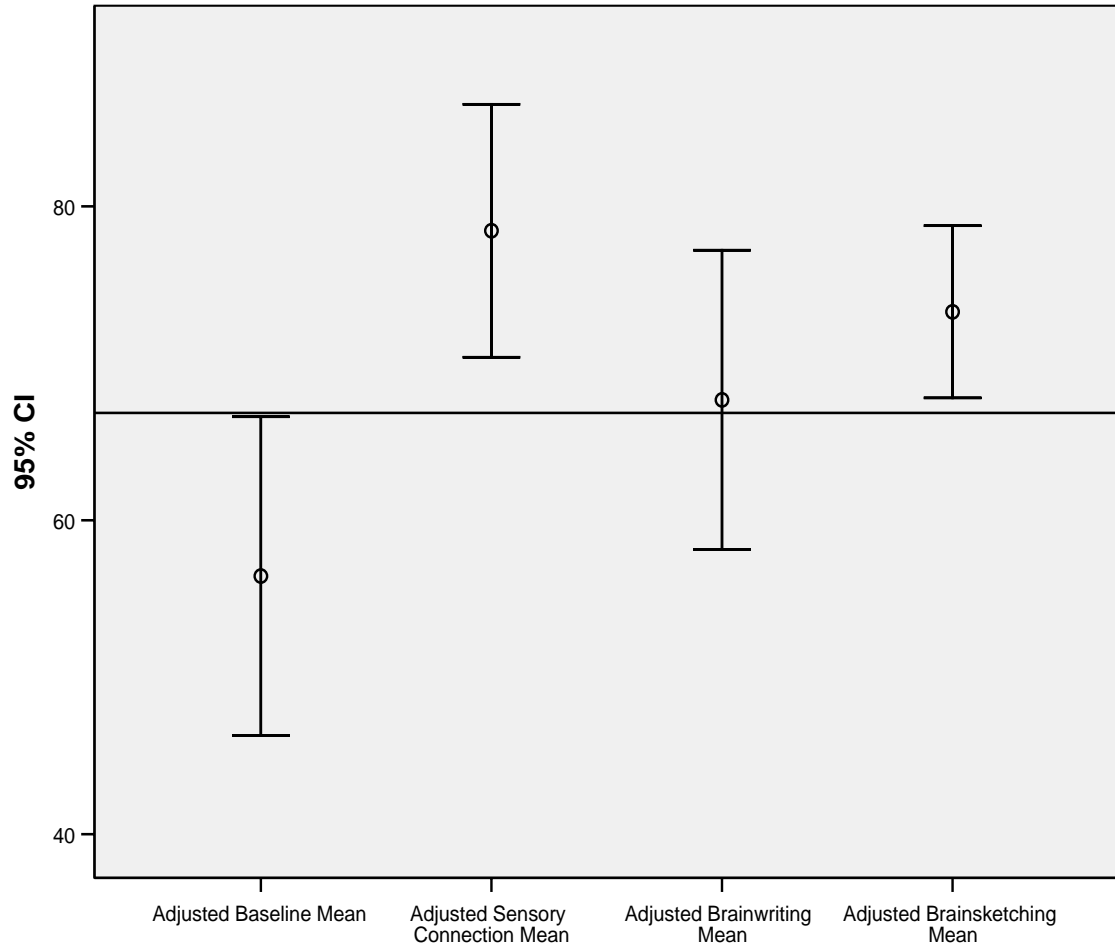


Figure 4.5: Adjusted Mean Scores: Resistance to Closure

Average Creative Strengths

An inspection of Table 4.11 reveals that overall there appears to be an increase in the students average creative strengths scores between the baseline measurement (M=37.72, SD=18.77) and the treatment groups. The greatest scores were observed after experiencing the sensory connection treatment (M=53.94, SD=25.28).

Table 4.11
Means and Standard Deviations: Average Creative Strengths

	n	M	SD
Baseline	18	37.72	18.77
Sensory Connection	18	53.94	25.28
Brainwriting	18	45.56	26.72
Brainsketching	18	51.50	27.86

As shown in Table 4.12, Mauchly's test indicated that the assumptions of sphericity had not been violated ($\chi^2=2.91$, $p=.714$). The results show that significant within-subject differences existed between the baseline measurement and the three treatment groups ($F(3, 51)=3.04$, $p<.05$).

