EFFECTS OF CREATIVE PROBLEM SOLVING INSTRUCTION UPON 6TH GRADE STUDENTS' PERFORMANCE ON A STANDARDIZED CREATIVITY MEASURE

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Abstract

Creativity, when examined holistically, is a complex, multidimensional phenomenon. Only, during the latter part of the twentieth century, has research sought to unravel the mysteries of the creative realm and place emphasis towards its value in the goals and methods of the United States educational system (Kaufmann, 1999). Cognitive studies have revealed that creative behavior can be learned yet in order to best capitalize on the benefits of creative personnel, individuals within both educational institutions and business organizations must develop a deeper understanding of this phenomenon so as to foster the growth and development of creative potential within its students/employees (Baker, Rudd & Pomeroy, 2001; Kvashny, 1982, Maraviglia & Kvashny, 2006). The purpose of this study was to determine if pedagogical methods designed to promote ideation would impact levels of creative thought on five constructs and a cumulative creative index score as measured by the Torrance Test for Creative Thinking (TTCT). To this end, a sixth-grade social studies creative problem solving unit was taught to a regular classroom of students who were randomly assigned to this treatment. Two additional regular classes of students taught in a traditional, expository manner were randomly assigned to serve as a control. A fourth, purposefully selected class of gifted and talented students served as a second treatment group. Treatment effects were found in two of the five TTCT constructs (elaboration and resistance to closure). A gender effect was found in the TTCT construct of abstractness, with females being more abstract in their thoughts than males. Although no significant treatment effect was found in the cumulative creativity measure, the researchers recommended that creative problem solving be systematically incorporated into sixth grade social studies classes. Additionally, it was recommended that subsequent research focusing upon gains in subject matter knowledge, student satisfaction, and student thought processes be conducted.

Introduction/Conceptual Framework

The concept of middle school programs in agricultural education is not new. According to Rossetti and McCaslin (1994), Virginia established middle school programs in 1926. In 1993, Frick predicted continued demand for middle school programs. Frick (1993) concluded a national study establishing a framework in middle schools by recommending that the profession document effective teaching strategies for this age group of students. In 1997, Fritz and Moody, in an assessment of middle school programs in Nebraska asked "Are our future instructors being prepared in the psychology of the adolescent learner?" (64) The present study was conducted to provide information about the effectiveness of a teaching approach on middle school learners.

Within the last decade, technological changes and advances in communication have catapulted society into what is now being coined "The Age of Information." To better prepare students as productive, self-sustaining contributors to society; educational institutions must move away from current pedagogical methods that are dependent solely on rote memorization and learning of facts. Given the dynamics and complexity of the world today, what is learned at this time may not necessarily hold true one to ten years later. Students must thus be prepared to respond to changes within a dynamic society. They must be flexible and develop creative problem-solving skills enabling them to be responsive in any given situation. Essentially, students must learn to think on their feet and adapt quickly by understanding patterns and making connections that lead to the production of new and viable ideas (Tomlinson, et al., 2002; Kvashny, 1982).

According to Biondi (1993), problems can be classified as being analytical, judgmental, or creative. In terms of creative problems (which are open-ended, having many solutions), he asserts that 99% of real-world problems could be placed in this category. It is believed that most people do not know how to formulate questioning patterns that allow for ideation and development of multiple solutions. In addition, research has indicated that individuals may also fear using creative strategies as such strategies may produce solutions that are considered not the norm. Analytical and judgmental thoughts are safe havens and create a "fit" within societal constructs. Teaching, in turn, follows similar societal expectations and many pedagogical methods are geared towards teaching the judicial mind and not creative thinking (Adams, 2001; Osborn, 2001; Parnes, 1997). Researchers in the field of creativity have often contended that creative thinking strategies can and should be taught (Parnes, 1997; Osborn, 1992). Treffinger, et al., (1992) noted in his studies of creative thinking that students benefit from creative teaching strategies by becoming independent of teacher assistance in solving problems. In addition, he developed a model encompassing both cognitive and affective domains that work together towards solving creative type problems. The foundation level of his creative thinking model rested on divergent thinking processes that included cognitive skills of fluency, flexibility, originality, elaboration, and cognition and memory. Affective dimensions at this level included curiosity, willingness to respond, openness to experience, risk taking, problem sensitivity, tolerance for ambiguity, and self-confidence. This foundation sets the stage for more complex levels of creative thinking as cognitive and affective domains are extended into the second and third levels (Figure 1).

