

Effect of Concept Mapping on Statistics Anxiety and Statistics Achievements: The Moderating Effect of Students' Learning Styles

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Abstract

This study investigated the effectiveness of concept mapping in reducing levels of statistics anxiety and improving statistics achievements within different students' learning styles. A teaching experiment was set up according a pre-test/post-test control group design. Participants were 80 students from two classes enrolled in applied statistics courses. The results showed that no matter what students' learning styles were, there were significant differences in statistics anxiety rating scale and achievement post-test scores between the two classes. The results indicated that the concept mapping strategy is a better strategy to significantly reduce students' statistics anxiety and improve students' statistics learning achievements than the traditional teaching method.

Keywords: Concept Mapping, Learning Styles, Statistics Anxiety, Statistics Achievements

1. Introduction

Statistical knowledge is applied commonly in the academic fields as well as in practice. As a result more and more undergraduates, or even postgraduates, of different backgrounds are required to include statistics in their compulsory curriculum (Onwuegbuzie & Leech, 2003).

However, for many undergraduate and even postgraduate students, statistics is among the most formidable courses in curriculum plans (Onwuegbuzie & Leech, 2003; Schacht & Stewart, 1990). Moreover, many researches indicate that when the undergraduate and postgraduate students encounter such concepts, questions, cases, instructional or test situations as are concerning statistics, they are likely to develop severe statistics anxiety (Feinberg & Halperin, 1978; Onwuegbuzie, 1998; Zeidner, 1991). These research results evidently demonstrate that statistics anxiety is nowadays

a prevalent issue deeply vexing the undergraduate and postgraduate students. Such negative outputs may debilitate learning. It has been proved in a great deal of literature published that statistics anxiety or statistics test anxiety is negatively associated with learning (Lalonde & Gardner, 1993; Onwuegbuize & Seaman, 1995).

However, there is not yet much literature expounding on use of instructional strategies for relieving statistics anxiety. Huntley, Schneider, and Aronson (2000) and Pan and Tang (2004, 2005) indicated that to mitigate statistics anxiety, it is necessary to develop more innovative instructional strategies. Therefore, this study is intended to apply concept mapping in the course of applied statistics and to study whether or not it is conducive to reduce statistics anxiety and improve statistics learning.

Claxton and Murrell (1987) and Sarasin (1999) point out that it is necessary to consider different learning styles between students when teachers use various teaching methods. Furthermore, Budd (2004) indicates that auditory learning style learners might be able to gain benefit through a traditional teaching method while visual learners do well with support of visual sense. However, tactile/ kinesthetic learners are able to learn through activities. Oughton and Reed (2000) shows learners of different learning styles demonstrate differently on the number of concepts, nodes, and links in concept maps as well as the depth of concept maps. Therefore, it can be inferred that using the concept mapping strategy should have different effects on students of different learning styles. However, there have been relatively few research studies which have compared the usefulness of concept mapping for students with different learning styles, especially in statistical education. This study has therefore attempted to investigate whether the concept mapping strategy's effect on reducing students' statistics anxiety and improving their academic achievement is affected by students' learning style types.

2. Method

2.1. Experimental design and participants

The experiment employed a non-equivalent pretest-posttest control group design. The participants in this study were two classes sophomore students enrolled in a business and economics statistics course at the National Changhua University of Education in Taiwan. The two classes were randomly assigned to one experimental class (i.e. concept mapping class) and one control class (i.e. traditional teaching class). The dependent measures were the statistics achievement post-test score and the statistics anxiety post-test score. Since the subjects in the two classes might have different prior knowledge and statistics anxiety, a pre-test measure of statistics knowledge and statistics anxiety served as covariates for the dependent measures. The teacher and the textbook for both classes were the same to reduce confounding effects.

None of the students reported previous experience in concept mapping.

