



A Study on the Application of Creative Problem Solving Teaching to Statistics Teaching

Ridong Hu

Huaqiao University, CHINA

Su Xiaohui

Huaqiao University, CHINA

Chich-Jen Shieh

Huaqiao University, CHINA

Received 20 October 2016 • Revised 12 February 2016 • Accepted 19 March 2017

ABSTRACT

Everyone would encounter the life issue of solving complicated problems generated by economic behaviors among all activities for making a living. Various life problems encountered therefore could be generalized by economic statistics. In other words, a lot of important events in daily life are related to economic statistics. For this reason, teaching students to understand the world, make reasonable decisions, and behave correctly on important personal or social issue has been the major objectives and directions of education. Taking universities in Fujian Province as the research subjects, including Xiamen University and Fuzhou University, the experimental design is applied to this study. The research results reveal that 1. creative problem solving teaching would affect attitudes toward learning, 2. creative problem solving teaching would influence learning achievements, 3. attitudes toward learning show significantly positive effects on learning effect in learning achievements, and 4. attitudes toward learning present notably positive effects on learning gain in learning achievements. According to the results, suggestions are eventually proposed in this study, expecting to train students' ability to make correct judgment and solve problems when facing the diverse and complicated information in the society or the critical choice of continuing study or looking for employment as well as to enhance the urgency.

Keywords: creative problem solving teaching, statistics, attitudes toward learning, learning achievements

INTRODUCTION

In the 21st century when emerging technologies are innovated, how humans solve daily problems by organizing, analyzing, and deducing previous and current knowledge through divergent and convergent thinking to solve daily problems is gradually emphasized in the world. It is the foresighted education objective that people have to avidly absorb new knowledge and present the creative problem solving ability in order to keep up with the civilization of technology and the rapid knowledge. Creative problem solving (CPS) teaching

© **Authors.** Terms and conditions of Creative Commons Attribution 4.0 International (CC BY 4.0) apply.

Correspondence: Chich-Jen Shieh, *Huaqiao University, Xiamen 361021, Fujian, China.*

✉ charleshie@gmail.com

State of the literature

- It is the foresighted education objective that people have to avidly absorb new knowledge and present the creative problem solving ability in order to keep up with the civilization of technology and the rapid knowledge.
- Creative problem solving teaching is a kind of training conforming to solving complicated problems, an effective learning to deal with problems in real life, and the teaching method to simultaneously enhance students' group education.
- Expecting to train students' ability to make correct judgment and solve problems when facing the diverse and complicated information in the society or the critical choice of continuing study or looking for employment as well as to enhance the urgency.

Contribution of this paper to the literature

- To hold teaching demonstrations, learning, or one-the-job training so that teachers could experience the importance of creativity and be induced personal teaching creativity as well as have teachers understand how to timely proceed creative problem solving teaching and well apply questioning skills to guide students constructing knowledge.
- Introduce statistics knowledge with current events in life into creative problem solving teaching. It would help students easily understand statistical ideas and enhance the learning transfer.
- To promote students' statistics learning initiative after class, teachers are suggested to cultivate the habits by including current events in life in classes so as to interest students and have students slowly cultivate the habit of after-class learning

is different from traditional didactic teaching, which is mostly teacher centered, often ignores students' initiative, and obstructs students' learning and development of creative thinking ability. Creative problem solving teaching, on the other hand, stresses on the training of creative thinking, focuses on the creativity learning process that it could be regarded as a learning model of integrated knowledge, which not only stresses on students' actively learning but also emphasizes the planning and proceeding of teachers and students commonly participating in teaching activities. In such teaching situations, students' active thinking to effectively solve problems would intangibly train the thinking ability so that they would not be discouraged or scared of dilemmas when facing problems in the future as well as present better ability and efficiency to solve problems. Since the approach emphasizes the common cooperation and development among students, it would assist students in the social development. In short, creative problem solving teaching is a kind of training conforming to solving complicated problems, an effective learning to deal with problems in real life, and the teaching method to simultaneously enhance students' group education.