To provide conceptual guidance for this study, the first foundation of this model was explored in detail using the Creative Problem-Solving (CPS) model designed to teach both divergent and convergent thinking strategies and hence is congruent with the upper levels of Treffinger's model of creative thinking. The CPS model was chosen to provide students with a learning environment that addressed both the affective and cognitive domains. In a proper climate for CPS, this approach enhances both individual and group interactions, thus reducing the amount of risk involved in responding creatively. The components of the model are Objective/mess Finding, Fact-Finding, Problem-Finding, Idea-Finding, Solution-Finding, and Acceptance-Finding. Often, the model is represented in the form of a diamond noting the areas where divergent thought expands and then merges into convergent thinking; however, each stage discussed is not an isolated event but rather can in itself incorporate the entire divergent and convergent thinking processes (Osborn, 2001; Isaksen & Parnes, 1985; Talbot, 1999).

Traditional teaching practices have often been criticized by creativity research gurus as suppressing creative thought and encouraging judicial and analytical problem-solving (Clark, 2002; Adams, 2001; Osborn, 2001; Biondi, 1993; Amabile, 1989). Strategies believed to foster divergent thinking processes were explored and incorporated into the lesson design of this study. Classroom and lesson design focused upon use of several techniques which were noted for supporting the development of divergent thinking and creative problem-solving.