2.2. Instruments

A statistics achievement pre-test was applied to evaluate the students' initial statistics knowledge, and a statistics achievement post-test was administered to measure the experimental effect on achievement. The two achievement tests were developed from the question database of the textbook. Both instruments included 10 multiple-choice and four calculation questions. The students scored four points for each correct answer to the multiple choice questions, and 10 points for each correct answer to the calculation questions. The pre-test range included chapters one through three of the textbook, and the post-test range included chapters four through seven. The KR (Kuder-Richardson) 20 reliability coefficients of both instruments were 0.83 and 0.88, respectively. The subjects were asked to complete both tests in three hours, under test conditions.

Statistical Anxiety Rating Scale (STARS) was used to evaluate students' statistics anxiety. This survey developed by Cruise and Wilkins in 1980 contains 51 items with 5-point Likert scale (1= strongly disagree; 5= strongly agree). In Cruise, Cash, and Bolton's (1985) research on statistics anxiety of 1,150 students, six major dimensions were loaded from factor analysis. The factor scores were loaded between 0.48 and 0.86 while the value of Cronbach's alpha was between 0.68 and 0.94 in their study. The test-retest reliability coefficient was between 0.67 and 0.83 in a 5 week study of other 161 students in the study in 1985. The result in this study showed a Cronbach's alpha coefficient was between 0.72 and 0.90.

This study adopted Learning Style Inventory (LSI) developed by Kolb (1984) to evaluate students' learning styles. It contains 12 items with 5-point Likert scale (1= strongly disagree; 5= strongly agree). Blakemore, McCray, and Coker (1984) and Sewall (1986) pointed out that the instrument has high construct validity, and the suitable target is university student and adult. Blakemore, McCray, and Coker (1984) evaluated the reliability of this instrument with the value of split reliability was between 0.55 and 0.58, and the test-retest reliability coefficient was between 0.49 and 0.60. Kraus, Reed, and Fitzgerald (2001) synthesized a series of the past studies and indicated the instrument's Spearman Brown reliability coefficient was between 0.54 and 0.83, the Cronbach's Alpha reliability coefficient was 0.29 and 0.71, and the test-retest reliability coefficient was between 0.34 and 0.73. Veres, Sims, and Locklear (1991) pointed out the instrument is quite valid in measuring learning styles. The result in this study showed a Cronbach's alpha coefficient was between 0.68.

2.3. Experimental procedure

First, at the beginning of the term, the teacher gave syllabuses to students and spent half an hour doing an introductory lecture about the course. Next, the teacher

required students to fill out the LSI. Second, before the pre-test implemented, the teacher spent four weeks teaching all students chapters one through three of the textbook using the expository teaching approach. A pre-test was then administered after finishing teaching chapter three. Students finished the pre-test and filled out the STARS within three hours. Third, after the pre-test finished, the teaching experiment was formally implemented. The students in two classes then randomly assigned to experimental class and control class.

In the experimental group, the teacher first explained why concept mapping is a useful tool for learning and how concept mapping can be used to show relationships among concepts, and then spent three hours training students to draw concept maps in accordance with the procedures suggested by Novak and Gowin (1984, pp. 32–34, Table 2.3). The teacher then taught from the textbook using teacher-constructed computer-assisted concept maps as the instructional medium. After finishing a chapter, the students were asked to use concept maps to represent what they had learned from the previous chapters. The teacher and the research assistants then corrected student-constructed concept maps together. During the correcting process, the teacher and the research assistants worked together in order to identify any statistical misconceptions and then modified these misconceptions for the class. After going through misconceptions using one hour in-class, students were asked to use the former same concepts to reconstruct their individual concept maps again. The students then used these modified concept maps as review tools for their independent studies. The above procedure was repeated until the end of chapter seven of the textbook, totalling an implementation period of 12 weeks.

In the control group, the teacher gave an introductory lesson that included the objectives of the lesson and how to proceed, and then taught from the textbook using teacher made computer-assisted abstracts as the instructional medium. After finishing a chapter, the students were asked to work on some questions. The teacher then taught the class correct answers to these questions. The above procedure was also repeated until the end of chapter seven of the textbook. The implementation period was the same as the experimental group.

Finally, at the end of the experiment, the statistics achievement and STARS post-tests were administered to the two classes to compare their learning achievements and anxiety levels.