Table 4.12
General Linear Model Repeated Measures ANOVA: Average Creative Strengths¹

	SS	df	MS	F	p
Within Groups	2817.15	3	939.05	3.04	.037
Error	15748.10	51	308.79		
Total	18565.25	54			

¹ Mauchly's $W=.83$, $\chi^2=2.91$, $p=.714$

The Bonferroni post-hoc analysis was used to determine the significant differences between the baseline measure and the treatments. The Bonferroni post-hoc analysis was unable to determine how the baseline and treatments differed. Figure 4.5 reveals the adjusted mean scores for the baseline and treatments.

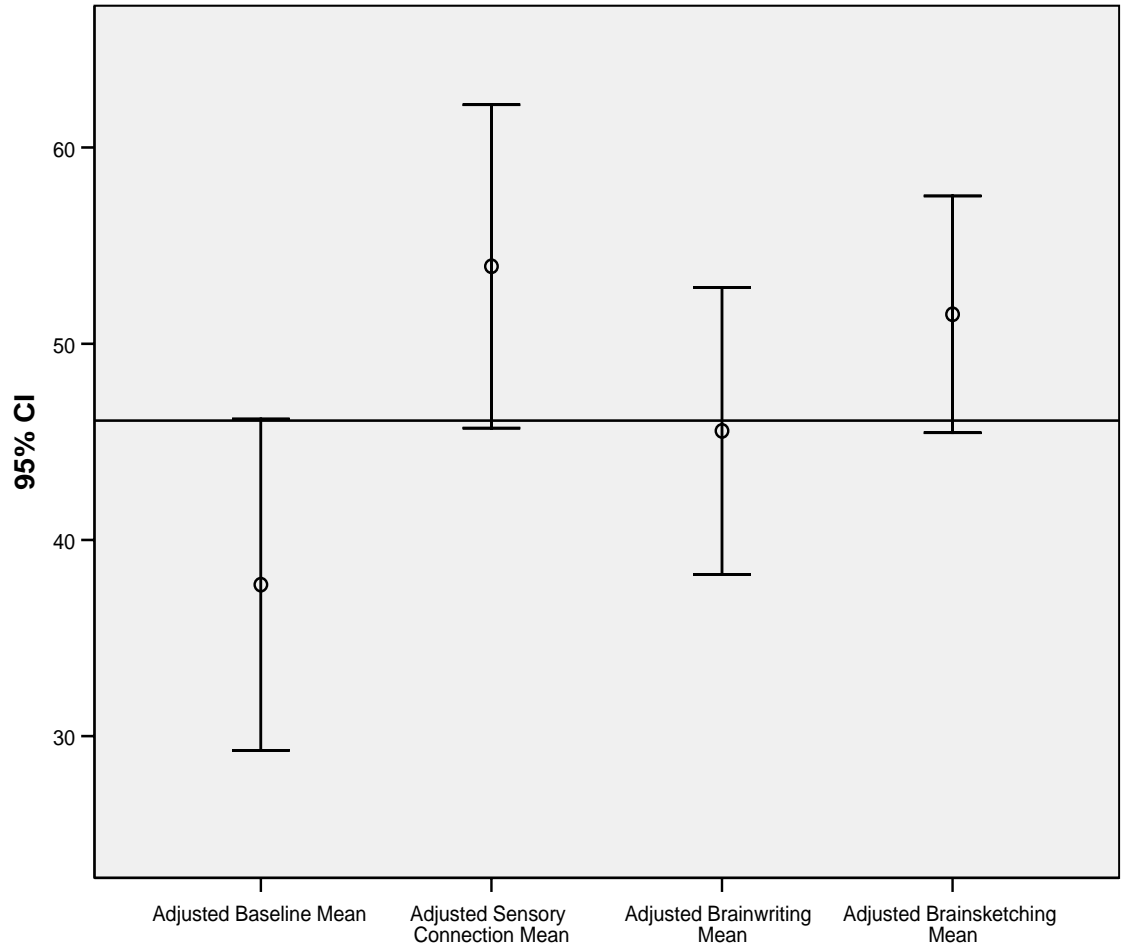


Figure 4.6: Adjusted Mean Scores: Creative Strengths

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

Chapter V provides a brief summary of the purpose of this study, as well as presenting the conclusions and recommendations that were derived from the findings in Chapter IV. In section one of this chapter, a general summary of this study is provided. Section two presents of the conclusions from the data, while section three provides recommendations.