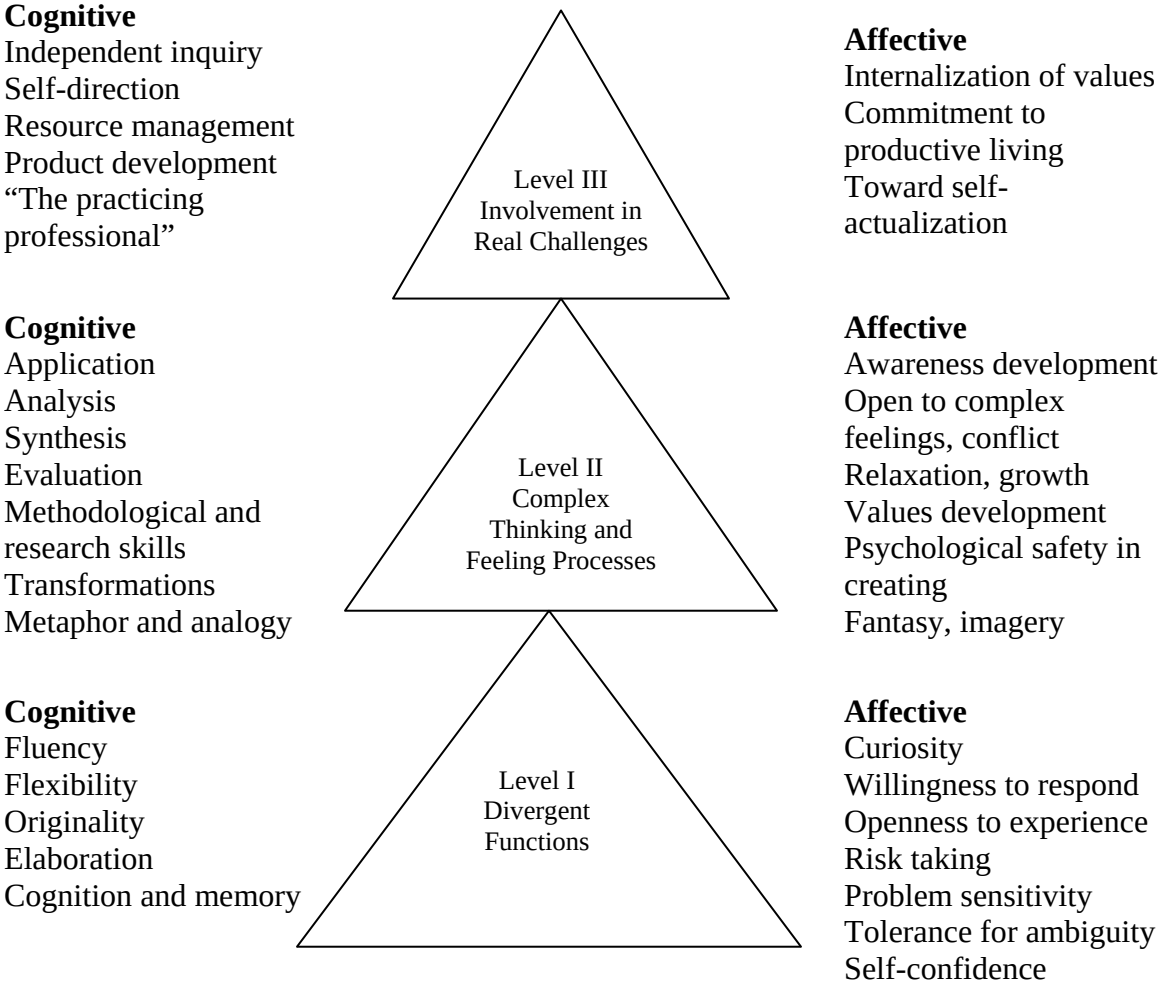

Figure 1: Creative learning model (Treffinger, et al., 1992)

Through Treffinger's research, divergent thinking is believed to be the foundation for creative problem-solving. It is dependent on the ability to formulate a multitude of original and unique ideas that are rich in detail, derived from many categories, and are defined or perceived as being different. Torrance and Goff (1990) defined these skills as fluency, flexibility, originality, elaboration, and redefinition. Osborn (1992, 2001) stated that divergent production is dependent upon an individual's ability to use his/her imagination and that teaching in turn should focus on methods which teach the ideation process. Based on his research, Osborn noted that the production of ideas calls for deferred judgment which has been supported by research as a viable method in producing significant results within the ideation process. In addition, Osborn also

found that ideas produced by individuals adopting the philosophy of "quantity breeds quality" in the problem-solving process provided 78% more usable ideas than those generated by individuals who set out to develop ideas based on quality first.

Biondi (1993) indicated that problems with creative thought often lie with the inability to formulate questioning patterns that extend the mind beyond obvious solutions. Open-ended questioning which suspends judgment and invites a multitude of different responses rather than "yes" or "no" answers are more likely to produce increased quantities of novel ideas. Osborn (2001) noted that questioning is a technique that has been known to stimulate the imagination and encourage ideation. It gives what he terms "conscious guidance" to the thinking process because individuals utilizing this technique are constantly questioning themselves with "what if" scenarios and stockpiling ideas developed from their queries. Creative thinking often requires individuals to consciously apply ideation practices in place of judicial and analytical thought. It is a mental effort that sometimes needs a jumpstart to get it up and moving. Note-taking, check listing, and attribute listing can initiate the imagination and set the stage for ideation because as these techniques are employed, effort is given towards thinking about solving the problem creatively, associations among ideas are created, and it serves as a storage tool for future referral, tweaking, and deliberation (Osborn 2001).

Parnes (1992) also noted that these very same tools practiced during CPS process can aid in tapping into the unconscious effort an individual's mind uses in solving a problem. He recommends that within the CPS process, time should be given to further defer judgment and just walk away from the problem when all ideas appear to be exhausted. This time away has often been termed incubation in which an individual "mulls over" the problem and becomes actively involved in a separate activity. During this time away, the unconscious mind may possibly remain at work on the original problem and through perhaps some unknown association or insight, develop a completely new and novel idea. Sometimes these ideas stay with the individual while others are fleeting glimpses that ultimately are lost. The practice of quickly jotting down ideas directly after a dream or revelation can limit the loss of a particular idea forever and enhance the creative problem solving process.

