EFFECTS OF INSTRUCTION IN CREATIVE PROBLEM SOLVING ON COGNITION, CREATIVITY, AND SATISFACTION AMONG NINTH GRADE STUDENTS IN AN INTRODUCTION TO WORLD AGRICULTURAL SCIENCE AND TECHNOLOGY COURSE

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ABSTRACT

The use of Creative Problem Solving (CPS) as an instructional strategy to increase the creativity levels of students across all levels of the curriculum is currently a popular topic of investigation. Curriculum content and the underlying objectives that are presented to students in public schools have been the subject of close scrutiny since school accountability became a hot topic during the 1980's. However, despite all the efforts to improve student productivity through a well defined curriculum, and possibly because of the increased emphasis on student accountability to reflect that student improvement, concern for the apparent declining creativity levels among students appears to be growing.

The purpose of this dissertation was to compare conventional instructional methodologies with those of creative problem solving. It was hypothesized that students' low, high, and total cognition levels, overall creativity levels, and satisfaction with instructional methodologies, improve as a result of instruction through creative problem solving strategies. By improving the levels of creativity within students, they will be better equipped to deal with the complex types of problems the future will present.

This study utilized an experimental, posttest only, control group design. Participants were ninth grade students (n=20) who were enrolled in an Introduction to World Agricultural and Science Technology I course. Posttests were administered to measure low, high, and total levels cognition at the conclusion of the course. For this measure of the dependent variable, a forty question (10 true/false, 25 multiple choice, and 5 short answer) test was administered. Pretests and posttests were administered to measure student creativity. A standardized Torrance Test of Creative Thinking (TTCT) was used as the measure of the dependent variable of creativity. Pretests, mid-tests, and posttests were used to measure student satisfaction. A satisfaction instrument developed by Brashears (2004) was used for the measurement of clarity, delivery, content, and total satisfaction as the dependent measure of satisfaction. These instruments were used to measure the five research hypotheses of the study.

Results of the study did not support the hypotheses that significant differences exist between creative problem solving and traditional instructional strategies, as they pertain to student cognition, creativity, and satisfaction. However, although not significant, possibly due to the small sample size, upon closer examination of group means, one can detect definite patterns of greater mean score gains among the CPS group over the traditional group in cognition, creativity, and satisfaction. Based on these findings, this researcher suggests that replications of this study be performed with larger sample sizes in different curriculum areas to further perpetuate the integration of creative problem solving strategies as an effective instructional strategy for all age groups and in all areas of the curriculum.

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CHAPTER I

INTRODUCTION

Introduction

Success in life is based on one’s ability to solve problems, great and small. According to Shinn (2004), the world is becoming increasingly complex. Due to population growth, technological advances, environmental degradation, migration, and immigration, today’s youth will need to be taught to deal with complex problems. This education must include relationship construction, reflection about experiences, articulation of information to others, and general engagement in a learning community. The creation of problem solving ability that exists in each of us will become a premium in the attainment of success (Treffinger, 1995).

One prime example of the ever increasing complexity of the environment is the information boom. The information age is not slowing down, with technological advances feeding the process at record rates. Since creativity is a useful and effective response to evolutionary change, it is more important now than ever before (Runco, 2004). According to Maraviglia and Kvashny (2006), it will be the learners who inherit the future during times of adverse change.

According to Meyer (1999), providing the American society with its educational needs has always been the initiative of agricultural education. Historically, learning in agricultural education has provided students with “hands-on” and “minds-on” intent, design, and delivery. The problem solving method has long been considered a significant part of the pedagogical foundation on which the philosophy of agricultural education is based. John Dewey was at the peak of his career when agricultural education emerged as a secondary school subject, thereby influencing many early teachings and readings of agricultural educators (Parr & Edwards, 2004).

As societal needs change with time, it is the obligation of all types of educational institutions to recognize those trends and adjust to the changing needs of the day. However, many educational programs do not have clearly defined purposes. There is no doubt that some educational work is being done by artistic teachers who lack a clear conception of goals, but do not have an intuitive sense of what is good teaching, what materials are significant, what topics justify addressing, and how to present material and deliver topics effectively with students. Nevertheless, if an educational program is to be planned and efforts are to be made for continual improvement, it becomes very necessary to develop and maintain a clear conception of the goals at which are being aimed. Therefore, these educational objectives become the criteria for selection of material, content outline, development of instructional procedures, and preparation of exams. Thus, all aspects of the educational program should become a means to accomplish basic educational purposes. In order to conduct systematic, intelligent educational programs, one must first be certain of educational objectives sought (Tyler, 1950).

Today, more than ever before, the need exists for educational institutions to prepare students to take cognitive knowledge to a higher level of understanding that will induce problem solving. John Dewey (1938) concluded that experience must be a significant element of quality education. He further maintained that all experiences created by traditional approaches to education are educational. However, quality of experience is differentiated by the design of the instruction. Equipping students with creative problem solving strategies and techniques should be a focal point for educational institutions at all levels.

As a result of recent research conducted by Maraviglia and Kvashny (2006), they reached the following conclusions about the levels of creativity being promoted in public schools today. They maintain that the important things we as individuals do depend on the habits of our minds. Furthermore, twelve years of required public schooling is remiss if the process of quality thinking (creative, critical, problem-solving, visionary, global, systemic, paradoxical, etc.) is not being deliberately taught. Finally, this deliberate teaching of processes for quality thinking should be a major ingredient for creating positive changes in the educational experience.

Despite the growing need for creativity in the classroom, increasing pressure to meet performance standards in the state and national accountability systems has compromised creativity. Although the accountability system focuses on core curriculum areas of math, science, social studies, and language arts; all areas of academic support have been mandated to compliment efforts in core curriculum areas, thus inhibiting creativity throughout the system (Osborn & McNess, 2002). Creativity requires a certain amount of freedom to create. Because of the rigidness of the current accountability system, rigidness is emphasized over approximation. However, narrowing a problem too early in the design process limits creativity (Marviglia & Kvashny, 2006). These externally mandated state and national standards necessitate that agricultural educators articulate their programs to meet both the academic and so-called “soft” skills crucial to student success in the workforce (Dailey, Conroy, & Shelley-Tolbert, 2001).

The current structure of education provides rewards for those who give the right answers, can remember facts, and keep quiet in class (Maraviglia & Kvashny, 2006). Educators must be taught, so they in turn can teach students, creative problem solving strategies necessary to successfully manage decision-making, communicating, and working within groups. However, this focal point of education must coincide with the simultaneous addressing of the academic demands of accountability.

Teachers, in general, support higher standards for both teaching and learning. However, many teachers are not adequately prepared to implement those standards (Garet, Porter, Desimone, Birman, & Yoon, 2001). According to Bush (1988), a central challenge for teachers is to understand and cultivate creativity by encouraging spontaneity, fluency, and freedom of expression in teaching. Although scientific concepts will remain of ultimate importance, educators must facilitate inferential thinking into the presentation of those concepts to create the type of deep understanding which is perquisite to creative thinking (McDaniel & Donnelly, 1996).

Children can be taught to think creatively (Torrance, 1992). Just as educational leaders in the field of agricultural education have been instrumental in experiential learning strategies promoted by John Dewey for over a century, creativity must become the focal point to prepare students for the challenges of the future. As interest levels in learning rise among students, through the philosophy of creativity, solutions to the difficult types of problems facing our nation's leaders will evolve simultaneously.

Statement of the Problem

It has already been established that creativity will be required to solve the complex problems that our future generations will face (Treffinger, 1995). Assuming that most people possess at least some creative potential, the question becomes how to evoke, access, stimulate, train or develop that creative potential (Feldhusen & Goh, 1995). According to Muhammad (2002), creativity can be defined by looking at four important aspects of it, which include creative personality traits, creative products, the creative process, or supporting environment. He further states that creative people tend to be above average in spontaneity, willing to take risks, playful, having a sense of humor, and open to new ideas and experiences.

However, in many educational settings, not only is creativity not encouraged, it is actually suppressed. According to Torrance (1962), evidence from both cross-sectional and longitudinal studies indicates that the development of creative thinking abilities is sacrificed by children of almost all ages. Of significance is the level of decline between the beginning of junior high and the end of high school. While some individuals recover their creativity, many lose their creative abilities permanently.

This researcher would suggest that just as physical fitness is beneficial to all, regardless of athletic prowess, creativity is beneficial to all who will be faced with complex future problems, regardless of the level of creative tendency that exists within an individual. While it is beneficial to know much about creativity traits in order to set benchmarks for levels of creative attainment, the real focus for educators should be increasing the creativity levels of all students, regardless of ability level. Torrance (1992) would maintain that creativity can and should be taught to all.

Establishing and implementing the best strategies for improving the creativity of students in public schools must become a priority for educators. These strategies must be implemented in such a way that compliments, rather than conflicts with, mastery of objectives established by state and national laws of accountability for public schools. These strategies should be implemented across the curriculum, regardless of grade level or subject matter. However, thus far, little empirical research has been located that would define the most effective practices, or the best methods for implementation. Additional research is needed to identify effective methods for creative problem solving practices, in which teachers can be trained, thereby enabling them to pass that information on to their students in classroom settings.

Purpose of the Study

According to Torrance (1962), of the different levels of education, the high school years have been the most neglected in creativity research. While a vast amount of information about "creative imagination" has been compiled on preschool, elementary, college and professional individuals, creative growth has rarely been recognized as an objective of secondary education. The purpose of this study was to determine whether the effects of implementing Creative Problem Solving (CPS) strategies in an Introduction to World Agricultural Science and Technology I course presented to a treatment group of ninth grade students would have a significant impact over the implementation of more traditional teaching strategies to a control group. The first area of measurement included academic achievement, as determined through a posttest only design of low-level, high-level, and total cognitive measurements. The second area of measurement included the measurement of increases in creative thinking ability, as determined through gain from pretest to posttest in scores on a standardized creativity test, the Torrance Test of Creative Thinking (TTCT). The third area of measurement included student satisfaction in the areas of clarity, delivery, and content. A covariate of standardized Texas Assessment of Knowledge and Skills (TAKS) scores in language arts, math, science, and social studies was used as a leveling factor for student cognition in the treatment and control groups. Also, a covariate of pretest scores in creativity was used as a leveling factor for student creativity in the treatment and control groups.

Specifically, problem solving and open-endedness were the two creativity strategies under investigation. The quality of investigative work done by students, when based on their own open-endedness, is of a significantly higher standard than when established by the teacher. These types of investigations encourage and develop students' talents in the areas of originality, creativity, and independence (Muhammad, 2002). In addition, divergent and convergent thinking exercises were investigated. This comparison was evaluated to determine the best fit for problem solving strategies as they relate to broad personality types.

Research Hypothesis

The following research hypotheses were tested, assuming that the covariates of standardized TAKS testing and pretest scores in creativity met with the predicted assumptions.

1. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the low-level cognition portion of the posttest than students in the traditionally instructed group.
2. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the high-level portion of the cognition posttest than students in the traditionally instructed group.
3. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the total cognition portion of the cognitive posttest than students in the traditionally instructed group.

4. With pretest scores on the creative thinking pretest as a covariate, students in the CPS group will score statistically higher on the creative thinking posttest than students in the traditionally instructed group.
5. Students in the CPS group will score statistically higher on the course satisfaction posttest than students in the traditionally instructed group.

Theoretical/Conceptual Framework

A review of CPS theories and research conducted by some of the well known experts in the field served as a framework for developing an effective creativity training program for the purposes of this study. Although it was the intent of this study to design a program that developed and measured CPS ability among all students, regardless of background, ability, or personality type, it was important to investigate some of the important previous findings in CPS that would enable this researcher to identify those characteristics within subjects of this study. Reviewing creativity theories and researching issues of assessing and fostering creativity provided useful tools for conducting an evaluation of the effectiveness of creativity training programs (Treffinger, Isaksen, & Firestien, 1983).

As evidenced by vast amounts of prior research in the area of CPS, there has always been a need for, and interest in, the topic. However, with the increasing complexity of the world's issues and affairs, creative thinking has become one of the most important skills children can acquire and develop during their early years of development. Creative thinking can be incorporated into a number of learning contexts to enrich the acquisition of knowledge and skills. Without the ability to think creatively, especially when it comes to problem solving, children will be unimaginative and lacking in the transferable skills necessary to engage in personal and professional life (Wheeler, Waite, & Bromfield, 2002).

A multitude of definitions for creativity are available for consideration. According to Torrance (1974), creativity is a process of developing sensitivity to the many problems, knowledge gaps, missing elements, disharmonies of life, and so on; identifying the difficulties; searching for solutions; making guesses of formulating hypotheses about the deficiencies; testing and retesting these hypotheses, and possibly modifying and retesting them; and finally, communicating the results. One reason that creativity is so multifaceted is because there are so many contributing factors to its development and expression. These factors include personal factors (cognitive, motivational, and attitudinal), social factors, and environmental factors (Basadur & Hausdorf, 1996). As this researcher has discovered, narrowing the topic of CPS into a definable, usable, and measurable instrument can be a daunting challenge.

The *Four-P* method of studying creativity is one of many popular patterns. This four approach method includes consideration of (1) the creative person, (2) the creative process, (3) the created product, and (4) press - the creative environment (Huang, 2005). For the purpose of developing the creativity training program, along with its evaluation, to be used in the study, these four domains of creativity development were investigated.

This completely packaged training program creates avenues for students to increase their creative skills, as evidenced by posttest results. Therefore, the approach for the design of the training program for this study was closely associated with instructional materials and techniques that foster creativity specific to problem solving.

During the developmental phase of this model for creativity, three distinct models of activity were converged upon. These models include problem solving, creative cognition, and social interaction (Wheeler et al., 2002). According to Scott, Leritz, & Mumford (2004), although creativity training programs differ with respect to domain specificity, all contain certain aspects of creativity, whether the focus is on divergent thinking, problem solving, or meta-analysis. Divergent thinking activities are designed to encourage students to generate multiple alternative solutions to problems, as opposed to only one correct solution. The six stages of problem solving, which include mess-finding, data-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding, that lead to broader operations of problem understanding, idea generation, and action planning, were given consideration in the program as well. Finally, meta-analyses entails a range of activities and techniques that require students to sharpen convergent skills in the integration of problem solving with problem thinking in this program of study. These classroom activities and teaching strategies, designed to increase student creativity as it relates to problem solving, were the focal point during the developmental phase of the study.

According to Huang (2005), for a training program to be considered a whole package, it must include the creation of a setting for people to increase their creative skills and yield creative products. In addition, a creative training program should be stable from the standpoint that it frees or releases potential in individuals, rather than focusing on the creation of new potential. Huang further alludes to Feldhusen's Creativity Model in reference to a product that includes meta-cognitive skills as an aspect of creativity-relevant skills. This model considers (1) meta-cognitive processing of new information and use of existing knowledge bases, (2) knowledge bases and mastery skills in a particular domain, and (3) personality variables such as attitude, disposition, and motivation. These personality variables that predispose individuals to search for alternatives, new configurations, or uniquely appropriate solutions might be the result of the prior influence of parents, teachers, peers, or personal experiences, or any of these combinations. In consideration of the creative impact of any product, one must remember that there may be as much creativity in making an idea real as there is in the initial generation of the idea (Guilford, 1950).

The initial consideration of the Four-P approach to CPS is that of the person who is creative. According to Alexander, Parsons, and Nash (1996), the characteristics of creative people can be classified into one of four categories. These categories include (1) biological components of genetics, neurology, anatomy, and physiology; (2) psychological components of personality, motivation, and emotional well-being; (3) sociological components of society, culture, and economy; and (4) knowledge components of conceptual and general strategic knowledge. As the creativity of a person is considered, this researcher considered creativity styles, ways in which individuals actually create, rather than levels of creativity (Houtz et al., 2003). Cognitive psychologists recognize that individuals react with their environment in demonstrably different ways in regard to how information is used to solve problems. In addition, examination of divergent versus convergent styles should be given consideration. Moreno and Hogan (1976) examined race and social class differences among individuals concerning creative potential. They contend that the need to conform, among black students and low socioeconomic individuals, inhibits the creativity of these individuals. However, although variables of race and social standing have been consistently associated with varying levels of creativity, they are less clearly associated with the potential for change. Therefore, the focus of training programs must remain on enhancement of creative problem solving ability, rather than racial and social barriers that may exist. Of the Four-P's approach to creativity, consideration of the person should be at a premium, from a priority perspective.

While sometimes difficult to distinguish between the categories of approach to the Four-P method, the focus of the majority of the literature seems to be in the area of process. Most would agree that the creative process is continuous. An integral part of all human intellectual performance, it increases through conscious intent, and it is a high-order intellectual process. Wheeler et al. (2002) refer to the Waller Model for Creative Process, which consists of four key stages. During the first stage, preparation, an individual logically and systematically examines an identified problem. In the next stage of incubation, as the individual lays the problem aside, he or she subconsciously dwells on it until a so-called “Eureka” moment occurs. As sudden insight emerges into one’s own consciousness, the third stage of illumination takes over. Finally, verification of the solution results from application of the solution to the original problem for affirmation. Another model supports a previously alluded to stance that any CPS process is not complete until both divergent and convergent thinking have occurred. From a model developed by Basadur in 1982, Basadur and Hausdorf (1996) refer to the three phases of creative problem solving that include problem-finding, problem-solving, and solution implementation. Interestingly, a two step process known as ideation-evaluation occurs within each of these phases. Ideation involves the generation of various options, points of view, and exceptions, minus critical judgment or analysis, which encompasses the divergent process. During the evaluation part of this equation, these freely developed thoughts are screened and selected, based on merit, through the convergent process. Thus, participants are trained to acquire skills in various techniques of both a divergent and convergent nature through practice, rather than mere abstract discussion. Although the literature contains many processes from which to select, these are two that seem appropriate for this proposed study.

According to Treffinger (1995), creative potential exists within all individuals. Furthermore, creativity is usually manifested according to the interests, preferences, and styles of individuals. Through personal assessment and deliberate intervention, in the form of training or instruction, individuals can make better use of their creative styles, enhance the level of their creative accomplishment, and more fully realize their creative potential. Numerous frameworks that depict CPS models have been developed over the years. The elements of CPS, as a system, enable individuals to use information about tasks, important needs and goals, and important inputs, to carry out the process for decisions that will lead to meaningful outcomes. As a result of recent research conducted by Maraviglia and Kvashny (2006), they concluded that the CPS model is the most significant and powerful framework for the enhancement of creative thinking. According to Isaksen and Treffinger (2004), Figure 1.1 depicts the most current graphic representation of the CPS system, CPS Version 6.1. The impacts of the variables introduced in this theoretical/conceptual framework will be discussed in greater detail during the Literature Review in Chapter II.

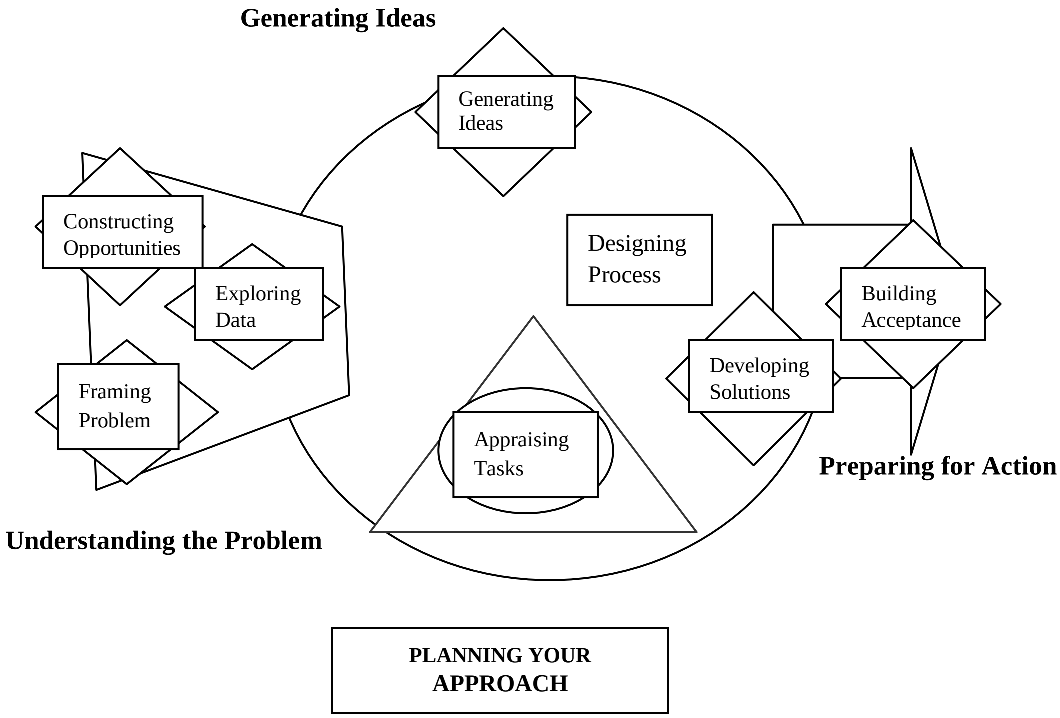


Figure 1.1. Elements of a Graphic Representation of CPS as a System * Adapted from *CPS Version 6.1*, (Isaksen, Dorval, and Treffinger, 2000)

Assumptions

This study assumed the following. It was first assumed that all students who participated in the study would be physically and mentally able to perform the activities and requirements within this course of study. The second assumption was that all participants were naïve to the topic of creative thinking as it relates to problem solving. It was also assumed that all participants were "typical" high school ninth grade students who were enrolled in an Introduction to World Agricultural Science and Technology I course as a local requirement of all ninth grade students in Roscoe High School. Fourth, it was assumed that all learners were "typical" learners that were not cognitively inhibited or categorized by an adverse learning disability. Fifth, it was assumed that students who were enrolled in the two classes would not discuss the strategies, experiences, and activities, thus causing confounding of the treatment. Although the teacher attempted to discourage subject interaction between the two groups, due to the small size of the school district, it is likely that interaction occurred. Looking back on the study, this end would have been better served if the teacher prompts posted around the room would have been removed daily, so the control group was never exposed to them.

Definition of Terms

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

- Acceptance-Finding – The second stage of the major CPS component of "planning for action" in which a search for several potential sources of assistance and resistance for possible solutions occurs. Assisters represent people, places, materials, and times that will support the plan and that will contribute to its successful implementation. Resisters represent potential obstacles such as people, places, materials, and things that might resist, go wrong, or be missing at a critical time. Acceptance-Finding helps the problem solver to identify ways to make the best possible use of assisters and to avoid, or overcome, possible sources of resistance. Acceptance-Finding also involves formulating an Action Plan, describing the specific steps that will be taken in order to implement a proposed solution (Treffinger, 1995).
- ALU – A technique for applying the principle of *affirmative judgment*, in which an option is analyzed carefully by considering its Advantages (A), Limitations

(L), and Unique Qualities (U). The limitations are phrased in the form of a question beginning with "How to…" or "How might…" to invite *ideas* for overcoming the *limitations* (Isaksen et al., 1994).

- Brainstorming – A group technique for generating many options based on the *divergent thinking* guidelines of *deferring judgment*, striving for quantity, freewheeling, and building on other ideas (Isaksen et al., 1994).
- Brainwriting – An example of the *brainstorming modification* technique in which group members write down their own ideas first and then share them with others (Isaksen et al., 1994).
- Convergent thinking – This process involves thinking toward a right answer or toward a relatively unique determined answer (Guilford, 1959).
- Course satisfaction – A consequence of the expectations and experiences of the subject and/or course (Markum & Hagan, 2004). Students in both the treatment and control groups will complete a measure of satisfaction through a researcher developed satisfaction instrument. This instrument is designed to measure satisfaction of clarity, delivery, and content of the unit of instruction.
- Creative performance – The result of simultaneous interactions among several important components of creativity (Maraviglia & Kvashny, 2006).
- Creative person – Refers to the personality, intellect, traits, habits, attitudes, etc. (Maraviglia & Kvashney, 2006).

- Creative press – Identifies the relationship between humans and the environment (Maraviglia & Kvashny, 2006).
- Creative problem solving (CPS) – This is a framework which can be used by individuals or groups to formulate problems, opportunities, or challenges; generate and analyze many varied, and novel options; and plan for effective implementation of new solutions or courses of action (Treffinger, 1995).
- Creative process – Refers to motivation, perception, learning, thinking, and communicating (Maraviglia & Kvashny, 2006).
- Creative products – Results from a developed idea becoming embodied in a tangible form known as a product (Maraviglia & Kvashny, 2006).
- Creative thinking ability – This is an innate ability that some individuals possess in greater abundance than others (Rose & Lin, 1984).
- Creative thinking skills – These are specific thinking strategies that can be developed through various teaching methods (Rose & Lin, 1984).
- Creativity – Creativity, or creative behavior, is that which demonstrates both uniqueness and relevance. It is manifested by such abilities as fluency, originality, abstractness of titles, elaboration, and resistance to premature closure (Torrance, 1968). Students in both the treatment and control groups were administered a pretest and posttest for creativity using the Torrance Test of Creative Thinking (TTCT) Figural Booklet A to measure creativity.

- Data-Finding – The second stage of the major CPS component of "understanding the problem" in which many important facts, opinions, concerns, paradoxes, and circumstances must be considered. This information is brought out by posing such question as "Who? What? When? Where? How? And Why?" These questions bring out key data and help the problem solver(s) focus more clearly on the most challenging aspects and concerns of the situation. Converging in Data-Finding involves identifying or constructing one or more clusters of significant data, which will point to the direction that subsequent problem development or solution efforts might take most fruitfully (Treffinger, 1995).
- Deferred judgment – A basic principle of CPS, particularly important in the creative or divergent phases of each stage, emphasizing the need to refrain from evaluation (criticism or praise) of ideas during the process of generating many options (Isaksen et al., 1994).
- Divergent thinking – The part of a process in which considerable searching is done and a number of answers will do… It is apparent that the traits of fluency, flexibility, and originality come from one general category of divergent thinking (Guilford, 1959).
- Experimental method – Instructional strategies used by the teacher to teach the treatment group. These strategies include techniques that challenge students' high-level cognition and include concepts and tactics associated with divergence and convergence. These concepts and tactics will be applied to the various stages

of the CPS process that include *mess-finding, data-finding, problem-finding, idea-finding, solution-finding,* and *acceptance-finding.*

- Flexibility – This is a creative ability in which a shift in thinking from one category to another occurs, with the number of category shifts determining the flexibility level (Torrance, 1968).
- Fluency – This is a creative ability having to do with the number of responses given or "the ability to produce ideas to fulfill certain requirements in a limited time…sheer quantity is the important consideration" (Guilford, 1959).
- Freewheel – To encourage all ideas, including those that might appear to be wild or silly possibilities. One of the four ground rules for idea generation (Isaksen et al., 1994).
- Generating ideas – The second of the three major CPS components in which an open-ended, invitational statement of a problem has been formulated, or already exists, the problem solvers' efforts may be focused on the need to generate options. This component involves one specific CPS stage, called Idea-Finding (Treffinger, 1995).
- High-level cognitive test scores – Test scores result from test questions which measure higher levels of cognition that address creativity and evaluation (Newcomb & Trefz, 1987). Levels of cognition are categorized from the simplest to the most complex to process based on Bloom's (1956) original work. This study is designed to measure the effects of multi-channel cues on high-level

cognition based on questions on the posttest. This material is implied, requiring students to connect factual information, rather than being taught directly within the unit (Brashears, 2004).

- Idea-Finding – This is the stage of the major CPS component of "generating ideas" in which the divergent phase involves the person or group in producing many options (fluent thinking), a variety of possible options (flexible thinking), novel or unusual options (original thinking), or a number of detailed or refined options (elaborative thinking). The converging phase of Idea-Finding provides opportunities to examine, review, cluster, or select promising options.
- Innovation – The result of creativity which emphasizes the product or outcome (Isaksen et al., 1994).
- Level of creativity – A person's capacity or ability to produce many, varied, or unusual ideas that are useful, or to elaborate on possibilities already generated; responds to the question, "How creative are you?" contrasted with Style of Creativity or Creativity Style (Isaksen et al., 1994).
- Low-level cognitive test scores – Test scores that result from test questions which measure lower levels of cognition (Newcomb & Trefz, 1987). These tests are designed to measure knowledge on Newcomb and Trefz's remembering and processing levels in the classification system. Items are taught directly within the unit of instruction, regardless of which treatment the student receives. They are measured by the questions on the posttest.

- Mess-Finding – This is the first stage of the major CPS component of "understanding the problem" in which ambiguous challenges and concerns often begin as a "mess." A mess is a broad statement of a goal or direction for problem solving. Usually, a mess has three general characteristics. It is broad, brief, and beneficial. The mess describes generally the basic area of need or challenge on which the problem solvers' efforts will be focused, remaining broad enough to allow many perspectives to emerge as one looks more closely at the situation (Treffinger, 1995).
- Originality – This refers to the production of "something no one else would think about" (Torrance, 1962).
- Planning for Action – The third of the three major CPS components in which a person or group recognizes a number of interesting or promising options. They may need assistance in strengthening those options, refining or developing them, making effective choices, and preparing for successful implementation. Novel or intriguing options are not necessarily useful or workable without extended effort and productive thinking. Thus, the focus of the Planning for Action component is on preparing and developing options for successful implementation. Two specific stages that are involved include Solution-Finding and Acceptance-Finding.
- Problem-Finding – The third stage of the major CPS component in "Understanding the Problem" in which the person or group working on the task will seek a specific or targeted question on which to focus their subsequent

efforts. Diverging in this stage involves generating many possible problem statements, phrased in a positive way by using an invitational stem such as "In what ways might…" or "How might…" effectively worded problem statements invite an open or wide-ranging search for many varied and novel options. They should be concise and free from limiting criteria (Treffinger, 1995).

- Solution-Finding – The first stage of the major CPS component of "Planning for Action" in which close examination of promising options to determine what steps will need to be taken occurs. If there are a few promising options, all of which might be implemented, the principal focus will be on refining or developing options, not all of which can be implemented, the task may focus more on ranking options or on setting effective priorities. When many new and promising options exist, the task may be to condense or compress the choices to make them more manageable, or to evaluate a number of options very systematically using explicit criteria (Treffinger, 1995).
- Toolbox – A collection of techniques used for divergent and convergent thinking in the CPS process (Isaksen et al., 1994).
- Traditional method – Instructional strategies used by the teacher to teach the control group. The strategies are limited to lecture, discussion, low-level cognition question/answer, multimedia presentation of material, laboratory assignments, guest speakers and field trips.

- Understanding the Problem – The first of three major CPS components in which the individual or group confronts an ambiguous situation that needs clarity or focus of direction. The problem solver may recognize this initially and so might begin with one of more of the three stages in this component. It is also possible that this component might be undertaken after early efforts to generate options or to implement possible solutions have led to recognition that the problem needs greater clarity, definition, or redefinition. This component includes three specific stages of *Mess-Finding*, *Data-Finding*, and *Problem-Finding* (Treffinger, 1995).

Limitations

This study possessed the following limitations that restricted the amount of inference that was available from the results to findings limited to ninth grade students. First of all, the sample for this study was limited geographically to Roscoe, Texas, a small rural region of West Texas. In addition, although the assignment of treatment and control groups was random, the population consisted of only ninth grade agricultural science students from rural West Texas. However, the sample of that population consisted of all ninth grade students at Roscoe High School that were enrolled in this agricultural science course. Next, sample size was a limiting factor as well. Of the 24 students in the ninth grade population, only 20 were used in the sample, since four students took the State Developed Alternative Assessment (SDAA) for special education students rather than the TAKS test, which was used as a covariate. There were 10 students randomly assigned to the treatment group and the other 10 assigned to the control group.

Beyond geographic and demographic limitations, this study had additional limitations. According to Huang (2005), measuring creativity can be even more difficult than measuring intelligence. This issue could be complicated even further in an attempt to assess the effectiveness of a creativity training program. Huang alludes to Alexander, Parsons, and Nash's Multi-Dimensional Interactive Process Model of Human Creativity as she suggests that a creativity training program might only access the "general strategic and conceptual knowledge" aspects of creativity. For creativity to be accurately assessed, consideration must also be given to "psychological" and "sociological" aspects of creativity.

Finally, the control group and the treatment group were both taught by the same teacher. Therefore, it was difficult to completely remove traditional teaching strategies from the instruction delivered to the treatment group. Additionally, it was equally difficult to completely remove the CPS teaching strategies from the instruction delivered to the control group, thereby threatening the validity of the results of the experiment.

Delimitations

This study was delimited to students enrolled in the ninth grade at the Roscoe Independent School District (ISD). The sample included the entire available population of ninth grade students at Roscoe High School who had TAKS scores that could be used as a covariate (n = 20). In addition, students were randomly assigned to either the treatment or control group through computerized random assignment. Selection of the group that served as the treatment group or control group was done on an equally random basis. Furthermore, the same teacher taught the exact same course objectives at precisely the same timeframe during the course of instruction for both the treatment and control groups. Finally, the study was conducted during the course of the 2006 Fall Semester, over the course of a 73 day period which concluded on Friday, December 1. Therefore, results of the study were collected over an extended period of time.

Significance of the Study

This study proved beneficial for a number of reasons. In a scholarly attempt to examine and report the effects of creative thinking instructional strategies on problem solving abilities of students, this study contributed to the advancement of creative thinking as it relates to problem solving. Having already established the fact that problems of the future will grow increasingly complex (Shinn, 2004), any attempt to increase the ability of individuals to solve those types of problems contains merit.

Much work has already been completed in the field of creative thinking and problem solving (Treffinger, 1995). However, teachers and students alike continue to struggle with creativity, due to classrooms characterized by an outdated lack of flexibility and innovation (Osborn & McNess, 2002). According to Treffinger (1995), creative potential exists within all individuals. Public education currently consists of a captive audience. As information from this study revealed the effects of creative instructional strategies on students' ability to solve complex problems related to agricultural science, these positive effects will be transferred beyond the realm of agricultural science, and into other age groups and areas of the curriculum. This particular investigation could break new ground for the manner in which students investigate complex problems, as a result of creative strategies implemented by innovative teachers. As schools attempt to better arm the students we influence with skills that will allow them future successes, the purpose of education is served.

Summary

The equipping of students with CPS strategies, as a resource for addressing the complex problems and issues of the future, is a necessity of effective education today. As a result of teaching students to use these strategies, educators will be preparing students to compete with other students around the world in higher education, as well as in the job market, that will lead to better jobs and a better life for themselves and those around them. The mission of schools today is to equip students with the ability to think creatively, critically, and reasonably as they are called upon to respond to problems or situations, for which the solutions are vague and often incomprehensible. The ability to effectively use research-based and time proven creative problem solving strategies to accomplish these ends will be a major advancement toward the successful completion of this most important of all missions.