LITERATURE AND HYPOTHESIS

Creative problem solving teaching

Hall et al. (2013) pointed out creativity as the complicated and diversified construct. In addition to coming out with ideas, it was necessary to know how to deal with a problem,

define a question, mobilize resources to solve problems, evaluate the value of the solution, and completely practice the solution. From the viewpoint of psychology, Lerner & Johns (2012) stated that it was important to clearly and definitely understand the cognitive structure of the problem situation when encountering new problems in the problem-solving process. Nevertheless, the cognitive structure had to be expanded or reconstructed as the purpose and restriction of problems were not realized. Since the problem solving method and result were a brand-new experience of a problem solver, it could be a kind of creation for the old experiences. Accordingly, problem solving was closely related to creativity with logical connection, as most problems needed to be solved with creative thinking, i.e. creativity. The problem solving phase was existed in the creativity inducing process (Bybee, 2011) that "creative problem solving" was different from "problem solving". The former considered more careful thinking in the problem solving process, while the latter emphasized the application of "divergent think" (Polychroni et al., 2011). In short, creative problem solving particularly stressed on various possible flexible measures before selecting or executing solutions and solving problems with systematic thinking (Mostafa & Esmaeel, 2012). In traditional didactic teaching, students learn knowledge passively that they do not clearly understand the occurred time and location of knowledge and further lose the ability to generate knowledge. Sun (2014) argued that, under creative problem solving teaching, teachers had to play the role of knowledge facilitators in students' learning process to cultivate student attitudes to tell truth, consider others' opinions, present reservation attitudes and proper suspicious attitudes through inquiry learning. Doig et al. (2011) indicated that, for successful creative teaching, teachers had to make proper decisions, realize the roles of problem diagnosticians and analyzers, know how to plan teaching environments, and understand students' interests, aptitudes, abilities, and willingness to creation so as to induce students searching for problems, knowing problems, and solving problems as well as to develop the creation potential.

Attitudes toward learning

McKiernan (2011) pointed out attitudes as the complicated psychological state of humans which could affect people's selection and judgment of people, affairs, and objects. Funda (2011) defined attitudes as positive or negative response tendency, correct or deviated understanding and reaction, and persistent and consistent behavioral tendency, rather than the behaviors, of individuals toward people or affairs. Renninger & Hidi (2011) considered that attitudes were learned, i.e. the organizational internal preparation state influencing individuals to make behavior selection for specific objects. Al-Mekhlafi & Nagaratnam (2011) regarded attitudes toward learning as being built in nurture, rather than inherited, and the phenomenon, rather than the essence, that it presented variability and could establish and cultivate students' positive attitudes toward learning through proper tutoring in school education. Sun et al. (2014) pointed out attitudes toward learning as learners' positive or negative emotion, evaluation, and approval or opposed tendency toward learned contents. Lin & Chuang (2014) referred attitudes toward learning to students' methods, motivation, and

attitudes engaging in learning activities, including learning methods, skills, and learning habits. Nguyen (2012) further pointed out the premise of good attitudes toward learning as the common realization of teachers and students to the value of teaching and learning; otherwise, the teaching effect would not be fulfilled.

Referring to Chang (2011), the dimensions of attitudes toward learning contain the followings.

- (1) Cognitive component: Cognitive component refers to individual belief or knowledge about affairs that the cognition of attitudes often appears true statement with evaluation, i.e. individual agreement or objection to the attitude object. For example, students know the rich professional knowledge of teachers to present the teaching materials with good organization.
- (2) Affective component: Affective component refers to individual emotional feelings, including positive and negative feelings of respect and contempt, like and dislike, sympathy and rejection. For instance, students evaluate a teacher as a friendly person and would like to be close to the teacher.
- (3) Behavioral tendency component: Behaviors refer to individual response tendency toward the attitude object, i.e. individual action to the attitude object as the explicit behavior toward certain affairs or people. It contains the possibilities of approaching, avoiding, or disregarding affairs. For example, students, with respect, would accept the activity arranged by teachers and actively inquire teachers for professional questions.