Purpose and Research Hypotheses

The purpose of this study was to determine the effects of using CPS instructional strategies upon sixth grade students' creative thinking attributes. Specifically, this study sought to determine if pedagogical methods designed to promote ideation among students would impact levels of creativity. The following research hypotheses were addressed in this study: (1) students in treatment groups receiving CPS instruction will have significantly higher fluency scores at the end of the unit than students receiving traditional instruction; (2) students in treatment groups receiving CPS instruction will have significantly higher originality scores at the end of the unit than students receiving traditional instruction; (3) students in treatment groups receiving CPS instruction will have significantly higher abstractness of title scores at the end of the unit than students receiving traditional instruction; (4) students in treatment groups receiving CPS instruction will have significantly higher elaboration scores at the end of the unit than students receiving traditional instruction; (5) students in treatment groups receiving CPS instruction will have significantly higher resistance to closure scores at the end of the unit than students

receiving traditional instruction; and (6) students in treatment groups receiving CPS instruction will have significantly higher creativity index scores (total creativity) at the end of the unit than students receiving traditional instruction.

Methods

According to Gall, Borg, and Gall (1996), in cases where random assignments of participants are not possible (such as in classroom settings), a quasi-experimental design can result in useful information and knowledge. From a classical research design perspective, a static group comparison design was utilized (Campbell & Stanley, 1963). Data were collected from four, sixth-grade classes, each containing approximately eighteen students in Ft. Stockton (TX) Middle School. Three of the classes were randomly assigned into two control groups (n=20, n=21 respectively) and one treatment group (n=17). In addition, a gifted and talented class was treated as a second treatment group (n=17). This allowed the researcher to compare the treatment effects on a regular cross-section of students and upon a class of gifted and talented students. The data collected from the two control groups, who were taught using a traditional expository approach, were combined for analysis purposes (n=41).

Data were collected during the 2004 fall semester. A six-week instructional unit was presented in regularly scheduled classes that were forty-five minutes long. The Torrance Test of Creative Thinking (TTCT) was given as a pre-test on September 7, 2004 and then as a post-test on November 1, 2004. Students of the control group were taught using the state adopted textbook and lecture formatted lessons. Students progressed through the chapters using a system of defining key vocabulary words, reading aloud the chapter, note taking, answering end-of-chapter questions, and completing supplemental worksheets that corresponded with the chapter of study.

The six-week unit of instruction was based upon the elements of the state curriculum known as the Texas Essential Knowledge and Skills (TEKS) and focused primarily upon geography and community/economic development. Historical agricultural content was integrated within the study as students explored the use of natural resources, societal distribution patterns, adaptations to physical environment, and modifications of physical environment such as terraced farming. Students within the treatment groups participated in learner-centered, game-like activities designed to develop creative problem-solving skills.

Unit activities incorporated the use of brainstorming, brainwriting/mapping, attribute listing, SCAMPER (an acronym that stands for questioning related to substitute, combine, adapt, modify/distort, put to other purposes, eliminate, rearrange/reverse) open-ended questioning, role-play, incubation instructional techniques and application of the entire CPS model. The treatment groups received instruction from the researcher and a gifted and talented specialist, both of whom have specialized training in Gifted and Talented curriculum and instructional strategies. During the course of the study, the two individuals met daily to discuss lesson plan designs and delivery of Creative Problem Solving instruction. The instructor teaching the control groups had over thirty years of public school classroom experience. The researcher also met daily with this teacher and held similar discussions related to content synchronization.

This study sought to determine if measurable differences in divergent thinking could be obtained through the use of Creative Problem-Solving strategies as measured by the TTCT-Form A. For this three-part timed test, subjects were asked to construct a picture, complete a series of incomplete drawings, and complete drawings from sets of parallel lines. According to Torrance, Orlow, and Safter, (1990):

> The term "creative thinking abilities" as used in the TTCT, refers to that constellation of generalized mental abilities that is commonly presumed to be brought into play in creative achievements…The author has maintained that high degrees of the abilities measured by tests such as the TTCT increase the chances that the possessor will behave creatively. Certainly, the author of these tests would never argue that possession of these abilities guarantees that an individual will behave creatively, any more than a high degree of intelligence guarantees intelligent behavior…Creative motivations and skills, as well as abilities, are necessary for adult creative achievement. (p. 1)