The purpose of this research was to examine the effects of instruction of students in CPS strategies within the context of Agricultural Education. This was accomplished by providing a treatment group with instruction of the Texas Essential Knowledge and Skills (TEKS) objectives for Introduction to World Agricultural Science and Technology I by means of the CPS technique. This group was compared to a control group that was instructed in those same TEKS objectives by more traditional methods of instruction that included lecture, teacher-centered discussion, question/answer, multi-media, etc. This posttest only design sought to determine the effectiveness of the treatment versus control levels of low-level, high-level, and total cognition. In addition, creativity was also investigated through a pretest/posttest comparison of the treatment and control groups in creativity as measured by the standardized TTCT. Finally, course satisfaction was also measured by a pre/mid/post course satisfaction instrument used to measure student satisfaction levels of clarity, delivery, and content.

The outcome of this research contains important implications, not only for those in the field of agriculture, but for all those in education. If students, regardless of existing levels of creativity, can increase levels of creative thinking as it applies to problem solving, through instruction using the CPS process, students' chances for successful happy lives increase significantly as well. The ramifications of increased levels of creativity within individuals will result not only in improved quality of life for those individuals, but for the population as a whole, as they reap the benefits of solutions to complex problems.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

Introduction

This review of literature was developed in an effort to identify bodies of research and knowledge relevant to this study. In addition, appropriate themes developed through summarization were significant to this study. This review emphasized the theoretical foundations for this investigation, as well as visual variables that served as the focal reference points throughout the study. Important aspects of the theoretical framework that served as the foundation of the research were addressed within the main sections of this literature review. Through this review of research into the area of creativity, and the theories resulting thereof, a framework for the design, development, implementation, and evaluation of an effective classroom creativity improvement program have been established (Treffinger et al., 1983).

Fostering Creativity

According to John Dewey, the whole process of education should be a process of teaching students to learn to think through the solution of real problems (Renzulli, 1982). According to constructivist philosophies of Jean Piaget, John Dewey, and Lev Vygotsky, the context of student learning should be coupled with multiple opportunities to make meaning (construct) of learning as it begins, progresses, and escalates (Parr & Edwards, 2004). More than ever before, creative thinking is needed to enable Americans to achieve our potential for the problems that lie ahead in the future (Parnes & Harding, 1962). There exists a great need for able, ready, and willing problem solvers to face the world of complexity in which we now live. Parnes and Harding (1962) further maintain that schools, whether high school, college, graduate, or professional school, do not give creativity the attention it deserves. The primary focus of education should be to train the mind. Some would maintain that only some aspects of creativity can be influenced by training (Alexander et al., 1996). However, other research indicates that creativity is teachable and can be improved upon, regardless of the current level of a person's creative skills (Fieldhusen & Clinkenbeard, 1986). According to Scott et al. (2004), to maximize its effect, training in creativity must be robust enough to allow for its generalization across many aspects of creativity, rather than on only a few specifics. As a result of these findings, when designing models for creative problem solving instructional strategies for high school age students, broad generalizations should be given significant consideration.

In a review of 142 studies on creativity training conducted by Torrance in 1972, 72% of those studies were deemed successful. In his summary of successful interpretations of those reviews, he concluded that some approaches were in fact more successful than others. The most successful approaches were those that included functioning in both cognitive and emotional realms, the provision of adequate structure and motivation, and frequent opportunities for students to experience involvement, practice, and interaction with teachers and other children.

In another comprehensive meta-analysis of 70 prior studies, conducted by Scott et al. (2004), these researchers concluded that well designed creativity training programs typically induce gains in performance. The goal of this research effort was to identify key characteristics of educational content and delivery methods that had a positive impact on developmental efforts. Results of this research indicated that more successful programs focus on development of cognitive skills and the exercise of realistic applications, supporting the theory of experiential learning (Dewey, 1938). Moreover, the effectiveness of this training was not limited by age, academic or occupational setting, or levels of giftedness. The findings of this meta-analysis lend further support to the concept that creativity can be increased among individuals through a well designed creativity training program, regardless of current levels of creativity within individuals.

A final meta-analysis conducted by Rose and Lin (1984) was investigated to determine the positive effects of a creativity training program. The design of this program divided creativity into six categories of (1) creative problem solving, (2) productive thinking, (3) the Purdue Creative Thinking Program, (4) other creative thinking programs, (5) school programs, and (6) special techniques. Based on the categories of creativity training design, researchers concluded that CPS resulted in more improvement in creativity levels of subjects who were studied than other categories of training. As a result of these and other findings, this researcher will focus efforts on the CPS Version 6.1 as the exemplary model (Isaksen & Treffinger, 2004). An in-depth examination of this model will be conducted as part of this review of the literature later in this chapter.

According to Marakus and Elam (1997), creativity is one of the most vague, ambiguous, and confusing terms in education and psychology. Research supports the idea that while levels of creativity differ within individuals, it is a teachable concept that can increase the levels of creativity in each of us (Torrance, 1972). As Parnes and Harding (1962) concluded over forty years ago, creativity will be a necessity when dealing with the types of problems that the future promises. Events of the past forty years, in terms of population explosion, declining natural resources, urban sprawl, migration, and immigration would not only support, but even accentuate, those conclusions (Shinn, 2004). Therefore, the focus of the remainder of this literature review will be on the analysis of a most effective approach to the design, development, implementation, and evaluation of an effective creativity training program that compliments existing curriculum for high school students (Treffinger et al., 1983).

The Four-P's Approach

The value in creativity within individuals is undeniable. According to Wheeler et al. (2002), creative thinking is one of the most important and useful skills children acquire during their early years of mental development. Creative ideas that result in solutions can enhance almost any human experience (Scope, 1998). Researchers have taken many approaches toward the study of creativity. One of the more common and popular methods has been the Four-P's approach. The Four-P's method categorizes the processes of creativity development into four categories of (1) the creative person, (2) the creative process, (3) the created product, and (4) press – a term from the field of education that refers to a relationship between human beings and their developmental environment (Cougar, Higgins, & McIntyre, 1993). Person refers to the personality, intellect, traits, habits, attitudes, etc. Process refers to motivation, perception, learning, thinking, and communicating. Product results from the developed idea as it develops into a tangible form. Press identifies the relationship between humans and their environment (Rhodes, 1961). Much of the research on creativity, conducted by a multitude of researchers, falls into one of these four categories.

According to Isaksen et al. (1994), the most comprehensive picture of the creative person takes into consideration not only characteristics or traits of the person, but also the kind of environment or context in which the person is working, the kinds of mental operations being used, as well as the nature of the desired outcomes or products. The Four-P's model provides a structure for understanding creativity and its application. The simplicity of this model allows for individual measurement and assessment of each of the four components, as well as for evaluation of the interaction of the components. This model can be applied to a specific function or to a program as a whole, thus allowing for a well defined program design, implementation, and evaluation (Couger et al., 1993). Therefore, as literature is examined for this study, that research will be reviewed as it relates to the categories of the Four-P's approach.

The First P: The Creative Person

In comparison with other aspects of creativity, not much has been written about the creative person. Even less has been written with accuracy. Ancient views associated creativity in a person with genius, and that creative people were born rather than made (Marakus & Elam, 1997). According to Couger et al. (1993), numerous fallacies exist regarding the creativity that lies within people. Due to the fact that much of the early publicized research was focused on the creativity within geniuses and highly accomplished professionals, most people do not view themselves as creative. In fact, most people believe that creativity is an inherited trait, with which only a few people are born. In A Source Book for Creative Thinking written in 1962, Parnes and Harding illustrate the views of Ross Mooney in this regard. According to Mooney, successful businesses should define the jobs to be filled, find persons to successfully fill those jobs by discovering extrinsic signs which mark such persons, and then look into the labor pool for individuals who possess those markings. In order to select talent, one must develop a clear pattern of discernable signs, which will empirically separate one person from another in the direction of creative talent, to continually refine this pattern for selection of persons from the labor pool. However, research indicates that creativity is present within everyone and is normally distributed (Rogers, 1970).

Many researchers believe there is consensus on creativity as a person’s capacity to produce ideas, inventions, artistic objects, insights, restructurings, and products which are evaluated by experts as being of high scientific, aesthetic, social, or technological value

(Feldhusen & Goh, 1995). J. P. Guilford is credited for much work in the study of the creative person. In a 1959 article in *American Psychologist*, he stated that psychologists have seriously neglected the importance of personality in discussions about creativity. While much research at that time attempted to associate creativity with high intelligence, or IQ, he maintained that creativity represents patterns in primary abilities. Those patterns often may be found in people who are not associated with high intelligence. Productivity depends upon primary traits that include interests, attitudes, and temperamental variables. Factors including sensitivity to problems, ideational fluency, flexibility of set, ideational novelty, synthesizing ability, analyzing ability, reorganizing or redefining ability, span of ideational structure, and evaluating ability should be primary considerations when evaluating creativity (Guilford, 1950).

A major problem with creativity in people is that most people utilize less and less of their natural creative abilities as they grow older. According to Runco (2004), one problem is that individuals and organizations are more likely to invest in traditional educational skills, such as literacy, than in creative skills. In nationwide studies of American school children, scores on creativity tests reveal a decline in creativity as students move through the school system, with a precipitous "4th grade slump" (Torrance, 1972). However, teachers can stimulate creativity in students by reinforcing the fact that all individuals are innately creative. Through encouragement of the use of proven techniques, teachers can help students restore the natural curiosity and originality they exhibited as preschoolers (Couger et al., 1993).

Encouragement to increase motivation for creativity should include both intrinsic and extrinsic motivation. Intrinsic motivation stems from the satisfaction of generating a creative idea and putting it into effect. Teachers can also provide extrinsic motivation through a reward system or other incentives. Teachers can also facilitate a creative climate in which students more easily obtain intrinsic satisfaction from the accomplishment of a creative task or project (Amabile, 1983).

According to Moreno and Hogan (1976), the influence of race and social-class should also receive consideration when examining the creative person. Some researchers question the differential creative problem solving performance of children from different social class levels and racial backgrounds. In a study conducted by Kohn (1969), a summary of three comparative studies concluded that white children were more creative than black children, and that high social class children were more creative than the lower social class children. However, little research has investigated the influence that race and social class level have on the training aspect of creative thinking and problem solving abilities. It must be reiterated at this point that emphasis in schools must be placed on increasing levels of creativity among all students, regardless of current ability level (Treffinger, 1995).

According to Brophy (1998), a creative person is an individual with a set of loosely coupled cognitive and affective subsystems freely evolving as they influence each other within intrapersonal and interpersonal "networks of enterprise". In addition, different kinds of problem solvers are best suited to work different problems. In the CPS model that will be examined in detail later in this review of the literature, emphasis is placed on the theory that (1) creative potential exists among all people, (2) creativity can be expressed among all people in an extremely broad array of areas or subjects, (3) creativity is usually approached or manifested according to the interests, preferences, or styles of individuals, (4) people can function creatively, while being productive to different levels, or degrees of accomplishment or significance, and (5) through personal assessment and deliberate intervention, in the form of training or instruction, individuals can make better use of creative styles, thus enhancing levels of creative accomplishment and full creative potential (Treffinger, 1995). It is from this vein that the creative person will be examined during the course of this research project. The focal point will be to determine an effective approach to work toward increasing creativity levels among students, regardless of gender, race, or socioeconomic background.

The Second P: The Creative Process

Past research on CPS has been focused primarily on the creative process phase. While other aspects of creativity are interesting and do have value, the creative process is the procedure that impacts change in individuals. By utilizing approaches that facilitate the creative process, educators can enhance the creative abilities in their students (Couger et al., 1993). According to Torrance (1997), major studies on the subject of creative process indicate overwhelmingly that significant positive results occur when creative abilities are deliberately nurtured.

The early accounts of the process of creative thinking attributed this phenomenon to divine intervention (Scope, 1998). According to this concept, the creative person served as a vessel of inspiration to others as he or she developed a creative product. Since that time, research in the area of creativity has focused on the individual. In 1933, Freud proposed the concept that creativity was the expression of sexual energy in a socially acceptable form. In 1959, Jung concluded that creativity was a basic human tendency to self-actualize. As recently as 1971, Maslow associated creativity with the apex of human evolution and achievement. However, with the rise of empiricism, more systematic methods of inquiry into the nature of creative individuals are now being conducted (Heinzen, 1991).

More recently, psychoanalytic and humanistic theories have focused on personality characteristics that contribute to the process of creativity (Heinzen, 1991). However, an abundance of recent research has been done to examine the link between cognitive processes and creativity (Scope, 1998). Maraviglia and Kvashny (2006) cite a 1952 conclusion drawn by Alex Osborn that creativity is much more than mere imagination. Rather, it is imagination coupled with both intent and effort, leading researchers to the examination of cognitive processes, as creativity is studied.

The definition of creativity has evolved from ancient views of inherent creativity into two main approaches: (1) origin-oriented and (2) process-oriented (Marakus & Elam, 1997). The origin-oriented approach is a psychoanalytical perspective supported by the likes of Sigmund Freud. This approach, which is focused more on creative origins than the process, holds that creativity arises from contrast within individuals. However, in stark contrast to the Freudian version, the process-oriented approach views creativity as a property of thought process existing within everyone to varying degrees that can be acquired and improved through instruction and practice (Marakus & Elam, 1997). These researchers further maintain that the creative problem solving process is present when one or more of the following conditions exist: (1) the solution is novel and valuable, (2) the thinking is considered unconventional, (3) the initial problem is vague or ill-defined, and (4) the solution process requires high motivation and intensity over a considerable span of time. Maraviglia and Kvashny (2006) refer to a 1926 book by Wallas in which creative thinking is believed to occur in four distinct stages of preparation, incubation, illumination, and verification. Each stage is crucial to that creative development within individuals.

One researcher transformed E.P. Torrance’s definition of the creative process into five well defined steps, upon which students can base their learning experiences and problem solving activities. These steps include (1) becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, and disharmonies, (2) identifying the difficulty, (3) searching for solutions by making guesses or formulating hypotheses about the deficiencies, (4) testing and retesting and possibly modifying and retesting them, and (5) communicating the results (Nash, 2001). This researcher would give his students opportunities with each of these steps, which in turn, allows them to attend and identify perplexing phenomena that represent gaps in knowledge. He further maintained that through this exercise, students reported this process to be quite helpful in the attempt to understand creativity and improve the creative process (Nash, 2001).

In research of the components of the creative process conducted by Heinzen (1991), he refers to Amabile (1983) and his componential definition of creativity and identified particular elements of three facets of creativity. These components include pragmatic (domain-relevant skills), cognitive (creative-relevant skills), and motivational considerations (task motivation). According to this theory, different measures of creativity focus on one of these three components. This componential definition converges on a wide variety of experimental research within creativity into specific areas of study, allowing researchers to conduct well defined studies of the process of creativity development (Heinzen, 1991).

In an examination of past research on the cognitive processes necessary for creative performance, Scope (1998) examined several theories. One theory identified cognitive processes necessary for creativity as problem identification, generation of solutions and ideas, and evaluation and modification of ideas and solutions. Another theory identified the three processes as understanding the problem, generating ideas, and planning for action, known as the CPS model (Treffinger, 1995). This CPS model will be the model used as the pattern for the development of this study. This model will be examined in detail later in this review of the literature.

Discovery learning, also referred to as “constructivist learning”, is one of many methods in the creative process. It covers both an instructional model and a series of strategies that focus on first-hand involvement of the student with the curriculum. The three primary attributes of this program include (1) the creation, integration, and generalization of knowledge through exploration and problem solving, (2) a process of learning driven by interest based activities in which the learner exercises some control over the sequence and frequency with which they occur, and (3) activities which strive to integrate new knowledge with the learner's existing knowledge (Bicknell-Holmes & Hoffman, 2000). Another constructivist theory for instructional technique maintains that instructional techniques must address four aspects of learning that include (1) a predisposition toward learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishment (Bruner, 1996). According to Huitt (2003), many advocates of the constructivist approach to the creative process suggest that educators should first consider the knowledge and experiences that students bring with them to a learning task. School curriculums should be designed to allow students to expand and develop this knowledge and experience by connecting it to new learning.

One well known researcher, whose primary focus was in the area of creative process, was E.P. Torrance. He was responsible for the development of the famous TTCT (Huang, 2005). As a result of his research, many creativity training programs place an emphasis on training in creative thinking skills and use this test as a measurement device for training effect. Torrance's (1974) definition of creativity is consistent with the underlying concepts of his test.

> Creativity is a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results. (p. 8)

As a result of data collected from 142 studies conducted on teaching children to think creatively, nine categories of strategies were classified. These nine categories included (1) training programs that emphasize the Osborn-Parnes Creative Problem Solving Procedures, (2) other disciplined approaches such as training in general semantics, creative research, and the like, (3) complex programs involving packages of materials, such as the Purdue Creativity Program; Covington, Crutchfield and Davies' Productive Thinking Program; and the Myers and Torrance Idea Books, (4) the creative arts as vehicles for teaching and practicing creative thinking, (5) media and reading programs designed to teach and give practice in creative thinking, (6) curricular and administrative arrangements designed to create more favorable conditions for learning and practicing creative thinking, (7) teacher/classroom variables, indirect and direct control, classroom climate, and the like, (8) motivation, reward, competition, and the like, and (9) testing conditions designed to facilitate a higher level of creative functioning or more valid and reliable test performance (Torrance, 1972). According to the results of this study, the highest percentage of success in teaching children creative thinking skills were those emphasizing the Osborn-Parnes training program, other disciplined approaches, the creative arts, and media-oriented programs. More importantly, results of the study support the likelihood that children can be taught to think creatively.

Today, much of the literature on creative thinking suggests that it is a complex cognitive activity. This complex activity must deal with the related cognitive activities of developing and using the knowledge base, as well as critical thinking, decision making, and meta-cognition. However, traditional approaches to creativity training and testing were more circumscribed in scope and viewed these activities as being outside the realm of creative thinking (Feldhusen & Goh, 1995).

Still, other researchers suggest that while most research in the area of creative instruction has focused on the cognitive aspect, it would also be beneficial to examine the affective and psychomotor aspects of creativity. Furthermore, this research should focus on more complex types of student activity and productivity in the realm of independent learning, as it relates to creativity. Only when students become involved with solutions to real problems, rather than mere exercises and activities, can true creativity be fostered. Classrooms must be non-judgmental settings which encourage risk-taking and persistence in the development of a creative product (Fieldhusen & Clickenbeard, 1986).

In a study of creative processes conducted in 1995, Feldhusen examined three aspects of creative thinking that included (1) meta-cognitive processing of newly acquired information, (2) large and fluent knowledge bases and mastery of skills within particular domains, and (3) personality variables that include attitudes, dispositions, and motivations acquired from parents, teachers, mentors, peers and personal experiences.

He concluded that these three aspects of creativity operate interactively in the development of creativity within individuals (Feldhusen, 1995).

Donald Treffinger refers to a model for creative learning that may be valuable for understanding the process of creativity development. This model consists of three levels for creative learning. Level I: Learning Basic Thinking Tools emphasizes the importance of supplying students with a number of fundamental “tools” for generating and analyzing ideas. These tools include divergent (creative) thinking tools such as brainstorming, attribute listing, and forced relationships (Treffinger, 1986). Divergent thinking moves away from already known and expected consequences, which makes this process synonymous with creativity (Maraviglia & Kvashny, 2006). However, these tools also include convergent (critical) thinking tools such as inference, deduction, relevance, analysis, and categorizing. In Level II: Learning and Practicing Problem Solving, students learn to apply basic thinking tools in a complex, systematic structure of problem-solving, such as the small group setting. In Level III: Dealing with Real Problems and Challenges, students are challenged to use the basic tools and problem solving methods they have learned, as they deal with real problems (Treffinger, 1986).

According to Getzels and Czikszentmihalyi (1967), the act of problem-finding is often in contrast with problem solving. These researchers conclude that finding, identifying, and clarifying problems is a preceding and more creative act than the more convergent behavior of problem solving. In addition, they contend that problem-finding is a more intense cognitive act than problem solving.

Joseph Renzulli attempts to summarize the process issue with a 1938 reference to John Dewey, who concluded that the whole education process should be conceived as one of a process for learning to think through solutions to real problems. He maintains that a product/process controversy exists in the topic of creativity education. He firmly states his belief that products grow out of real problems and are important. However, their importance lies only insofar as these products serve as vehicles whereby the processes can be applied in authentic fashion. In addition, the processes upon which problem solvers focus in structured training sessions have no value in and of themselves, unless they are applied to actual situations (Renzulli, 1982). While it helps clarify the topic of creativity to accurately define the integral aspects and parts of creativity, the real issue remains that the creative process must contribute to real world solutions to have value.

The Third P: The Created Product

Of the Four-P's, not as much literature is available regarding the created product as the other three P's of person, process, or press. Creativity names the phenomenon in which a person communicates a new concept. That new concept is what is known as the product (Rhodes, 1961). The product approach to creativity has as its focal point outcomes and those things that result from the creative process. The assumption is that studies of products, such as painting, poems, designs, and publications are highly objective, and therefore measurable. The value of this approach can be seen in the amazing productivity of the likes of Piaget and Picasso. However, one flaw with productivity as a measure of creativity may lie in the fact that one's productivity can also be misleading. What it takes to be productive sometimes differs from what it takes to be creative. An individual can be productive without being original, but originality is the most widely acknowledged requisite of creativity (Runco, 2004).

Isaksen et al. (1994) maintain that creative products, or outcomes, may come in a variety of sizes and shapes and from many different contexts. The products are not limited to the arts and sciences, but may be found in any discipline or endeavor of the human domain. The focus of this aspect of creativity is on characteristics of outcomes rather than people or their environments. These products may be tangible in nature, such as an invention or marketable products, or they may be intangible, such as learning, new services, or the design of new processes.

Rhodes (1961) takes one of the more unique approaches in his research of the creative product. According to his theory, the mystery surrounding creativity can be summarized by organizing its artifacts into categories, first by type and then by degree of newness. One category of ideas is by media of expression (music, art, poetry, and inventions). A second category of ideas recognizes mood (pastoral, satiric, and didactic moods in poetry; and allegro, andante, and adagio moods in music). A third category of ideas recognizes values (art, as pictures are classified according to aesthetic value; and mechanics, as machines are classified according to their use). He states that an idea refers to a thought that was communicated to other people. This thought may take place in the form of words, paint, clay, metal, stone, fabric, or other material. When this idea is converted into a tangible form, it becomes a product. Each product of an individual's mind or hands represents a record of his or her thinking. These creative products of man must then be classified in the scope of newness and importance (Rhodes, 1961).

Rhodes (1961) further maintains that theoretically classified ideas are of a higher order in the scale of creativity than ideas for inventions, just as ideas for new inventions are of a higher order on the scale than ideas for existing inventions. The logic behind the method of classification is based upon the impact of the idea. One theory may generate numerous inventions, just as one invention may eventually generate numerous modifications of that original invention.

One classification of theoretical idea, or doctrine, refers to Taylor's Typology. Edward Taylor became known for his alignment with some of the more conservative typologists of the Puritan covenant. Taylor's reliance upon the conservative use of this typology for hermeneutics and meditation was deemed "radical" by Seventeenth Century Christian standards. However, Taylor himself viewed this so-called radicalism as poetic, on the basis of personal spiritual reality and intrinsic desire for personal expression (Rowe, 1986).

Regardless of the accuracy of measurement of creativity, research supports that its levels can be increased within individuals. One effective approach to improving creativity within individuals is to establish a standard for creativity that would be desirable to attain. According to Parnes and Harding (1962), examining the end product is often the preferred approach of administrators in public education settings. With accountability at a premium, school administrators search for "bang for their bucks". While business enterprise often has the luxury of searching for talent that defines the end product, educational administrators must refine their talent searches to teachers who can successfully build the end product of creativity within their students. Regardless of the situation, the best way to proceed is to first identify the criteria for a creative product and then move back from that identification to teachers who can produce the maximum creative potential within each student (Parnes & Harding, 1962).

Couger et al. (1993) present another argument for identifying the desired end product of creativity at the outset. Their research indicates that as people are informed about their native creativity capabilities, and receive positive support through a creative climate, it is logical to assume that creative products and services will result. Therefore, it is necessary to establish visible and measurable creativity standards in the design of creativity curriculum.

The Fourth P: Press - The Creative Environment

A discussion of creativity would be incomprehensive without considering environmental impacts upon creativity. Throughout one's life, environmental factors form a psychological press that may be either constructive or destructive to one's creativity (Rhodes, 1961). These impacts may be both physical, and social. Isaksen et al. (1994) argue that the creative environment is a consideration of the context, place, situation, or climate in which creativity takes place. This environment includes those factors which either promote or inhibit creative behavior. As the interaction between the person and the environment press an individual, the creativity level of that individual either increases or decreases.

One significant environmental impact upon one's creativity should be his or her educational experiences. In schools where active learning methods prevail, students demonstrate significantly higher achievement. Teachers in successful schools tend to focus on reasoning and problem solving by offering students challenging and interesting activities which foster thinking, creativity, and production. In addition, these teachers make available a variety of pathways to learning that accommodate different intelligences and learning styles. This approach allows students to make choices and contribute to some of their own learning experiences by engaging in hands-on learning (Parr & Edwards, 2004). According to Parnes and Harding (1962), from an educational standpoint, the teacher must be concerned with how and what to teach. The ultimate criterion for this pattern for development should be based on circumstances that release creative production.

Environmental barriers to creativity in problem solving are those factors that interfere with an individual's problem solving efforts. Such barriers include (1) a belief that only one type of thinking is required for innovative outcomes, (2) resistance to new ideas, (3) isolation, (4) a negative attitude toward creative thinking, (5) autocratic decision making, (6) reliance on experts, various strategic blocks which limit the utilization of resources, or (8) an over emphasis on competition or cooperation (Isaksen et al., 1994).

In response to the environmental barriers to creativity in problem solving, Isaksen et al. (1994) refer to a scholarly, research-based short list of twelve environmental factors that are conducive to environmental creativity.

1) Provide freedom to try new ways of performing tasks; allow and encourage individuals to achieve success in an area and in a way possible for him/her; encourage divergent approaches by providing resources and room rather than controls and limitations.
1) Point out the value of individual differences, styles and points of view by permitting the activities, tasks or other means to be different for various individuals.
2) Establish an open, safe atmosphere by supporting and reinforcing unusual ideas and responses of individuals when engaged in both creative/exploratory and critical/developmental thinking.
3) Build a feeling of individual control over what is to be done and how it might best be done by encouraging individuals to have choices and involving them in goal-setting and decision-making processes.
4) Support the learning and application of specific creative problem solving techniques and skills in the classroom and on tasks which are appropriate.
5) Provide an appropriate amount of time for the accomplishment of tasks and provide the right amount of work in a realistic time frame.
6) Provide a non-punitive environment by communicating that you have confidence in the individuals with whom you work. Reduce concern of failure by using mistakes as positives to help individuals realize errors and meet acceptable standards and provide affirmative feedback and judgment.
7) Recognize some previously unrecognized and unused potential. Challenge individuals to solve problems and work on new tasks in new ways. Ask provocative questions.
8) Respect an individual's need to work alone or in groups. Encourage self-initiated projects.

> 9) Tolerate complexity and disorder, at least for a period. Even the best organization and planning requires clear goals and some degree of flexibility.
> 10) Create a climate of mutual respect and acceptance among individuals so that they will share, develop, and learn cooperatively. Encourage a feeling of interpersonal trust and teamwork.
> 11) Encourage a high quality of interpersonal relationships and be aware of factors like: a spirit of cooperation, open confrontation and resolution of conflicts, and the encouragement for expression of ideas. (pp. 19-20)

In his book Guiding Creative Talent, Torrance alluded to some general goals for educators that include a healthy individuality and development of conditions that will encourage creativity in the classroom, thereby counteracting pressure toward regression to mediocrity. These essentials to creative classroom environments include (1) rewarding diverse contributions, (2) helping creative persons recognize the value of their own talents, (3) avoid exploitation, (4) accept limitations creatively, (5) develop minimum skills, (6) make use of opportunities, (7) develop values and purposes, (8) hold to purposes, (9) avoid the equation of divergence with mental illness or delinquency, (10) reduce emphasis on sex roles, (11) help students learn to be less obnoxious without sacrificing their creativity, (12) reduce isolation, and (13) help students learn how to cope with anxieties, fears, hardships, and failures.

According to Amabile (1983), of all the social and environmental factors that might influence creativity, most can be found in some form in the classroom. Although these factors may be higher in educational environments, it is likely easiest to control them there. Three factors that have a direct impact on educational environment are peers, teacher characteristics and behavior, and overall classroom climate. Unfortunately, peer pressure in classrooms can undermine creativity, as students tend to want to conform with their peers, thereby inhibiting willingness to take risks in exploring new paths to solutions.

In reference to the effects of teacher characteristics on creativity, little research has been recorded on the topic. However, research does suggest that teacher attitudes might be conducive to student creativity. Teachers' beliefs in student autonomy showed a positive correlation with student preference for challenge, curiosity, and desire for independent mastery. Interestingly though, 1962 research conducted by Getzels and Jackson suggests that teachers often view creativity among students as bothersome, due to playfulness, humor, and independence that may be difficult for teachers to control.

While few teacher characteristics have been researched, much research has been conducted in the area of classroom environments that might increase creativity. Openness in the classroom, which includes characteristics of flexibility, student choice, curriculum integration, and small or large group activities, was compared to traditional classrooms that concentrate on the likes of group reading and math drill. It was interesting to note that results from these studies suggest that traditional classrooms were less conducive to creativity than openness in the classroom, further clarifying that intrinsic task motivation is encouraged through a relative lack of extrinsic constraint. When students are free from pressures of pleasing the teacher, doing better than other students, winning good grades, or meeting deadlines, they are more apt to excel in innovative exploration with materials and ideas (Amabile, 1983).

One researcher observed two important features in how teachers handle creativity education in the classroom. According to Gehlbach (1987), teachers may have provided students with opportunities to be creative more often than they have provided genuine instruction in the process. In addition, creative opportunities have typically been confined to the visual arts and written composition. He further suggests that these are contributing factors to reasons why conventional approaches to the development of children's creative skills may have failed.

Effective instruction consists of more than merely providing students with an opportunity to learn. Therefore, the design of effective instruction must go beyond the mere provision of opportunity (Gehlbach, 1987). Three things are typically included in a quality instructional design. First, the learner is systematically exposed to the knowledge or skill to be learned. Second, the learner is engaged in some form of active practice with that knowledge or skill. Third, the learner is provided with feedback, usually by the teacher, regarding the quality of that practice. Ultimately, quality instruction involves exposure of the learner to material or skills in a powerful enough manner that the probability of successful practice is high (Gehlbach, 1987).

Another aspect of creativity that could be classified as environmental is the acquisition of cognitive skills that lead to creative thinking. These skills include problem recognition, problem definition, generating possible solutions, testing solutions, and selection of the best solutions (Gehlbach, 1987). Attention must be given to the transfer of these skills as students are taught to self-monitor and practice them. Ideally, these skills will be infused into the curriculum rather than taught in isolation (Scope, 1998). Through personal assessment and deliberate intervention, individuals can enhance creativity styles, thus increasing levels of creative accomplishment (Treffinger, 1995).

The question then becomes one of which educational experiences result in an increase in creativity levels of students (Scope, 1998). According to Torrance (1972), educational experiences can be designed to teach children how to think creatively. He further maintained that most successful approaches in the process are those that involve both cognitive and emotional functioning, provide adequate structure and motivation, and provide opportunities for involvement, practice and interaction with teachers and other children.

The success of an educational environment often hinges on the adaptation of teaching to learning differences among students (Baker, Hoover, & Rudd, 2000). Maraviglia and Kvashny (2006) credit Guilford with the conclusion that too critical of an environment is deadly to creative thinking. Therefore, a learning environment that promotes student creativity must include teachers who are adept at enhancing the creativity skills of their students. It is the teacher’s responsibility to ensure that students experience an environment that fosters creativity, while covering state mandated learning objectives.

One problem that teachers at the secondary level face is that teachers are generally more specialized in one or two subject matter areas, but many are often far from being experts in these subject areas. Sometimes students, especially at the secondary level, quickly outdistance the teacher in competencies related to highly specialized topics in a given subject area. As teachers feel challenged by students who have surpassed their upper levels of expertise, it is common for teachers to attempt to put the reins on these students. This often unconscious effort on behalf of teachers is contradictory to the necessary development of the next generation of leaders and creativity producers (Renzulli, 1982). According to Renzulli, the antidote for this dilemma is for teachers to become true experts in the basic skills of their areas of expertise. This expertise involves knowing knowledge structures, as characterized by certain organizational patterns, human and material resources, research methods and techniques, and vehicles for communicating findings with those who share a mutual interest. In addition, teachers must demonstrate a true willingness to help students locate resources, open doors, and knock down barriers as they occur.

Couger et al. (1993) refer to five key factors to ensure a creative climate. These factors include (1) a secure environment with minimal administrative interference, (2) an organizational culture that makes it attractive and easy for people to discover and solve problems independently, (3) rewards for performance structured to minimize the chances that intrinsic motivation will be contaminated, (4) willingness to take risks in the targeted areas for creativity and innovation, and (5) providing individuals with formal and informal training to enhance creativity.

Certain teacher training programs, including the Purdue Creativity Program, the Productive Thinking Program by Covington, and the Ginn Reading 360 Program by Clymer, are examples of programs designed to train teachers to raise the level of creativity among their students. These programs are designed to present students with problems that require creative solutions, thereby providing students with practice in the development of these creative solutions. By taking advantage of tested and proven professional development opportunities, that compliment the creativity that exists within each of us, teachers can rest assured that they will be equipped with the necessary tools to meet this challenge.

Scott, Leritz, & Mumford (2004) suggest that while creativity training programs may vary somewhat, they should all address aspects of creativity that include divergent thinking, problem solving, and meta-analysis of a range of programs and techniques. Basadur and Hausdorf (1996) stated that a change in attitude should also result from training in CPS. Results of reports on the effects of training for attitudinal change indicated a change of behavior as well, resulting in greater productivity. To the extent that individuals value new ideas, do not have negative stereotypes, and are not too busy for new ideas, they are more likely to engage in creative behavior. Therefore, it should be the role of the teacher to provide these scenarios that induce creativity among students in their classrooms.

Feldhusen and Goh (1995) conclude that effective environmental conditions should be arranged to be conducive to change, flexibility, and openness, with an emphasis placed upon domain or subject specific topics. Due to its complexity, accessing creativity should probably be viewed as a long range developmental process. This process should be one that leads from actualization of childhood creative potential into adult achievement. By providing this type of creative educational environment, future generations will be well supplied with individuals capable of arriving at solutions to the complex problems of the future (Isaksen et al., 1994).