Learning achievements

Mercer et al. (2011) mentioned that learning achievements could judge teachers' teaching being "effective teaching" according to students' test performance (Chesser, 2011) and were used for evaluating students' achievement of teaching objectives. Teaching objectives, according to the function, could be divided into cognitive, affective, and psychomotor domains, where cognitive domain was used for designing the evaluation of learning achievements. Grant et al. (2011) indicated that Guilford regarded creation and problem solving abilities as the most complicated mental activities of humans, where existing knowledge and experiences needed to be re-transformed to generate new products and responses (Oyler et al., 2012). Baker (2011) argued that, with poor knowledge, imagination could hardly be enriched to generate sufficient opinions; besides, creative behaviors would not succeed due to the lack of comprehensive opinion assessing ability. Seifert & Espin (2012) also stated rich cognitive experiences as the basis of creativity and problem solving ability that advantageous cognition ability was the essential condition for creation and problem solving (Wu, 2012).

Referring to Huang et al. (2011), learning achievements contain the following dimensions.

(1) Learning effect – including test achievements, time for progress, and term achievements.

(2) Learning gain – covering learning satisfaction, achievements, and preference.

Research hypothesis

Zoabi (2012) integrated creative problem solving teaching into G3 social studies and discovered that creative problem solving teaching could significantly enhance students' learning interests in social studies. Al-Mekhlafi & Nagaratnam (2011) applied cooperative learning and problem solving teaching with creative thinking to G10 meteorology course and revealed no remarkable difference between two groups in "attitudes toward learning Earth science". Hall et al. (2013) studied G11 mathematical gifted students and ordinary students with creative problem solving training and found out no significant difference between two groups in attitudes toward science (Mostafa & Esmaeel, 2012).

H1: Creative problem solving teaching would affect attitudes toward learning.

Lin & Chuang (2014) applied creative problem solving teaching to microcontroller course in vocational high schools and concluded the better performance on the learning achievements of programming logic than the control group. Aiming at G10 students, Lerner & Johns (2012) evaluated the learning achievements of Earth science and revealed that students receiving creative problem solving teaching notably outperformed the others with traditional interactive teaching. Funda (2011) indicated that the application of problem solving strategies to teaching could effectively improve students' learning achievements, particularly on the application and analysis of knowledge (Polychroni et al., 2011). McKiernan (2011) applied creative problem solving teaching to G6 social studies, and Chang (2011) applied it to G3 social studies; both studies revealed notable differences in the learning achievements between the experimental group and the control group. Doig et al. (2011) applied creative problem solving teaching to technology education in junior high schools, and Baker (2011) applied it to G4 science course; the results also presented remarkable differences in the learning achievements between two groups.

H2: Creative problem solving teaching would affect learning achievements.

Seifert & Espin (2012) found out the significant correlations between students' attitudes and achievements. Huang et al. (2011) concerned about the effect of attitudes toward statistics on the achievement of statistics and discovered that ones with more positive attitudes toward statistics appeared higher achievement of statistics and those with higher achievement of statistics presented positive opinions on statistics. Baker (2011) stated that attitudes were regarded as a key factor in learning outcome. Wu (2012) proposed that statistics learners' attitudes to objectives were the key success factors in the statistics learning; and, the relations between attitudes toward statistics learning and learning achievements of statistics were complementary. Grant et al. (2011) mentioned that most successful statistics learners presented positive attitudes toward statistics. Nevertheless, Sun (2014) considered that the effect of

attitudes on achievements was far more than the effect of achievements on attitudes (Oyler et al., 2012). A lot of domestic and international research revealed the correlations between attitudes toward statistics learning and statistics learning.

H3: Attitudes toward learning present significantly positive effects on learning effect in learning achievements.

H4: Attitudes toward learning show remarkably positive effects on learning gain in learning achievements.

RESEARCH METHODOLOGY

Measurement of research variable

(1) Attitudes toward learning

Referring to Chang (2011), attitudes toward learning are divided into three dimensions of 1.cognitive component, 2.affective component, and 3.behavioral tendency component in this study.

(2) Learning achievements

Referring to Huang et al. (2011), it is classified into 1.learning effect and 2.learning gain.