The TTCT results in quantitative scores for the following norm-referenced constructs: (1) fluency-the ability to produce a large number of figural images; (2) originality-unusualness or rarity of response; (3) abstractness-the ability to produce good titles and to capture the essence of information involved; (4) elaboration-ability to develop, embroider, embellish, carry out, or otherwise elaborate ideas; and (5) resistance to premature closure-the ability to keep a figure open and delay closure long enough to make the mental leap that makes original ideas possible. In addition, overall creativity was assessed. Content and construct validity has been established by the TTCT test developer (Torrance et al., 1990). Intra-rater reliability coefficients are above the .90 level (Torrance, et al., 1990).

Data were analyzed using the Statistical Package for Social Science (SPSS 14.0). Tests for statistical significance were set at the .05 level. A General Linear Model (GLM) Analysis of Covariance (ANCOVA) was used to determine the effects of the creative problem solving instruction upon student's creativity. Post-treatment TTCT scores were used as covariates in an effort to equate the groups. Independent variables included treatment effects, gender, socioeconomic status, and ethnicity. Student qualification for the free and reduced lunch program (as reported in the PEIMS) served as a proxy to determine family socioeconomic status. This resulted in a four-way General Linear Model (GLM) ANCOVA, where main effects for the independent variables were detected, along with three, two-way interactions (treatment x gender, treatment x ethnicity, treatment x SES), three, three-way interactions (treatment x gender x ethnicity, treatment x gender x SES, treatment x ethnicity x SES), and one, four-way interaction (treatment x gender x ethnicity x SES). According to Field (2000), ". . . ANCOVA can help us to exert stricter experimental control by taking into account confounding variables to give us a 'purer' measure of effect of the experimental manipulation." (p. 301). SPSS for Windows was also used to determine effect size using eta squared. According to Green, Salkind, & Akey, 2000), levels of effect size can be small, modest, or large using the values, .01, .06, and .14 respectively.

Findings

Hypothesis One: Students in treatment groups receiving CPS instruction will have significantly higher fluency scores at the end of the unit than students receiving traditional instruction. The adjusted means for fluency was greatest for regular students taught in the creative problem-solving class (M=27.71) followed by regular students taught with traditional instructional methods (M=26.79) and finally by gifted and talented students taught using the CPS model (M=25.09). In terms of gender, females had a slightly higher adjusted score on fluency (M=26.54) as compared to males (M=26.28). Examination of adjusted mean scores for ethnicity revealed higher adjusted scores for white (non-Hispanic) students (M=28.18) as compared to Hispanic students (M=24.96). Economically disadvantaged students appeared to have greater adjusted mean scores (M=28.11) than the non-economically disadvantaged students (M=24.73). A general linear model (GLM) ANCOVA was conducted to determine main and interaction effects on fluency, gender, ethnicity, and socio-economic status. The resulting analysis revealed no significant main or interaction effects within the data[1].

Hypothesis Two: Students in treatment groups receiving CPS instruction will have significantly higher originality scores at the end of the unit than students receiving traditional instruction. The adjusted means for originality were greatest for students taught in the traditional classroom setting (M=18.78), followed by regular students taught using CPS strategies (M=18.28) and the gifted and talented group taught with CPS strategies (M=17.70). In terms of gender, the adjusted means were greater for females (M=18.42) compared to males at (M=18.06). Ethnicity revealed higher scores for white (non-Hispanic) students (M=19.70) compared to Hispanic students (M=17.05). Students classified as economically disadvantaged had higher adjusted means (M=19.08) than those identified as non-economically disadvantaged (M=17.43). The researchers conducted a GLM ANCOVA to determine the effects on originality of class, gender, ethnicity, and socio-economic status. The resulting ANCOVA revealed no significant main or interaction effects within the data.[2]

Hypothesis Three: Students in treatment groups receiving CPS instruction will have significantly higher abstractness of title scores at the end of the unit than students receiving traditional instruction. The adjusted means for abstractness of titles was greatest for gifted and talented students taught with CPS (M=8.76) followed by regular students taught by way of CPS (M=7.72) and followed finally by regular students taught via traditional (expository) methods (M=6.15). In terms of gender, females had greater adjusted scores on abstractness of titles (M=8.70) compared to males (M=6.12). As per ethnicity, Hispanic students had higher adjusted means on abstractness of titles (M=7.70) than white (non-Hispanic students (M=7.31). The non-economically disadvantaged students had higher adjusted means (M=8.18) than did those students classified as economically disadvantaged (M=6.87).