Summary of the Four P's Approach to CPS

Creative performance can be viewed as the result of simultaneous interactions among several components of creativity. As researchers examine the nature of the individual, the process, the product, and the press (environment); this interaction results in various levels and styles of creativity (Maraviglia & Kvashny, 2006). After over forty years of examination of factors which enhance creative thinking, these authors have suggested three specific guidelines for approaching the topic. To begin, active involvement and practice must take over where theory leaves off. Theory is meaningless if it never results in affirmative action. Second, deferring judgment of the effects of creativity will help prevent premature judgment and early closure. Third, developing an environment that encourages creativity will help individuals minimize, or possibly avoid, roadblocks to the process. According to Maraviglia & Kvashny (2006), "Man is happiest when he is creating. In fact, the highest state of which man is capable lies in the creative act." (p. 8) An open, safe environment for reinforcement of ideas and responses, coupled with non-punitive atmosphere of mutual respect and acceptance, encourages spontaneity, a key ingredient of creativity. In addition, without denying that there are better and worse procedures that schools may adopt, in the long run, for the procedures and practices of classrooms to be truly effective, they must reflect bold thinking, free reign of the imagination, and creativity in performance. Finally, this support must not only come from the school, but from the community and culture at large (Getzels & Jackson, 1962).

The History of CPS

CPS has been identified as one of the more effective problem solving models. This model stems from the original work of Alex Osborn over fifty years ago. Over the past fifty years of research and development on CPS, many important contributions have been made by those interested in developing this talent (Isaksen & Treffinger, 2004). This developmental process has been a gradual, systematic approach that emerged from a group of scholars linked by institutional and foundational linkages. Today, the CPS process has been successfully applied in a variety of educational settings among a variety of age groups, ranging from early childhood through adulthood (Treffinger, 1995).

The developmental process of the CPS model consists of a “family” of approaches that emerged from a common foundation over a period of several decades (Isaksen & Treffinger, 2004). By examining the CPS model from a historical perspective, those interested in the topic can get an idea of the substantial amount of research and theory that has gone into the current model, as we know it today (Isaksen & Treffinger, 2004).

During its origin, Alex Osborn's motivation for creating the CPS model was to create new and useful solutions for enhancing problematic situations (Osborn, 1953). He was one of the first researchers to publicly state his belief that every person possesses creative potential. Osborn advocated that imagination and judgment, characteristics possessed by all in varying degrees, are two of the main essentials for creativity. It is on that original theory of individual creativity that the focus of CPS is based today (Treffinger, 1995).

Osborn was a pioneer in CPS for the education profession as well. In the mid 1950's, he teamed with Sidney Parnes, another pioneer in the field of creative problem solving. Together, these two researchers developed the original five process model, which became known as CPS model (Version 2.2). Figure 2.1 illustrates this version.

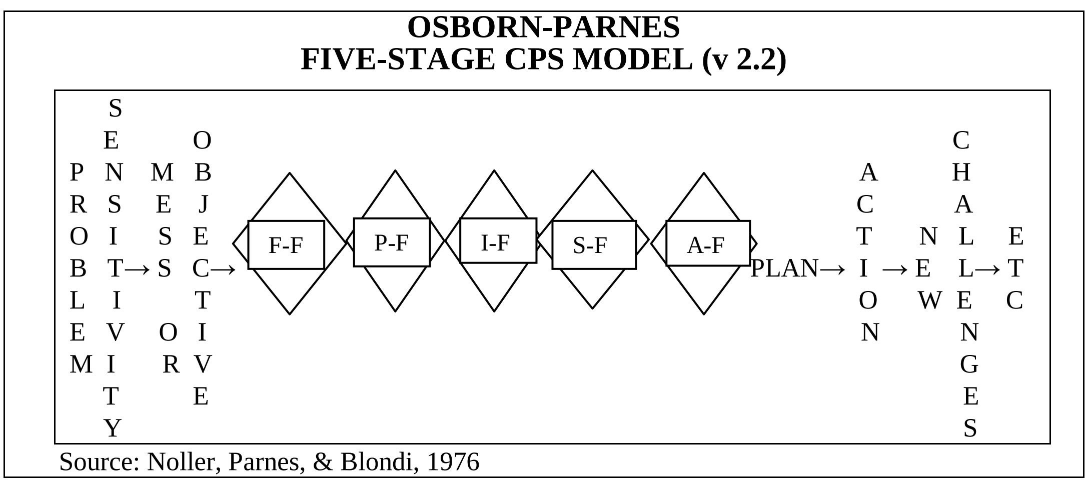


Figure 2.1. Osborn-Parnes Five Stage CPS Model (Version 2.2)Footnote: F-F=Fact Finding; P-F=Problem Finding; I-F=Idea Finding; S-F=Solution Finding; A-F=Acceptance Finding

According to Isaksen and Treffinger (2004), research evidence from this Creative Studies Project established the Osborn-Parnes approach to creative problem solving as a viable method for the deliberate and intentional development of creative behavior. This model included the stages of *Fact-Finding, Problem-Finding, Idea-Finding, Solution-Finding, and Acceptance-Finding* (Treffinger, 1995). During the sixties and seventies, Parnes and Osborn teamed with other creativity pioneers, Noller and Biondi, to design an application process for the CPS model in the form of an academic program at both the undergraduate and graduate levels of higher education (Treffinger, 1995). As Parnes began to provide resource materials for those interested in facilitating CPS, it became apparent to these researchers that the more CPS education that students had completed, the more creative tendencies these individuals had developed. In addition, individual differences based on student learning styles and individualized instruction became apparent.

As a result of these findings, Isaksen and Treffinger implemented a Cognitive Styles Project to provide deeper investigation into the effects of these apparent individual differences. Particular emphasis was placed on the investigation of cognitive style and climate for creativity when learning and applying CPS. Also, a sixth stage, *Mess-Finding*, was added to the CPS model in 1985 (Isaksen & Treffinger, 1985). In addition, they broadened the scope of the Fact-Finding stage and renamed it *Data-Finding*. In addition, these six stages of CPS were further refined by clustering them into three categories of: (1) Understanding the Problem: Mess-Finding, Data-Finding, and

Problem-Finding, (2) Generating Ideas: Idea-Finding, and (3) Planning for Action: Solution-Finding and Acceptance-Finding (Treffinger, 1995). Figure 2.2 represents the new CPS model (Version 3.0) created by Isaksen and Treffinger in 1985. This model modified the Osborn-Parnes approach by taking into account the new evidence regarding individual differences and creativity climate (Isaksen & Treffinger, 1985).

CREATIVE PROBLEM SOLVING (v3.0)

Divergent Phase	Problem Sensitivity	Convergent Phase
Experiences, roles and situations are searched for messes… Openness to experiences; exploring opportunities.	Diverge **MESS FINDING** Converge	Challenge is accepted and systemic efforts undertaken to respond to it.
Data are gathered; the situation is examined from many different viewpoints: information, impressions, feelings, etc. are collected.	**DATA FINDING**	Most important data are identified and analyzed.
Many possible statements of problems and subproblems are generated.	**PROBLEM FINDING**	A working problem statement is chosen.
Many alternatives and possibilities for responding to the problem statement are developed and listed.	**IDEA FINDING**	Ideas that seem most promising or interesting are selected.
Many possible criteria are formulated for reviewing and evaluating ideas.	**SOLUTION FINDING**	Several important criteria are selected to evaluate ideas. Criteria are used to evaluate, strengthen, and refine ideas.
Possible sources of assistance and resistance are considered; potential implementation steps are identified.	**ACCEPTANCE FINDING**	Most promising solutions are focused and prepared for action. Specific plans are formulated to implement solution.
	NEW CHALLENGES	

Source: Isaksen, S.G. & Treffinger, D. J. (1985), *Creative Problem Solving:* The basic course. Buffalo, NY: Bearly Limited

Figure 2.2. CPS Version 3.0

As researchers continued to study the impact of CPS, they began to examine the process in a variety of settings and specific applications. According to Isaksen and Treffinger (2004), the results of these studies provided five significant findings regarding the effectiveness of CPS. The findings include:

1. It is possible to make a difference with CPS for many kinds of complex creative opportunities and challenges across a wide variety of contexts and situations. Put simply, "CPS works."
2. There were many unanswered questions about how people might improve their effectiveness in applying CPS in response to their own needs and the varying demands of groups, tasks, and contexts. Put simply, "CPS could work better and in different ways."
3. Effective applications of the CPS process involved dynamic interactions among many factors, including people, outcomes, climate, and methods, rather than a static, invariant process. Put simply, "CPS is a suite of tools that can be used in many and varied ways."
4. People who were exposed to CPS chose to use selected parts of the overall process based on their assessment of how the stages or tools might naturally help them deal with a certain task of challenge. Put simply, "People preferred to apply CPS in natural, comfortable ways."
5. When we examined numerous case studies of CPS application we observed that people commonly used CPS to clarify their understanding of problems, to generate ideas, and/or to plan for taking action. We concluded that the six stages of CPS could be clustered into three main sections or components. Put simply, "People often chose to apply parts of CPS that met their needs." (Isaksen & Treffinger, 2004)

As a result of these findings, these researchers were prompted to change their description of the CPS framework again. This time it was adapted to make it more workable and to reflect the ways in which it was being used by its practitioners. Version 4.0 of CPS organized the six CPS stages into three main categories of problem solving components that were based on how individuals naturally behaved. Figure 2.3 is used to depict the three major categories and six stages in the CPS process as it had evolved (Isaksen & Treffinger, 2004).

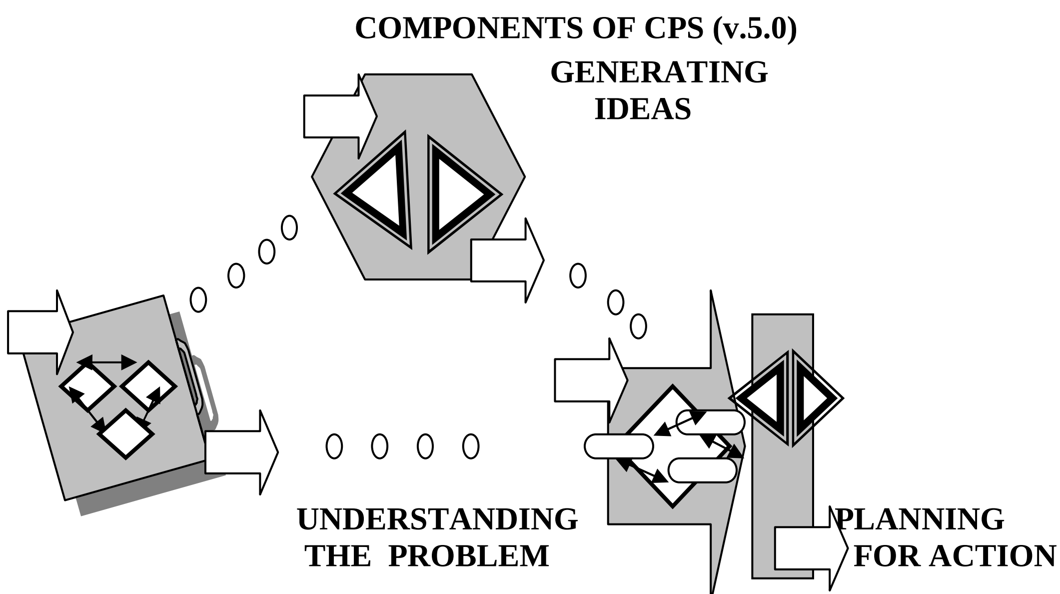
CPS COMPONENTS AND STAGES (v.4.0)

	Understanding the Problem
Diverge **Mess-Finding** Converge	Seeking opportunities for problem solving Establishing a broad, general goal for problem solving.
Data-Finding	Examining many details, looking at the mess from many viewpoints. Determining the most important data to guide problem development.
Problem-Solving	Considering many problem statements. Constructing or selecting a specific problem statement.
	Generating Ideas
Idea - Finding	Producing many varied and unusual ideas. Identifying promising possibilities, alternatives or options having interesting potentials.
	Planning for Action
Solution-Finding	Developing criteria for analyzing and refining promising possibilities. Choosing criteria, and applying them to select, strengthen, support, promising solutions.
Acceptance-Finding	Considering possible sources of assistance /resistance and possible actions for implementation. Formulating a specific plan of action.

Adapted from Treflfinger, D.J., & Isaksen S.G. (1992). *Creative Problem Solving: An Introduction.* Sarasota, FL: Center for Creative Learning

Figure 2.3. CPS Version 4.0

In 1987, as a result of the constructivist movement in education, Isaksen and Treffinger began to discover the importance of flexibility when using the CPS process. This constructivist approach argued that each individual must construct his or her own process approach in a personally meaningful way (Brooks & Brooks, 1993). As a result, the principles of intentional and purposeful cognition and the importance of creating personal meaning in one's approach were incorporated into the CPS model, in an attempt to enhance its power and practicality. The graphics of this model took a descriptive approach to describe the necessary inputs, actual cognitive processes, and the outputs for each of the three components and stages of CPS. At this stage of CPS model development, it was also implied that the components, stages, and phases might be used in a variety of different orders or sequences. Figure 2.4 provides a graphic illustration that problem solvers may not always need all the steps in the process, suggesting that there might be tasks for which other methods might be just as effective as CPS (Isaksen & Treffinger, 2004).



Source: Isaksen, S.G., et. Al. (1992). *Current approaches and applications of problem solving: A focus on facilitation.* Buffalo, NY: Center for Studies in Creativity.

Figure 2.4. Components of CPS Version 5.0

Another contribution to CPS, for which Isaksen and Treffinger can be credited, is in terms of problem definition. As opposed to traditional views of problems from a negative perspective, these researchers redefined CPS problems as opportunities and challenges for successful change (Isaksen & Treffinger, 1985). According to this viewpoint, as people face daily challenges, these challenges represent opportunities for personal and professional growth. Therefore, a problem might be considered any important, open-ended, and ambiguous situation which requires examination of options for potentially successful solutions (Treffinger, 1985).

In 2000, Isaksen, Dorval, and Treffinger once again began to introduce significant changes into the language of the CPS framework. The Understanding the Challenge component was transformed into three stages of Constructing Opportunities, Exploring Data, and Framing Problems. Constructing Opportunities now involves the generation of broad, brief, and beneficial statements that help set the principle direction for problem solving efforts. The stage of Exploring Data now includes generating and answering questions about significant information, feelings, observations, impressions, and questions about the task at hand. The stage of Framing Problems now involves the framing of a problem statement to serve as a focal point of subsequent efforts (Isaksen & Treffinger, 2004).

In addition to major modifications to the component known as Understanding the Challenge, the major components of Generating Ideas and Preparing for Action also underwent minor changes. The Generating Ideas component and its stages began to include the formulation of varied, unusual options for response to problems. Included in the Preparing for Action component are now the two stages of Developing Solutions - analyzing, developing, and refining positive options and Building Acceptance - searching for potential sources of assistance and resistance while identifying influential factors for successful implementation (Isaksen & Treffinger, 2004).

Finally, after modifying the language of existing components, a new component of Planning Your Approach was also added to the process. This component became an integral part not only of the graphic part of the CPS framework, but in practice as well. Planning Your Approach is now used to in two facets. First, it is used as a management component to guide problem solvers in the analysis of the situation. In addition, it is also viewed as a process component to deliberately select the process components and stages in the overall CPS process (Isaksen & Treffinger, 2004).

Creative Problem Solving Model
(CPS Version 6.1)

From its inception over fifty years ago, the approach to CPS today has evolved into an effective framework supported by theory and research and built upon five fundamental principles. These five fundamental principles include the belief that (1) creative potential exists among all people, (2) creativity can be expressed among all people in an extremely broad array of areas or subjects, (3) creativity is often approached according to the interests, preferences, or styles of individuals, (4) people can function creatively, while being productive to different levels of accomplishment or significance, and (5) through personal assessment and deliberate intervention, in the forms of training and instruction, individuals can make better use of their creative styles, enhance their levels of accomplishment, and thus realize their creative potentials more fully (Treffinger, 1985).

At its most basic level, the CPS framework involves techniques that have either a divergent or convergent emphasis. These techniques provide a structured approach to creative problem solving. Although structured, the steps in the process will vary, just as they do in the natural problem solving process, based on the nature of the problem or situation. Diversity is a key element to an effective CPS framework (Isaksen et al., 1994).

According to Treffinger, Isaksen, and Dorval (2003), Creative Problem Solving is a proven, portable, powerful, practical, and positive model designed to assist in solving problems and creatively managing change. The model is proven by over fifty years of worldwide use and hundreds of published studies regarding its effectiveness and impact. It is portable in the fact that it is easy to learn and can be applied by many age groups in a variety of organizations, settings, and cultures. It is powerful in the sense that it can stimulate important and lasting changes in life and work. It is practical in the sense that it can be used to deal with every day challenges, as well as long term challenges and opportunities. Finally, it is positive from the standpoint that it can unleash creative talent and focus constructive thinking.

As a result of the development of the most recent version of CPS 6.1, these developing researchers have moved toward a more flexible view of the CPS process. As a result of this new process perspective, researchers have moved away from a fixed, pre-determined sequence of steps in the process, and toward a more personalized assessment of each individual situation. This most recent assessment of the process includes analysis of intended outcomes, people, situations, and methods. This new process has been labeled Task Appraisal (Isaksen et al., 1994). According to Isaksen and Treffinger (2004), the CPS system can now incorporate productive thinking tools for the generation and focus of options, the CPS process components and stages, as well as the CPS management component, and its integrated application. In addition, the inclusion of a diagnostic tool to stylistic characteristics relevant to problem solving behavior has also been included in the model.

According to Treffinger (1995), the CPS framework is not a simple, step-by-step model in which every group can successfully deal with any problem by merely running through a prearranged set of steps. On the contrary, successful use of the today's CPS model requires the investment of a substantial degree of reflection, imagination, judgment, and energy into creative problem solving efforts. However, this framework does provide one with a structured set of operational resources to draw upon, on an as needed basis.

The components of the CPS framework, depicted in Figure 2.5 below, include the four major components and the six specific stages of those major components. A detailed examination of these major components, as well as the six specific stages within these major components, will be conducted throughout the remainder of this review of the literature.

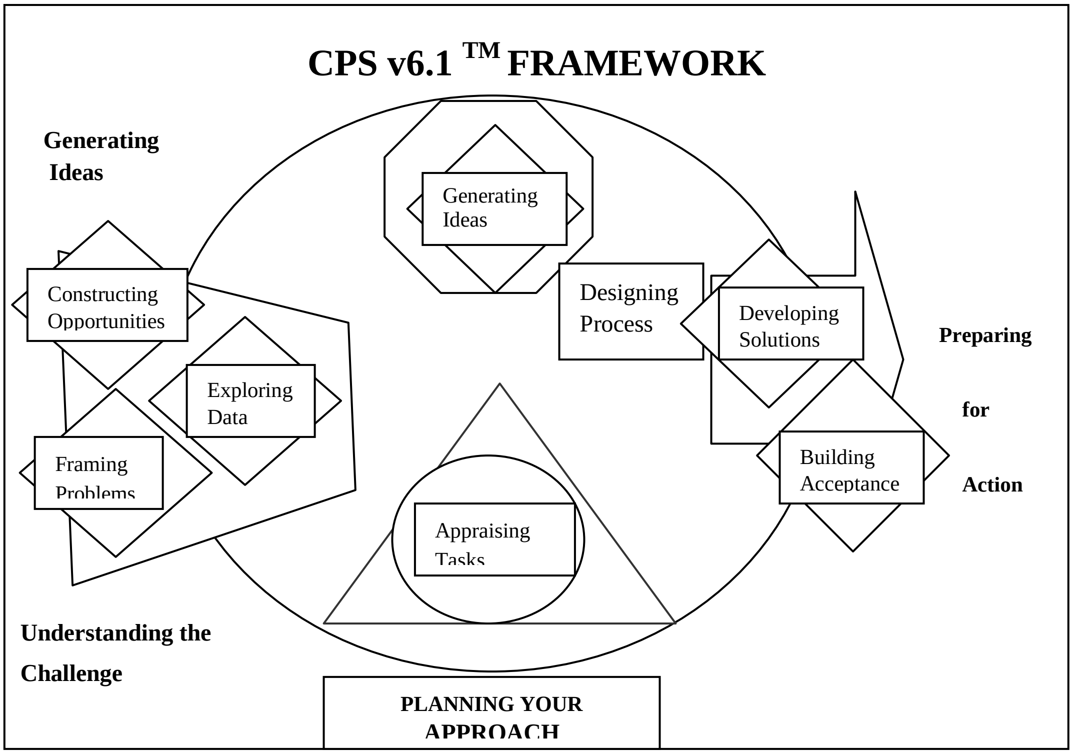


Figure 2.5. Elements of a Graphic Representation of CPS as a System * Adapted from *CPS Version 6.1*, (Isaksen, Dorval, and Treffinger, 2000)

The history behind the past fifty years of development of the CPS model indicates a pattern of continuous refinement and ongoing commitment in the process of seeking new directions and examining the process from different perspectives. However, this model will never be complete. The developers of this model continue to demonstrate a commitment to the promotion of continuing research, development, and evaluation of CPS components, stages, tools, and meta-cognitive elements (Isaksen & Treffinger, 2004). The remainder of this literature review will focus on the four major components and the six stages that underlie these components, as well as the evaluation component of the CPS process.

Understanding the Problem

This component of CPS involves gaining a clear focus on one's problem solving efforts. Often in the CPS process, a major breakthrough may occur simply by ensuring that the right problem or situation is being addressed (Isaksen et al., 1994). As a result of further revisions to the CPS model in 2003, these researchers began referring to this component as Understanding the Challenge (Treffinger et al., 2003). Although many researchers choose to approach Problem-Finding as a first, but separate, step to the problem solving approach, the CPS model does not allow that distinction. According to the CPS model, the task at hand is analyzed initially to determine if a problem or situation exists. This analysis may include outcomes, people, context, and methodological options. Only after this analysis is complete will the major CPS component of Understanding the Problem become necessary, if relevant. Once it has become apparent that the situation in question needs clarification, the problem solver will begin one or more appropriate stages of the Understanding the Problem component of the CPS model (Treffinger, 1995).

As previously mentioned, the newest stage of the component of Understanding the Problem is Mess-Finding. According to Treffinger (1995), a mess is a broad, brief, and beneficial statement of a direction for problem solving. This stage usually describes the focus of the problem solvers' challenge, as many perspectives are examined during this closer look at the situation. During this stage, the situation is usually fuzzy, broad, and ill-defined. Also, there are usually a wide variety of tasks at this stage, each having the potential for a mess (Isaksen et al., 1994). Revisions to this stage of the CPS component in 2003 resulted in the model now being referred to as Constructing Opportunities. The benefit of this stage of the model to problem solvers is that it allows them to focus energy on positive directions and move forward with confidence and enthusiasm (Treffinger et al., 2003).

Another stage of this component is the compilation of facts, opinions, impressions, concerns, paradoxes, and circumstances under consideration. This stage is accurately named Data-Finding. The question of who, what, when, where, how, and why are posed during this phase, in an attempt to identify key data necessary for clarification of the specific concerns of the situation. This examination stage of the process allows problem solvers to gather information, perceptions, and feelings in an attempt to gain a better understanding of the problem (Isaksen et al., 1994). During this convergent stage of the process, clusters of significant data point to the best direction for effective problem solutions (Treffinger, 1995). The advantage of this stage in the process, also referred to as Exploring Data, is that it assists problem solvers in locating current realities of the task that help them to eliminate distractions from the goal of understanding the situation (Treffinger et al., 2003).

A third stage in the Understanding the Problem component of CPS is Problem-Finding. According to Isaksen et al. (1994), this stage is designed to help the problem solver develop workable, specific, and stimulating problem statements. During this divergent phase of the component, specific questions are targeted as the focal point of the effort. Many possible problem statements will be phrased in a positive way through the use of the "invitational stem" method ("In what ways might…" or "How might…"). Through the effective wording of problem statements, a wide range of novel options, concise but free from limiting criteria, will evolve (Treffinger, 1995). Now commonly referred to as Framing Problems, this stage allows problem solvers to express challenges in ways that create enthusiasm for discovering and constructing creative ideas (Treffinger et al., 2003).

Generating Ideas

The second major component of the CPS framework entails the generation of ideas that hopefully will become solutions for the situation in question. Unlike the multiple stages of the Understanding the Problem component of CPS, this component concentrates on one major component of CPS. According to Isaksen et al. (1994), this stage is used to develop many varied, new, or unusual ideas to determine a solution to a previously identified problem or situation. Sometimes erroneously equated with "brainstorming", this component is used to develop clearly stated possibilities and identify promising possibilities (Treffinger et al., 2003). This process of developing open-ended options is known as Idea-Finding. This is another divergent stage of the model which requires fluent thinking (producing many options), flexible thinking (variety of options), original thinking (unusual options), and/or elaborative thinking (a number of detailed options). This divergent phase in the process is then followed by a convergent phase, in which the results of the divergent process are clustered for examination and selection of the most promising options (Treffinger, 1995). Also referred to as Generating Ideas, the benefits of this stage of the process to problem solvers is that it allows them to stretch their thinking by thinking “inside the box” in new ways, as well as “outside the box” (Treffinger et al., 2003).

Planning for Action

The final major component in the CPS process involves the preparation and development of identified options, in order to prepare for successful implementation. The end product of this component is a plan of action to carry out the developed solution (Isaksen et al., 1994). According to Treffinger (1995), novel or intriguing options are not necessarily beneficial in the absence of productive thinking (pondering) on these options. The two specific stages of Solution-Finding and Acceptance-Finding are integral to this phase of the CPS process.

Solution-Finding entails working on promising ideas to analyze, refine, and improve upon them (Isaksen et al., 1994). It requires intensive examination of potential options prior to implementation. The principal focus during this stage is on refinement, and possibly even ranking of options. Condensed choices of the most manageable and systematically effective products must be agreed upon during this stage of the process (Treffinger, 1995). According to Treffinger et al. (2003), the benefit of this stage to problem solvers is that it allows them to use practical tools to turn good ideas into powerful solutions.

The remaining stage of the CPS process, Acceptance-Finding, involves a search for potential assistance, or possibly even resistance, to possible solutions. According to Treffinger (1995), this assistance may come in the form of people, places, materials, or time to support the successful implementation of the plan. Resistance may also come from people, places, materials, or things. Consideration of things that could potentially go wrong aids the problem solver to overcome these sources of resistance before they become a roadblock to the proposed solution. Through the establishment of specific methods to build support or overcome solutions, effectiveness is increased (Treffinger et al., 2003). According to Isaksen et al. (1994), this stage deals with not only making, but managing change. The emphasis is on the actual implementation of the solutions that have been developed. Follow-through, commitment, and obtaining support for the recommended solutions, while minimizing resistance, should be the focal point of this stage.

Planning Your Approach

CPS is a powerful and flexible system to help organize, select, and apply the necessary tools for effective problem solving. However, CPS is not a cure-all for any and all problems, needs or opportunities, and will not be as effective when used in a rigid and automatic progression through a fixed set of strategies or steps. To maximize the value of the CPS process in problem solving, it is necessary to understand the people involved, the type of challenge or situation, and the task upon which CPS will be focused (Isaksen et al., 1994).

Planning Your Approach is an additional main component in today's Version 6.1 of the CPS model. Through this component, problem solvers are able to track their thinking while it is occurring to avoid veering form the focal point of the situation. According to Treffinger et al. (2003), this component customizes the solution process to allow for a personalized approach in the application of the CPS model.

The first stage of this component, Appraising Tasks, helps problem solvers to determine whether CPS is the best choice of instruments for dealing with a particular situation. Considerations at this stage include the people involved, the desired results, the working context, and available methods. The advantage of this stage of the model is that it ensures the selection of the best people, resources, and methods for application of the method, thereby increasing the chances of success (Treffinger et al., 2003).

By conducting a well designed task appraisal, the problem solver is able to understand many things about the situation, thus avoiding a blind jumping in process that could lead to misapplication of the process. This appraisal involves personal orientation of the people, the situational outlook surrounding the task, and the actual features and qualities of the task itself. Once this process is complete, the problem solver can then enter the preparation phase of the CPS process with confidence that it is appropriate for addressing the situation or problem (Isaksen et al., 1994). The information in Table 2.1 depicts some of the potential costs and benefits of using CPS that should be given consideration during the task appraisal phase of the process.

Table 2.1.
Costs and Benefits of CPS.

COSTS & BENEFITS OF USING CPS	
Costs	**Benefits**
CPS requires honesty and a real need for openness on the part of the client.	Using CPS ensures productive action on meaningful challenges and concerns.
It takes commitment and energy for individuals and teams to learn and apply the special CPS language, tools and process framework.	Having a common problem solving language promotes teamwork and helps people work across functions and disciplines.
CPS requires thoughtful and deliberate planning to create unique pathways for use.	CPS is a flexible structure organizing many tools and techniques and providing many levels of application.
It takes self-control and courage to work beyond traditional, patterned or habit bound ways of thinking.	CPS provides a productive and dynamic balance of divergent and convergent thinking.
Group CPS clientship takes more time and energy for convergence, decision making and reaching agreement than working with an individual client.	CPS provides for group ownership which builds commitment for implementation and encourages the consideration of more factors and information.
Using a CPS resource group requires effective and efficient communication and coordination to keep them focused on providing alternatives rather than owning the challenge.	CPS allows for the use of a resource group to encourage a diversity of perspectives, expertise, and information to bear; decreasing the likelihood of gaps or missed opportunities for problem solving.

Source: Isaksen, S.G., Dorval, K.B., and Treffinger, D.J. (1994). *Creative Approaches to Problem Solving,* Dubuque, IA: Kendall-Hunt

Once that it has been determined that the use of CPS will be appropriate for the situation in question, there are a number of considerations that must be made during the design of the process (Isaksen et al., 1994). The final stage of this component and the overall model is the Designing Process. During this stage, problem solvers use their knowledge of the task and the identified needs of the situation to plan the CPS components, stages, or tools that will be best suited to the attainment of the particular goal. In choosing this approach, efficiency of effort is also increased, which in turn will increase chances for success (Treffinger et al., 2003).

Although the specific aspects regarding the client were explored during the Task Appraisal, other considerations of clientship must be considered while designing the appropriate CPS model. According to Isaksen et al. (1994), levels of interest, influence, and the need for imagination of the client should be investigated during this phase of the process. It is important to the success of the process to know just how high of a priority the task really is to the task owner. Influential factors, including the degree to which people feel empowered to engage in problem solving, how power is perceived and used, and how leadership is considered are also important factors in the design of the model. In addition, knowing that the client is truly seeking something unique or different (imagination) ensures the problem solver that creative thinking will be worth the investment.

Role identification is another aspect of the design process that must be mapped out initially. It is important to verify that each person assigned to a role has a thorough understanding of how that role should unfold. Also, as a facilitator of the process, it is imperative that this individual understands the function of this role, particularly in group settings. Prior to any CPS group session, the facilitator is charged with specific assignments and the assurance of understanding among all participants in that session (Isaksen et al., 1994).

Gehlbach (1987) suggests four specific criteria that must be present in task design for the task to be both genuinely instructional, as well as genuinely supportive of creative thought. These criteria include (1) knowledge and skill requirements must be within the repertoires of all learners, (2) task completion criteria must be stated functionally and based on observable phenomena, (3) tasks should be solvable by means of a variety of specific learning behaviors, and (4) task completion must be challenging enough to ensure that all learners will produce task products that are novel.

Finally, once the task appraisal efforts of background information regarding the players and the situation have been evaluated, the final step in the design involves careful consideration of the needs within the task and the CPS components that will most effectively satisfy those needs (Isaksen et al., 1994). Major components of Understanding the Problem, Generating Ideas, and Planning for Action, along with the relevant stages therein, will then be considered for implementation of the most appropriate components. The information in Figure 2.6 accurately depicts the process for planning to transform ideas into action (Isaksen et al., 1994).

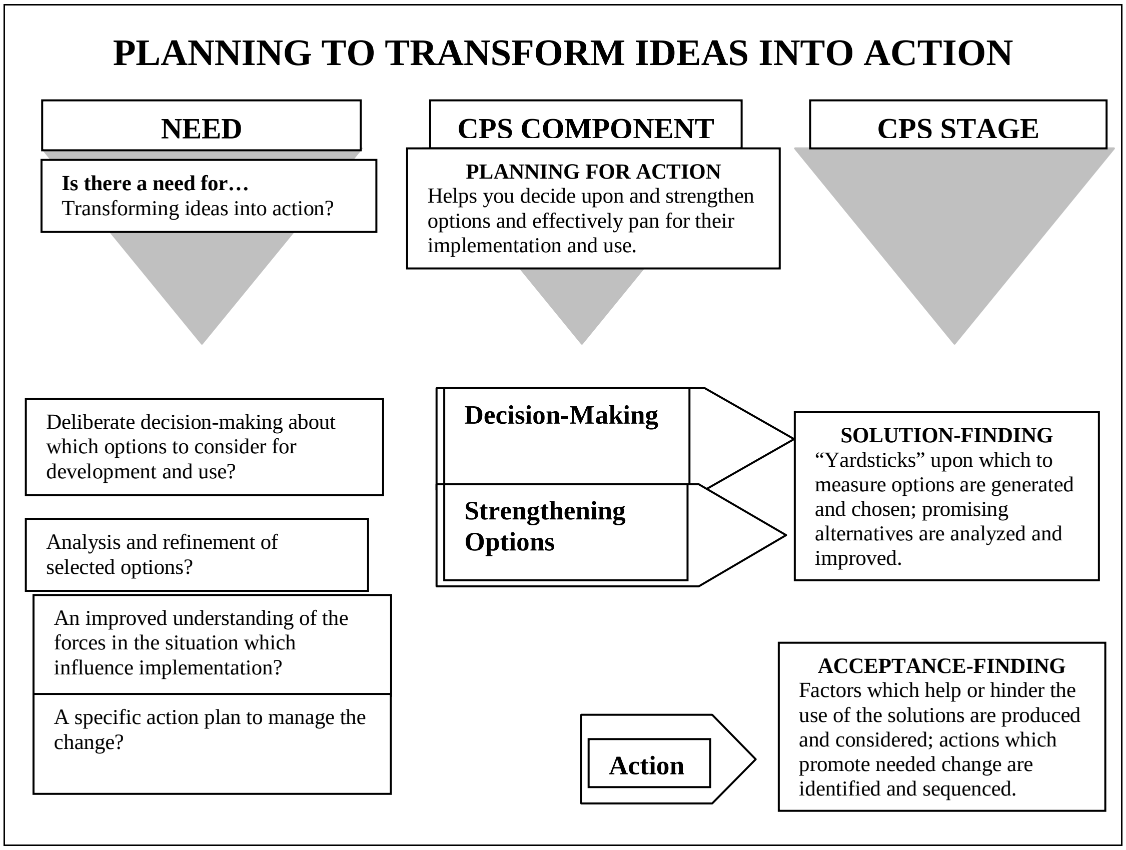


Figure 2.6. Planning to Transform Ideas into Action

Balancing Creative Strategies

Successful use of CPS involves knowing how to balance the use of both divergent and convergent thinking strategies. Some situations may require greater emphasis upon divergent thinking and the additional time necessary for generating additional options. On the other hand, some situations may call for an emphasis on convergent thinking, when the need is primarily in the area of analysis, evaluation, and improvement (Isaksen et al., 1994).