Research subject and sampling data

Taking universities in Fujian Province as the research subjects, including Xiamen University and Fuzhou University, the experimental design is used for this study. Total 220 students in four classes are studied, among which two classes are the experimental class (110 students) with creative problem solving teaching and another two classes (110 students) are the control class with general traditional didactic teaching. The experimental teaching is preceded 16 weeks for 3 hours per week (total 48 hours). The retrieved questionnaire is analyzed with SPSS, and Factor Analysis, Reliability Analysis, Analysis of Variance, and Regression Analysis are utilized for testing the hypotheses.

Analysis method

Analysis of Variance is utilized in this study for discussing the difference of creative problem solving teaching in attitudes toward learning and learning achievements, and Regression Analysis is further applied to understand the relations between attitudes toward learning and learning achievements.

ANALYSIS RESULT

Reliability and validity analysis

With Factor Analysis, attitudes toward learning in this study are extracted three factors of “cognitive component” (eigenvalue=2.784, $\alpha=0.88$), “affective component”

Table 1. Difference Analysis of creative problem solving teaching in attitudes toward learning

Variable		F	P	Scheffe post hoc
Creative problem solving teaching	Cognitive component	10.534	0.002*	creative problem solving teaching>general traditional teaching
	Affective component	13.628	0.000*	creative problem solving teaching>general traditional teaching
	Behavioral tendency component	16.255	0.000*	creative problem solving teaching>general traditional teaching

* stands for $p < 0.05$

(eigenvalue=2.367, $\alpha=0.89$), and “affective component” (eigenvalue=1.962, $\alpha=0.85$). The cumulative covariance explained achieves 82.163%.

With Factor Analysis, learning achievements are extracted two factors of “learning effect” (eigenvalue=3.168, $\alpha=0.90$) and “learning gain” (eigenvalue=2.833, $\alpha=0.91$). The cumulative covariance explained reaches 85.639%.

Effects of creative problem solving teaching on attitudes toward learning and learning achievements

(1) Difference Analysis of creative problem solving teaching in attitudes toward learning

Analysis of Variance is utilized for discussing the difference of creative problem solving teaching in attitudes toward learning. From **Table 1**, creative problem solving teaching (4.16) shows significantly higher cognitive component than general traditional teaching (3.67), creative problem solving teaching (4.22) presents remarkably higher affective component than general traditional teaching (3.83), and creative problem solving teaching (4.62) reveals higher behavioral tendency component than general traditional teaching (3.25). H1 is therefore supported.

(2) Difference Analysis of creative problem solving teaching in learning achievements

Analysis of Variance is applied to discuss the difference of creative problem solving teaching in learning achievements. From **Table 2**, creative problem solving teaching (3.92) appears notably higher learning achievements than general traditional teaching (3.16) and creative problem solving teaching (3.75) shows remarkably higher learning gain than general traditional teaching (3.02) that H2 is supported.

Table 2. Difference Analysis of creative problem solving teaching in learning achievements

Variable		F	P	Scheffe post hoc
Creative problem solving teaching	Learning effect	21.386	0.000*	creative problem solving teaching>general traditional teaching
	Learning gain	23.247	0.000*	creative problem solving teaching>general traditional teaching

* stands for $p < 0.05$

Table 3. Analysis between attitudes toward learning and learning achievements

Dependent variable→ Independent variable↓	Learning achievements			
	Learning effect		Learning gain	
Attitudes toward learning	β	Beta	β	Beta
Cognitive component	2.166**	0.202	1.924*	0.185
Affective component	2.382**	0.221	2.437**	0.236
Behavioral tendency component	2.627**	0.253	2.224**	0.212
F	18.419		21.377	
Significance	0.000***		0.000***	
R2	0.232		0.271	
Adjusted R2	0.016		0.021	

Note: * stands for $p < 0.05$, ** for $p < 0.01$.