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[1] Although the assumption of homogeneity of variance was met for this analysis, the assumption of homogeneity of regression slopes was not met.

[2] The assumption of homogeneity of variance was not met for this analysis; however the assumption of homogeneity of regression slopes was met.

A significant main effect was detected on abstractness of titles for gender (F=4.17, df=22,1, p=.046). Holding the pretest scores constant, female students scored significantly higher on abstractness of titles compared to their male counterparts. Although significantly different, the partial eta squared revealed a modest effect size. Gender by itself accounted for 7.4% of the overall (effect+error) variance. A significant two-way interaction (F=3.74, df=2, p=.030) was also discovered between class and gender. In the regular classroom using CPS, males outperformed females. However, in the gifted and talented classroom taught using CPS and in the classroom taught using traditional teaching methods, females scored higher on abstractness of titles (Figure 2). Although significantly different, a modest interaction effect size was detected. The interaction of class and gender accounted for 12.6% of the overall (effect + error) variance.

Hypothesis Four: Students in treatment groups receiving CPS instruction will have significantly higher elaboration scores at the end of the unit than students receiving traditional instruction. The adjusted means for elaboration was greatest for regular students taught by way of CPS (M=6.24) followed by gifted and talented students taught with CPS (M=6.19) and finally by regular students taught via traditional (expository) methods (M=5.19). In terms of gender, females had greater adjusted scores on abstractness of titles (M=6.13) compared to males (M=5.50). As per ethnicity, white (non-Hispanic) students had a slightly higher adjusted mean on elaboration (M=5.89) than Hispanic students (M=5.80). The non-economically disadvantaged students had higher adjusted means (M=5.90) than did those students classified as economically disadvantaged (M=5.78).

The ANCOVA[3] data revealed a significant main effect on elaboration for class (F=3.88, df=22, 2, p=.027). Although significantly different, the partial eta squared revealed a modest effect size. Class by itself accounted for 13.1% of the overall (effect + error) variance. A LSD post hoc analysis was conducted to determine how the classes differed. There was a significant difference between the control group and the regular students taught by CPS, and the control group and the G/T students taught with CPS. There was no significant difference between the treatment groups.

[3] Although the assumption of homogeneity of variance was met for this analysis, the assumption of homogeneity of regression slopes was not met.