Problem sensitivity is critical to effective implementation of the CPS process. Each of the six stages in this process represents a very important part of the process.

These stages serve to exemplify the importance of efforts to search, stretch thinking, and consider many possibilities, otherwise known as diverging on the possibilities. This process should then be followed by efforts to screen and select the most important or promising possibilities, also known as the convergent process. In the CPS process, it is imperative that problem solvers learn to use effective methods for both generating and evaluating ideas. Therefore, it is necessary to strive for reasonable balance between the divergent and convergent processes. This dynamic balance between these effective tools is the single most important factor that makes the CPS process so powerful and productive (Isaksen & Treffinger, 1985). The illustration in Figure 2.7 provides an accurate depiction of the desired balance between the divergent and convergent phases of the Creative Problem Solving Process.

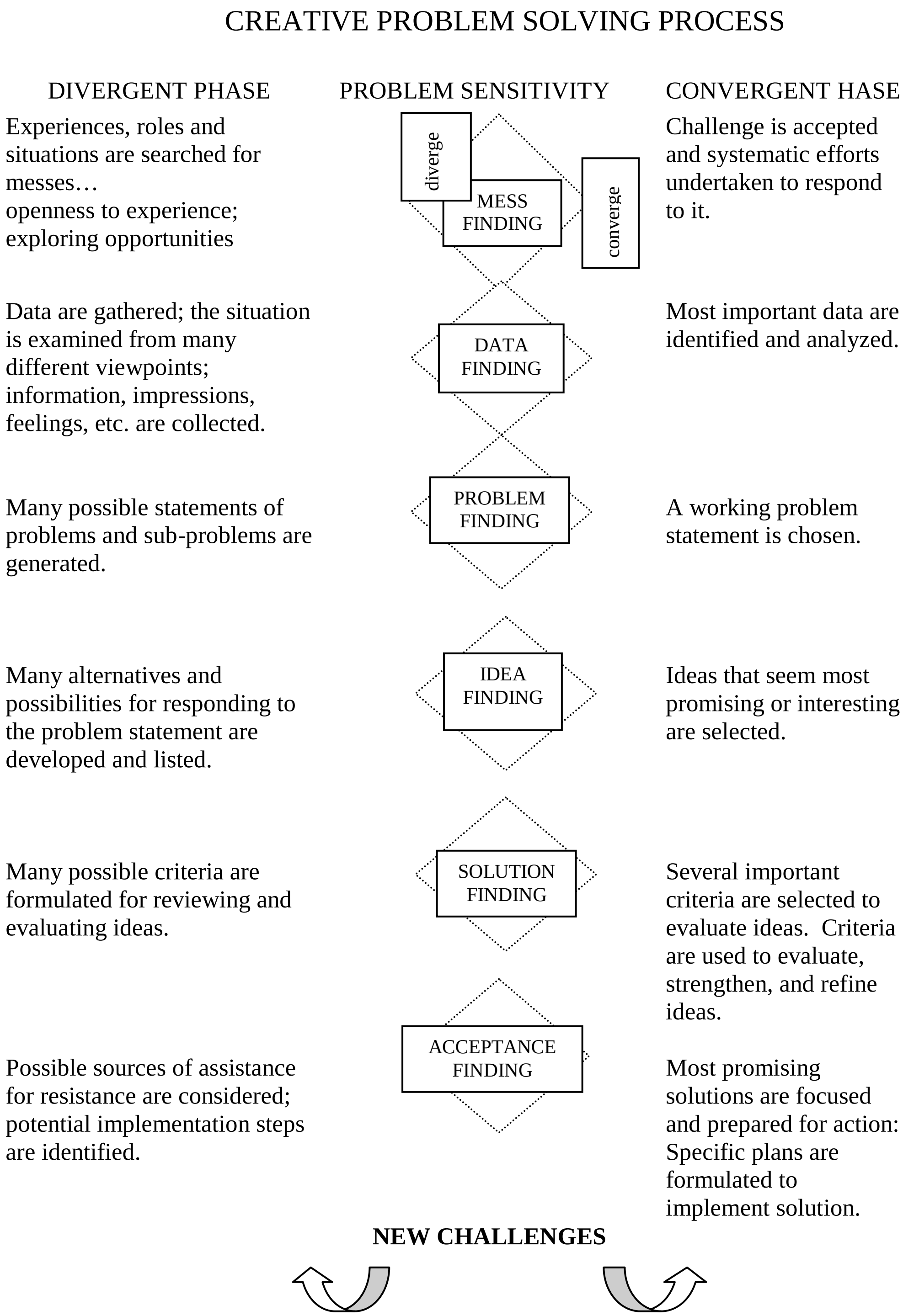


Figure 2.7. The Creative Problem Solving Process

Guidelines for Divergence

Evaluating ideas as they are generated risks inhibition of the flow of ideas. During the process of generating new options, stretching the search for unique possibilities requires freedom from evaluation. Free flow of ideas, absent from any forms of criticism, allows an individual to maximize his or her creative potential (Isaksen et al., 1994).

According to Isaksen et al. (1994), researchers have several options at their disposal during the process of generating options. These options include deferring judgment, striving for quantity, freewheeling, or seeking combinations of strategies. Deferred judgment is simply postponement of analysis until a full menu of possibilities has been made available for consideration. Although judgment is a necessary aspect of problem solving, being too quick in this process reduces the overall creative potential for the best solution. An important concept behind striving for quantity is the belief that quantity often breeds quality. In other words, the more available options from which one may choose, the greater the chance that some of those options will be original. The term freewheeling frees the problem solver from concern that some options may be considered wild or silly. Sometimes the wildest options may result in the greatest degree of effectiveness. Freewheeling stretches one's boundaries, which is necessary to combat mental laziness, one of the most common obstacles to creativity in individuals. Finally, a process commonly referred to as "piggy-backing" new connections from previous ideas is a common method for effectively combining these other divergent strategies within the CPS framework.

One of the most commonly known, yet least understood, divergent techniques in the CPS process is brainstorming (Isaksen et al., 1994). Often mistaken as being synonymous with group discussion, brainstorming can be effectively used in any stage of the CPS process. However, another common misuse of this process is the scenario in which someone in the group deems it necessary to immediately find fault with any newly generated idea. The most effective use of the brainstorming technique usually requires the presence of a qualified individual to coordinate this process within a group of four or five people. However, research supports the theory that when used correctly, brainstorming can be a powerful tool in all phases of the CPS process.

Guidelines for Convergence

Although not as commonly associated with CPS as the divergent process, effectiveness in the CPS process often mandates use of convergence. Just as brainstorming is commonly misapplied within the divergent thinking process, the convergent process is often abused as well. When individuals decide to swiftly slam the door on the overall process and seek to find fault with options until only one option remains, effectiveness often evaporates just as quickly (Isaksen et al., 1994).

According to Isaksen et al. (1994), three convergent thinking guidelines must be applied when using convergent thinking to avoid misuse of this process. Affirmative judgment is a process of focusing on the positive aspects of an option prior to focusing on any limitations. As limitations are later considered, one should avoid the tendency to kill ideas by stating concerns in the form of questions, rather than derogative statements.

Deliberation is another specific tool for effective convergence in the CPS process. This systematic approach to analysis and refinement of options involves making deliberate choices regarding alternatives. Consideration of novelty is yet another recommended approach to the convergent process. Avoiding the tendency to skip over novel ideas, in favor of more conventional, less threatening options, ensures that the novelty sought during the divergent process is nurtured during convergence. A final tip for maximizing the effectiveness of the convergent process is to remember the important principle of "staying the course". It is often difficult following a deliberate divergent thinking effort not to lose sight of the original intent of the situational process. With many fascinating options from which to select, one must remain focused on the most important options.

Isaksen and Treffinger (1985) refer to the ALU technique as an effective means of productive management of novelty ideas during the convergent phase of CPS. ALU stands for Advantage, Limitations, and Unique Qualities. When considering advantages, it is important that they be legitimate, even if one must stretch to find them. During the consideration of limitations, it is important that they are formed as questions to encourage the development of idea generation through overcoming weaknesses. By identifying unique or unusual elements from the divergent process, ALU seeks out novelty in ideas, which is the primary purpose for CPS. While there are many effective tools to call upon during the CPS process, these are some of the more commonly used as effective strategies. The information in Table 2.2 lists some of the more commonly used tools for CPS.

Table 2.2.
Commonly Used Tools from the CPS Toolbox

CPS TOOLBOX	
Divergent Tools	**Convergent Tools**
Analytic Generation These are tools in which you break an issue into its parts or sub-parts to focus on generating ideas. These tools include attribute listing and morphological matrix.	**Isolating "Hilts"** The technique is used to screen, select and sort options which are intriguing, interesting or especially useful.
Brainstorming Variations These are tools that modify Brainstorming to increase its range of outcomes and broaden its use. These tools include brainstorming with Post-its and brainwriting.	**Highlighting** Highlighting is used to condense or compress large numbers of options into more meaningful and manageable categories.
Brainstorming Brainstorming is a group generation technique in which group members follow four basic ground rules to help increase the number, variety, and novelty of options generated.	**Advantages, Limitations, & Unique Qualities** ALU provides a structured approach to identifying the Advantages (strengths), Limitations (weaknesses) and Unique Qualities (novel or unusual elements) of an option.
Idea Checklists These tools work within the existing flow of ideas to stimulate new thinking by asking thought-provoking questions. These tools include SCAMPER.	**Paired Comparison Analysis (PCA)** PCA is used to compare, rank, or prioritize options by comparing all options against each other and making evaluations about their relative sense of importance.
Forcing Relationships A category of tools which uses stimulus to break the generation flow of options to trigger novel of unusual alternative. These tools include force fit and sensory search for relationships.	**Evaluation Matrix** The matrix is used to systematically analyze a number of options against criteria.

Source: Isaksen, S.G., and Treffinger, D.J. (1985). *Creative Problem Solving: The Basic Course (2nd ed.)* Buffalo, NY: Bearly Limited

Implications of CPS for Education

According to Brophy (1998), problems that can be solved through means requiring creativity vary widely in complexity and knowledge needs, as well as the amount of divergent and convergent thought that must go into their solutions. CPS has been used successfully in education from primary grades through higher education and even adult education, to train individuals to address those needs (Puccio, 1994). According to Treffinger (1995), an outgrowth of continuing research and development in the field of CPS has created new opportunities for application of the CPS model in education. These opportunities include redefining its value, reexamining its structure, creating a need for proficiency in meta-cognitive skills, and the process of profiling CPS.

As the CPS process has become better understood within the field of education, the need to move from teaching about CPS to using the process as a meaningful approach for addressing important concerns facing education has evolved. The goal for CPS has become to enable students to deal creatively and successfully with real life challenges. With a growing emphasis in education upon authenticity, the most powerful application of CPS for students is that it allows them to deal with real opportunities to develop real solutions (Treffinger, 1995). However, although motivating and facilitating conditions make a difference in creative functioning, those differences are greatest and most predictable when deliberate teaching is involved (Torrance, 1972).

Along with real world opportunities for solutions, development at school has stemmed reexamination of the steps in the process (Treffinger, 1995). Researchers have discovered that specific steps in the process of solution development sound better in the mock development of solutions to hypothetical, staged problems than they are applicable in the real world of problem solving. A contemporary approach provides a more flexible framework, with an "adjust as you go" attitude.

According to Treffinger (1995), CPS today calls for proficiency in various types of meta-cognitive skills. These skills range from mastering creative and critical thinking tools to generating and analyzing ideas to the more complex skills of understanding people, desired outcomes, and available resources. These meta-cognitive skills lie at the heart of the CPS process and require deliberate attention, practice, and debriefing if the benefits of the process are to be maximized (Treffinger, 1995).

A final new development in the educational realm of CPS involves the necessity to be able to profile personality characteristics and styles that influence effective creative behavior. According to Treffinger (1995), by better understanding not only inhibiting, but facilitating factors of a student's creativity, the interrelationship between instruction and assessment can be established. This new view toward educational possibilities of CPS will allow researchers to more effectively evaluate and distinguish between successful and unsuccessful CPS instruction.

Rose and Lin (1984) conducted a meta-analysis of long term creativity programs. They concluded that over a period of more than thirty years, a variety of techniques and instructional materials have been developed to facilitate creative thinking. A common premise to all approaches is that through training, practice, and encouragement in the use of creative skills, the degree of creativity manifested within individuals can increase. Admittedly, creativity is an innate ability that some individuals possess in greater abundance than others. However, through a variety of teaching methodologies, in the form of education and training, this innate ability can be stimulated and nourished within all individuals (Rose & Lin, 1984).

Evaluating Creativity

In a study conducted by Scott et al. (2004), conclusive evidence of the effectiveness of creativity training emerged. According to their findings, creativity training, which stresses the cognitive processes commonly believed to underlie creative efforts, can be positively impacted through effective instruction in creative behavior. These processes linked to the generation of new ideas, specifically problem-finding, conceptual combination, and idea generation, were proven to be the most powerfully influenced as a result of the training.

Furthermore, results of this same study suggested that since creativity training is often brief, it is unlikely that this type of training could develop expertise in the field of creativity. However, it is more likely that creativity training equips individuals with a set of strategies for working with existing knowledge. Support for this argument stems from the consideration that various training techniques are positively related to increases in critical thinking, convergent thinking, constraint identification, and use of analogies. All techniques, in which people are shown how to work with information in a systematic fashion, were positively impacted. On the contrary, however, techniques which require less concrete guidance in the application of information, such as expressive activities and imagery, were negatively impacted (Scott et al., 2004).

According to Amabile (1983), most evaluation studies of CPS are limited to informational demonstrations that train individuals to use deferment of judgment and, at times, produce more and better ideas than untrained individuals. However, Feldhusen and Goh (1995) maintain that the assessment of such a multidimensional construct as creativity requires multiple channels of measurement such as tests and inventories. These measurement devices should measure not only the cognitive processes, motivations, interests, attitudes, and styles associated with the individual, but also the products, presentations, and performances that are all results of the creative process. Environmental factors should also be taken into consideration, so that a multivariate picture of the creative capacity of an individual is reflected as well (Feldhusen & Goh, 1995).

Just as defining and identifying creativity within individuals can be challenging due to its ambiguity, evaluation of this phenomenon can be equally challenging. In the final analysis, because of the complexity of the topic, accessing creativity should be viewed as a long range developmental process. However, this process should lead to adult achievement and actualization of childhood creative potential (Feldhusen & Goh, 1995).

Most research implies that creativity is beneficial, since it enhances problem solving, adaptability, self-expression, and health. Creativity is expressed in different ways in different domains, as evidenced by the study of domain differences of personality, process, product, and press. Creativity has developed many diverse applications. Creativity is applied widely, as it is viewed by many as a driving force behind innovation and evolution, while providing original ideas and options. However, creativity is also a reaction to the many challenges of life, as it often assists with problem solving and even avoiding problems, in its reactive and proactive realms. While creativity can facilitate problem solving, not all creativity solves problems and not all problem solving requires creativity (Runco, 2004).

Student Satisfaction

One aspect of creativity that warrants evaluation is in the area of student satisfaction. Researchers in the area of Creativity Education have concluded that the process not only contributes to students' ability to solve problems. Of almost equal value is the conclusion that Creativity Education adds to student satisfaction, leading to a more positive attitude toward school.

One exploratory study examined the influence of instruction in creativity on students' scientific investigative abilities. Getting pupils to creatively plan, perform, and interpret their own experiments represents a substantial break from more traditional teacher directed approaches to practical work. Results of this study indicated that teachers should move away from the teacher directed approach to a more open-ended investigative approach. Competence in the performance components of planning and communicating, and more specifically in strategies of problem identification and problem formulation, were enhanced. An unintended result was also an increase in student satisfaction, as students received more control over their learning (Shahrin, Toh, Ho, & Wong, 2002).

In a survey of students at Buffalo State University College in 1969, five major points of emphasis were noted in this regard. Most noteworthy, was the fact that students felt that their understanding of the material from other courses increased because of the learned skill of probing more deeply through the persistent questioning as to why, or how might I better my situation. Survey results also indicated the advantages of learning to solve math problems creatively by breaking them down and considering a number of different ways to solve a single problem. Students noted that learning philosophy became easier when the mind has been trained to think in a step by step process. In addition, brainstorming for approaches to problems in physics resulted in the realization that the first solution was usually not the result of the first idea. In psychology class, students noted that training in creativity had opened their minds to the problems of people and the way in which they think, allowing for approaches to a problem from different directions. In political science, it was noted that thinking creatively enabled students to envision the way people throughout the course of history had reacted to significant events, allowing students to imagine themselves in those historical situations. According to these and other reported results of the research in Creative Education, it becomes a lifetime skill for solving problems (Noller & Parnes, 1972).

In a study conducted to determine the effects of implementation of a problem solving model for program development, student satisfaction levels were also measured. Results of this study revealed that by focusing on problem solving heuristics, skills and knowledge gained by students was not only beneficial to programming, but was also easily transferable to other subject areas. Interestingly, in comparison with earlier semesters of instruction using more traditional instructional methodologies, course evaluations of the instructors and the course indicated greater student satisfaction with the course, its content, and methodology (Deek, Turoff, & McHugh, 1999).

Summary

The review of the literature of creativity supports the initial hypotheses that the world is becoming increasingly complex. As modern conveniences abound, technology has impacted most facets of life. While more opportunities exist today than ever before, the demands required to take advantage of those opportunities are also greater than ever (Runco, 2004).

Along with this continuing increase in complexity comes a continuing need to improve the creativity within individuals, thus allowing individuals to successfully deal with these complexities of life. The emphasis upon an increase in creative skills of individuals also brings with it complex challenges. Creativity has often been referred to as one of the most vague, ambiguous, and confusing terms in education and psychology (Marakus & Elam, 1997).

In an attempt to bring definition to creativity that will lead to the design of an effective educational program, which will develop and enhance the levels of creativity within individuals, the topic has been subdivided. The ubiquitous Four-P's approach to the topic categorizes creativity into that of a person, a process, a product, and a press, or situation (Feldhusen & Goh, 1995). Through thorough examination of the complexities of each of these aspects of individual creativity, researchers can more accurately determine the most effective approaches to use in addressing the identified needs of these specific areas.

The CPS Version 6.1 brings further definition to the specific area of problem solving in the overall process of creative development (Isaksen et al., 2000). By categorizing this process into major components of Understanding the Problem, Generating Ideas, and Planning for Action, and then analyzing stages within these components, a research based educational program can be designed. By adding an overall summative phase of Planning the Approach to this model, educators are provided with a model for the development of creative thinking strategies and techniques that can be designed to fit within the objective requirements of any curriculum area at any age level.

As a result of this research-based, scientific approach to creative education, teachers will be equipped with the necessary tools to address one of the most challenging problems ever to face this nation. The creativity levels within individuals, necessary to effectively address the complex problems facing future generations, will be impacted in a positive direction. As proven time and again throughout history, the well-being of this nation's constituency lies in the educational levels of its individuals. This review of the literature serves to support that premise.

CHAPTER III

METHODOLOGY

Context of the Study

A long range goal of Roscoe ISD is to effectively implement CPS techniques into the instructional design of its course offerings across all subject areas and grade levels. It is anticipated that through an effective design, delivery, and evaluation of this study, the positive impacts of CPS for the educational realm will be exemplified. As a result of the positive impact of this study of the effects of CPS as an instructional strategy in Introduction to World Agricultural Science and Technology I, Roscoe ISD has a mid range goal of developing a specific course in CPS to be implemented at the 7^{th} grade level beginning in the fall of 2007. In further anticipation of the positive impacts of CPS, Roscoe ISD intends to develop an active and aggressive teacher professional development program. The focus of this professional development will be to train teachers to effectively use CPS instructional strategies in the presentation of their entire curriculum in grades kindergarten through 12.

This study was conducted at Roscoe High School in the Roscoe Independent School District, a small rural school district in the Rolling Plains region of West Texas. Roscoe ISD is a single campus district that contains three separate campus departments within one physical location and a total current enrollment of 287 students. Roscoe Elementary School includes grades kindergarten through sixth grade and has a current enrollment of 135 students. Roscoe Junior High School consists of grades 7 and 8 with an enrollment of 51 students. Roscoe High School consists of grades 9 through 12 and has an enrollment of 101 students. The ethnic makeup of Roscoe ISD is 56% Hispanic, 41% Anglo, 2% African American and 1% American Indian. The socioeconomic status of the student body is 62% free or reduced lunch and 38% regular.

The Agricultural Science Department at Roscoe High School offers six different agricultural science courses from the approved curriculum each semester to approximately 95 different students. Of these six course offerings, five of the courses are offered in only one section, while the sixth course, Introduction to World Agricultural Science and Technology I and II are offered in two sections each fall and each spring semester respectively. All ninth grade students at Roscoe High School are enrolled in Introduction to World Agricultural Science and Technology I during the fall semester of their freshman years and Introduction to World Agricultural Science and Technology II during the spring semester of their freshman years.

This study was conducted during the fall semester of the 2006-2007 school year in the two sections of the Introduction to World Agricultural Science and Technology I courses, which were offered to all ninth grade students in Roscoe High School during that school year. There were 24 projected ninth grade students enrolled in the course for the 2006-2007 school year. Of that total, 4 special education students who were not tested by the TAKS test were eliminated from the study, leaving a total of (n = 20). Of the 20 students, 4 were female and 16 were male; 7 were Anglo and 13 were Hispanic; of which

5 were considered first generation Hispanics. Of the 20 ninth grade students, 10 students were assigned to the morning section of Introduction to World Agricultural Science and Technology I, which was scheduled from 8:50- 9:35 a.m. The other 10 students were assigned to the afternoon section of Introduction to World Agricultural Science and Technology I, which was offered from 1:05-1:50 p.m. This study took place in the Agricultural Science Classroom, the Agricultural Mechanics Laboratory, and the Agricultural Science Land Laboratory at Roscoe High School. This study was conducted during the same time frame when and in the same physical location in which Introduction to World Agricultural Science and Technology I is traditionally offered, in an attempt to enhance the internal and external validity of the study.

Research Design

The research design selected for this study was an experimental, randomized subjects, posttest only, control group design (Tuckman, 1999). The rationale for this design resulted from the fact that subjects for the treatment and control groups were randomly assigned by a computerized assignment process. In addition, the selection of the treatment and control groups was done on a random basis as well (Tuckman, 1999). The logistics for randomization of the students within the courses, and the randomization of the treatment and control groups, was simplified by the fact that all ninth grade students at Roscoe High School enroll in Introduction to World Agricultural Science and Technology I during the fall semester of their freshman years.

Administrative assistance for this study was provided by the teacher and this researcher. Occasionally, participants in the study were required to begin class early or stay late after class to complete phases of the classroom instructional strategies of the study. Therefore, cooperation from the high school principal in adjusting daily class schedules was necessary on occasion. In addition, a specialist in the area of curriculum and instruction from the Region 14 Education Service Center (ESC 14) in Abilene, Texas, provided assistance with the development, implementation, and evaluation of instructional strategies in the area of creative problem solving. These strategies were implemented with the randomly selected treatment group over the same curriculum that was administered to both the treatment and the control groups.

This study resulted in some threats to both internal and external validity. Internal validity occurs when the outcomes of the study are a result of the systematic function of the study, rather than some outside factor. Realistic threats to internal validity in this study came in the area of interaction as subjects in the treatment and control groups realized they were receiving two different instructional approaches to the same curriculum (Tuckman, 1999). To help offset this threat, the instructor and program administrators attempted to remain as discreet as possible in regard to these differences until the conclusion of the study. Selection of subjects was not a threat because of randomization. Other threats to internal validity, such as history and maturation were not factors because of the use of a control group. Finally, experimental mortality was not a threat, since all ninth grade students at Roscoe High School take this course in fulfillment of a local Roscoe ISD policy requirement.

A study has external validity when the results obtained from the study can be generalized in the real world to other similar programs or approaches. A threat to the external validity of this study occurred, as students in the treatment group realized that the intent of the effect was to stimulate more creativity among individuals from within that group. Another threat to external validity was found in the small number of subjects in the study, which resulted in the study results providing less generality to the whole population (Tuckman, 1999). Other threats to external validity, such as selection bias, were not threatening, since all possible members of this particular sample were participants in the study.

In any experiment, there may be unmeasured variables that vary systematically, thereby confounding the results of the experimental manipulation (Field, 2000). Analysis of Variance (ANOVA) was considered as a means of increasing the precision and power of the data analysis. ANOVA treats potentially confounding variables as control variables. This process neutralizes the effects of these variables on the dependent variable, thereby separating out the potentially biasing characteristics that tend to vary in uncontrolled ways from group to group (Tuckman, 1999).

This experimental design was applied to ensure maximum experimental control. ANOVA was incorporated into this design to provide increased statistical control through further equation of the experimental groups (Tuckman, 1999; Field, 2000). This researcher believes that through this experimental design, the experimental controls and statistical controls, coupled with the fact that the participants in the study were comprised of the entire possible sample at Roscoe High School, resulted in the balance necessary to achieve tenable results.

Population and Sample

The population for this study consisted of ninth grade students at Roscoe High School who were enrolled in Introduction to World Agricultural Science and Technology I. This course is a local requirement of Roscoe ISD that is offered each fall semester, stemming from the belief that students in this school district can gain substantial academic benefit from mastery of the objectives outlined in this unique curriculum. In addition, as a result of exposure to this agricultural science curriculum during their initial ninth grade year of high school, a high percentage of these students opt to take additional agricultural science electives during their tenth, eleventh, and twelfth grade years of high school. Policy makers within Roscoe ISD believe that this additional exposure to the agricultural science curriculum and objectives will result in long term benefits, in the form of lifetime skills. Students will need to recall these skills on a regular basis in their pursuit of true measures of future success.

A computer generated random assignment of these students (n=20) was made after registration for the 2006-2007 school year was complete. Half of the 20 students with TAKS scores were randomly assigned to the a.m. session of the course, while the other half of that number was randomly assigned to the p.m. session. In addition to random assignment of participants to each section, the two sections were randomly selected for distinction between the treatment group and control group, in an attempt to further strengthen the experimental design of the study.

The modest size of the sample can be attributed to the fact that the sample was comprised of the entire ninth grade class at Roscoe High School who had taken the TAKS test. Although participants were not required to participate in the study, as anticipated, 100% participation was achieved. A minimal amount of distinction was made between the treatment and control groups by the teacher and administrators. Furthermore, no further reference to the study was made than what is required by the IRB process, until the final results were compiled and tabulated.

All participants were presented with a Human Subjects Consent Form (Appendix A) before the conclusion of the 2005-2006 school year in May of 2006. The additional students, who moved into the District prior to the beginning of the 2006-2007 school year, were administered the Institutional Review Board (IRB) consent form during the second class period of that school year on Thursday, August 17, 2006. Both the treatment and control groups met on a five day per week (Monday through Friday) basis for 73 days. The fall semester began on Wednesday, August 16 and the study concluded on Friday, December 1, 2006.

As anticipated, all eligible subjects (n=20) participated in all phases of testing (posttest only design was implemented for measurement of low-level, high-level, and total cognition; pretest and posttest evaluations for creativity were used; and satisfaction was measured by a pre-measurement, mid-measurement, post-measurement design). No distinction was made between the treatment group and the control group in regard to any test administrations. These tests were administered to determine scores on low-level cognitive test questions, high-level cognitive test questions, total cognition tests, standardized creativity tests, and student course satisfaction instruments. Group sizes for the treatment group (n = 10) and control group (n = 10) were totally equal. According to McGregor (2002), if group sizes are not equal, un-weighted measures in the form of estimated marginal means should also be reported in the results (Field, 1999).

It was assumed that the number of valid scores available for analysis during the study would remain at (n = 20). The negative effects of mortality were not a factor, since the course is a local requirement of Roscoe ISD. A student moving out of the district would have been the only threat in this regard.

Procedures

Procedures for the design of this study followed a well planned, systematic process of teacher and student development in the CPS process. The teacher was instructed in the CPS instructional process in order to effectively present the curriculum to the treatment group in a manner that would positively stimulate their creative thinking processes. It had been hypothesized that this stimulation of students' creative processes would lead to enhanced levels of creativity within those individuals, as evidenced by distinctions between the treatment and control groups in posttest scores of low-level, high-level, and total cognition, creative thinking and problem solving ability, as well as course satisfaction.

Teacher Development

Teacher development of skills in the CPS process began in the spring of 2006 and extended through the summer and fall of 2006. A curriculum and instructional design specialist from ESC 14 in Abilene, Texas had been contracted to assist in the process of teacher training and development in CPS instructional strategies. This specialist, the agricultural science teacher, and this researcher conducted an initial meeting on Tuesday, April 4, 2006. The context of this meeting was to set up a schedule for teacher training and the design of an effective set of CPS delivery strategies to be implemented with the treatment group for the study in Introduction to World Agricultural Science and Technology I during the fall semester of 2006. As a result of that initial meeting, additional meetings were scheduled and conducted on Friday, May 19; Thursday, June 8; Monday, August 21; Tuesday, September 12; Monday, September 18; Monday, September 25; Monday, October 2; Monday, October 9; Monday, October 23; Monday, October 30; Monday, November, 6; Monday, November 13; Monday, November 20; and Monday, November 27.

The purpose of those meetings was for the three of us together to develop a better understanding of the CPS process. The incentive for those meetings was the anticipation that it would be impossible to instruct others to become more creative if the teacher did not have a good grasp of that concept himself. Specifically, teacher training included the development of the teacher in the two major categories of creativity, divergent and convergent thinking.

According to Isaksen and Treffinger (1985), there are some specific ground rules to follow when using the CPS process. The divergent ground rules include deferring judgment, looking for a number of ideas, accepting all ideas, stretching the imagination, allowing simmering time for new ideas, and seeking combinations of ideas. Convergent ground rules consist of being deliberate, being explicit, avoiding premature closure, taking the risk of examining difficult issues, developing affirmative judgment, and keeping the eyes on the objective.

In addition to becoming conditioned to the divergent and convergent ground rules, the teacher was acclimated to the six stages of the CPS process, and the divergent and convergent applications of each of these stages. These stages include mess-finding, data-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding (Isaksen & Treffinger, 1985). Upon completion of experimentation with these concepts of the CPS process, the teacher was equipped with instructional strategies for implementing the Introduction to World Agricultural Science and Technology I curriculum.

Student Education

The CPS strategies that students in the study learned were taken primarily from four major sources. These sources included Creative Problem Solving; The Basic Course (Isaksen & Treffinger, 1985), Creative Approaches to Problem Solving (Isaksen, Dorval, & Treffinger, 1994), Managing Virtual Changes – A Guide to Creative Problem-Solving in the Design Profession (Maraviglia & Kvashny, 2005), and The Creative Action Book and Guide (Parnes, Noller, & Biondi, 1977).

One aspect of student instruction in CPS entails the same aforementioned areas of divergent and convergent thinking, in which the teacher has been professionally developed in the ground rules as such (Isaksen & Treffinger, 1985). Students experienced both divergent and convergent activities in the stages of mess-finding, data-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding (Isaksen & Treffinger, 1985). Within these six stages of CPS, students received exposure to both direct and indirect instructional techniques. Direct instruction is a technique that relies on deliberate CPS training and educational programming, ranging from the teaching of a few basic CPS tools to more advanced levels of CPS facilitation. Indirect instructional strategies in CPS involve linking creative problem solving to other subject matter or initiatives, in which the primary emphasis is on solving the problem. Simply stated, there is a relevant and practical outcome for the student (Isaksen et al., 1994).

Another aspect of the CPS process that students in the treatment group gained exposure to during this study is aesthetics (whole brain thinking). According to Maraviglia and Kvashny (2005), most people have a dominant side of their brains, upon which they tend to rely almost exclusively, thereby failing to develop the other side of the brain. The analytical (left) side of the brain is used by individuals who tend to use logic and reasoning to arrive at solutions. However, the intuitive (right) side of the brain is used most by individuals who rely on feeling or intuition to solve problems. Research supports the conclusion that individuals who learn to exercise and use both sides of their brains become more effective at arriving at solutions to complex problems. Therefore, students in the treatment group were also exposed to activities and exercises that help students develop the less dominant side of their brains.

Finally, another aspect of the CPS process to which students in the treatment group gained exposure was twofold in nature. First, the personal creativity of the students was to be nurtured. Second, students gained experience with reaching and implementing creative decisions. This aspect involved alternating back and forth between “imaginative” (divergent) thinking and “judicial” (convergent) thinking (Noller, Parnes, & Biondi, 1976). A “learning by doing” atmosphere was designed to allow students to act creatively in the process of arriving at creative solutions to problems or situations. Internal and external factors that stimulated the imagination were also employed during this part of the process. Students gained self-confidence, motivation, open-mindedness, and greater expression of curiosity, consciousness of creative efforts, sensitivity to problems, and an increased ability to produce original, quality ideas that lead to solutions, as a result of these CPS activities (Noller et al., 1976). A schedule of the stages of the CPS treatments that were administered by day, week, and phase can be visualized in Table 3.1.

Table 3.1. Schedule of CPS Stages by Day, Week, and Phase.

Week	Phase	Stage of CPS					
		M-F	D-F	P-F	I-F	S-F	A-F
1	Divergent			w	w		
	Convergent					w	w
2	Divergent	t-w			m	m	w
	Convergent	t	t-w-f		m	m	w
3	Divergent	m					
	Convergent	m	m-t-w-r			w-r	f
4	Divergent	w-f	w	w	w	w-r	w
	Convergent	w	w	w	w	w-r	t-w-f
5	Divergent		t-w	m-t-w	m-t-w		
	Convergent		t-w	t-w	t-w		r
6	Divergent	f		t-w-f	t-w		
	Convergent	f		t-w-f	t-w	r-f	m-r
7	Divergent	m-w	m-w	m	m-w-f	m-f	m-f
	Convergent	m-t-r	m-t-w	m-t	m-t-r-f	m-t-r-f	m-t-f
8	Divergent	t-w-r-f	t-w-r-f	t-w-r-f	t-w-r-f	t-w-r-f	t-w-r-f
	Convergent	t-w-f	m-t-w-f	t-w-f	t-w-f	t-w-f	t-w-f
9	Divergent	w-r	t-w-r	w-r	w-r	w-r-f	w-r
	Convergent	w-r	t-w-r	w-r	w-r	w-r-f	w-r
10	Divergent	m	t-w			t-w	
	Convergent	m				f	r
11	Divergent		m-w-r-f		m	m-f	
	Convergent	t	t-w-r-f			m	f
12	Divergent			t-w-r	m-w-r	w-r-f	w-r-f
	Convergent			t-w-r	m-w-r	w-r-f	r
13	Divergent		m-w-r-f	w-r	m-t		
	Convergent		m-f		m-t	w-r-f	t
14	Divergent		m	t-w-r-f	w-t	m-w-t	w-t
	Convergent		m-t	w-r-f	w-t	m-w-t	m-t-w-f
15	Divergent	m	m		w		w
	Convergent	m	m-t		m-w	m-t	m-w

M-F = Mess-Finding, D-F = Data-Finding, P-F = Problem-Finding, I-F = Idea-Finding, S-F = Solution-Finding, A-F = Acceptance-Finding.
m = Monday, t = Tuesday, w = Wednesday, r = Thursday, f = Friday.