Data source: Self-organized in this study

Correlation Analysis of attitudes toward learning and learning achievements

(1) Correlation Analysis of attitudes toward learning and learning effect

According to the analysis results, **Table 3**, the test of H3 shows remarkable effects of cognitive component ($\beta=2.166^{**}$), affective component ($\beta=2.382^{**}$), and behavioral tendency component ($\beta=2.627^{**}$) on learning effect that H3 is supported.

(2) Correlation Analysis of attitudes toward learning and learning gain

Based on the analysis results, **Table 3**, the test of H4 appears significant effects of cognitive component ($\beta=1.924^*$), affective component ($\beta=2.437^{**}$), and behavioral tendency component ($\beta=2.224^{**}$) on learning gain that H4 is supported.

CONCLUSION

The research findings show the assistance of creative problem solving teaching in students' problem solving ability. Creative problem solving teaching, in comparison with

general traditional didactic teaching, could improve students' positive attitudes toward learning. Apparently, most students show positive responses to creative problem solving teaching and agree that creative problem solving teaching is suitable for teaching statistics. Such a method could enhance the interests in statistics, help memorize statistical concepts and train problem solving, and promote the problem solving ability. As a result, statistics education should be based on problem events and teachers should guide the discussion so that students could learn statistical concepts. The combination of statistics and creative problem solving teaching would present complementary effect. Comparing to directly giving answers in traditional teaching, stressing on students' creative problem solving ability could better conform to the spirit of modern school education and indirectly help students face diverse and complex issues in life in order to better adapt to the future. Furthermore, the cultivation of problem solving ability relies on long-term and normal practice of creative problem solving teaching to change students' habits of seeking for answers from teachers and parents. In this case, such important abilities would be developed by the common endeavor of teachers and students; and, it depends on the emphasis of parents, schools, and teachers to offer practice opportunities for students.

SUGGESTION

Aiming at above research results, the following suggestions are proposed in this study.

1. To reinforce the training of teachers understanding the teaching theories and the practical application of creative problem solving

The questioning skills and the education enthusiasm of teachers are the key success factors in creative problem solving teaching. Nonetheless, teachers have been good at and accustomed to traditional didactic teaching that teachers for the first time proceeding creative problem solving teaching still act as ones imparting knowledge and might easily lose the patience to skillfully guide students thinking and constructing knowledge. Relevant education sectors are suggested to hold teaching demonstrations, learning, or one-the-job training so that teachers could experience the importance of creativity and be induced personal teaching creativity as well as have teachers understand how to timely proceed creative problem solving teaching and well apply questioning skills to guide students constructing knowledge. In this case, teachers could smoothly complete teaching activities and achieve the spirit and objectives of creative problem solving teaching.

2. To stress on and develop the teaching activity design for creative problem solving teaching

In comparison with traditional didactic teaching, students with creative problem solving teaching present notable effects on cognitive performance. Current statistics materials are taught with traditional didactic teaching. It is therefore suggested to introduce statistics knowledge with current events in life into creative problem solving teaching. It would help students easily understand statistical ideas and enhance the learning transfer; besides, it is better to adopt events in life to the teaching materials.

3. To promote after-class learning initiative

To promote students' statistics learning initiative after class, teachers are suggested to cultivate the habits by including current events in life in classes so as to interest students and have students slowly cultivate the habit of after-class learning, to lead students finding out the reasons for learning statistics and the objective. On one hand, they could establish self-awareness, self-confidence, and success anticipation of statistics; on the other hand, they are continuously induced the positive affection engaging in statistics learning so as to receive the maximum benefits.

ACKNOWLEDGEMENTS

The Project Support: 1. The masters of national cultural and the talent self-selected project in the "A Group of Four". 2. The research base funding of humanities and social sciences at Huaqiao University.