3. Results

3.1. The statistics anxiety comparison between concept mapping and traditional teaching classes

Since the statistics anxiety pre-test scores may have influenced the experimental effect, a two-way analysis of covariance (ANCOVA) was applied. The pre-test scores

were the covariates, the class, learning style and interaction were the independent variables, and the statistics anxiety post-test scores were the dependent variables. After controlling for the covariates, the main effect for post-test scores attained significance, $F= 6.69$, $p < .05$ (see Table 1). The average score of statistics anxiety post-test for concept mapping class is 129.05 while the average score for traditional teaching class is 142.80. The result indicated that the experimental class that was exposed to concept mapping has a significantly lower statistics anxiety than the control class that received traditional expository teaching.

The learning style and the interaction of class and learning style both have not achieved statistically significant level, $F=1.25$, $p=.30$; $F=0.89$, $p=.45$. The result revealed that students with different learning styles have not appeared significantly difference in statistics anxiety. The result also showed that no matter what students' learning styles are, there were significant differences in statistics anxiety rating scale post-test scores between the two classes. The results indicated that the concept mapping strategy is a better strategy to significantly reduce students' statistics anxiety than the traditional teaching method.

Table 1. Analysis of covariance for the statistics anxiety test of the two classes.

Source of variation	Sum of squares	df	Mean square	F-value
Model	33007.02	8	4125.88	12.20**
Covariates	24752.08	1	24752.08	73.17**
Class	2261.25	1	2261.25	6.69*
Learning style	1266.51	3	422.17	1.25
Class*Learning style	897.64	3	299.21	0.89

* $p < .05$ ** $p < .01$

3.2. The statistics achievement comparison between concept mapping and traditional teaching classes

Since the statistics achievement pre-test scores may have influenced the experimental effect, a two-way analysis of covariance (ANCOVA) was applied. The pre-test scores were the covariates, the class, learning style and interaction were the independent variables, and the statistics achievement post-test scores were the dependent variables. After controlling for the covariates, the main effect for post-test scores attained significance, $F= 7.263$, $p < .01$ (see Table 2). The average score of statistics achievement post-test for concept mapping class is 72 point while the average score for traditional teaching class is 54.08. The result indicated that the experimental class that was exposed to concept mapping has a significantly higher statistics achievement than the control class that received traditional expository

teaching.

The learning style and the interaction of class and learning style both have not achieved statistically significant level, $F=0.57$, $p=.64$; $F=0.21$, $p=.89$. The result showed that students with different learning styles have not appeared significantly difference in statistics achievements. The result also showed that no matter what students' learning styles are, there were significant differences in achievement post-test scores between the two classes. The results indicated that the concept mapping strategy is a better strategy to significantly improve students' statistics learning achievements than the traditional teaching method.

Table 2. Analysis of covariance for the statistics achievement test of the two classes.

Source of variation	Sum of squares	df	Mean square	F-value
Model	14741.38	8	1842.67	7.05**
Covariates	7881.94	1	7881.94	30.14**
Class	1899.56	1	1899.56	7.26**
Learning style	447.47	3	149.16	0.57
Class*Learning style	165.39	3	55.13	0.21

* $p<.05$ ** $p<.01$

4. Conclusions

This study was intended to apply concept mapping strategy in the course of applied statistics and to study whether or not it is helpful to reduce statistics anxiety and improve statistics learning achievements. This study also investigated whether the concept mapping strategy's effect on reducing students' statistics anxiety and improving their academic achievements is affected by students' learning style types.

The results appeared that no matter what students' learning styles were, the concept mapping strategy more effectively reduced students' statistics anxiety and improved students' learning achievements than the traditional expository teaching method. In addition, students with different learning styles have not appeared significantly difference in statistics anxiety and achievements. The results were in accordance with previous studies in other disciplines (Chiou, 2009; Czerniak, 1998; Horton et al. 1993; Jegede, Alaiyemola, & Okebukola, 1990; Novak 1990), indicating that concept mapping strategy effectively reduced students' statistics anxiety and produced positive outcomes in students' statistics performance.

5. Acknowledgements

This work was partially supported by National Science Council of the Republic of China, under grant number NSC 98-2410-H-018-016-.

6. References

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