Data Collection

The data for this study was collected in the fall of 2006. The pretest data for creativity was collected during the first week of school, which began on Wednesday, August 16 and ended on Friday, August 18. A measurement of student satisfaction was also administered in the form of a pre-measurement during the first week of the semester, again at the mid-way point, and at the conclusion of the study, to compliment student descriptive measures.

The actual experiment was conducted over the course of approximately 16 weeks during the semester, which began on Wednesday, August 16 and ended on Friday, December 1. Posttest data to measure low-level, high-level, and total cognition among the subjects were collected at the end of the study, which concluded on Friday, December 1. At the conclusion of the 16 week instructional period, posttests were conducted during the week of Monday, November 27 through Friday, December 1. These posttests consisted of low-level, high-level, and total cognition, creativity, and a measurement of course satisfaction.

The course was delivered to both the treatment and the control groups in an identical setting. Both groups experienced the same curriculum on the same day, only at different times of day. While most of the course around which this study was designed did involve a classroom setting, there were occasional laboratory settings constructed in the Agricultural Mechanics Laboratory, the greenhouse, and at the Agricultural Science Land Laboratory, depending on the objectives for the lesson of the day. The control group received the curriculum through traditional instructional strategies of lecture, discussion, slides, question and answer, etc. However, the treatment group was presented the curriculum through the use of various divergent, convergent, and whole brain activities recently mentioned. During the course of the study, students were encouraged not to share content or procedures utilized within their respective groups, whether they be in the treatment or the control group (McGregor, 2002). A schedule of the data collection dates can be visualized in Table 3.2

Table 3.2. Schedule of Data Collection by Date.

Data Collection Schedule	
TTCT (Baseline)	Thursday, August 17, 2006
Satisfaction (Baseline)	Friday, August 18, 2006
Satisfaction (Midline)	Friday, October 6, 2006
TTCT (Posttest)	Tuesday, November 28, 2006
Satisfaction (Posttest)	Wednesday, November 29, 2006
Low-level Cognition (Posttest)	Thursday, November 30, 2006
High-level Cognition (Posttest)	Friday, December 1, 2006

Instrumentation

Instrumentation refers to the measurement or observation procedures to be used during an experimental study. These procedures typically include tests, mechanical measuring instruments, and judgment by observers (Tuckman, 1999). The instrumentation devices for this study were limited to measurements of cognition, creativity, and satisfaction.

Cognition Test

The posttest (Appendix E) for low-level, high-level, and total cognition was a 40 question test. This test consisted of 10 true/false questions, 25 multiple choice questions for low-level cognition and 5 short answer, open-ended questions for high-level cognition. The low-level cognition questions were over material directly covered in the units, while the higher cognitive level questions required application of learned information to the solution of a problem or situation (Brashears, 2004). These instruments were developed by the researcher and course instructor, with assistance provided by the curriculum/instructional specialist from ESC 14.

The item content for these tests was consistently coordinated with the course content and material. The content of the tests varied between low and high levels of cognition. These cognition levels were based on the properties of Bloom's Taxonomy of Educational Objectives for the Cognitive Domain (Seddon, 1978). These levels progressed upward from the lowest level of knowledge, to comprehension, application, analysis, and synthesis, and eventually to the highest level of cognition, which is evaluation. McGregor (2002) refers to these levels of cognition as they are condensed by the 1987 Newcomb and Treftz Model into areas ranging from the lowest level of remembering, to processing and creating, followed by the highest cognitive level of evaluation. Questions on the low-level cognition portion of the posttest were derived from lower level skills of processing and remembering. Questions on the high-level cognition portion of the posttest were derived from higher level skills of creation and evaluation (Newcomb & Treftz). The information in Table 3.3 illustrates a replication by

Whittington and Newcomb (1991) of the 1987 Newcomb and Treftz Comparison Model of Bloom's six levels of cognition with their four levels of cognition.

Table 3.3.
Comparison of Bloom's Taxonomy with Newcomb and Treft's Classification.

Bloom's Taxonomy	Newcomb-Treftz Model
Knowledge	Remembering
Comprehension	▼
Application	Processing
Analysis	▼
Synthesis	Creating
Evaluation	Evaluating

According to Tuckman (1999), test validity is the extent to which a test instrument measures what it purports to measure. The posttest for cognition in this study measured the knowledge levels of first year agricultural science students in their overall knowledge of basic agriculturally related concepts. To ensure content and face validity of these tests, a panel of agricultural and educational experts from Texas Tech University and Texas A&M University reviewed the instruments prior to their actual administration. Revisions were made to the instruments upon recommendation.

Test reliability means that the test measures consistently. Before a researcher draws any conclusions from a study, he or she should assess the reliability of the test instrument (Tuckman, 1999). According to Brashears (2004), a researcher may conduct a field test for reliability on two populations. By calculating the posttest reliability through SPSS, using the Kuder-Richardson-20 (KR-20), the coefficient alpha will evaluate the items for reliability (Tuckman, 1999).

Creativity Tests

The TTCT was the measurement device used to measure creative thinking in this study. These tests have been widely used for evaluating creativity programs and are recommended for assessing creativity in groups ranging from kindergarten age through graduate school (Kvashny, 1977). As a result, these standardized tests have undergone extensive literature review in regard to reliability and validity. Acceptable levels of reliability and strong evidence of predictive validity make the TTCT a popular measuring device for the assessment of behaviors associated with creativity (Isaksen & Puccio, 1988). The tasks and activities of the TTCT chosen for this study were those that have not only withstood tests for reliability and validity, but were also those that are economically administered and scored.

The level of creativity was measured by the TTCT, Thinking Creatively With Pictures Figural Booklet A (Torrance, 1998). This instrument, which measures the production of divergent ideas, consists today of five subtests, including fluency, originality, abstractness of titles, elaboration, and resistance to premature closure. The fluency score refers to the number of ideas a person expresses through interpretable responses that use the stimulus in a meaningful manner. Originality refers to the infrequency and unusualness of response. Abstractness of titles refers to the ability to produce good titles involving the thinking processes of synthesis and organization. In scoring elaboration, credit is given for each pertinent detail (idea, piece of information, etc.) added to the original stimulus figure, its boundaries, and/or its surrounding space. Resistance to premature closure refers to the ability of a creative person to remain open and delay closure long enough to make the mental leap that makes original ideas possible. This is measured by the individual's tendency to close the incomplete figures immediately with straight or curved lines (Torrance, 1998). As a result of numerous investigations of this instrument's construct, concurrent, and predictive validity, this instrument has proven to be a valid measure of creativity levels within individuals.

Satisfaction Evaluation Instrument

Both the treatment group and the control group completed a satisfaction instrument at the beginning, mid-way point, and conclusion of the study, during the final week of the study. Participants in the study were asked to evaluate the course using a researcher designed satisfaction instrument (Appendix F). This instrument measured student satisfaction in the three areas of clarity, delivery, and content. Each section was comprised of five questions which allowed students to answer using a Likert-type scale ranging from: 1 = "Strongly Disagree" to 5 = "Strongly Agree". Face and content validity of this instrument has already been verified by a team of three faculty members in the Department of Agricultural Education and Communications at Texas Tech University. These faculty members possess knowledge and experience in the creation of these types of instruments (Brashears, 2004).

According to Brashears (2004) a pilot test to determine the reliability of the instrument has already been conducted. From a group of 35 agricultural education students enrolled in distance education courses, a Cronbach's alpha was calculated for each section. Results indicated ά = .83 for clarity, ά = .75 for delivery, and ά = .80 for content, resulting in an overall Cronbach's alpha on the 15 item instrument of ά = .90.

In addition, a post-hoc reliability calculation has already been conducted on 98 students who have previously completed this satisfaction instrument. Results for the post-hoc revealed ά = .83 for clarity, ά = .75 for delivery, and ά = .80 for content, resulting in an overall post-hoc total of ά = .90 (Brashears, 2004).

Lesson Content and Treatment

The treatment and control groups received identical lesson content (Appendix B). The only aspect of the lesson that was manipulated was the instructional strategies used for the treatment group. The control group received traditional instructional strategies, while the treatment group received instructional strategies based on the concept of the CPS model for instructional strategy (Isaksen, Dorval, & Treffinger, 2000).

Lesson content for this study came directly from the Introduction to World Agricultural Science and Technology I: A Teacher's Resource Guide (CEV Multimedia, Ltd. Ed., 2004). This multimedia curriculum employs several of the senses and methods of comprehension to impart knowledge and skills. Research indicates that the synergy created from reading, listening, seeing, and practicing is greater than the effect of single media approaches. The multimedia approach embraces the philosophy that the sum of all the human senses is greater than its parts (CEV Multimedia, 2004).

The CEV Multimedia Curriculum provides the curriculum in various mediums which include videotapes, DVD's, CD-ROMS, Microsoft Power Point® presentations, and written material. There are two sections in the Teacher's Resource Guide which divide the material into multimedia materials and additional materials. The multimedia material coordinates the CEV curriculum for Introduction to World Agricultural Science and Technology I with the TEKS objectives (Appendix C), which are required by state law to be taught in this course (Texas Education Agency, 1997). The additional materials for each topic provide additional resources and curriculum correlation charts. These correlation charts serve to associate the TEKS objectives for Introduction to World Agricultural Science and Technology I with the CEV products (CEV Multimedia, 2004).

Two additional resources for this curriculum provided additional supplemental support. An Internet Resources list provided online resources that compliment the various aspects of the curriculum (CEV Multimedia, 2004). Also, a resource that provided assistance with Supervised Agricultural Experiences (SAE), another objective requirement of the course, was available through this curriculum. SAE Central provides a website that contains a series of eight power point lessons over SAE programs which recommend activities for Introduction to World Agricultural Science & Technology I. These activities include topics on entrepreneurship, placement, analytical/experimental research, and supplementary improvement (CEV Multimedia, 2004).

The actual CEV curriculum for Introduction to World Agricultural Science and Technology I (Appendix D) contains a series of 37 lessons that cover a multitude of fundamental agricultural topics. These topics address the basics in the areas of the politics and research behind agriculture, animal science, environmental science, food and fiber science, basic metallurgy, career planning, poultry and fish production, agricultural profitability, canine selection and confirmation, human impacts on the environment, shop skills and safety, floral design, hunting and fishing, sustainable agriculture, nutrition, and world agriculture and population survival issues (CEV Multimedia, 2004). Another positive aspect of this curriculum is that it provides virtual field trips in areas of egg production, fish hatchery, greenhouse, the Pitchfork Ranch, the San Joaquin Valley, a thoroughbred horse farm, and tractor manufacturing (CEV Multimedia, 2000). These authentic experiences enable students to grasp and retain information more readily than they could through many of the more traditional curriculums.

While the control group for this study received this curriculum through these aforementioned multimedia techniques, the treatment group received only a portion of the multimedia approach. The emphasis on instructional techniques that were used to implement the Introduction to World Agricultural Science and Technology I curriculum with the treatment group was primarily in the area of CPS strategies. Both divergent and convergent techniques were applied to the six stages of CPS, which include mess-finding, data-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding (Isaksen & Treffinger, 1985). In addition, the CPS strategy of whole brain thinking was applied to relevant aspects of the lessons as applicable (Maraviglia & Kvashny, 2005). While the treatment group did not receive the multimedia strategies to the same extent as the control group, they did receive multiple strategies in the concentrated areas of creative problem solving.

Data Analysis

Participants took pretests for evaluation of creativity and pre-measurements of student satisfaction. In addition, students were administered another student satisfaction instrument for clarity, delivery, and content at the mid-point of the study. Posttest only assessments in areas of low-level, high-level, and total cognition were also administered at the conclusion of the course. In addition to the student satisfaction instrument, the TTCT, a standardized test, was re-administered at the conclusion of the course in the form of a posttest.

The specific posttest instrument for measurement of cognition consisted of 40 questions (10 true/false, 25 multiple choice, and 5 short answer/essay). When administration of these instruments was complete, scores were hand calculated. After results were tabulated for each test, the results were entered in the Statistical Package for the Social Sciences (SPSS) for Windows 12.0 data analysis program (Field, 2000).

In addition to pretest, mid-test, and posttest data, descriptive data were collected that included age, gender, ethnicity, socioeconomic status, class rank, grade point average (GPA), and TAKS scores from the core curriculum areas of language arts, math, science, and social studies. All descriptive data were analyzed and presented in the form of counts, percentages, means, standard deviations, standard error, and confidence intervals (Field, 2000).

Tests for significant treatment effects of all a priori selected covariates that showed a correlation with the dependent variable were conducted for each of the five hypothesis using ANOVA, since a priori selected covariates correlated with the dependent variable. A preliminary analysis of collected data was conducted to determine whether the use of ANOVA would produce tenable results. Before ANOVA can yield tenable results the selected variable must be proven to be correlated with the dependent variable. The purpose of including covariates was to reduce the within group error variance and to eliminate confounding variables. Pearson-Product Moment correlations were conducted in SPSS 12.0 to determine whether correlations existed between selected covariates. In addition, this variable must meet the assumptions of linearity and homogeneity.

ANOVA measures the ratio of systematic variation to unsystematic variation through a measure known as the F-ratio. The assumptions of ANOVA must also be tenable. However, it is noted that analysis of variance is a robust test (Fields, 2000). According to Field (2000), drawn samples must be random and independent of the representative population. If the independence assumption is violated, the test will yield inaccurate results.

In testing for equality of variance using Levene's test for homogeneity of variance, if the F value calculated was insignificant, the researcher concluded that the assumption of the differences between the variances was zero (Fields, 2000). In some of the analyses, the Levene's test for homogeneity of variance between groups was statistically significant, which violated one of the assumptions for ANOVA. Consequently, the researcher utilized the Browne-Forsythe F test (F_{BF}) for the omnibus ANOVA hypotheses, which is recommended in place of the F test in cases where variances between groups are not equal (SPSS/PC v.12).

The following null hypotheses were tested at the $p < .05$ level.

H_o1: With the pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, there is no significant difference between the low-level cognitive test scores of students receiving instruction through traditional instructional techniques and students receiving instruction through CPS instructional methods.

H_o2: With the pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, there is no significant difference between the high-level cognitive test scores of students receiving instruction through traditional instructional techniques and students receiving instruction through CPS instructional methods.

H_o3: With the pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, there is no significant difference between the total cognitive test scores of students receiving instruction through traditional instructional techniques and students receiving instruction through CPS instructional methods.

H_04: With pretest scores in creativity as a covariate, there is no significant difference between creative thinking scores of students receiving instruction through traditional instructional techniques and students receiving instruction through CPS instructional methods.

H_o5: There is no significant difference between satisfaction levels with course instructional delivery methods of students receiving instruction through traditional instructional techniques and students receiving instruction through CPS instructional methods.

In order to analyze the data on low-level, high-level, and total student cognition, creativity, and course satisfaction, several techniques were used. The students' posttests were examined to determine the relationship between that instrument and the course objectives that were taught. According to Trochim (2001), in order to use ANOVA design, the posttest must be highly correlated with the course objectives as they were presented to the students. Creativity should be perfectly correlated since the same TTCT Figural Form A was used for both the pretest and the posttest. Data analysis of student satisfaction (clarity, delivery, content, and total) was conducted through the use of a pre/mid/post evaluation design for that area of measurement. Finally, student scores on the effects of instruction through means of creative problem solving compared to traditional modes of instruction were examined.

An MS Excel spreadsheet (Thalheimer & Cook, 2002) was used to determine effect size, based upon the SPSS 12.0 ANOVA F-values and sample sizes. This option produces the value of Cohen's *d*, which is a measure of the size of experimental effect, or proportion of variance of the dependent variable, as it relates to the factor. Cohen's *d* is defined as the difference between the means, M_1-M_2, divided by standard deviation, σ, of either group. Cohen maintained that standard deviation of either group could be used when the variances of the two groups are homogeneous (Cohen, 1988). Unlike significance tests, effect size is independent of sample size. Its measures summarize the findings from a specified area of research. When calculating Cohen's *d* from F tests, the following interpretation was recommended (Thalheimer & Cook, 2002):

Negligible effect >=-0.15 to <.15,

Small effect >=.15 to <.40,

Medium effect >=.40 to <.75,

Large effect >=.75 to <1.10,

Very large effect >=1.10 to <1.45, and

Huge effect >1.45.

Summary

The researcher, accompanied by a curriculum specialist from ESC 14 and a teacher professionally developed in techniques for administration of CPS instructional strategies, used three instruments to collect data from ninth grade Introduction to World Agricultural Science and Technology I students before, during, and after delivery of the semester long course. The teacher delivered the course over a 16 week period using traditional instructional strategies with the control group and CPS instructional strategies with the treatment group. Students received a posttest only in areas of low-level, high-level, and total cognition. However, for measurement of figural creativity, students received both a pretest and a posttest. For the measurement of course satisfaction, students received a pre-evaluation, mid-evaluation, and post-evaluation for satisfaction in the areas of clarity, delivery, and content. Data from each of these measurements were recorded and stored in an SPSS database for analysis in an effort to answer the research questions raised by the study.

CHAPTER IV

FINDINGS AND RESULTS

Introduction

The purpose of this study was to determine if any measurable learning effects would result from the use of Creative Problem Solving (CPS) instructional strategies when compared to more traditional methods of instruction for students enrolled in an Introduction to a World Agricultural Science and Technology course. Ninth grade students enrolled in the course were studied in order to determine whether significant differences exist between students who were taught using CPS strategies of divergence, convergence, and aesthetics as compared to students who receive instruction through traditional inductive instructional methods of lecture, discussion, question/answer, multimedia, etc.

The previous chapter described the methodology used in the experimental study. The context of the study, representative population and sample, data collection, instrumentation, lesson content and treatment, and data analyses were discussed. Chapter IV presents the results of the data analysis generated from the representative sample participants. A total of 33 tables and 8 figures are used in Chapter IV to present the data analysis and accompanying narrative.

Data were collected and analyzed to test the following research hypothesis:

1. With the pretest standardized scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score

statistically higher on the low-level cognitive portion of the posttest than students in the traditionally instructed group.

2. With the pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the high-level cognitive portion of the posttest than students in the traditionally instructed group.
3. With the pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the total cognition portion of the posttest than students in the traditionally instructed group.
4. With pretest scores in creativity as a covariate, students in the CPS group will score statistically higher on the Creative Thinking posttest than students in the traditionally instructed group.
5. Students in the CPS group will score statistically higher on the Course Satisfaction instrument than students in the traditionally instructed group.

Univariate Analysis Results

Descriptive data were collected for both the treatment and control groups and includes age, gender, ethnicity, socioeconomic status, TAKS scores, and GPA of students. In addition, pretest scores were collected for creativity and course satisfaction. Mid-test scores were collected for course satisfaction (clarity, delivery, and content).

Posttest scores were collected for creativity and course satisfaction, while a posttest only score was collected for low-level, high-level, and total cognition.

Participants for the study were selected based on their enrollment in Introduction to World Agricultural Science and Technology I, a course taken each fall by every ninth grade student in Roscoe, Texas, in fulfillment of a local policy requirement. A sample (n=20) of eligible participants was identified to serve as subjects during the experiment. Although there were originally 24 students enrolled in the course, 4 special education students had taken the State Developed Alternative Assessment (SDAA) rather than the TAKS. Since the TAKS test was used as a covariate, the SDAA scores could not be considered comparable to the TAKS scores in terms of measurability. Upon completion of all semester long course instruction, testing, and measurement a total number of (n= 20) were available for analysis.

Of the initial available participants, 16 (80%) of the original participants were male and 4 (20%) were female. The average age of participants was 14.1 years (SD = .31) and included 18 students who where 14 years of age and 2 students who were 15 years of age. Also, of those original participants, 35% were Anglo and 65% were Hispanic. Additionally, 45% were of average or above average socioeconomic status, while 55% were considered low socioeconomic, based on their qualification for free or reduced school lunch prices. Table 4.1 displays the dispersion of participants based on sex, age, ethnicity, and socioeconomic status.

Table 4.1.
Sex, Age, Ethnicity, and Socio-economic Status of Participants.

Grouping Variable	Frequency	Percentage
Sex	n	%
Male	16	80
Female	4	20
Total	20	100
Age	n	%
14	18	90
15	2	10
Total	20	100
Ethnicity	n	%
Anglo	7	35
Hispanic	13	65
Total	20	100
Socio-economic Status	n	%
Regular Lunch	9	45
Free/Reduced Lunch	11	55
Total	20	100

Analysis and Equity Between Traditional and Creative Problem Solving Groups

An initial analysis was completed in order to verify equality between the CPS group and the group receiving instruction through more traditional means. A series of independent t-tests were utilized to determine if any significant differences existed between the treatment and control groups in terms of standardized test scores and grade point averages. The TAKS is the standardized measurement of student academic performance in Texas. Students in the eighth grade in Texas are tested in the core curriculum areas of language arts, math, science, and social studies. The GPA is the localized measurement of student academic performance in Roscoe ISD.

Table 4.2 summarizes the Mean, Standard Deviation, and Equality of Variance that were used in equating the traditional and CPS groups for significant differences on the following variables: TAKS language arts scores, TAKS math, TAKS science, TAKS social studies, and GPA.

Table 4.2.
Comparison of Differences in CPS and Traditional Groups by TAKS Scores and GPA.

Instrument	Group	n	M	SD	*F*	p
TAKS	CPS	10	2260.80	285.75	.067	.799
Lang Arts	Traditional	10	2355.40	235.91		
TAKS	CPS	10	2175.80	254.23	.004	.951
Math	Traditional	10	2237.20	200.48		
TAKS	CPS	10	2140.00	217.15	.531	.475
Science	Traditional	10	2194.40	253.03		
TAKS	CPS	10	2403.20	195.28	1.052	.319
S-Studies	Traditional	10	2405.50	213.75		
GPA	CPS	10	85.09	6.63	.380	.546
	Traditional	10	90.07	5.33		

Participants were given the forty-item posttest (Appendix E) during the week of November 27 through December 1, 2006. The posttest was administered by the teacher and scores were tabulated by the teacher, the researcher, and the curriculum specialist from the Region 14 Education Service Center. The test instrument consisted of 40 items. The first ten were true/false followed by 25 multiple choice questions. These questions were measurements of low-level cognition by the participants. They were graded exclusively by the teacher on a scale of correct = 2 and incorrect = 0. The final five questions were short answer/essay type questions that were graded by the teacher, researcher, and specialist using a rubric designed by the specialist to systematically score those types of questions. These five questions were designed to measure high-level cognition and were graded on a scale of totally correct = (6), totally incorrect = (0), and partially correct = (1-5). Results of the posttest are displayed by group in Table 4.3.

Table 4.3.
Posttest Cognition Mean Scores and Standard Deviations by Treatment Level.

Instrument	Treatment Level					
	CPS[1] (n = 10)		Traditional[2] (n = 10)		Total (n = 20)	
	M	SD	M	SD	M	SD
Posttest						
Low Cog[a]	50.40	8.154	50.20	12.908	50.30	10.509
High Cog[b]	14.80	5.770	12.60	5.602	13.70	5.648
Total Cog[c]	65.20	11.603	62.80	17.022	64.00	14.231

[a] 70 point scale, [b] 30 point scale, [c] 100 point scale
[1]Creative Problem Solving, [2] Traditional

According to mean scores, students in the CPS group outperformed students in the traditional group on all three measures of the cognition posttest, including low-level, high-level, and total cognition. The smallest mean difference was in the area of low-level cognition, which was an expected outcome, since CPS instructional strategies are not designed to impact low-level cognitive learning as much as high-level cognition. The largest mean score difference was in the area of high-level cognition. This was also an expected outcome, since CPS instructional strategies are designed to impact problem solving strategies, which require application of problem solving techniques to problems not previously experienced by learners. Total cognition would naturally be the middle mean score in a measurement of cognition levels that is the sum of low-level and high-level cognition scores.

The Creativity Instrument consisted of a standardized test of creativity known as the TTCT Figural Form A. This instrument was administered in the form of a pretest during the week of August 16-18, 2006 and then again in the form of a posttest during the week of November 27 through December 1, 2006. This item measures creativity in five areas of fluency, originality, abstractness of titles, elaboration, and resistance to premature closure. The mean scores for each of these five areas of creativity are presented by treatment group in Table 4.4.

Table 4.4.
Pretest/Posttest Creativity Mean Scores and Standard Deviations by Treatment Level.

Instrument	Treatment Level					
	CPS[1] (n = 10)		Traditional[2] (n = 10)		Total (n = 20)	
Pretest	M	SD	M	SD	M	SD
Fluency[a]	89.00	18.05	105.40	23.36	97.20	21.99
Originality[b]	101.70	18.21	118.30	23.47	110.00	22.15
Titles[c]	103.30	26.95	108.00	28.69	105.65	27.20
Elaboration[d]	74.80	5.90	77.30	11.97	76.05	9.28
Resistance[e]	80.70	19.39	104.00	16.84	92.35	21.34
Average[f]	90.00	14.24	102.60	15.75	96.30	15.98
Posttest	M	SD	M	SD	M	SD
Fluency[a]	102.90	17.91	116.70	23.74	109.80	21.65
Originality[b]	108.90	22.13	119.90	20.37	114.40	21.46
Titles[c]	98.90	38.86	94.30	45.30	96.60	41.15
Elaboration[d]	79.60	9.92	92.30	9.75	85.95	11.58
Resistance[e]	96.60	15.09	99.00	21.40	97.80	18.06
Average[f]	97.00	16.40	104.50	16.78	100.75	16.60

[a]Number of ideas, [b]Unusualness of response, [c]Ability to produce good titles, [d]Pertinent detail, [e]Resistance to premature closure, [f]Average of means and standard deviations
Range = 0-180

Total mean scores for creativity suggest that the traditionally instructed group is higher in creativity than the CPS group. However, it is interesting to note that the CPS group closed the gap for total average creativity from the pretest to the posttest. The CPS group improved by 7 points from 90.00 on the pretest to 97.00 on the posttest, while the traditional group improved less than 2 points from 102.60 on the pretest to 104.50 on the posttest.

The satisfaction instrument (Appendix F) consisted of 15 Likert-type items that measured participant satisfaction in three construct areas: clarity, delivery, and content. Each of the three areas was comprised of five statements with a five-point scale for agreement or disagreement. This resulted in each construct area being measured on a scale of 5 – 25. In addition, a variable was created by summing the three construct scores to determine a total satisfaction index score. This variable was measured on a scale of 15 – 75. The mean scores for each construct area by treatment are presented in Table 4.5.

Table 4.5.
Pretest/Mid-test/Posttest Satisfaction Mean Scores and Standard Deviations by Treatment Level.

Construct	Treatment Level					
	CPS[1] (n = 10)		Traditional[2] (n = 10)		Total (n = 20)	
	M	SD	M	SD	M	SD
Pretest						
Clarity[a]	18.00	1.83	16.60	2.17	17.30	2.08
Delivery[a]	17.70	1.95	16.80	2.62	17.25	2.30
Content[a]	17.10	2.03	15.70	2.36	16.40	2.26
Total[b]	52.80	4.78	49.10	6.07	50.95	5.64
Mid-test						
Clarity[a]	18.90	1.37	18.90	2.96	18.90	2.25
Delivery[a]	19.60	1.27	17.10	3.38	18.35	2.80
Content[a]	18.10	2.38	16.80	2.15	17.45	2.31
Total[b]	56.60	3.78	52.80	7.25	54.70	5.96
Posttest						
Clarity[a]	17.60	1.78	16.50	4.74	17.05	3.53
Delivery[a]	18.60	2.50	15.90	5.22	17.25	4.22
Content[a]	16.80	2.44	15.10	4.63	15.95	3.71
Total[b]	53.20	6.00	47.50	14.26	50.35	11.04

[a] 25 point scale, [b]75 point scale
[1] Creative Problem Solving, [2] Traditional

Total mean scores for the three content areas were similar between the pre, mid, and post administrations of the satisfaction instrument: Pre, 50.95; Mid, 54.70; and Post, 50.35. It was interesting to note that satisfaction was highest at the mid-way point of the course. However, it is also noteworthy that at each administration of the satisfaction instrument the CPS group indicated slightly greater satisfaction than the traditionally instructed group: Pre, CPS = 52.80 v. Traditional = 49.10; Mid, CPS = 56.60 v. Traditional = 52.80; and Post, CPS = 53.20 v. Traditional = 47.50. A final note of interest among the CPS group was that the delivery aspect of satisfaction was higher than clarity or content at both the mid-way point and final administrations of the satisfaction instrument: Mid, CPS = 19.60 and Post, CPS = 18.60.

Results Related to Research Hypothesis One

1. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the low-level cognitive portion of the posttest than students in the traditionally instructed group.

Low-level cognition items on the posttest consisted of 10 true/false and 25 multiple choice questions. These items were graded and entered into the SPSS database as right = (2) and wrong = (0).

A Pearson Product Moment Correlation was calculated to determine the relationship between low-level cognition scores and TAKS language arts, TAKS math, TAKS science, and TAKS social studies scores. The resulting value for the calculations was determined to be $r = .109$ for TAKS language arts, $r = .305$ for TAKS math, $r = .441$ for TAKS science, and $r = .221$ for TAKS social studies. Since the value of r was less than < .70 (Trochim, 2001), an analysis of variance was conducted to determine the relationship between low-level cognition scores and methods of instruction.

A one-way analysis of variance was conducted to evaluate the relationship between low-level cognition and the two treatment levels of the independent variable. Treatment one consisted of instruction being delivered using CPS strategies. Treatment two consisted of instruction being delivered using traditional methods of instruction. The dependent variable for this research hypothesis was the student's low-level cognition for the semester of instruction as measured by the posttest low-level cognition score for each individual student. As reported in Table 4.6., the mean for low-level cognition was slightly greater for students in the CPS group (M = 50.40).

Table 4.6.
Descriptive Summary Table for Low-Level Cognition.

Group	n	M[1]	SD
CPS	10	50.40	8.154
Traditional	10	50.20	12.908
Total	20	50.30	10.509

[1] 70-point scale

A bar chart depicting the increased low-level cognition of the CPS group compared to the traditional group is displayed in Figure 4.1.

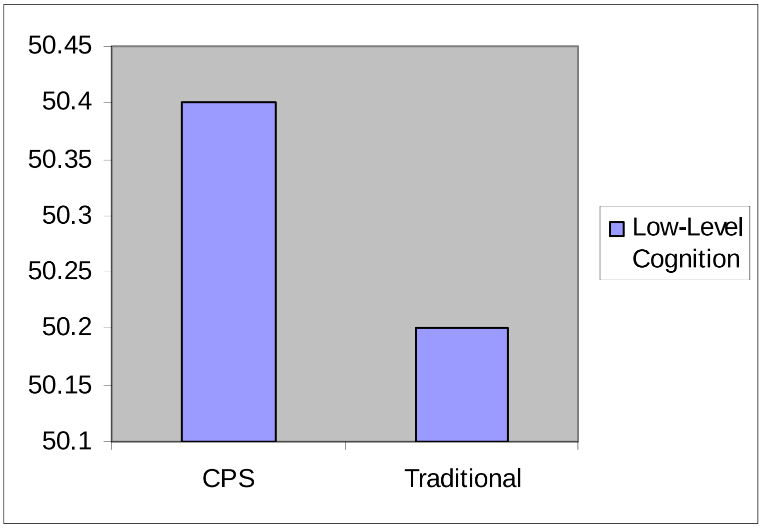


Figure 4.1. Low-Level Cognition Posttest Mean Scores

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were not statistically significant ($F_{Levene's}$= .497, df=1,18, p=.49). Therefore, the researcher concluded that variances of the two treatment groups for low-level cognition were not significantly different from each other. The results of this test are displayed in Table 4.7.

Table 4.7.
Variance between CPS and Traditional Groups in Low-level Cognition.

Measurement	Equality of Variance	
	F[1]	p
Low-level Cognition	.497	.490

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment low-level cognition scores (F= .002, df= 1,18, p=.97). The relative magnitude of the experimental treatment was negligible (Cohen's d= .03). Results of this ANOVA are reported in Table 4.8.

Table 4.8.
ANOVA Summary Table: Differences in Low-level Cognition Posttest Scores for CPS and Traditional Groups.

Source	SS	df	MS	F	p	*d*
Between	.200	1	.200	.002	.967	.03
Within	2098.000	18	116.556			
Total	2098.200	19				

The results of the one-way ANOVA failed to support the research hypothesis that low-level student cognition would be significantly greater for students exposed to CPS than for students exposed to traditional methods of instruction. It is interesting to note that students in the CPS group had slightly lower mean scores on TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA than students in the traditional group. However, although non-significant, students in the CPS group had a higher mean score than students in the traditional group on the low-level cognition posttest. This statistic may be an indicator of more improvement in low-level cognition scores among the CPS group than the traditional group, as a result of the CPS method of instruction.

Results Related to Research Hypothesis Two

2. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the high-level cognition portion of the cognitive posttest than students in the traditionally instructed group.

High-level cognition items on the posttest consisted of five open-ended, short answer/essay questions. These items were graded using a rubric and entered into the database as right = 6 and wrong = 0. Students who partially answered the question but failed to answer completely were given partial credit (1-5) for that particular question.

A Pearson Product Moment Correlation was calculated to determine the relationship between high-level cognition scores and TAKS language arts, TAKS math, TAKS science, and TAKS social studies scores. The resulting value for the calculations was determined to $r = .535$ for TAKS language arts, $r = .573$ for TAKS math, $r = .693$ for TAKS science, and $r = .602$ for TAKS social studies. Since the value of r was less than < .70 (Trochim, 2001), an analysis of variance was conducted to determine the relationship between high-level cognition scores and methods of instruction.

A one-way analysis of variance was conducted to evaluate the relationship between high-level cognition and the two treatment levels of the independent variable. Treatment one consisted of instruction delivered through CPS instructional strategies. Treatment two consisted of instruction delivered through traditional methods of instruction. The dependent variable for this research hypothesis was the student's high-level cognition for the semester of instruction as measured by the posttest high-level cognition score for each individual student. As reported in Table 4.9, the mean for high-level cognition was greatest for students in the CPS group ($M = 14.80$).