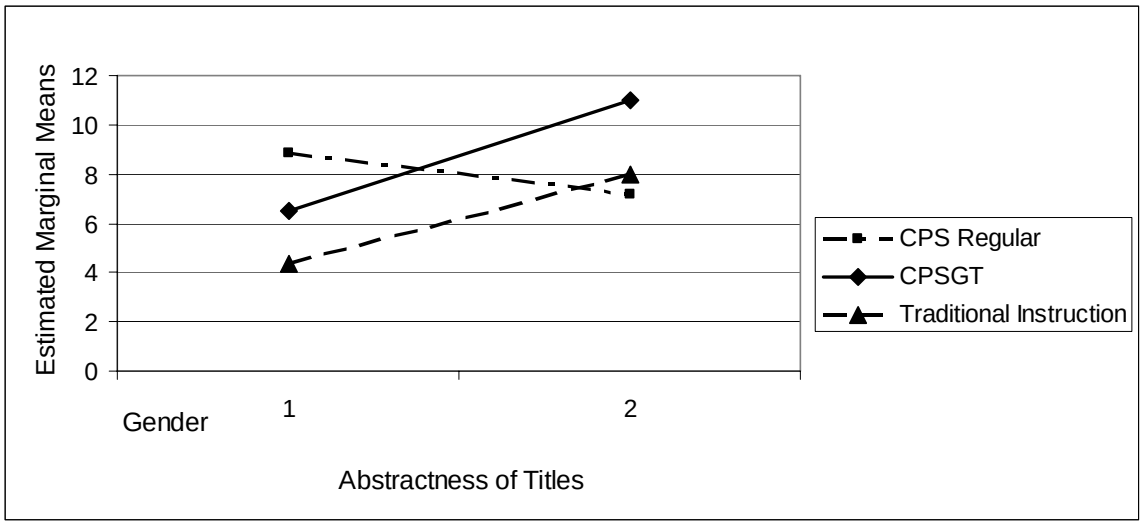

Figure 2: Interaction Effect of Class and Gender for Abstraction of Titles (1=Males, 2=Females)

Hypothesis Five: Students in treatment groups receiving CPS instruction will have significantly higher resistance to closure scores at the end of the unit than students receiving traditional instruction. The adjusted means for resistance to closure was greatest for regular students taught using CPS strategies (M=15.39), followed by the gifted and talented group taught with CPS strategies (M=14.42) and finally by students taught in the traditional classroom setting (M=12.75). In terms of gender, the adjusted means were greater for females (M=14.42) compared to males (M=13.55). Ethnicity revealed higher scores for white (non-Hispanic) students at (M=14.20) compared to Hispanic students (M=13.97). Students classified as non-economically disadvantaged had higher adjusted means (M=14.15) than those identified as economically disadvantaged (M=14.00).

A significant main effect[4] was detected on resistance to closure for class (F=4.26, df=22, 2, p=.019). Holding the pretest scores constant, the LSD post hoc analysis revealed that students in the regular class taught using the CPS model scored significantly higher on resistance to closure as compared to students taught by traditional (expository) instruction. No significant difference was discovered between students in the traditional "control" group class and the G/T students taught with CPS strategies in regards to resistance to closure scores. There was also no significant difference found between the regular class taught using CPS strategies and the G/T class taught using the same treatment. Although significantly different, the partial eta squared revealed a modest effect size. Class by itself accounted for 14.1% of the overall (effect + error) variance.

According to Figure 3, a significant two-way interaction was discovered between class and socio-economic status (F=3.33, df=22, 2, p=.044). There was little difference among students in the treatment and control groups that were identified economically disadvantaged; however, there was a substantial difference in students identified non-economically disadvantaged, where

[4] Although the assumption of homogeneity of variance was met for this analysis, the assumption of homogeneity of regression slopes was not met.

those taught using CPS strategies scored higher on resistance to closure measures. Although significantly different, a modest interaction effect size was detected. The interaction of class and gender accounted for 11.3% of the overall (effect + error) variance.