REFERENCES

- Al-Mekhlafi, A. M., & Nagaratnam, R. P. (2011). Difficulties in teaching and learning grammar in an EFL context. *International Journal of Instruction*, 4(2), 69-92.
- Baker, C. (2011). Foundations of bilingual education and bilingualism (Vol. 79). Multilingual matters.
- Bybee, R.W. (2011). Scientific and engineering practices in K-12 classrooms: Understanding a framework for K-12 science education. *The Science Teacher*, 78 (9), 34-40.
- Chang, B. Y. (2011). The roles of English language education in Asian cont- ex. *Journal of Pan-Pacific Association of Applied Linguistics*, 15(1), 191-206.
- Chesser, W. D. (2011). Chapter 5: The E-textbook Revolution. *Library Technology Reports*, 47(8), 28-40.
- Doig, B., Groves, S., & Fujii, T. (2011). The critical role of task development in Lesson study. In L. Hart, A. Alston & A. Murata (Eds.), *Lesson study research and practice in mathematics education* (pp. 181-199). Dordrecht, the Netherlands: Springer.
- Funda, K. (2011). Using songs as audio materials in teaching Turkish as a foreign language. *Turkish Online Journal of Educational Technology*, 10(4), 378-383.
- Grant, A., Gottardo, A., & Geva, E. (2011). Reading in English as a first or second language: The case of grade 3 Spanish, Portuguese, and English speakers. *Learning Disabilities Research & Practice*, 26(2), 67-83.
- Hall, C., Kent, S. C., McCulley, L., Davis, A., & Wanzek, J. (2013). A new look at mnemonics and graphic organizers in the secondary social studies classroom. *Teaching Exceptional Children*, 47-55.
- Huang, J. Y., Clarke, K., Milczarski, E., & Raby, C. (2011). The assessment of English language learners with learning disabilities: Issues, concerns, and Implications. *Education*, 131(4), 732-739.
- Lerner, J. W., & Johns, B. H. (2012). *Learning disabilities and related mild disabilities: teaching strategies and new directions* (12th ed.). Belmont, CA: Wadsworth Cengage Learning.
- Lin, M.-H., & Chuang T.-F. (2014). The effects of the leadership style on the learning motivation of students in elementary schools. *Journal of Service Science and Management*, 7 (1), 1-10.
- McKiernan, G. (2011). Configuring the 'Future Textbook'. *Search*, 19(4), 43-47.
- Mercer, C. D., Mercer, A. R., & Pullen, P. C. (2011). *Teaching students with learning problems* (8th ed.). Upper Saddle River, N.J.: Pearson.

- Mostafa, P., & Esmaeel, A. (2012). Teacher motivational practice, student motivation, and possible L2 selves: An examination in the Iranian EFL context. *Language Learning*, 62 (2), 571-594.
- Nguyen, H. T. (2012). General education and special education teacher collaborate to support English language learners with learning. *Disabilities Issues in Teacher Education*, 21(1), 127-152.
- Oyler, J. D., Obrzut, J. E., & Asbjornsen, A. E. (2012). Verbal learning and memory functions in adolescents with reading disabilities. *Learning Disability Quarterly*, 35(3), 184-195.
- Polychroni, F., Economou, A., & Printezi, A. (2011). Verbal memory and semantic organization of children with learning disabilities. *Learning Disabilities: A Contemporary Journal*, 9(2), 27-44.
- Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist*, 46(3), 168-184.
- Seifert, K., & Espin, C. (2012). Improving reading of science text for secondary students with learning disabilities: Effects of text reading, vocabulary learning, and combined approaches to instruction. *Learning Disability Quarterly*, 35(4), 236-247.
- Sun, J. C.-Y. (2014). Influence of polling technologies on student engagement: An analysis of student motivation, academic performance, and brainwave data. *Computers & Education*, 72, 80-89.
- Sun, J. C.-Y., Martinez, B., & Seli, H. (2014). Just-in-time or plenty-of-time teaching? Different electronic feedback devices and their effect on student engagement. *Educational Technology & Society*, 17(2), 234-244.
- Wu, S.-Q. (2012). Exploring senior high school EFL students' motivation, strategy use, and English achievement via structural equation modeling. *NCUE Studies in Language, Literature*, 9, 159-190.
- Zoabi, K. (2012). Self-esteem and motivation for learning among minority students: A comparison between students of pre-academic and regular programs self-esteem and motivation for learning among minority students: A comparison between students of pre-academic and regular programs. *Creative Education*, 3(8), 1397-1403.

<http://iserjournals.com/journals/eurasia>