Table 4.9.
Descriptive Summary Table for High-Level Cognition.

Group	n	M[1]	SD
CPS	10	14.80	5.770
Traditional	10	12.60	5.602
Total	20	13.70	5.648

[1] 30-point scale

A bar chart depicting the increased high-level cognition of the CPS group compared to the traditional group is displayed in Figure 4.2.

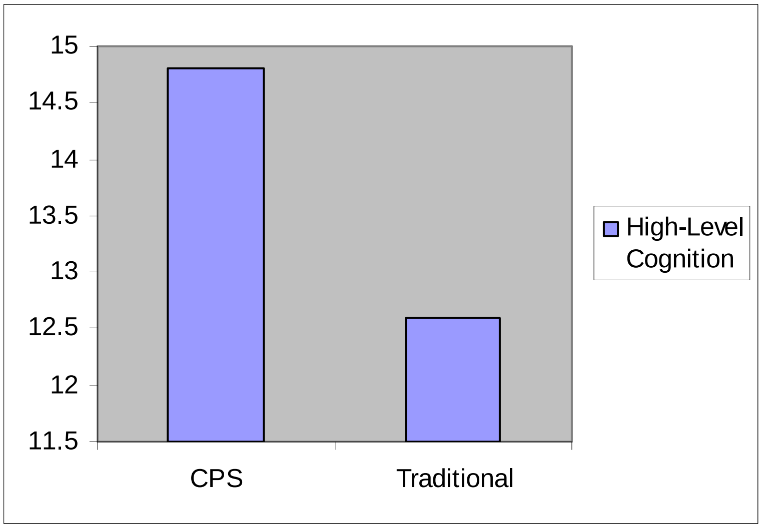


Figure 4.2. High-Level Cognition Posttest Mean Scores

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were not statistically significant ($F_{Levene's}$=.092, df=1,18 , p=.766). Therefore, the researcher concluded that variances of the two treatment groups for high-level cognition were not significantly different from each other. The results of this test are displayed in Table 4.10.

Table 4.10.
Variance between CPS and Traditional Groups in High-Level Cognition.

Measurement	Equality of Variance	
	F[1]	p
High-level Cognition	.092	.766

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment high-level cognition scores (F=.748, df=1,18, p=.398). The relative magnitude of the experimental treatment was medium (Cohen's d=.41). Results of this ANOVA are reported in Table 4.11.

Table 4.11.
ANOVA Summary Table: Differences in High-Level Cognition Posttest Scores for CPS and Traditional Groups.

Source	SS	df	MS	F	p	*d*
Between	24.200	1	24.200	.748	.398	.41
Within	582.000	18	32.333			
Total	606.200	19				

The results of the one-way ANOVA failed to support the research hypothesis that high-level student cognition would be significantly greater for students exposed to CPS than for students exposed to traditional methods of instruction. It is interesting to note that students in the CPS group had lower mean scores on TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA than students in the traditional group. However, although non-significant, students in the CPS group had a slightly higher mean score with a slightly greater standard deviation on high-level cognition than students in the traditional group. This statistic might be viewed as an indicator of greater improvement in high-level cognition scores among the CPS group than the traditional group, as a result of the CPS method of instruction.

Results Related to Research Hypothesis Three

3. With standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the total cognition portion of the cognitive posttest than students in the traditionally instructed group.

The test for total cognition consisted of a combination of the total scores for low-level and high-level cognition. Since the low-level cognition test scores ranged on a scale from a low of 0 to a high of 70, and the high-level cognition scores ranged on a scale from a low of 0 to a high of 30, the scoring range for the total cognition variable was on a scale of 0 to 100.

A series of Pearson Product Moment Correlations were calculated to determine the relationships between total cognition scores and TAKS language arts, TAKS math, TAKS science, and TAKS social studies scores. The resulting value for the calculations was determined to $r = .293$ for TAKS language arts, $r = .453$ for TAKS math, $r = .601$ for TAKS science, and $r = .402$ for TAKS social studies. Since the value of r was less than $< .70$ (Trochim, 2001), an analysis of variance was conducted to determine the relationship between total cognition scores and the methods of instruction.

A one-way analysis of variance was conducted to evaluate the relationship between total cognition and the two treatment levels of the independent variable. Treatment one consisted of instruction delivered through CPS instructional strategies. Treatment two consisted of instruction delivered through traditional instructional strategies. The dependent variable for this hypothesis was the student's total cognition for the semester of instruction, as measured by the posttest total score for each individual student. As reported in Table 4.12, the mean for total cognition was greatest for students in the CPS group ($M = 65.20$).

Table 4.12.
Descriptive Summary Table for Total Cognition.

Group	n	M[1]	SD
CPS	10	65.20	11.603
Traditional	10	62.80	17.022
Total	20	64.00	14.231

[1] 100-point scale

A bar chart depicting the increased total cognition of the CPS group compared to the traditional group is displayed in Figure 4.3.

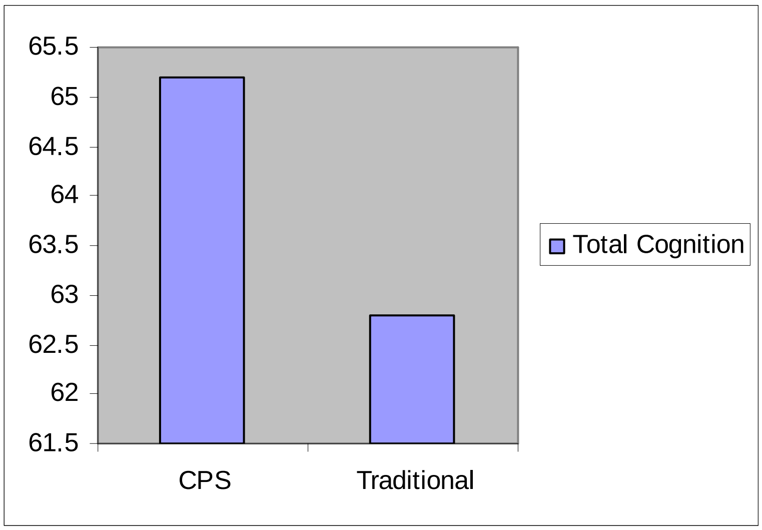


Figure 4.3.Total Cognition Posttest Mean Scores

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were not statistically significant ($F_{Levene's}$=1.027 , df=1,18 , p=.324). Therefore, the researcher concluded that variances of the two treatment groups for total cognition were not significantly different from each other. The results of this test are displayed in Table 4.13.

Table 4.13.
Variance between CPS and Traditional Groups in Total Cognition.

Measurement	Equality of Variance	
	F[1]	p
Total Cognition	1.027	.324

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment high-level cognition scores (F=.136, df=1,18, p=.717). The relative magnitude of the experimental treatment was small (Cohen's d=.17). Results of this ANOVA are reported in Table 4.14.

Table 4.14.
ANOVA Summary Table: Differences in Total Cognition Posttest Scores for CPS and Traditional Groups.

Source	SS	df	MS	F	p	*d*
Between	28.800	1	28.800	.136	.717	.17
Within	3819.200	18	212.178			
Total	3848.000	19				

The results of the one-way ANOVA failed to support the research hypothesis that total student cognition would be significantly greater for students exposed to CPS than for students exposed to traditional methods of instruction. As a note of interest, students in the CPS group had lower mean scores on TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA than students in the traditional group. However, although non-significant, students in the CPS group had a slightly higher mean score and a slightly smaller standard deviation on total cognition than students in the traditional group. This statistic may be an indicator of greater improvement in total cognition scores among the CPS group than the traditional group, as a result of the CPS method of instruction.

Results Related to Research Hypothesis Four

4. With pretest scores in creativity as a covariate, students in the CPS group will score statistically higher on the Creative Thinking posttest than students in the traditionally instructed group.

Student creativity levels were measured by the TTCT Figural Form A. These tests have been widely used for evaluating creativity programs and for assessing creativity in groups ranging from kindergarten age through graduate school (Kvashny, 1977). As a result, these standardized tests have undergone extensive literature review in regard to validity and reliability, resulting in the TCCT becoming a popular device for assessing behaviors associated with creativity (Isaksen & Puccio, 1988).

The most recently revised version of the TTCT Figural Form A measures creativity in five distinct areas, as well as a sixth element of average for total creativity. The five distinct areas include fluency, originality, abstractness of titles, elaboration, and resistance to premature closure, with the total creativity consisting of the average score for totals of the five distinct categories. The five areas produced standard scores that were reported on a scale with a mean of 100 and a standard deviation of 20. In addition, a sixth variable designed to measure the average for overall student creativity was constructed by averaging the sum of the five areas of creativity categorized by the TTCT Figural Form A assessment. The dependent variables were the six scores for creativity.

A series of Pearson Product Moment Correlations were calculated to determine the relationship between pretest and posttest scores for creative fluency, originality, abstractness of titles, elaboration, resistance to premature closure, and average total creativity. The resulting value for the calculations was determined to be r = .91 for fluency, r = .80 for originality, r = .54 for abstractness of titles, r = .54 for elaboration, r = .58 for resistance to premature closure, and r = .89 for average creativity. When the value of r is greater than > .70 (Trochim, 2001), an analysis of covariance must be conducted to determine the relationship between pretest and posttest scores of the two treatment levels of the independent variable. However, when the value of r is less than < .70 (Trochim, 2001), and analysis of variance must be conducted to determine the relationship between pretest and posttest scores. Therefore abstractness of titles, elaboration, and resistance to premature closure were analyzed through ANOVA. Fluency, originality, and average creativity were analyzed through a general linear model (GLM) ANCOVA. Treatment one consisted of instruction through CPS instructional strategies. Treatment two consisted of traditional instructional strategies.

A general linear model analysis of covariance was conducted to determine the main effects of instructional strategy upon creative fluency. As revealed in Table 4.15, the adjusted mean for fluency was greatest for students in the CPS group ($M_{adjusted}$=110.31).

Table 4.15.
Descriptive Summary Table for Creative Fluency.

Independent Variable	n	M Unadjusted[1]	M Adjusted
CPS	10	102.90[a]	110.31
Traditional	10	116.70[a]	109.29

[1] 180- point scale
[a] Covariate Appearing in Model Evaluated: Pre-Fluency = 97.20

A linear comparison of the increased creative fluency of the CPS group compared to the traditional group is displayed in Figure 4.4.

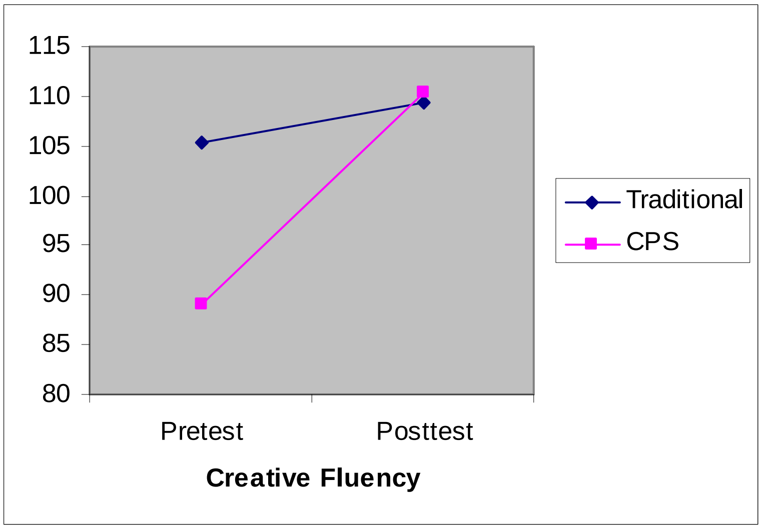


Figure 4.4. Pretest/Posttest Mean Comparison of Creative Fluency

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were statistically non-significant ($F_{Levene's}$=.104, df=1,18, p = .75). Therefore the researcher concluded that variances of the two treatment groups for creative fluency were not significantly different from each other, allowing the assumption for homogeneity to be met. The results of this test are displayed in Table 4.16.

Table 4.16.
Variance between CPS and Traditional Groups on Creative Fluency.

Measurement	Equality of Variance	
	F[1]	p
Creative Fluency	.104	.751

[1]Levene's statistic – test of homogeneity of variance

The ANCOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment fluency scores, holding pretreatment fluency scores constant (F=.048, df=1, p=.83). The relative magnitude of the experimental treatment was negligible (Cohen's d=.10). Results of this ANCOVA are reported in Table 4.17.

Table 4.17.
ANCOVA Summary Table: Differences between CPS and Traditional Groups on Creative Fluency.

Source	SS	df	MS	F	p	*d*
Corrected Model	7355.291	2	3677.645	40.234	.000	2.99
Intercept	385.225	1	385.225	4.214	.056	.97
Pre-Fluency	6403.091	1	6403.091	70.051	.000	3.95
Group	4.414	1	4.414	.048	.829	.10
Error	1553.909	17	91.406			
Total	250030.000	20				
Corrected Total	8909.200	19				

The results of the GLM ANCOVA failed to support the research hypothesis that creative fluency would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting to note that the mean score for the CPS group improved in excess of 7 points when factoring in the covariate of pretest scores for fluency, while the mean score for the traditional group declined after inserting the pretest score as a covariate.

A second analysis of covariance was conducted to determine the relationship between creative originality and the two levels of the treatment groups. The dependent variable in this ANCOVA test was the score for creative originality. As revealed in Table 4.18, the adjusted mean for originality was greatest for students in the CPS group ($M_{adjusted}$=115.46).

Table 4.18.
Descriptive Summary Table for Creative Originality.

Independent Variable	n	M Unadjusted[1]	M Adjusted
CPS	10	108.90[a]	115.46
Traditional	10	119.90[a]	113.37

[1] 180- point scale
[a] Covariate Appearing in Model Evaluated: Pre-Originality = 110.00.

A linear comparison of the increased creative originality of the CPS compared the traditional group is displayed in Figure 4.5

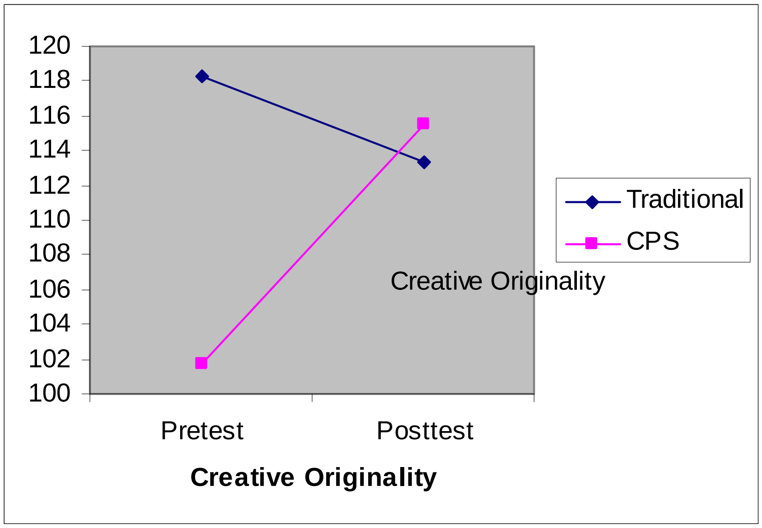


Figure 4.5. Pretest/Posttest Mean Comparison of Creative Originality

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were statistically non-significant ($F_{Levene's}$=1.689, df= 1,18, p = .21). Therefore the researcher concluded that variances of the two treatment groups for creative originality were not significantly different, allowing the assumption for homogeneity to be met. The results of this test are displayed in Table 4.19.

Table 4.19.
Variance between CPS and Traditional Groups on Creative Originality.

Measurement	Equality of Variance	
	F[1]	p
Creative Originality	1.689	.210

[1]Levene's statistic – test of homogeneity of variance

The ANCOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment originality scores, holding pretreatment originality scores constant (F=.103, df=1, p=.75). The relative magnitude of the experimental treatment was negligible small (Cohen's d=.15). Results of this ANCOVA are reported in Table 4.20.

Table 4.20.
ANCOVA Summary Table: Differences between CPS and Traditional Groups on Creative Originality.

Source	SS	df	MS	F	p	*d*
Corrected Model	5570.346	2	2785.173	14.897	.000	1.82
Intercept	477.480	1	477.480	2.554	.128	.75
Pre-Originality	4965.346	1	4965.346	26.557	.000	2.43
Group	19.277	1	19.277	.103	.752	.15
Error	3178.454	17	186.968			
Total	270496.000	20				
Corrected Total	8748.800	19				

The results of the GLM ANCOVA failed to support the research hypothesis that creative originality would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting to note that the mean score for the CPS group improved by almost 7 points when factoring in the covariate of pretest scores for originality, while the mean score for the traditional group declined by inserting the pretest score as a covariate.

A one-way analysis of variance was conducted to determine the relationship between abstractness of titles and the two treatment levels. The dependent variable in the ANOVA was the abstractness of titles dimension of the TTCT. As reported in Table 4.21, the mean for creative abstractness of titles was greatest for students in the CPS group (M=98.90).

Table 4.21.
Descriptive Summary Table for Creative Abstractness of Titles.

Group	n	M[1]	SD
CPS	10	98.90	38.857
Traditional	10	94.30	45.304
Total	20	96.60	41.146

[1] 180-point scale

A linear comparison of the increased creative abstractness of titles of the CPS group compared to the traditional group is displayed in Figure 4.6.

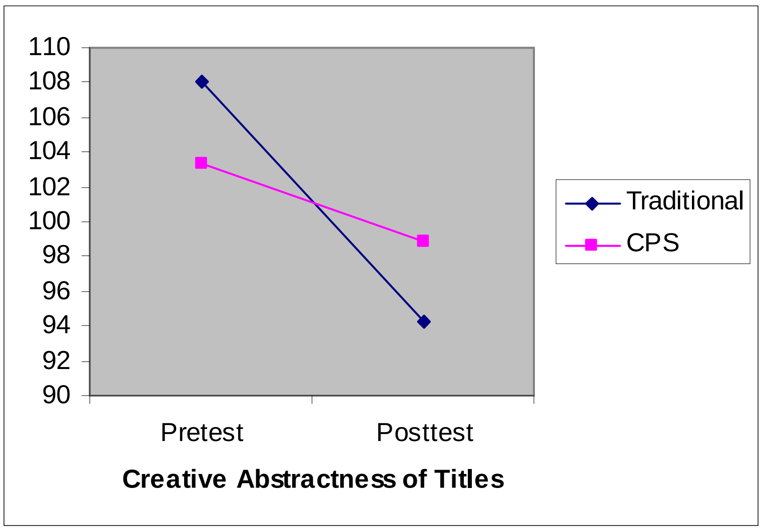


Figure 4.6. Pretest/Posttest Mean Comparison of Creative Abstractness of Titles

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were statistically non-significant ($F_{Levene's}$=.991, df=1,18), p = .33). Therefore the researcher concluded that variances of the two treatment groups for creative abstractness of titles were not significantly different from each other. Results from this test are displayed in Table 4.22.

Table 4.22.
Variance between CPS and Traditional Groups on Creative Abstractness of Titles.

Measurement	Equality of Variance	
	F[1]	p
Abstractness of Titles	.991	.333

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in creative abstractness of titles scores (F=.059, df=1,18, p=.81). The relative magnitude of the experimental treatment was negligible (Cohen's d=.12). Results of this ANOVA table are reported in Table 4.23.

Table 4.23.
ANOVA Summary Table: Difference between Treatment Groups on Creative Abstractness of Titles.

Source	SS	df	MS	F	p	*d*
Between	105.800	1	105.800	.059	.810	.12
Within	32061.000	18	1781.167			
Total	32166.800	19				

The results of the one-way ANOVA failed to support the research hypothesis that creative abstractness of titles would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting to note that the mean score of the CPS group was lower than that of the traditional group on the pretest, yet that mean score was higher on the posttest.

A one-way analysis of variance for creativity was conducted to determine the relationship between elaboration and the two treatment levels. The dependent variable in the ANOVA was the elaboration dimension of creativity. As reported in Table 4.24, the mean score for creative elaboration was greatest for the traditional group (M=92.30).

Table 4.24.
Descriptive Summary Table for Creative Elaboration.

Group	n	M[1]	SD
CPS	10	79.60	9.924
Traditional	10	92.30	9.753
Total	20	85.95	11.583

[1] 180-point scale

A linear comparison of the creative elaboration of the CPS group and the traditional group is displayed in Figure 4.7.

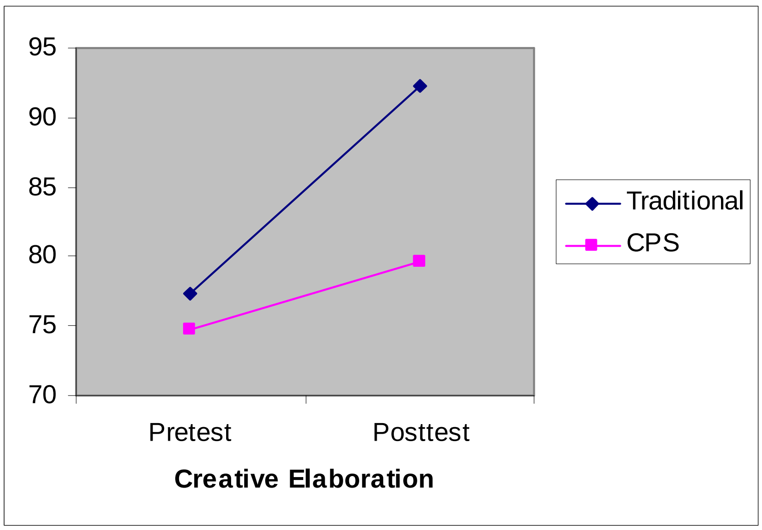


Figure 4.7. Pretest/Posttest Mean Comparison of Creative Elaboration

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were not significant ($F_{Levene's}$=.003, df=1,18, p = .95). Therefore the researcher concluded that variances of the two treatment groups for creative elaboration were not significantly different from each other. Results from this test are displayed in Table 4.25.

Table 4.25.
Variance between CPS and Traditional Groups on Creative Elaboration.

Measurement	Equality of Variance	
	F[1]	p
Creative Elaboration	.003	.955

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class differed significantly in their post-treatment level scores (F=8.331, df=1,18, p= .01). The relative magnitude of the experimental treatment was very large (Cohen's d=1.36). Results of this ANOVA are reported in Table 4.26.

Table 4.26.
ANOVA Summary Table: Difference between Treatment Groups on Creative Elaboration.

Source	SS	df	MS	F	p	*d*
Between	806.450	1	806.450	8.331	.010	1.36
Within	1742.500	18	96.806			
Total	2548.950	19				

The results of the one-way ANOVA failed to support the research hypothesis that creative elaboration would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. In fact, the inverse is true due to the fact that the traditional group scored significantly higher than the CPS group on creative elaboration.

A one-way analysis of variance was conducted to determine the relationship between resistance to premature closure and the two levels of treatment. The dependent variable in this ANOVA was the resistance to premature closure dimension of creativity. As reported in Table 4.27, the mean for creative resistance to premature closure was greatest for students in the traditional group (M=99.00).

Table 4.27.
Descriptive Summary Table for Creative Resistance to Premature Closure.

Group	n	M[1]	SD
CPS	10	96.60	15.094
Traditional	10	99.00	21.396
Total	20	97.80	18.063

[1] 180-point scale

A linear comparison of the increased creative resistance to premature closure of the CPS group compared to the traditional group is displayed in Figure 4.8.

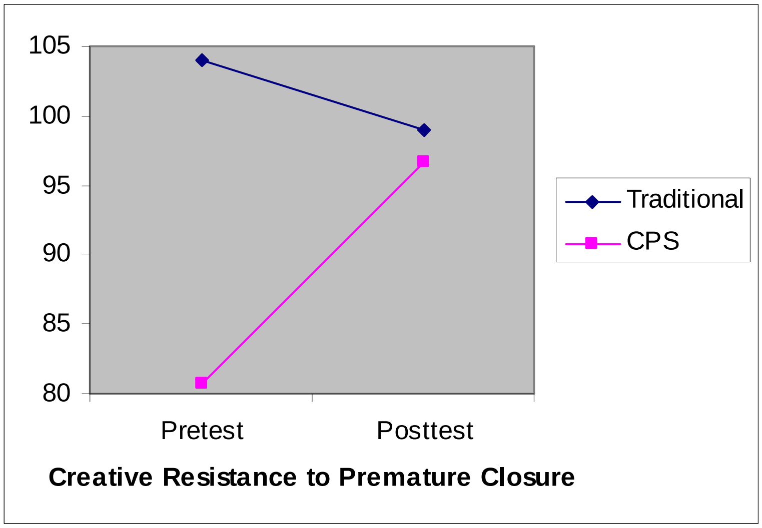


Figure 4.8. Pretest/Posttest Mean Comparison of Creative Resistance to Premature Closure

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were non-significant ($F_{Levene's}$=.036, df=1,18, p=.85). Therefore the researcher concluded that variances of the two treatment groups for creative resistance to premature closure were not significantly different from each other. Results from this test are displayed in Table 4.28.

Table 4.28.
Variance between CPS and Traditional Groups on Creative Resistance to Premature Closure.

Measurement	Equality of Variance	
	F[1]	p
Resistance to Closure	.036	.851

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment resistance to premature closure scores (F=.084, df=1,18, p=.77). The relative magnitude of the experimental treatment was negligible (Cohen's d=.13). Results of this ANOVA are reported in Table 4.29.

Table 4.29
ANOVA Summary Table: Difference between CPS and Traditional Groups on Creative Resistance to Premature Closure.

Source	SS	df	MS	F	p	*d*
Between	28.800	1	28.800	.084	.775	.13
Within	6170.400	18	342.800			
Total	6199.200	19				

The results of the one-way ANOVA did not support the research hypothesis that creative resistance to premature closure would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting that the mean score for the CPS group increased almost 16 points from pretest to posttest, while the mean score for the traditional group declined by 5 points during that same period.

In addition to the two analysis of covariance tests conducted for fluency and originality, and the three one-way analysis of variance tests conducted for abstractness of titles, elaboration, and resistance to premature closure, a third ANCOVA was conducted to determine the total of the averages of the five dimensions of creativity. The dependent variable for this ANCOVA was the average of the standard scores for the five dimensions of creativity. As revealed in Table 4.30, the adjusted mean score for total average creativity was greatest for students in the CPS group ($M_{adjusted}$=103.22).

Table 4.30.
Descriptive Summary Table for Total Average Creativity.

Independent Variable	n	M Unadjusted[1]	M Adjusted
CPS	10	97.00[a]	103.22
Traditional	10	104.50[a]	98.28

[1] 180- point scale
[a] Covariate Appearing in Model Evaluated: Pre-Average = 96.30.

A linear comparison of the increased total average creativity of the CPS group compared to the traditional group is displayed in Figure 4.9.

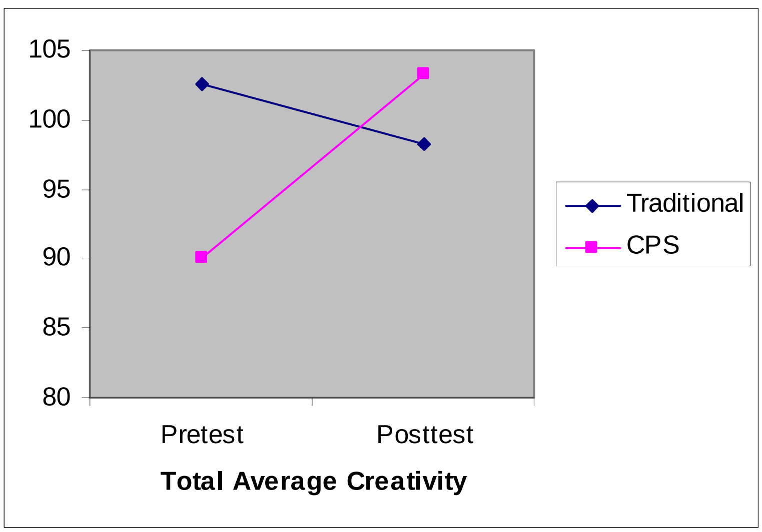


Figure 4.9. Pretest/Posttest Mean Comparison of Total Average Creativity

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were non-significant ($F_{Levene's}$=.116, df=1,18, p=.737). Therefore the researcher concluded that variances of the two treatment groups for overall creativity were not significantly different, allowing the assumption of homogeneity of variance to be met. The results of this test are displayed in Table 4.31.

Table 4.31.
Variance between CPS and Traditional Groups in Total Average Creativity.

Measurement	Equality of Variance	
	F[1]	p
Average Creativity	.116	.737

[1]Levene's statistic – test of homogeneity of variance

The ANCOVA revealed that the CPS class and the traditional class did not differ significantly in the post-treatment average creativity scores, holding pretreatment average creativity scores constant (F=1.733, df=1, p=.21). The relative magnitude of the experimental treatment was medium (Cohen's d=.63). Results of this ANCOVA are reported in Table 4.32.

Table 4.32.
ANCOVA Summary Table: Differences between CPS and Traditional Groups on Total Average Creativity.

Source	SS	df	MS	F	p	*d*
Corrected Model	4235.527	2	2117.763	35.994	.000	2.83
Intercept	13.882	1	13.882	.236	.633	.23
Pre-Total Creative	3954.277	1	3954.277	67.208	.000	3.86
Group	101.945	1	101.945	1.733	.206	.63
Error	1000.223	17	58.837			
Total	208247	20				
Corrected Total	5235.750	19				

The results of the GLM ANCOVA failed to support the research hypothesis that total average creativity would be greater for students exposed to CPS than for students exposed to traditional methods of instruction.

Results Related to Research Hypothesis Five

5. Students in the CPS group will score statistically higher on the Course Satisfaction posttest than students in the traditionally instructed group.

A series of one-way analysis of variances were conducted to determine the relationship between student satisfaction and the two treatment levels. The satisfaction instrument that was developed and pilot tested by Brashears (2004). The instrument consisted of 15 Likert-type items. The first five items were designed to determine student satisfaction with the clarity of the curriculum material and the clarity of the teacher during the delivery of that material. Items six through ten were designed to gain student response to questions relating to delivery of curriculum material and methods of instruction. The final five items were designed to measure student satisfaction levels for the content of the semester long course of instruction. The five-point Likert-type items were entered into the database as a distribution on a scale of 1-5, with 1 representing strongly disagree and 5 representing strongly agree. The three areas (clarity, delivery, and content) produced scores that could range from 5-25. In addition, a fourth variable designed to measure overall student satisfaction was constructed through summation of the three areas of clarity, delivery, and content into one overall total student satisfaction score that could range from 15 to 75. The dependent variables were the four scores for satisfaction.

A one-way analysis of variance was conducted to determine the relationship between student satisfaction for clarity and the two treatment levels of the independent variable, CPS and traditional methods of instruction. The dependent variable for this

ANOVA was satisfaction of clarity. As reported in Table 4.33, the mean score for satisfaction of clarity was greatest for students in the CPS group (M=17.60).

Table 4.33.
Descriptive Summary Table for Satisfaction of Clarity.

Group	n	M[1]	SD
CPS	10	17.60	1.776
Traditional	10	16.50	4.743
Total	20	17.05	3.531

[1] 25-point scale

Although the subsequent inferential analysis is concerned with the treatment effects upon the post-treatment satisfaction of clarity, Figure 4.10 presents a visual display of the linear trends contrasting pre-treatment satisfaction of clarity and post-treatment satisfaction of clarity by students in the control and treatment groups.

Figure 4.10. Pre-Study/Post-Study Mean Comparison of Satisfaction of Clarity

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were statistically not significant ($F_{Levene's}$=2.987, df=1,18, p=.102). Therefore, the researcher concluded that variances of the two treatment groups for satisfaction for clarity were not significantly different. Consequently, variances between groups were assumed equal, and the assumption of homogeneity of variance was met. Results from this test can be seen in Table 4.34.

Table 4.34.
Variance between CPS and Traditional Groups on Satisfaction of Clarity.

Measurement	Equality of Variance	
	F[1]	p
Satisfaction of Clarity	2.978	.102

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment satisfaction of clarity scores (F=.472, df=1,18, p=.50). The relative magnitude of the experimental treatment was small (Cohen's d=.32). Results of this ANOVA are reported in Table 4.35.

Table 4.35.
ANOVA Summary Table: Differences between Treatment Groups on Satisfaction of Clarity.

Source	SS	df	MS	F	p	*d*
Between	6.050	1	6.050	.472	.501	.32
Within	230.900	18	12.828			
Total	236.950	19				

The results of the one-way ANOVA did not support the research hypothesis that satisfaction for clarity would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting to note that while the mean scores of the CPS and the traditional groups were identical on the pre-study satisfaction of clarity analysis, that mean score was higher among the CPS group on the post-study analysis.

A second one-way analysis of variance was conducted to determine the relationship between student satisfaction for delivery and both levels of treatment. The dependent variable in this ANOVA was the mean score for satisfaction of delivery. As reported in Table 4.36, the mean score for satisfaction of delivery was greatest among the CPS group (M=18.60).

Table 4.36.
Descriptive Summary Table for Satisfaction of Delivery.

Group	n	M[1]	SD
CPS	10	18.60	2.503
Traditional	10	15.90	5.216
Total	20	17.25	4.216

[1] 25-point scale

Although the subsequent inferential analysis is concerned with the treatment effects upon the post-treatment satisfaction of delivery, Figure 4.11 presents a visual display of the linear trends contrasting pre-treatment satisfaction of delivery and post-treatment satisfaction of delivery by students in the control and treatment groups.

Figure 4.11. Pre-Study/Post-Study Mean Comparison of Satisfaction of Delivery

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were significant ($F_{Levene's}$=4.694, df=1,18, p=.04). Consequently, variances between groups were assumed unequal, and the assumption of homogeneity of variance was not met. The results of this test can be seen in Table 4.37.

Table 4.37.
Variance between CPS and Traditional Groups on Satisfaction of Delivery.

Measurement	Equality of Variance	
	F	p
Satisfaction of Delivery	4.69	.044

[1]Levene's statistic – test of homogeneity of variance

As a result of this finding of significance on Levene's test, a Brown-Forsythe test was conducted for equality of means. The results of the Brown-Forsythe were non-significant, allowing the researcher to assume equal variances and continue with the pursuit of discovery of difference in CPS verses traditional instruction for determining that mean differences existed. The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment satisfaction of delivery scores (F_{BF}=2.178, df=1,18, p=.16). Therefore the researcher concluded that variances of the two treatment groups for satisfaction of delivery were not significantly different from each other. The results of this test can also be seen in Table 4.38.

Table 4.38.
ANOVA Summary Table: Differences between Treatment Groups on Satisfaction of Delivery.