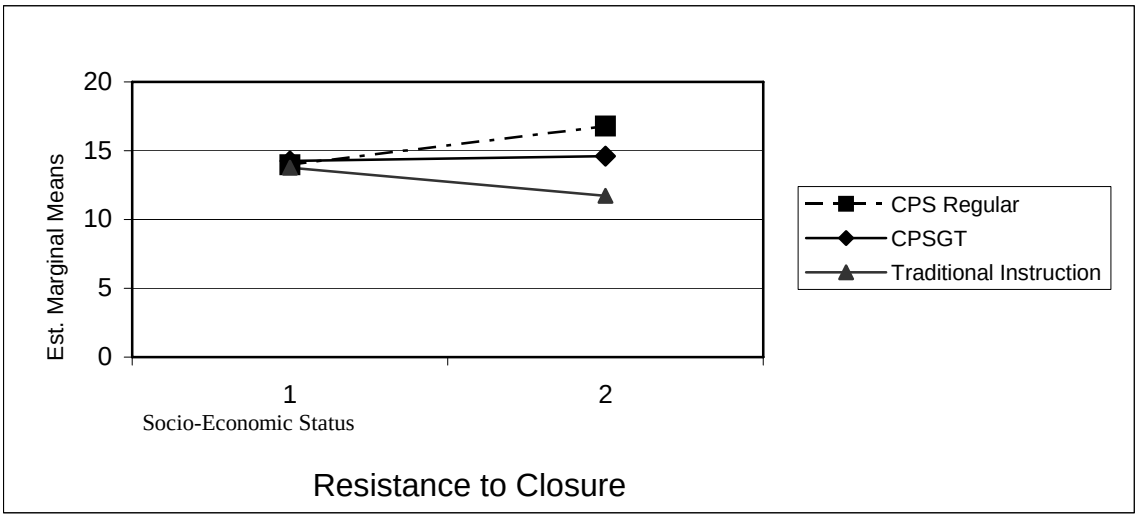

Figure 3: Interaction Effect Between Class and Socio-Economic Status for Resistance to Closure (1=Economically Disadvantaged, 2=Non-Economically Disadvantaged)

Hypothesis Six: Students in treatment groups receiving CPS instruction will have significantly higher creativity index scores (total creativity) at the end of the unit than students receiving traditional instruction. The adjusted means for creative index scores was greatest for regular students taught using CPS strategies (M=112.9), followed by the gifted and talented group taught with CPS strategies (M=110.9) and finally by students taught in the traditional classroom setting (M=104.3). In terms of gender, the adjusted means were greater for females (M=112.0) compared to males (M=105.6). Ethnicity revealed higher scores for white (non-Hispanic) students (M=110.6) compared to Hispanic students (M=107.9). Students classified as economically disadvantaged had slightly higher adjusted means (M=109.4) than those identified as non-economically disadvantaged (M=108.8). The resulting ANCOVA[5] revealed no statistically significant main or interaction effects within creativity index scores.

Conclusions/Discussion/Recommendations/Implications

Although the analyses revealed that three of the creativity constructs (fluency, originality, and abstractness) were not affected by the treatment, a gender effect was noted in abstractness. Females scored higher on abstractness of titles than males. In addition, a two-way interaction effect on abstractness of titles was found between gender and class. This interaction was disordinal in that the simple main effect of gender was different for the treatment and control groups. In the regular classroom using CPS, males outperformed females; however, in the gifted and talented classroom taught using CPS and in the classroom using traditional teaching methods, females outperformed males on abstractness of titles. These disordinal differences may

[5] Although the assumption of homogeneity of variance was met for this analysis, the assumption of homogeneity of regression slopes was not met.

be more succinctly explained through research conducted by Kolb and Fry (1975) in which four basic learning styles were inclusive of abstract and reflective thought. These differences in gender performance may be attributed more too how groups of individuals think within a context of Kolb and Fry's learning model than the impacts CPS has upon them.

Significant treatment effects were found in the creativity constructs of elaboration and resistance to closure. Certainly any improvement in elaboration, or the ability to build upon one's thought, is an important finding of this study. Improvements in one's ability to maintain the thought process without premature closure is of great consequence. However, the interaction between the treatment and socioeconomic status in terms of premature closure was troubling. This interaction was ordinal, in that the CPS instruction seems to benefit students from higher socio-economic households. In fact, regular students taught by CPS had the greatest gains in resisting premature closure. Could it be that students from lower socioeconomic homes have less of an opportunity to think creatively or to dream? Could it be that to reap the benefits of creative problem solving instruction, that it may take longer periods of time for students from economically disadvantaged homes?

Overall the treatment did not significantly impact creative index scores (overall creativity). A close inspection of the means revealed a lesser, non-significant trend in the data. Students in both the gifted and talented class and the regular class seemed to benefit overall based upon a comparison of their pre-treatment and post-treatment overall creativity scores. This leads one to ask whether larger sample sizes or longer interventions would have resulted in significant gains in overall creativity.

The short-term gains in creative thinking found in this study leads the authors to recommend that creative problem solving be incorporated into middle school agricultural education programs. It is hoped that these findings will be useful in the codification of age-appropriate teaching strategies as called for by Frick (1993). It is also recommended that subject matter gains and student satisfaction be examined. Additionally, researchers should receive input from other subject matter teachers pertaining to student transferability of creative problem solving skills to contextual areas beyond social studies. Mixed-method research needs to be conducted in this area to better understand the thought processes of students.

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