Summary

Wingenbach (2002) had asked the question, “What is the best approach for including the creative thinking process in agricultural education courses? (p. 1)” This study has been developed in order to answer this very question. The researcher has reviewed the current literature on creatively. While reviewing the literature, it was discovered that creative thinking involves learning how to generate new ideas

After researching different teaching techniques that were designed to strengthen a person’s ability to create new and alternative ideas, the researcher developed three lesson plans as interventions. The divergent teaching techniques of sensory connection, brainwriting, and brainsketching were then administered to the undergraduate students who voluntarily participated in the study. The researcher utilized the Torrance Test for Creative Thinking (TTCT) as the primary source of data collection.

Conclusions

The results from Chapter IV exposed several themes that can be concluded from this study. Within this section the researcher examines the measured constructs and the differing teaching techniques in order to derive further recommendations.

Examined Constructs

The results from this study showed a wide spectrum of results when looking at the examined constructs and three teaching techniques. When examining the fluency of the students, their ability to generate new ideas, the results showed that as a group, the means differed significantly. Although the post-hoc analysis yielded non-significant results, a visual inspection of the graphical representation presented leads one to conclude that the major difference was between the baseline measure and the brainsketching exercise. This finding is consistent with the prior research of Felder (1987) and Kvashny (1982).

While observing the originality of the students during the duration of this study, no significant differences were found between the students' baseline measurement and any of the three divergent teaching techniques. Even though overall, no significant difference was found, a numerical increase was observed after the baseline measure. The extent to which this observation is of practical significance will be left to the interpretation by others.

The third construct that was studied was abstractness, related to the students' ability to generate titles that fully capture the events of what the information was dealing with. No significant differences were found between the three treatments and the

baseline measurement. The brainsketching exercise produced scores even lower than the adjusted baseline mean. At a practical level, could it be that brainsketching exercises have a deleterious effect upon abstractness?

While monitoring the students' ability to elaborate, organize, and pay careful attention to detail, no significant difference was detected. This study indicates that a non-significant lesser finding did emerge. The students' scores indicated that their ability to elaborate on an idea decreased throughout the study. Although this finding is not consistent with prior research, (Kvashny, 1982) it appears that the three interventions may have a deleterious effect upon elaboration. The analysis of the students' resistance to closure scores resulted in a significant increase from baseline data to scores secured after the brainsketching activity. These results are consistent with findings by Kvashny (2005), showing that providing students the opportunity to build on alternative options increases their resistance to premature closure in divergent thinking.

In terms of overall creative thinking scores, a significant difference was found between the baseline measure and measures after the interventions. Although further analysis resulted in an inability of the researcher to conclusively tease out specific differences, the visual data supports the conclusion that overall, the sensory connection and brainsketching activities were the most influential upon overall creativity. It is interesting to note also, that overall positive trend was observed in overall creative scores.

Examination of Cumulative Treatment Affect

Although this study was designed to look only at an initial baseline measurement and differences immediately only after each of the three interventions, this leads one to ask in the case of the final intervention, was the observation based upon the unique contribution of the intervention, or were differences based upon a cumulative affect of residual carryover from the two preceding interventions?

It should be noted also that in the controlled environment of this study, the researcher never explicitly taught students about creative thinking, creative problem solving, or divergent thinking techniques. This leads one to ask whether or not if the researcher would have made the implicit more explicit, would creative thinking scores have been more pronounced after the baseline measure?

Recommendations

Based on this study's findings and conclusions, the following recommendations for further action and investigation are forwarded. Based upon this group of students only, it appears that there is evidence that divergent thinking techniques can affect college student scores on a standardized measure of creativity. However, the researcher did not look at cognitive performance or student satisfaction as outcome measures. Subsequent studies should do so. Also, subsequent research should be designed to compare both within and between subject differences by including another group of students as a control. It would also strengthen the findings if immediate affects were measured after an intervention, and assessed for a baseline measure sometime following

the intervention, to see if students return to a baseline measure. Granted this would require the addition of more testing, it would be interesting to see if performance on the test immediately after a “fun” or “novel” intervention is based upon some type of euphoria that may diminish over time. It should be noted that verbal feedback from the students pertaining these treatments, the students enjoyed the activities. It is also recommended that this study be replicated using alternative versions of the Torrance Test for Creative Thinking. Additionally, it is recommended that alternate divergent teaching techniques be studied to determine their affects upon creative thinking, student satisfaction, and cognitive performance.