Source	SS	df	MS	F_{BF}	p	*d*
Between	36.450	1	36.450	2.178	.164	.7
Within	301.300	18	16.739			
Total	337.750	19				

The results of the one-way ANOVA did not support the research hypothesis that student satisfaction for delivery would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is noteworthy that mean scores for satisfaction of delivery were consistently higher for the CPS group throughout the pre, mid, and post-evaluation process.

A third one-way analysis of variance was conducted to determine the relationship between satisfaction of content with the course of instruction and the two treatment levels. The dependent variable in this ANOVA was the satisfaction content score. As reported in Table 4.39, the mean for content satisfaction was greatest for students in the CPS group (M=16.80).

Table 4.39.
Descriptive Summary Table of Satisfaction of Content.

Group	n	M[1]	SD
CPS	10	16.80	2.440
Traditional	10	15.10	4.630
Total	20	15.95	3.706

[1] 25-point scale

Although the subsequent inferential analysis is concerned with the treatment effects upon the post-treatment satisfaction of content, Figure 4.12 presents a visual display of the linear trends contrasting pre-treatment satisfaction of content and post-treatment satisfaction of content by students in the control and treatment groups.

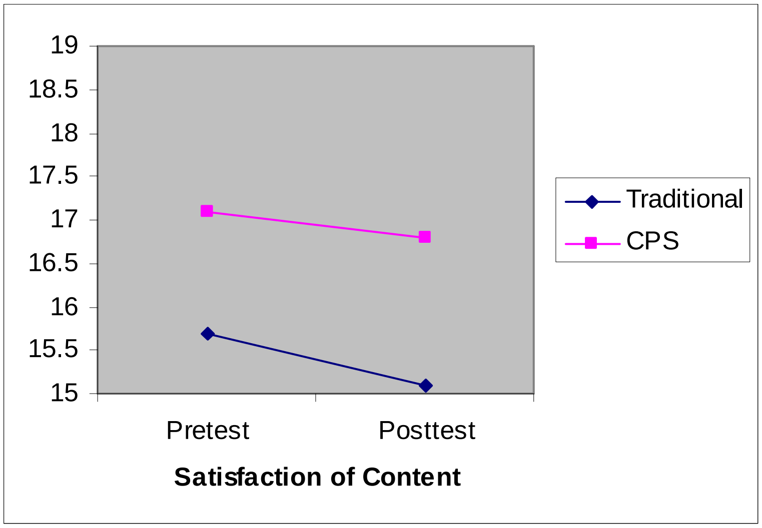


Figure 4.12. Pre-Study/Post-Study Mean Comparison of Satisfaction of Content

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were non-significant ($F_{Levene's}$=2.161, df=1,18, p=.16). Therefore the researcher concluded that variances between the two treatment groups for satisfaction for content were not significantly different from each other. Results from this test can be seen in Table 4.40.

Table 4.40.
Variance between CPS and Traditional Groups on Satisfaction of Content.

Measurement	Equality of Variance	
	F[1]	p
Satisfaction of Content	2.161	.159

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment content satisfaction scores (F=1.055, df=1,18, p=.32). The relative magnitude of the treatment was medium (Cohen's d=.49). Results of this ANOVA are reported in Table 4.41.

Table 4.41.
ANOVA Summary Table: Differences between Treatment Groups on Satisfaction of Content.

Source	SS	df	MS	F	p	*d*
Between	14.450	1	14.450	1.055	.318	.49
Within	246.500	18	13.694			
Total	260.950	19				

The results of the one-way ANOVA did not support the research hypothesis that satisfaction for content would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is noteworthy that mean scores for content satisfaction were consistently higher for students in the CPS group throughout the pre, mid, and post-evaluations.

In addition to the three one-way analysis of variance tests conducted for clarity, delivery, and content, a fourth one-way analysis of variance was conducted to determine total satisfaction for the course of instruction including both treatment levels. The dependent variable in the ANOVA was the sum of scores on each of the three categories for student satisfaction. As reported in Table 4.42, the mean score for total student course satisfaction was greatest for the CPS group (M=53.20).

Table 4.42.
Descriptive Summary Table for Total Course Satisfaction.

Group	n	M[1]	SD
CPS	10	53.20	5.996
Traditional	10	47.50	14.261
Total	20	50.35	11.042

[1] 75-point scale

Although the subsequent inferential analysis is concerned with the treatment effects upon the post-treatment total course satisfaction, Figure 4.13 presents a visual display of the linear trends contrasting pre-treatment total course satisfaction and post-treatment total course satisfaction by students in the control and treatment groups.

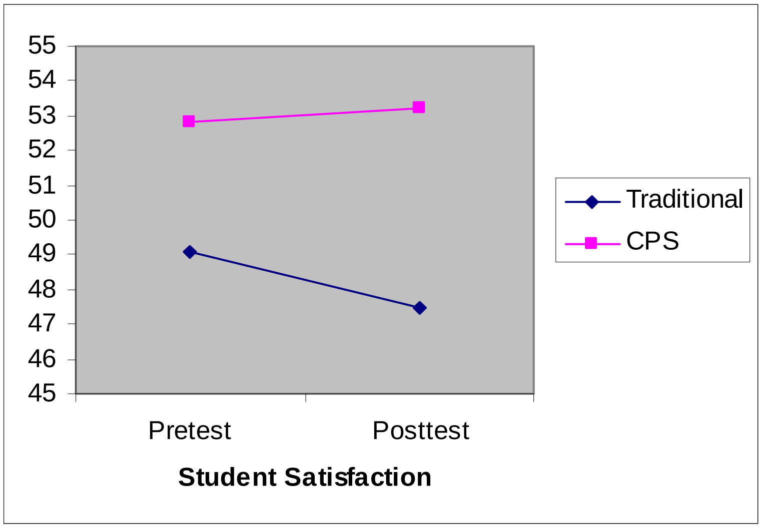


Figure 4.13. Pre-Study/Post-Study Mean Comparison of Total Course Satisfaction

Levene's statistic was calculated to determine homogeneity of variances. The results of this test were statistically non-significant ($F_{Levene's}$=3.662, df=1,18, p=.07). Therefore, the researcher concluded that variances of the two treatment groups for overall course satisfaction were not significantly different from each other. The results of this test are displayed in Table 4.43.

Table 4.43.
Variance between CPS and Traditional Groups in Total Course Satisfaction.

Measurement	Equality of Variance	
	F[1]	p
Course Satisfaction	3.662	.072

[1]Levene's statistic – test of homogeneity of variance

The ANOVA revealed that the CPS class and the traditional class did not differ significantly in their post-treatment course satisfaction scores (F=1.357, df=1,18, p =.26).

The relative magnitude of the experimental treatment was medium (Cohen's d=.55). Results of this ANOVA can be seen in Table 4.44.

Table 4.44.
ANOVA Summary Table: Differences between Treatment Groups on Total Course Satisfaction.

Source	SS	df	MS	F	p	*d*
Between	162.450	1	162.450	1.357	.259	.55
Within	2154.100	18	119.672			
Total	2316.550	19				

The results of the one-way ANOVA did not support the research hypothesis that total course satisfaction would be greater for students exposed to CPS than for students exposed to traditional methods of instruction. However, it is interesting to note that although not significant, mean scores of students in the CPS group for total course satisfaction were consistently higher throughout the pre, mid, and post-evaluation periods.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

Chapter V presents a brief summary of the purposes of the study as well as conclusions and recommendations that were derived from findings in Chapter IV. This chapter is comprised of three sections. A general summary of the study is presented in section one. Section two presents a review of the findings for each research question, while section three discusses recommendations that were a direct result of the investigation.

Summary

The primary purpose of the study was to determine if any measurable effects of student creativity levels would result from the use of Creative Problem Solving (CPS) teaching strategies and techniques in an Introduction to World Agricultural Science and Technology course. Ninth grade students enrolled in the course were assessed in order to determine if significant differences exist in low-level, high-level, and total cognition, levels of creativity, and levels of course satisfaction between students who were instructed by means of CPS teaching strategies and techniques, including divergence, convergence, and aesthetics, in comparison to students who were instructed by traditional means of lecture, discussion, question/answer, etc.

A review of classic and current literature indicates several important considerations that resulted in the focus for this study. The review emphasized the theoretical foundations for the investigation, in addition to organized, well defined, research-based categories and models for CPS. Through these sections of the review, familiar themes and models were linked to levels of low-level, high-level, and total cognition, as well as creativity levels. The Theory of CPS, as depicted by Isaksen et al. (2000) CPS Version 6.1, was the theoretical foundation for the study and provided support for the methodology used therein. The CPS model creates a vivid picture of a creativity development format and strategies through such divergent and convergent activities as mess-finding, data-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding. Supporting literature, including Heinzen (1991), Couger et al. (1993), and Nash (2001), related to the Four-P'*s* method of categorizing creativity by the person, process, product, and press (environment), accompanied by the CPS Model of defining creative development as Understanding the Problem, Generating Ideas, Preparing for Action, and Planning the Approach offered direct insight into the plan for developing creative thinking skills of students in the treatment group. Many of the desired benefits of problem solving ability, low and high levels of cognition, and creativity emerged as a result of incorporating CPS strategies and activities into the course of instruction for the treatment group in this study.

Although the benefits of creative problem solving may seem apparent to readers, the literature also served to suggest that without strategic planning and knowledge of the correct use of the process, results can range from minimal to detrimental. It is critical that the teacher have a good knowledge and understanding of the CPS process, which includes accurate identification of the problem or situation in question. Even then, CPS is not necessarily appropriate for every instructional topic. However, for those topics that are vague, ambiguous, abstract, and possibly even hidden from view, the CPS process can result in unique and effective experiences (Parnes & Harding, 1962; Renzulli, 1982; Treffinger et al., 1983; Gehlbach, 1987; Marakus & Elam, 1997; Scott et al., 2004).

Other research findings in CPS have exemplified the commonalities shared by the approach to creative problem solving adhered to during the course of this study. This study was an attempt to focus on specific activities and ideas conducive to creativity that would induce increased low-level, high-level, and total cognitive functions in the process, while also increasing figural creativity and satisfaction with the process itself. The following research hypotheses were tested.

1. With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the low-level cognitive portion of the posttest than students in the traditionally instructed group.
2. With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score

statistically higher on the high-level cognitive portion of the posttest than students in the traditionally instructed group.

3. With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the total cognition portion of the posttest than students in the traditionally instructed group.

4. With pretest scores in creativity as a covariate, students in the CPS group will score statistically higher on the Creative Thinking posttest than students in the traditionally instructed group.

5. Students in the CPS group will score statistically higher on the Course Satisfaction posttest than students in the traditionally instructed group.

Research hypotheses one, two, and three were tested through means of a cognition posttest. Low-level cognition, pertaining to research hypothesis one, was tested on Part I of the posttest. High-level cognition, pertaining to research hypothesis two, was tested on Part II of the posttest. Total cognition, pertaining to research hypothesis three, was tested by the combination of Parts I and II of that same posttest. Research hypothesis four was tested using a pretest/posttest format of The Torrance Test of Creative Thinking: Figural Form A. Research hypothesis five was tested by using a pre/mid/post-study format of a Brashears (2004) developed 15 question satisfaction instrument.

Conclusions

Research Hypothesis One

With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the low-level cognition portion of the posttest than students in the traditionally instructed group.

The results from this study indicate that the implementation of CPS instructional strategies into an Introduction to World Agricultural Science and Technology I course did not significantly increase low-level cognition scores for the students in the CPS group over the traditional group. These results are consistent with the work of Bush (1998) and Scope (1998). However, although no significance was revealed, an interesting inter-group consistency developed. When examining the mean data of the two groups, although not significant, the data does reveal higher average low-level cognition scores among the CPS group, despite the fact that the traditional group had higher pre-study mean scores in TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA. Treffinger (1995) found similar relationships between CPS and traditional instructional methods on high-level cognition scores. Rose and Lin (1984) found these relationships more significant when treatments were extended to 24 months. Further research may explore the development time required for CPS as a learning-teaching strategy. The results of this comparison can be seen in Table 5.1.

Table 5.1.
Pre-study/Post-study Mean Comparison of CPS and Traditional Groups on Low-Level Cognition.

Instrument	Group	N	Pre-Study M[1]	Post-Study M[2]
TAKS Language Arts	CPS	10	2260.80	NA
	Traditional	10	2355.40	
TAKS Math	CPS	10	2175.80	NA
	Traditional	10	2237.20	
TAKS Science	CPS	10	2140.00	NA
	Traditional	10	2194.40	
TAKS Social Studies	CPS	10	2403.20	NA
	Traditional	10	2405.50	
GPA	CPS	10	85.09	NA
	Traditional	10	90.07	
Low-Level Cognition	CPS	10	NA	50.40
	Traditional	10		50.20

[1] Group means for TAKS scores and GPA prior to the study
[2] Group means for low-level cognition scores at conclusion of study

Research Hypothesis Two

With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the high-level cognition portion of the posttest than students in the traditionally instructed group.

The results from this study indicate that the implementation of CPS instructional strategies into an Introduction to World Agricultural Science and Technology I course did not significantly increase high-level cognition scores for the students in the CPS group over the traditional group. However, although no significance was revealed, an interesting inter-group consistency developed. When examining the mean data of the two groups, although not significant, the data does reveal higher average high-level cognition scores among the CPS group, despite the fact that the traditional group had higher pre-study mean scores in TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA. The results of this comparison can be seen in Table 5.2.

Table 5.2.
Pre-study/Post-study Mean Comparison of CPS and Traditional Groups on High-Level Cognition.

Instrument	Group	N	Pre-Study M[1]	Post-Study M[2]
TAKS Language Arts	CPS	10	2260.80	NA
	Traditional	10	2355.40	
TAKS Math	CPS	10	2175.80	NA
	Traditional	10	2237.20	
TAKS Science	CPS	10	2140.00	NA
	Traditional	10	2194.40	
TAKS Social Studies	CPS	10	2403.20	NA
	Traditional	10	2405.50	
GPA	CPS	10	85.09	NA
	Traditional	10	90.07	
High-Level Cognition	CPS	10	NA	14.80
	Traditional	10		12.60

[1] Group means for TAKS scores and GPA prior to the study
[2] Group means for high-level cognition scores at conclusion of study

<u>Research Hypothesis Three</u>

With pretest standardized TAKS scores in language arts, math, science, and social studies as a covariate, students in the CPS group will score statistically higher on the total cognition portion of the posttest than students in the traditionally instructed group.

The results from this study indicate that the implementation of CPS instructional strategies into an Introduction to World Agricultural Science and Technology I course did not significantly increase total cognition scores for the students in the CPS group over the traditional group. However, although no significance was revealed, an interesting inter-group consistency developed. When examining the mean data of the two groups, although not significant, the data does reveal higher average total cognition scores among the CPS group, despite the fact that the traditional group had higher pre-study mean scores in TAKS language arts, TAKS math, TAKS science, TAKS social studies, and GPA. The results of this comparison can be seen in Table 5.3.

Table 5.3.
Pre-study/Post-study Mean Comparison of CPS and Traditional Groups on Total Cognition.

Instrument	Group	N	Pre-Study M[1]	Post-Study M[2]
TAKS Language Arts	CPS	10	2260.80	NA
	Traditional	10	2355.40	
TAKS Math	CPS	10	2175.80	NA
	Traditional	10	2237.20	
TAKS Science	CPS	10	2140.00	NA
	Traditional	10	2194.40	
TAKS Social Studies	CPS	10	2403.20	NA
	Traditional	10	2405.50	
GPA	CPS	10	85.09	NA
	Traditional	10	90.07	
Total Cognition	CPS	10	NA	65.20
	Traditional	10		62.80

[1] Group means for TAKS scores and GPA prior to the study
[2] Group means for total cognition scores at conclusion of study

Research Hypothesis Four

With pretest scores in creativity as a covariate, students in the CPS group will score statistically higher on the Creative Thinking posttest than students in the traditionally instructed group.

The results from this study indicate that the implementation of CPS instructional strategies into an Introduction to World Agricultural Science and Technology I course did not significantly increase creativity levels for those students, as opposed to those students who received the same instructional objectives through traditional methods of instruction. Although no significance was detected, an interesting inter-group consistency developed. When examining the mean data between the two groups, although not significantly different, the data does reveal some distinct areas of improvement in creativity, based on small improvements from the pretest at the beginning of the course until the posttest at the conclusion of the course.

For fluency, an ANCOVA was conducted based on a >.70 Pearson Product Moment correlation between fluency pretest and posttest scores. The purpose of the ANCOVA was to detect significant posttest mean score differences between the CPS and traditional groups. Although not significant, the pretest means revealed a 16 point higher mean score among the traditional group. However, the adjusted mean score, after the implementation of analysis of covariance, revealed a 1 point higher mean score among the CPS group.

For originality, an ANCOVA was conducted based on a >.70 Pearson Product Moment correlation between the pretest and posttest mean scores. The purpose of the ANCOVA was to detect significant posttest mean score differences between the CPS and traditional groups. Although not significant, the pretest mean score indicated an almost 7 point higher mean score among the traditional group, while the adjusted mean score, after the analysis of covariance, resulted in a 2 point higher mean score among the CPS group.

For abstractness of titles, a one-way ANOVA was conducted. Although not significant, the pretest mean score was almost 5 points higher among the traditional group, while the unadjusted mean score for the CPS group was 4 points higher on the posttest.

For elaboration, a one-way ANOVA was conducted. Elaboration was the only measured area of creativity, in which the mean score for the traditional group increased more than that of the CPS group from pretest to posttest.

For resistance to premature closure, a one-way ANOVA was conducted. The mean score of the traditional group was 3 points higher on the posttest than the mean score of the CPS group. However, it is noteworthy that the mean score for the CPS group improved 16 points from pretest to posttest, while the mean score of the traditional group actually declined by 5 points.

Finally, for average pretest creativity scores, an ANCOVA was conducted since the Pearson Product Moment correlation produced a >.70 correlation between pretest and posttest scores. The pretest mean scores of the traditional group were 12 points higher than those of the CPS group, while the adjusted mean scores on the posttest, after the analysis of covariance, were 5 points higher among the CPS group than the traditional group. The results of this comparison can be seen in Table 5.4.

Table 5.4.
Pretest/Posttest Mean Comparison of CPS and Traditional Groups on Creativity.

CREATIVITY TEST	GROUP	STATISTIC	PRETEST M	POSTTEST U[1] M	POSTEST A[2] M
Fluency	CPS	ANCOVA	89.00	102.90	110.31
	Traditional		105.40	116.70	109.29
Originality	CPS	ANCOVA	101.70	108.90	115.46
	Traditional		118.30	119.90	113.37
Abstractness of Titles	CPS	ANOVA	103.30	98.90	
	Traditional		108.00	94.30	
Elaboration	CPS	ANOVA	74.80	79.60	
	Traditional		77.30	92.30	
Resistance to Prem. Closure	CPS	ANOVA	80.70	96.60	
	Traditional		104.00	99.00	
Average of Creativity	CPS	ANCOVA	90.00	97.00	103.22
	Traditional		102.60	104.50	98.28

[1] Unadjusted mean of analysis of variance and covariance
[2] Adjusted mean of analysis of covariance

Research Hypothesis Five

Students in the CPS group will score statistically higher on the Course Satisfaction posttest than students in the traditionally instructed group.

The results from this study indicate that the implementation of CPS instructional strategies into an Introduction to World Agricultural Science and Technology I course did not significantly increase levels of course satisfaction for those students, when compared to students who received the same instructional objectives through traditional means of instruction. However, although no significance was detected, an interesting inter-group consistency developed. When examining the mean data of the two groups, although not significantly different, the data does reveal a greater level of satisfaction among the CPS group in all areas of satisfaction, including clarity, delivery, content, and overall satisfaction. The mean of the CPS group was slightly higher than that of the traditionally instructed group. However, in none of these areas was that difference significant at the .05 level.

For clarity, a one-way ANOVA was conducted. Although mid-study mean scores for clarity were identical, the post study mean score of the CPS group was slightly higher than that of the traditional group.

For delivery, a one-way ANOVA was conducted. Of the three individual areas of satisfaction, the largest gap in satisfaction means between the two groups was in the area of delivery, where the trend toward significance was also greatest.

For content, a one-way ANOVA was conducted. Although non-significant, the mean scores of the CPS group were also slightly higher for satisfaction of content at the post-study interval.

Finally, for total creativity, a one-way ANOVA was also conducted. Once again, although non-significant, the mean scores indicate that greater total course satisfaction existed among the CPS group than the traditionally instructed group by almost 6 points. The results of this comparison can be seen in Table 5.5.

Table 5.5.
Pre-Study/Post-Study of CPS and Traditional Groups on Satisfaction.

SATISFACTION	GROUP	PRE-M[1]	MID-M[2]	POST-M[3]
Clarity	CPS	18.00	18.90	17.60
	Traditional	16.60	18.90	16.50
Delivery	CPS	17.70	19.60	18.60
	Traditional	16.80	17.10	15.90
Content	CPS	17.10	18.10	16.80
	Traditional	15.70	16.80	15.10
Total	CPS	52.80	56.60	53.20
	Traditional	49.10	52.80	47.50

[1] Pre-study mean for treatment groups, [2] Mid-study mean for treatment groups
[3] Post-study mean for treatment groups

Discussion

No statistically significant differences were revealed in the areas of low-level cognition, high-level cognition, total cognition, creativity, or course satisfaction. Therefore, one might conclude that the advantages of instructing students in creative problem solving strategies is no more effective than more traditional instructional strategies of lecture, question/answer, multi-media, etc. However, although no significance was detected, several interesting inter-group consistencies developed between the CPS and traditional groups, causing this researcher to reconsider the results.

An immediate observation can be made that upon examination of mean scores of low-level, high-level, and total cognition, the CPS group performed better than the traditional group. Also, that better performance occurred despite the fact that the pre-study leveling instruments of TAKS scores and GPA indicated that the traditional group was cognitively higher than the CPS group. This observation supports the original hypothesis that students do score higher in areas of low-level, high-level, and total cognition when instructed using CPS strategies than with traditional instructional strategies (Isaksen et al., 1994; Treffinger et al., 2003; Hanson, 2006).

The same observation was made for creativity. Pretest mean scores of the CPS group were lower across the board in all five individual areas of creativity of the TCCT, as well as in total average creativity. However, the CPS group's mean scores were higher than the traditional group on the posttest in four of the six areas of creativity. In addition, they had closed the gap considerably in one of the other two areas, while widening the gap only in the area of elaboration. This observation also supports the original hypothesis that students will become more creative as a result of instruction in CPS, as opposed to traditional instructional methods (Parnes & Harding, 1962; Torrance, 1972; Fieldhusen & Clinkenbeard, 1986; Maraviglia & Kvashny, 2006; Norton, 2006).

Finally, in the third area of measurement, course satisfaction, the mean scores for satisfaction would indicate that the CPS group was more satisfied with the course than the traditional group. Mean scores were higher across the board in all three individual areas of satisfaction that were measured, in addition to overall satisfaction. This observation supports the original hypothesis that students will be more satisfied with courses delivered through creative problem solving strategies than with delivery through more traditional strategies (Markum & Hagan, 2004).

As mentioned earlier, this researcher believes the probability exists that had the sample sizes of the groups been larger, significance might have been attained. The linear comparison of the mean scores between groups would suggest that assumption to be accurate. However, due to the small class sizes in Roscoe ISD, this study could not have been conducted with larger samples and maintained the true experimental effect sought. However, the true experimental effect would have been enhanced if students in the control group had not been exposed to the CPS teacher prompts posted around the room. Regardless of the findings, however, the methodological approach was sound. Therefore, this author would like to advise the readers to approach the findings and conclusions of this study with that qualification in mind. The review of the literature reveals documented evidence that instructional methods that incorporate creative problem solving strategies are superior to traditional methods of instruction for accomplishing desired outcomes related student growth in cognition, creativity, and satisfaction with learning.

Recommendations

Based on this study's findings and conclusions, the following recommendations for further action can be made.

Recommendations for Improvement of Practice

The review of the literature for this inquiry strongly supports the use of CPS instructional strategies in the classroom. Numerous benefits for learning are positively correlated with the use of CPS in education. Significant effects from this study were found that support the need for, and benefits of, implementation of CPS into classroom instructional strategies and methods. Concepts and approaches to instruction that require students to call upon high-level cognition and creativity to solve complex problems not only increase low-level, high-level, and total levels of cognition, as well as creativity levels, it also increases students' satisfaction with the educational process (Markum & Hagan, 2004).

In addition to student satisfaction, teacher satisfaction with the CPS process was also evaluated during this study. The teacher kept a weekly log that contains comments regarding challenges and accomplishments from each individual week, as well as teacher satisfaction with the CPS process. In summation of the overall experience, the teacher noted that the CPS process does require greater effort than traditional instructional strategies. However, it is the opinion of the teacher that the advantages of CPS far outweigh the disadvantages, in terms of student growth, making the process worth the extra effort.

It is therefore the recommendation of this researcher that educators, when appropriate and feasible, utilize CPS in the form of divergence, convergence, and aesthetics as a means of increasing the creative problem solving abilities of students. In doing so, students will benefit in terms of increased levels of cognition and capacity for creativity, as well as overall satisfaction with the learning process, all key elements of student success in today's educational environment.

Roscoe ISD plans to implement a course in Creative Problem Solving for all seventh grade students in the district beginning with the 2007-2008 school year. In addition, the district has a goal for implementation of Creative Problem Solving as a district-wide instructional philosophy across the grade levels and across curriculum areas by 2010. Although the implementation process for accomplishment of these district goals is already underway, planning for extensive professional development in the CPS process for teachers is in the development phase as well. At the August 2007 teacher in-service meetings, teachers will be issued guidelines and receive professional development training in the implementation of divergent, convergent, and aesthetic instructional strategies from the teacher in this study, Jacob Tiemann, the curriculum consultant from this study, Rose Burks, and myself. Implementation of CPS strategies throughout Roscoe ISD will actually begin during the fall 2007 semester.

Recommendations for Further Research

Selected students appeared to become more engaged in learning with the treatment. This may be due to several factors that should be explored. Because of general trends for higher achievement in cognition and creativity, accompanied by more satisfaction of students in the CPS treatment, this study should be replicated. Replications should take place using larger sample sizes, in other academic disciplines, in other grade levels, and in other regions of Texas and throughout the United States, in order to provide a more comprehensive and detailed examination of the effects of CPS tactics on learning. Attempts to analyze grading procedures as they relate to satisfaction should also be examined. Perhaps this analysis could explain the downward spiral from the mid-point to the conclusion of the study for both the treatment and control groups.

A second recommendation is that this study be replicated among other Agricultural Science teachers in Introduction to World Agricultural Science and Technology I courses in similar settings to the one at Roscoe High School. This replication would serve to provide additional confirmation of the results derived from this specific study.

A third recommendation would be to call for additional studies in CPS instructional strategies using versions other than the CPS Version 6.1. This model is only one of a wide array of instructional models for the CPS process. Additional research into a wide array of CPS models will lead to a deeper understanding of the process, as well as the discovery of more appropriate models designed to better satisfy the specific needs of particular individuals or groups.

A final recommendation would be to call for additional studies to be conducted in the area of teacher professional development in CPS instructional strategies. The teacher is an integral part of any effective CPS lesson. However, effective CPS instructional strategies do not occur by happenstance. On the contrary, effective CPS instructional strategies are the result of many hours of planning, organization, implementation, and evaluation of CPS content and delivery on the part of the teacher. This process must be a learned process, rather than a natural occurrence. To avoid lag time at the outset of a study, extensive professional development of the teacher in best practices for integrating CPS instructional strategies into instructional objectives would allow for greater impact in student learning throughout the course of study.

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APPENDIX A

PROTECTION OF HUMAN SUBJECTS (IRB)

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

May 5, 2006

Dr. Mathew Baker
Ag Ed & Communications
Mail Stop: 2131

Regarding: 500430 Effects of Instruction in Creative Problem Solving in Cognition, Satisfaction and Creativity Among Ninth Grade Students in An Introduction to World Agricultural Science and Technology Course

Dr. Mathew Baker:

The Texas Tech University Protection of Human Subjects Committee approved your claim for an exemption for the proposal referenced above on May 5, 2006.

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.

Richard P. McGlynn, Chair
Protection of Human Subjects Committee

Informed Consent

Project Title: Effects of Instruction in Creative Problem Solving on Cognition, Creativity, and Satisfaction Among Ninth Grade Students in an Introduction to World Agricultural Science and Technology Course

Please read this document carefully before you decide to allow results to be included in this study.

Purpose of the research study:

The purpose of this research is to determine if instructional strategies using methods of Creative Problem Solving (CPS) produce greater results in measures of cognition, satisfaction, and creative thinking levels when presented to high school agricultural students than more traditional measures of instructional delivery.

What you will be asked to do in the study:

1) Complete a 40 item low/high cognition pretest during the first week of the fall 2006 semester (this is a non-timed assessment).
2) Complete a 40 item low/high-cognition posttest during the final week of the fall 2006 semester (this is a non-timed assessment).
3) Complete a standardized creative thinking pretest.
4) Complete a standardized creative thinking posttest.
5) Complete an evaluation of course content and delivery methods for the unit of instruction.

Time required:

Approximately 5 hours of normally scheduled class time.

Risks:

No risk of physical, psychological, or economic harm to you is foreseen.

Benefits/Compensation:

There is no compensation or other direct benefit to you for participation. Participants will be distributed results from the study during the spring 2007 semester.

Confidentiality:

Your identity will be kept confidential to the extent provided by law. Your name will not be used in any report or publication of the results of this study.

Voluntary Participation:

Your participation in this study is completely voluntary. There is no penalty for not participating.

Whom to contact if you have questions about the study:

Kim Alexander (doctoral student)
Superintendent
Roscoe Independent School District
P.O. Box 579
Roscoe, Texas 79545
Phone: (325) 766-3629
Fax: (325) 766-3138
E-mail: kda@roscoe.esc14.net

I have read the above information and **will/will not** participate in the study.

Student Signature	Parent or Guardian Signature

Kim Alexander

Effects of Instruction in Creative Problem Solving in Cognition, Creativity, and Satisfaction Among Ninth Grade Students in an Introduction to World Agricultural Science and Technology Course

Rationale: Research continues to impart new information and data that affect agriculture and education. The method of imparting that information and data is the basis for transformational knowledge. A sound rationale and theoretical framework are essential in order to structure an effective delivery strategy for contemporary agricultural education. Using an experimental study consisting of a control group and a treatment group, this study will examine the effectiveness of creative problem solving as an instructional strategy, as compared to traditional instructional strategies in the delivery of course objectives for agricultural science education. Comparisons will be drawn from these two groups based on standards established from researcher developed tests of low and high level cognition, standardized tests in creativity levels, and a researcher developed course satisfaction instrument. The findings will provide a basis for developing standards for the most effective method of instructional delivery of course curriculum content.

Subjects: Twenty-seven ninth grade agricultural science students enrolled in an Introduction to World Agricultural Science and Technology course will be the subjects of this study. Fourteen of these subjects will be randomly assigned to the treatment group and the remaining thirteen students will serve as subjects for the control group. Considerations will be given to age, sex, socioeconomic status, ethnic origin, class rank, and GPA.

Procedures: Students enrolled in World Agricultural Science and Technology as a requirement of fulfillment of their ninth grade agricultural science curriculum will be randomly assigned to either a treatment or control group. In addition, the treatment and control groups will be randomly selected to compliment the experimental design of the study. Students will be leveled during the initial phase of the study according to the covariates of class rank and GPA. Subjects of the study will be coded in SPSS and individual identities of students will remain anonymous. In addition, subjects will be not be distinguished as members of the treatment or control group. Finally participation in the study will be voluntary as students enrolled in this course will not be required to participate in the study.

Participants in the study will be administered a pretest and a posttest in low and high levels of cognition. Although researcher developed, this test has been approved by a panel of agricultural education experts from Texas Tech University. Additionally, students will be administered a standardized Torrance Test of Creative Thinking (TTCT) pretest and a posttest to determine levels of creativity before and after the instructional delivery of the course. Finally, students will be administered a validity and reliability tested satisfaction instrument designed to measure clarity, delivery, and content at the conclusion of the course.

The content of the course curriculum will be identical for both groups and aligned with instructional objectives outlined in Texas State Law by the Texas Essential Knowledge and Skills (TEKS). The only distinction between the treatment and control groups will be the method of instructional delivery. Subjects in the treatment group will receive instruction through research based methods of creative problem solving (CPS). Subjects in the control group will receive instruction through traditional methods of classroom instructional delivery.

Adverse Events and Liability: Response to questions to determine knowledge of the course curriculum subject matter, levels of creativity, or course satisfaction could not reasonably place the subjects at risk of damage to reputation, self-esteem, or any other bodily or personally damaging consequences.

Consent Form: A consent form is attached.

Attachments: Above referenced consent form, researcher developed measurements of low and high level cognition, a standardized Torrance Test of Creative Thinking, and a researcher developed satisfaction instrument.

APPENDIX B

LESSON OUTLINE FOR CPS GROUP

Lesson Outline for CPS Treatment Group
9th Grade
Introduction to World Agricultural Science and Technology I
Fall 200**6**

Wednesday, August 16

1. Class Introduction
2. Have students develop classroom rules
    a. Brainstorm individually (1 minute)
    b. Brainstorm in small groups (3 minutes)
        1) CPS Problem-Finding = Divergence
        2) CPS Idea-Finding = Divergence
    c. Whole group debate/discussion to determine which of the 3 to 4 rules are most appropriate (15 minutes)
        1) CPS Solution-Finding = Convergence
        2) CPS Acceptance-Finding = Convergence
3. Draw depictions of rules to post

Thursday, August 17

1. Administer Torrance Test of Creative Thinking (TTCT)
2. Discuss TTCT and how it relates to what they will be doing in class

Friday, August 18

1. Pre-test: Course Satisfaction Survey (5-10 minutes)
2. Discuss Creative Problem-Solving (CPS)
    a. Posters
3. Activity/Problem situation

Monday, August 21

(TEKS 119.2 c3B)

1. What is your favorite food?
2. Think-Pair Share: Cheeseburger Activity
    a. Think regarding where a cheeseburger comes from (1-3 minutes)
    b. Share with a partner (2 minutes)
    1) CPS Idea-Finding = Divergence & Convergence
3. Video (15 minutes)
4. Discuss/elaborate
5. Give the process for making a hotdog, etc. to students and have them determine what the end product could be
    a. CPS Solution-Finding = Divergence & Convergence
6. Share/debate

Tuesday, August 22
(TEKS 119.2 c3A,B,C; c7A; c5B)
1. As a class, develop a semantic map on politics and another on agriculture to build background knowledge and see connections
2. Have students develop a Venn diagram to compare and contrast these two topics
   a. CPS Mess-Finding = Divergence & Convergence
3. Add necessary teacher information to Venn diagram and lead into homework assignment
   a. Homework: Research main points that were not covered and report back to class. (e.g. USDS, FSA, TDA, APHIS, FDA, etc.
   b. What problem or situation might lead to this agency?
      1) CPS Data-Finding = Convergence

Wednesday, August 23
(TEKS 119.2 c3A,B,C; c7A; c5B)
1. Add homework information to semantic map and Venn diagram
2. Student will share in small groups what situations they came up with that might lead them to using these agencies
   a. CPS Mess-Finding = Divergence & Convergence
3. Activity: Which drawing best depicts the relationship between agriculture and politics? Explain.
   a. CPS Acceptance-Finding = Divergence & Convergence
   b. Note: Students will do this activity individually but give explanations to the entire class
4. Review
5. Quiz

Thursday, August 24
(TEKS 119.2 c1B; c4A)
1. Record books

Friday, August 25
(TEKS 119.12 c6F)
1. Article summaries – Write article about how politics affect agriculture in your community. Examples:
   a. "Local Drought Causes Pool Prices to Soar"
   b. "New Hunting Regulations Increase/Decrease Participation"
      1) CPS Data-Finding = Convergence
2. Continue with record books if applicable

Monday, August 28
(TEKS 119.12 c3A,B,C)
1. Hook: Survivor activity
   a. CPS Mess-Finding = Divergence & Convergence
   b. CPS Data-Finding = Convergence

Tuesday, August 29

(TEKS 119.12 c3A,B,C)

1. Explore:
   a. Research most heavily populated areas of the world with demographics
   b. Research where the majority of the world's food is grown
      1) CPS Data-Finding = Convergence

Wednesday, August 30

(TEKS 119.12 c3A,B,C)

1. Continue with Exploration activity
   a. Develop a visual to represent this information (i.e. map, chart, graph)
      1) CPS Data-Finding = Convergence
      2) CPS Solution-Finding = Convergence
   b. Gallery Walk – As a group, develop at least one question to ask each group regarding their visual
   c. Question and answer session

Thursday, August 31

(TEKS 119.12 c3D; c5B,C,D; c9A)

1. Explain visual aids
2. Video (28 minutes)
3. Discuss and make connections between video and activities
4. Create a plan for feeding the hungry in the area (i.e. Nolan County)
   a. CPS Data-Finding = Convergence
   b. CPS Solution-Finding = Convergence
5. As a class, identify one activity to put into practice (e.g. local food drive)

Friday, September 1

(TEKS 119.12 c6F,D,E)

1. Article summaries
   a. Draw a picture to depict the main point of article
   b. Have students explain drawing to class
      1) CPS Acceptance-Finding = Convergence

Monday, September 4

Holiday

Tuesday, September 5

(TEKS 119.12 c3D; c5B,C,D; c9A)

1. Test using TAKS Test Generator (multiple choice and open-ended)
   a. Questions over the 120 minute DVD not included

Wednesday, September 6

(TEKS 119.12 c4C)

1. Explore
   a. Put student in charge of a class meeting regarding the girls' vs. boys' locker rooms or length of lunch period to decide who should get a longer lunch, etc.
   b. Brainstorm possible stumbling blocks that prevent a meeting from running smoothly
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence
   c. Discuss rules that would have been helpful in running the meeting
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Convergence

Thursday, September 7

(TEKS 119.12 c4A,B,C)

1. Brainstorm for qualities that comprise a good team
2. Brainstorm for qualities that make up a good leader
   a. CPS Solution-Finding = Divergence
3. Explain
4. Read and discuss Chapter 2 on parliamentary procedure and compare the qualities of leaders/teams that the class developed to those listed in the book
   a. CPS Solution-Finding = Convergence

Friday, September 8

(TEKS 119.12 c6D,E,F)

1. Article summaries
2. Choose an item and explain how it relates to agriculture
   a. CPS Mess-Finding = Divergence
   b. CPS Acceptance-Finding = Convergence
3. Write a ¾ page explanation to present to the class

Monday, September 11

(TEKS 119.12 c4A,B,C)

1. Challenge students to find ways to help them become more creative problem-solvers
   a. Brainstorm in small groups
      1) CPS Problem-Finding = Divergence
      2) CPS Idea-Finding = Divergence
   b. Share brainstorming ideas with the class
   c. Select the top ideas and determine how to put into action
   d. If possible, put one or more ideas into action

Tuesday, September 12

(TEKS 119.12 c4C)

A. Assign parliamentary workbook information to groups
1. Students will:
   a. Problem – Determine how to present information to the class creatively

b. Gather information – Use Parliamentary Procedure Handbook to gather information needed for presentation
   1) CPS Data, Problem, Idea-Finding = Divergence
c. Rank ideas – Determine what information is most important for other students to know
   1) CPS Data, Problem, Idea-Finding = Convergence
d. Present ideas to class

Wednesday, September 13
(TEKS 119.12 c4C)
1. Same as Tuesday
   a. CPS Data, Problem, Idea-Finding = Divergence & Convergence

Thursday, September 14
(TEKS 119.12 c4C)
A. Parliamentary Procedure – Main motion
1. Group 1: Chapter 5 – Prepare to teach information to the class with applicable examples/situations
2. Group 3: Chapter 6 – Same as Group 3
   a. CPS Acceptance-Finding = Convergence

Friday, September 15
(TEKS 119.12 c6D,E,F)
1. Article summaries
   a. Write an article entitled: "If You Had to Show an Animal, What Problems Might One Encounter?"
      1) CPS Mess, Problem, Idea-Finding = Divergence & Convergence
   b. Quiz students about possible solutions

Monday, September 18
(TEKS 119.12 c4C)
A. Parliamentary Procedure – Refer to a committee
1. Group 5: Chapter 8 – Teach information to rest of class with applicable examples/simulations
2. Group 6: Chapter 10 – Same
3. Model parliamentary procedure –Refer to a committee – (reteach)
   a. CPS Data, Idea-Finding = Convergence
4. Homework for Friday – Teacher selected article over a "Hot Political Topic"
   a. Develop a solution to solve the "Hot" topic that teacher selected
   b. Topic = Pope versus Muslim
      2) CPS Mess-Finding = Divergence
      1) CPS Acceptance-Finding = Convergence

Tuesday, September 19
(TEKS 119.12 c4C)

A. Parliamentary procedure (student modeling)
   1. Reteach chapters 5-8
      a. CPS Idea, Problem-Finding = Divergence & Convergence

Wednesday, September 20
(TEKS 119.12 c4C)
A. Parliamentary procedure (student modeling)
   1. Chapter 9
      a. Ammendments
         1) CPS Idea, Problem-Finding = Divergence & Convergence

Thursday, September 21
(TEKS 119.12 c4C)
A. Review steps of Parliamentary Procedure
B. Quiz over Parliamentary Procedure
   1. CPS Solution, Acceptance-Finding = Convergence

Friday, September 22
(TEKS 119.12 c6D,E,F)
   1. Article summary
      a. Present solutions from "Hot Political Topic" assignment (Pope vs. Muslim)
      b. Debate solutions
         1) CPS Mess, Problem-Finding = Divergence
      c. Strive for consensus
         1) CPS Mess, Problem, Solution-Finding = Convergence

Monday, September 25
(TEKS 119.12 c8A,B)
1. Categorize random objects and label each category
   a. CPS Mess, Data-Finding = Divergence
2. Students will rotate around room and guess how each group categorized objects
   a. CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence
3. Students explain thinking behind categories
   a. CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Convergence
4. Lead into power point over swine
   a. Look at pictures of 5 – 6 hogs
   b. Compare traits of each hog
   c. List traits
5. Give each student a copy of notes over swine

Tuesday, September 26
(TEKS 119.12 c8A,B)
   1. View slide over individual hog breeds
      a. CPS Data-Finding = Convergence

2. Students organize information into chart to see relationship between breeds of hogs
   a. Semantic Feature Analysis Chart
      1) CPS Data, Solution-Finding = Convergence
3. Discuss
4. Brainstorm ways to help identify breeds
   a. CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Convergence

<u>Wednesday, September 27</u>

(TEKS 119.12 c8A,B)

1. Visit Ag Science barn to identify breeds & discuss breed terminology
   a. CPS Data-Finding = Divergence & Convergence
2. Students will develop an acrostic for each breed
   a. CPS Mess, Idea-Finding = Divergence

<u>Thursday, September 28</u>

(TEKS 119.12 c8A,B)

1. Review acrostic and semantic feature chart for swine breed identification
   a. CPS Mess, Idea-Finding = Convergence
2. Quiz over breed identification and terminology
   a. CPS Solution-Finding = Convergence
   b.

<u>Friday, September 29</u>

(TEKS 119.12 c6D,E,F)

1. Article summary
   a. Write "The Day in the Life of a Pig" article for one of the breeds
      1) CPS Idea, Solution, Acceptance-Finding = Divergence & Convergence

<u>Monday, October 2</u>

(TEKS 119.12 c8A,B)

1. Introduce top 10 economically feasible cattle breeds
   a. Development, history, and terminology
   b. Identify characteristics of cattle breed from pictures
      1) CPS Data-Finding = Divergence & Convergence

<u>Tuesday, October 3</u>

(TEKS 119.12 c8A,B)

2. Continue introduction of top 10 economically feasible cattle breeds
   a. Development, history, and terminology
   b. Understanding the climate, describe why each breed will or will not be profitable for production in this breed of cattle
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Wednesday, October 4

(TEKS 119.12 c8A,B)

3. Introduce top 10 economically feasible cattle breeds
   a. Development, history, and terminology
   b. Understanding of the climate and explain why each breed will or will not be profitable for production in this breed of cattle
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Thursday, October 5

1. Midpoint Satisfaction Survey (10 minutes)

(TEKS 119.12 c8A,B)

4. Introduce top 10 economically feasible cattle breeds
   a. Development, history, and terminology
   b. Understanding of the climate and explain why each breed will or will not be profitable for production in this breed of cattle
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Friday, October 6

(TEKS 119.12 c6D,E,F)

1. Quiz over Cattle Breed identification
   1. Article – "Develop a New Breed of Cattle by Combining Traits Conducive to Profitability in This Area"
      1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Monday, October 9

Staff Development (no school)

Tuesday, October 10

(TEKS 119.12 c8A,B)

1. Introduce top 6 important sheep and goat breeds
   a. Development, history, and terminology
   b. Identify and discuss characteristics of sheep/goat breeds from pictures
   c. Trip to Ag Farm for hands on experience
      2) CPS Data-Finding = Divergence & Convergence

Wednesday, October 11

(TEKS 119.12 c8A,B)

2. Continue introduction of top 6 important sheep/goat breeds
   a.Development, history, and terminology
   b. Power Point over sheep/goats
   c. What if there was only one breed?

1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Thursday, October 12

(TEKS 119.12 c8A,B)

3. Continue introduction of top 10 economically feasible cattle breeds
    a. Development, history, and terminology
    b. Discuss distribution and consumption of sheep/goats
    c. Summary of development, distribution, consumption of sheep/goats
    d. Who, what, when, where, how, why of sheep/goat distribution/consumption in computer lab
        1) CPS Mess, Data, Problem, Idea, Solution, Acceptance-Finding = Divergence & Convergence

Friday, October 13

(TEKS 119.12 c6D,E,F)

1. Article summary
    b. Write article over sheep production
        1) Summarize and give view of the topic
            a) CPS Solution-Finding = Divergent
        2) Discuss solutions to problems
            b) CPS Solution-Finding = Convergent

Monday, October 16

(TEKS 119.12 c3A,B,C,D; c8A,B,D,E; c7A)

1.Basic Animal Science
    a. Reproduction and roles of animals in our lives
        1) Show CEV video over Basic Animal Science
            a) CPS Mess-Finding = Divergent & Convergent

Tuesday, October 17

(TEKS 119.12 c3A,B,C,D; c8A,B,C,D,E)

1. Animal housing, nutrition, health, shots, and castrations
    a. Give 3 examples of animal housing for species beef, swine, sheep, & goats
    b. Explain the nutritional requirements for one species
        1) What might one feed and why to meet those requirements?
    c. What are some of the major health concerns for selected species?
        1) i.e. diseases, routine vaccinations, illness prevention, etc.
    d. CPS Data-Finding, Solution-Finding = Divergence

Wednesday, October 18

(TEKS 119.12 c3A,B,C,D; c8A,B,C,D,E)

2. Continuation of animal housing, nutrition, health, shots, and castrations
    a. Give 3 examples of animal housing for species beef, swine, sheep, & goats

b. Explain the nutritional requirements for one species
   1) What might one feed and why to meet those requirements?
c. What are some of the major health concerns for selected species?
   2) i.e. diseases, routine vaccinations, illness prevention, etc.
d. CPS Data-Finding, Solution-Finding = Divergence
e. Discussion

Thursday, October 19
(TEKS 119.12 c3A,B,C,D; c8A,B,C,D,E)

3. Discuss intramuscular and subqueautneous injections and castration methods
4. Demonstration and hands-on
   a. Practice shots on oranges and live castration
      1) Acceptance-Finding = Convergence

Friday, October 20
(TEKS 119.12 c6D,E,F)
. Article summary
   a.Write article over summary of the week's lesson over Basic Animal Science
      2) Summarize and give view of the topic
         a)CPS Solution-Finding = Divergent
      2) Discuss solutions to problems
         a)CPS Solution-Finding = Convergent

Monday, October 23
(TEKS 119.12 c5C,E,F)

1. Basic Environmental Science
   a. What is renewable energy and alternative fuels
      1) Fill roasting pans with soil & pour water on it to demonstrate erosion
      2) Make connection between soil stability & agricultural stability for crops
   b. Discuss connection between dependence of agriculture on the environment
      1) CPS Data-Finding = Divergence
      2) CPS Idea-Finding = Divergence
      3) CPS Solution-Finding = Divergence & Convergence

Tuesday, October 24
(TEKS 119.12 c5C,E,F)

1. Renewable and non-renewable energy sources
   a. Students will write their definition of renewable/non-renewable sources
   b. Teacher will converge on a working definition from student convergence (board)
   c. Students will categorize note cards containing renewable energy terms
      1) CPS Mess-Finding = Convergence
      2) CPS Data-Finding = Convergence

Wednesday, October 25
(TEKS 119.12 c5C,E,F)

1. Alternative fuel sources (biodiesel, ethanol, electricity, hydrogen, propane, methanol)
   a. Students will conduct internet research on alternative fuel sources for Friday article summaries
      1) Two students will be assigned to each fuel source to gain different perspectives
         a) Consideration given to how fuel is made and the potential impact for these fuels on the environment and agriculture
         b) A rubric will be followed to ensure comprehensiveness of answers
         c) Sources will be sited in list form
      2) CPS Data-Finding = Divergence & Convergence

Thursday, October 26
(TEKS 119.12 c5C,E,F)

1. Alternative fuel sources (continued)
   a. Internet research (continued)
      1) CPS Data-Finding = Divergence & Convergence

Friday, October 27
(TEKS 119.12 c5C,E,F)

1. Write article summary: Why Renewable Energy Sources Are Economically and Environmentally Important
   a. Summarize and support view of the topic
      1) CPS Data-Finding = Divergent & Convergent
      2) CPS Solution-Finding = Convergent
      3) CPS Acceptance-Finding = Convergent

Monday, October 30
(TEKS 119.12c8A,C,D)

1. Basic Food and Fiber Science
   a. Draw picture of the world without plants or animals
      1) Students will explain/defend drawing to the class
         A) CPS Idea-Finding = Divergent & Convergent

Tuesday, October 31
(TEKS 119.12c8A,C,D)

1. Basic Food and Fiber Science (continued)
   a. View half CEV power point over Basic Food and Fiber Science
   b. Students will devise questions over content
      1) Students will teach the answer for their question to the remainder of the class
         a) CPS Problem-Finding = Divergent & Convergent

Wednesday, November 1
(TEKS 119.12c8A,C,D)

1. Basic Food and Fiber Science (continued)
   a. View second half of CEV power point of Basic Food and Fiber Science
   b. Students will draw questions from a hat to answer and teach to the rest of the class
      1) CPS Problem-Finding = Divergent & Convergent
      2) CPS Idea-Finding = Divergent & Convergent
      3) CPS Solution-Finding = Divergent & Convergent
      4) CPS Acceptance-Finding = Divergent

<u>Thursday, November 2</u>
(TEKS 119.12c8A,C,D)
1. Basic Food and Fiber Science (continued)
   a. Draw a picture of the "Perfect Farm to Sustain Human Life"
      1) Use map colors
      1) Explain and discuss
         a) CPS Problem-Finding = Divergent & Convergent
         b) CPS Idea-Finding = Divergent & Convergent
         c) CPS Solution-Finding = Divergent & Convergent
         d) CPS Acceptance-Finding = Divergent & Convergent

<u>Friday, November 3</u>
(TEKS 119.12 c5C,E,F)
1. Write an article summary: Search and find article related to the week's topic
   a. Summarize and support the viewpoint of how it relates to Food and Fiber Science
      1) CPS Solution-Finding = Divergent & Convergent
      2) CPS Acceptance-Finding = Divergent

<u>Monday, November 6</u>
(TEKS 119.12c8A,B,C)
1. Plant Structure and Functions
   a. Gather plant samples around the campus
      1) Identify basic structures from those samples
      2) Classify the plant samples by structures and function
         a) CPS Data-Finding = Divergent & Convergent
         b) CPS Idea-Finding = Divergent & Convergent

<u>Tuesday, November 7</u>
(TEKS 119.12c8A,B,C)
1. Plant Structure and Functions (continued)
   a. Brainstorm functions of plant structures (stems, leaves, flowers, & seeds)
   b. Teacher will clarify functions of plant structures with CEV power point
      1) CPS Idea-Finding = Divergent
      2) CPS Acceptance-Finding = Convergent

Wednesday, November 8
(TEKS 119.12c8A,B,C)

1. Plant Structures and Functions (continued)
    a. Teacher will continue clarification through plant structure power point
    b. Students will dissect leaves and discuss specific plant structures
    c. Students will dissect and discuss seeds of plant structures
        1) CPS Data-Finding = Divergent
        2) CPS Problem-Finding = Divergent
        3) CPS Solution-Finding = Convergent

Thursday, November 9
(TEKS 119.12c8A,B,C)

1. Plant Structures and Functions (continued)
    a. Dissect stems, roots and flowers
    b. Teacher will continue clarification of plant structures
    c. Students will discuss stems, roots, and flowers (purpose)
        1) CPS Data-Finding = Divergent
        2) CPS Problem-Finding = Divergent
        3) CPS Solution-Finding = Convergent

Friday, November 10
(TEKS 119.12 c5C,E,F & c8A,B,C)

1. Individual research
    a. Categorize plant structures into sexual or asexual reproduction and explain the process
        1) Which plant structures such as stems, roots, leaves, flowers and seeds fall into which category of reproduction?
            a) CPS Data-Finding = Divergent & Convergent
            b) CPS Idea-Finding = Divergent & Convergent
            c) CPS Solution-Finding = Convergent
            d) CPS Acceptance-Finding = Convergent

Monday, November 13
(TEKS 119.12 c5F & c8B,E)

1. Wildlife Management
    a. View and classify real antlers for quality and explain why
    b. Justify selections to the class
        1) Learn how to measure antlers and explain quality
            a) CPS Data-Finding = Divergent & Convergent
            b) CPS Solution-Finding = Divergent & Convergent
            c) Acceptance-Finding = Convergent

Tuesday, November 14
(TEKS 119.12 c5F & c8B,E)

1. Wildlife Management (continued)

a. Guest speaker to present:
   1) Who administers laws and regulations?
   2) What are the laws and regulations?
   3) Why are laws and regulations necessary?
      a) CPS Data-Finding = Convergent
      b) CPS Problem-Finding = Divergent
      c) CPS Acceptance-Finding = Convergent

Wednesday, November 15
(TEKS 119.12c5F & c8B,E)

1. Wildlife Management (continued)
   a. Teacher will hand out 3 different scenarios pertaining to laws and regulations
      1) Laws
      2) Land management
      3) Animal management
   b. Students will work in groups of two to find solutions to law and regulation scenarios
      1) CPS Problem-Finding = Divergent & Convergent
      2) CPS Idea-Finding = Divergent & Convergent
      3) CPS Solution-Finding = Divergent & Convergent
      4) CPS Acceptance-Finding = Divergent & Convergent

Thursday, November 16
(TEKS 119.12 c5F & c8B,E)

1. Wildlife Management (continued)
   a. Students will present findings from scenario acitivities
      1) Students will try to reach consensus on feasibility and alternative solutions to scenario problems
         a) CPS Problem-Finding = Divergent & Convergent
         b) CPS Idea-Finding = Divergent & Convergent
         c) CPS Solution-Finding = Divergent & Convergent
         d) CPS Acceptance-Finding = Divergent & Convergent

Friday, November 17
(TEKS 119.12 c6D,E,F)

1. Students will develop an article over:
   a. Why fair chase is important to management of wildlife population
      1) Class presentations
      2) Discussion of pros and cons of presentations
         a) CPS Problem-Finding = Divergent & Convergent
         b) CPS Acceptance-Finding = Convergent

Monday, November 20

1. Torrance Test of Creative Thinking
   a. Posttest

1) CPS Mess-Finding = Divergent & Convergent
2) CPS Idea-Finding = Divergent & Convergent

Tuesday, November 21

1. Post Satisfaction Instrument

Wednesday, November 22

(Holiday)

Thursday, November 23

(Holiday)

Friday, November 24

(Holiday)

Monday, November 27

(TEKS 119.12 c4C)

1.Parliamentary procedure
   a. Mock meeting
   b. Discussion
   c. Q&A review
      1) CPS Idea-Finding = Convergent
      2) CPS Solution-Finding = Convergent
      3) Acceptance-Finding = Convergent

Tuesday, November 28

(TEKS 119.12 c8A,B,E)

1. Basic Livestock Terminology & Concepts
   a. Review power point of breeds
   b. Students will pick a breed and summarize finer points of that breed for the class
   c. Students will figure feed cost/profit scenarios for hogs
      1) CPS Data-Finding = Convergent
      2) CPS Solution-Finding = Convergent

Wednesday, November 29

(TEKS 119.12)

1. Review for cognition test
   a. Basic environmental science review
      1) Conservation of energy review activity
   b. Wildlife management review
      1) Why is Wildlife Management Important?
         a. Mock writing assignment using scoring rubric criteria
   c. CPS Idea-Finding = Divergent & Convergent
   d. CPS Acceptance-Finding = Divergent & Convergent

Thursday, November 30

1. Low level cognition test
   a. 10 true/false questions
   b. 25 multiple choice questions

Friday, December 1

1. High level cognition test
   a. 5 open-ended questions

APPENDIX C

TEKS OBJECTIVES FOR INTRODUCTION TO WORLD AGRICULTURAL SCIENCE AND TECHNOLOGY I

Chapter 119.12 Introduction to World Agricultural Science and Technology (One-Half Credit).

(a) General requirements. This course is recommended for students in Grades 9-12. This course may be offered to students in grade 8 for high school credit.

(b) Introduction. To be prepared for careers in the broad field of agriculture/ business, students need to attain academic skills and knowledge, to acquire knowledge and skills related to agriculture, business, and the workplace, and to develop knowledge and skills regarding career opportunities, entry requirements, and industry expectations. To prepare for success, students need to have opportunities to learn, reinforce, apply, and transfer their knowledge and skills and technologies in a variety of settings.

(c) Knowledge and skills.

(1) The student learns the employability characteristics of a successful worker in the modern workplace.

The student is expected to:

- (A) identify career development and entrepeneurship opportunities in the field of agriculture/agribusiness;
- (B) apply competencies related to resources, information, interpersonal skills, and systems of operation in agriculture/agribusiness;
- (C) demonstrate knowledge of personal and occupational safety practices in the workplace;
- (D) identify employers' expectations, appropriate work habits, and good citizenship skills; and
- (E) plan supervised agricultural experience programs.

(2) The student identifies concepts related to cultural diversity.

The student is expected to:

- (A) identify significant similarities and differences in international agriculture;
- (B) explain the variety of world markets; and
- (C) know marketing factors and practices that impact other cultures.

(3) The student describes the historical, current, and future significance of the agricultural industry.

The student is expected to:

- (A) define agriculture;
- (B) identify the scope of agriculture and its effect upon society;
- (C) identify significant historical and current agricultural developments; and
- (D) identify potential future scenarios for food and fiber systems.

(4) The student analyzes the structure of agricultural leadership organizations.	The student is expected to: (A) describe life skills for effective leadership; (B) identify opportunities for leadership development; and (C) demonstrate democratic principles in conducting effective meetings.
(5) The student explains the food and fiber system at local, state, national, and international levels.	The student is expected to: (A) identify reasons for world trade; (B) identify the political impact of agriculture; (C) identify the interdependency of agriculture and the environment; (D) demonstrate the impacts of agriculture upon land, air, and water resources; (E) identify alternative fuels; and (F) know environmental protection and remediation methods.
(6) The student demonstrates appropriate personal and communication skills.	The student is expected to: (A) describe professional and ethical work habits; (B) define the uses of proper etiquette and behavior; (C) identify appropriate personal appearance and health habits; (D) identify written and oral communication skills; (E) apply preparation skills to prepared and extemporaneous oral presentations; and (F) demonstrate speaking skills.
(7) The student applies appropriate research methods on agricultural topics.	The student is expected to: (A) define major fields of agricultural research and development; (B) identify and apply research in the food and fiber products industries; (C) explain and interpret the labeling of agricultural products; and (D) describe the scientific method of research.
(8) The student identifies basic plant and animal science concepts.	The student is expected to: (A) define terms related to food and fiber production; (B) describe the animal products industry; (C) describe the plant products industry; (D) describe the fiber products industry; and (E) list basic management practices.

(9) The student safely applies basic science and mathematical skills to mechanical agricultural systems.	The student is expected to: (A) explain the impact of mechanization on world agricultural production; (B) demonstrate safety and appropriate laboratory procedures; (C) identify metal and prepare a shop plan or working drawing; and (D) perform basic metal-working skills.

Source: The provisions of this §119.12 adopted to be effective September 1, 1998, 22 TexReg 4953

APPENDIX D

CORRELATIONS BETWEEN CEV CURRICULUM AND TEKS OBJECTIVES

CORRELATION BETWEEN CEV & TEKS OBJECTIVES	
CEV Curriculum	**TEKS Objectives**
Agriculture: Politics & Research	3A,B,C;5B;7A,B
America the Bountiful	11
Basic Animal Management	Supporting Course Materials
Basic Animal Science	5C,D,E,F
Basic Environmental Science	7B;8A,B,D
Basic Food & Fiber Science	9C,D
Basic Metallurgy	6A,B,C
Career Planning Basics	Supporting Course Materials
Engine Fundamentals	1C
EXCEL Beef Plant	1C
EXCEL Pork Plant	Supporting Course Materials
Field Trip: Egg Production	Supporting Course Materials
Field Trip: Fish Hatchery	Supporting Course Materials
Field Trip: Greenhouse	Supporting Course Materials
Field Trip: Pitchfork Ranch	Supporting Course Materials
Field Trip: San Joaquin Valley	Supporting Course Materials
Field Trip: Thoroughbred Farm	Supporting Course Materials
Field Trip: Tractor Manufacturing	Supporting Course Materials
Finding the Profit in Agriculture	Supporting Course Materials

Fundamental Canine Select./Confirm.	Supporting Course Materials
Human Impact on the Environment	3B
Introduction to Livestock Feeding	1B
Occupational Guidance for Agriculture	1A,B,C,D
Oxy-Acetylene Cutting	9C,D
Oxy-Acetylene Welding: Safety/Intro.	9B,C,D
Parliamentary Procedure CD-ROM	4C
Plant Structures & Functions	Supporting Course Materials
Principles of Floral Design	8C
Regulations: Hunting & Fishing	1A
Supplements	Supporting Course Materials
Sustainable Agriculture	1B,D;3B;5D;7B
Teacher Resource Guide	1E;7D
The Cheeseburger	1B;8A
Understanding Nutritional Labeling	7C
WF: Essential Plant Nutrients	Supporting Course Materials
WF: Principles of Plant Growth	Supporting Course Materials
WF: Soil – A Medium for Plant Growth	Supporting Course Materials
WFH: Water & Plant Growth	5D
World Agriculture/Population: Balance	2A,B,C;3B,C,D;5A,B,C,D;9A

APPENDIX E

POSTTEST FOR LOW-LEVEL, HIGH-LEVEL AND TOTAL COGNITION

Name ______________________________

Date _______________________________

INTRODUCTION TO WORLD AGRICULTURAL SCIENCE AND TECHNOLOGY I SEMESTER EXAM

PART I: Low Cognition (10 True/False; 25 Multiple Choice; Correct = 2 point each)

A. TRUE/FALSE: Circle the "T" if the statement is true, or circle the "F" if the statement is false.

1. T F The six classes of nutrients are water, carbohydrates, proteins, fat, vitamins and minerals.

2. T F Japan has to export over 70% of the food needed to feed its people.

3. T F An acre is about the size of a football field.

4. T F The mother's first milk is called colostrum, which contains vitamins and antibodies.

5. T F Today, each American farmer produces enough food to feed 125 people.

6. T F Fertilized eggs are typically sold to consumers in grocery stores.

7. T F Alfalfa hay and oat straw are good examples of the dry forage and roughages class.

8. T F Nature and human conflict curtail population growth in four drastic ways: war, starvation, disease and pests.

9. T F Cattle ruminants, meaning they have a three compartment stomach.

10. T F Fats contain about 2.5 times as much energy per unit of weight as do proteins and carbohydrates.

B. MULTIPLE CHOICE: Circle the letter of the choice that best completes the following statements.

11. The length of time from conception to birth is known as _______________.
    A. Pregnancy
    B. Labor
    C. Germination
    D. Gestation

12. What is the most expensive part of cattle production?
    A. Slaughter
    B. Ear tagging
    C. Feed
    D. Hormone injection

13. The average fast food cheeseburger contains 440 calories. If you ate 54 cheeseburgers in a year, how many calories would you have consumed from the cheeseburgers?
    A. 52,166
    B. 23,760
    C. 18,953
    D. 21,998

14. Which of the following animals has a gestation period of 283 days?
    A. Sow
    B. Chicken
    C. Goat
    D. Cow

15. What is America's largest industry?
    A. Agriculture
    B. Retail
    C. Oil
    D. Electronics

16. How many different amino acids synthesize proteins?
    A. 15
    B. 20
    C. 10
    D. 5

17. Which of the following is not an advantage of using ethanol as an alternative fuel source?
    A. Inexpensive
    B. Reduces independence on foreign oil
    C. Reduces pollution
    D. Renewable fuel

18. Hydropower, solar, and wind are which type of energy?
    A. Alternative
    B. Renewable
    C. Fossil
    D. Non-renewable

19. Which of the following recyclable materials is considered hazardous?
    A. Paper
    B. Plastic
    C. Motor oil
    D. Aluminum

20. What percent of Texas land is privately owned?
    A. 13%
    B. 29%
    C. 97%
    D. 78%

21. The purpose of a main motion is to __________________.
    A. Close meetings
    B. Present business
    C. Encourage courtesy
    D. Consider options

22. Which is <u>not</u> an alternative fuel?
    A. Oil
    B. Biodiesel
    C. Hydrogen
    D. P-Serius

23. All of the following are pertinent facts of a main motion except _______.
    A. A second is required
    B. It is debatable
    C. It is amendable
    D. It requires a two-thirds majority vote

24. Hunting and fishing laws are made to___________.
   A. To annoy hunters
   B. To ensure a fair chase
   C. To make the state money
   D. To relieve stress

25. Which is the main drawback of using solar energy?
   A. Harmful emissions
   B. Limited resources
   C. Radioactive waste
   D. Area needed

26. Which of the following is <u>not</u> a characteristic of a Hampshire swine?
   A. Erect ears
   B. White belt over front shoulders
   C. Poor growth efficiency
   D. Good carcass traits

27. Economic traits of swine production are __________________.
   A. Poor feed conversion
   B. Small litters
   C. High fat content
   D. Heavy muscling

28. An angora goat grows which type of hair?
   A. Cashmere
   B. Mohair
   C. Wool
   D. Kinky

29. The Trans-Texas Corridor is projected to consume _________ acres of agricultural land.
   A. 3,000
   B. 600,000
   C. 250,000
   D. 1,000,000

30. What is the most popular breed of meat goat?
   A. Billy goat
   B. Angora goat
   C. Nanny goat
   D. Boer goat

31. Why might a motion be referred to a committee?
    A. To speed up the process
    B. To secure a recommendation from a larger body
    C. To temporarily delay action on an item of business
    D. To insure privacy in dealing with delicate issues

32. What frame size is characteristic of Charolais cattle?
    A. Large
    B. Medium
    C. Small
    D. Dwarf

33. Which breed of cattle revolutionized the beef cattle industry in the United States?
    A. Brahman
    B. Longhorn
    C. Hereford
    D. Angus

34. Castration is the removal of ____________________.
    A. Horns
    B. Testicles
    C. Ovaries
    D. Tail

35. What is the reproductive part of a tomato plant?
    A. Seed
    B. Root
    C. Leaf
    D. Flower

PART II: High Cognition (Scoring range from a low of completely incorrect = 0 points to a high of completely correct = 6 points)

C. OPEN-ENDED: Provide a detailed, factual, and comprehensive answer to five of the following six questions. (omit one)

1. Explain in detail a real-life situation in which Parliamentary Procedure could improve.

2. Where does a cheeseburger come from?

3. Explain the relationship between politics and agriculture.

4. Develop a new breed of swine by combining traits conducive to profitability.

5. How does the health of animals affect you as a human?

6. Describe how life would be without fossil fuels.

APPENDIX F

SATISFACTION INSTRUMENT

Name ________________________

School ________________________

Please circle the number that best describes your feelings about each statement below.

Clarity		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Course materials were relevant to the objective.		1	2	3	4	5
The unit(s) was well organized.		1	2	3	4	5
The objectives of the unit(s) were appropriately defined.		1	2	3	4	5
The work requirements were clear.		1	2	3	4	5
The assignment directions were easy to follow.		1	2	3	4	5
Delivery		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The method for delivering the material was appropriate for the unit.		1	2	3	4	5
Material presented in the lectures was interesting.		1	2	3	4	5
The lab activity was interesting.		1	2	3	4	5
Instructional methods made the material easier to learn.		1	2	3	4	5
Grading procedures were fair.		1	2	3	4	5
Content		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I enjoyed the unit(s) more than normal unit(s) in other classes.		1	2	3	4	5
The unit(s) was a valuable learning experience.		1	2	3	4	5
I found the class instruction more challenging than traditional teaching.		1	2	3	4	5
These were excellent unit(s) of instruction.		1	2	3	4	5
I would be interested in more material being presented in this manner.		1	2	3	4	5