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APPENDIX A

HUMAN SUBJECTS INFORMED CONSENT FORM

Informed Consent

Project Title: Effects of Divergent Teaching Techniques Upon Creative Thinking Abilities of Collegiate Students in Agricultural Systems Management Courses

Please read this document carefully before you decide to participate in this study.

Utilizing divergent thinking tools in a mechanized agriculture classroom is a research study conducted by Matthew Norton under the direction of Dr. Matt Baker at Texas Tech University. The purpose of this study is to determine the effect of alternative teaching methods used to stimulate divergent thinking within a class of twenty-four students enrolled in AGSM 2302. This study will be conducted during the fall semester of 2005 at Texas Tech University.

Participants in this study will be asked to complete the Torrance Test for Creative Thinking (TTCT) four times during the semester. The TTCT is a timed, three-part test (30 minutes). The students will be asked to construct a drawing, create pictures from a series of incomplete drawings, and to complete a drawing from sets of parallel lines. There are no foreseeable risks or discomforts to the subject. The participants will not receive any benefits for participating in this study.

Participants' names will not be used in any publication resulting from this research. Participation in this study is voluntary and you may withdraw from the study at anytime with out penalty or loss of benefits to which the subject is otherwise entitled.

Dr. Matt Baker will answer any questions you have about the study. For questions about your rights as a subject or about injuries caused by this research, contact the Texas Tech University Institutional Review Board for the Protection of Human Subjects, Office of Research Services, Texas Tech University, Lubbock, Texas 79409. Or you can call (806)742-3884.

This consent form is not valid after September 30, 2006.

Whom to contact if you have questions about the study:

Matt Baker, Ph.D.
Departmental Chairperson
Department of Agricultural Education and Communication
P.O. Box 42131
Lubbock, Texas 79409-2131
Phone: (806) 742-2816
E-Mail: matt.baker@ttu.edu

Matthew Norton
Graduate Assistant
Department of Agricultural Education and Communication
P.O. Box 42131
Lubbock, Texas 79409-2131
E-Mail: matt.norton@ttu.edu

Agreement:

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: _____ Date: _____
Principal Investigator: _____ Date: _____

**Texas Tech University
Institutional Review Board for the Protection of Human Subjects
Office of Research Services
203 Holden Hall/MS 1035
742-3884**

Richard P. McGlynn, Chair
Protection of Human Subjects Committee

August 30, 2005

Dr. Mathew Baker
Ag Ed & Communications
Mail Stop: 2131
Regarding: 500116 Utilizing Divergent Thinking Tools in a Mechanized
Agriculture Classroom

Dr. Mathew Baker:

The Texas Tech University Protection of Human Subjects Committee approved your claim for an exemption for the proposal referenced above on August 30, 2005.

Exempt research is not subject to continuing review, but any modifications that (a) change the research in a substantial way, (b) might change the basis for exemption, or (c) might introduce any additional risk to subjects should be reported to the IRB, before they are implemented, in the form of a new claim for exemption or a proposal for expedited or full board review.

Extension of exempt status for exempt projects that have not changed is automatic. You should inform the Secretary of the Committee when the exempt research is completed (at least via response to yearly reminders) so that the file can be archived.

Best of luck on your project.

Richard P. McGlynn, Chair
Protection of Human Subjects Committee

APPENDIX B

SENSORY CONNECTION WORKSHEET

SENSORY CONNECTION Worksheet

Statement: _____

List of observations:

Stimulus #1: _____

Connections: _____

Stimulus #2: _____

Connections: _____

Stimulus #3: _____

Connections: _____

Stimulus #4: _____

Connections: _____

APPENDIX C
BRAINWRITING FORM

BRAIN WRITING WORKSHEET

Statement:

STUDENT	IDEA 1	IDEA 2	IDEA 3
STUDENT 1			
STUDENT 2			
STUDENT 3			
STUDENT 4			
STUDENT 5			
STUDENT 1			
STUDENT 2			
STUDENT 3			
STUDENT 4			
STUDENT 5			

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Agree (Permission is granted.)

Matthew Norton
Student Signature

4-18-2006
Date

Disagree (Permission is not granted.)

Student Signature

Date