The effect of color enhancing concept map materials on Statistics learning

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color enhancing concept map

Abstract

The purpose of this study is to examine the effect of concept maps and color enhancement on Statistics learning. Subjects were 95 compulsory Statistics students in a university who were randomly assigned to 4 groups. The four different teaching groups included clustered and hierarchical color enhancing concept map material groups (clustered and hierarchical CECM), black-and-white concept map material group (BWCM), and traditional linear material group (TLM). According to the purpose of this study, the experimental results showed that no matter what students’ learning styles were, students using CECM and BWCM can perform better in improving their statistics learning achievements than students using TLM. The results also showed that no matter what students’ learning styles were, students adopting CECM can be better in enhancing their statistics achievements than students using BWCM.

Keywords: color enhancement, concept map, learning style, statistics.
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Introduction

Referring to the assimilation theory of cognitive learning proposed by Ausubel (1963), Novak and Gowin (1984) proposed the concept map as one tool for teaching, learning and evaluation. Thus far the concept map has been extensively and well-effectively applied to teaching various academic disciplines such as Business education (Chiou, 2008, 2009), Chemistry (Novak, 1984), Language teaching (Carrell, Pharis, & Liberto, 1989), Mathematics (Malone & Dekkers, 1984), Medicine (Laight, 2004) and Physics (Roth & Roychoudhury, 1993).

As one basic unit to develop the human being’s senses and memories, colors possess superior expression and identifiability or psychological imagery effect (Davidoff, 1991). In contrast to monotonic teaching materials, colorful ones substantially attract student attention (Bacon & Egeth, 1997; Kaptein, Theeuwes, & van der Heijden, 1995; Pett & Wilson, 1996), effectively save time in searching information (Pett & Wilson, 1996; van Schaik & Ling, 2001), and promote student learning memory (Pett & Wilson, 1996; Schwier, Misanchuk, & Boling, 2000). In this regard, colorful teaching material, compared to the monotonic ones, is an instrument to improve the interaction between students and teaching materials and it can not only catch student attention but encourage student to learn more in a comfortable way (Pett & Wilson, 1996; Schwier et al., 2000; Tufte, 1990).

Despite concept maps and colorful teaching materials can significantly improve learning achievements have been confirmed in the previous studies, studies about the impact on the learning achievements by integrating these two teaching materials are rare. With the knowledge map and the display of colors integrated, Hall and
Sidio-Hall (1994) studied college students and found that their learning memories receiving colorful teaching materials (both the knowledge map materials and conventional ones) were significantly superior to those receiving monotonic teaching materials.

Despite the concept map seldom cited in literatures of business education in contrast to other academic disciplines, it is applicable to business education but few studies verified its effectiveness instead (e.g. Chiou, 2008, 2009). In addition, the positive effects of colorful teaching materials on students’ learning achievements have been demonstrated in previous studies (Bacon & Egeth, 1997; Kaptein et al., 1995; Pett & Wilson, 1996; Schwier et al., 2000). However, research about the topic of effectively improving student’s learning achievements by the colorful teaching materials with the concept maps is wanting thus far. Knowledge of statistical methods is becoming increasingly important for students in many disciplines (Chiou, 2009). Unfortunately, for many undergraduate and graduate students, Statistics is one of the most difficult courses in their programs of study (Onwuegbuzie & Leech, 2003). Therefore, in consideration of the important of Statistics and few literatures studying student learning achievement by integrating the concept map and colors with teaching materials, this paper intends to examine the effect of concept maps and different color enhancements on Statistics learning.

**Method**

**Experimental Design**

This study adopted randomized subject with unequalled pretest-posttest control group design. Participants in this study were 95 students enrolled in applied statistics
courses at National Changhua University of Education in Taiwan. None of the students had any experience with concept map materials. To minimize the differences in students’ Statistics prior knowledge, we randomly assigned students into four groups in which 23 in clustered color enhancing concept map material groups (clustered CECM), 25 in hierarchical color enhancing concept map material groups (hierarchical CECM), 21 in black-and-white concept map material group (BWCM), and 26 in traditional linear material group (TLM). Each group received identical lectures and pretest and took the same posttest after received lectures by using different learning materials. Fig. 1-4 are the examples of four materials.
Experimental Process

Five phases were involved in this experiment. Phase one, the teacher taught chapter one to three using textbook lecturing method from week one to week six with three hours per week. In phase two, a pre-test was then administered during the formal class time of three hours in week seven. In phase three, the teacher spent approximately 10 minutes in class assigning the students to four groups randomly as well as announcing the teaching time per week for each group. The time of teaching using individual material for each group is two hours per week, and the total implementation period is 8 weeks.

Phase four is the formal experimental period, the teacher taught chapter four to six for each group from week eight to fifteen with two hours per week. The teaching materials adopting for clustered CECM group is clustered color enhancing concept map materials. The teaching materials adopting for hierarchical CECM group is hierarchical color enhancing concept map materials. The teaching materials adopting for BWCM group is black-and-white concept map materials, while the teaching materials using for TLM group is the traditional linear materials.

In phase five, the post-test was administered to the four groups to compare their learning achievements.

Instruments

The Statistics achievement pre- and post-tests, developed from the question database of the textbook, were utilized to determine the students’ initial Statistics abilities and the experimental effect on achievement, respectively. All instruments included twenty multiple-choice questions. The students scored 5 points for each correct answer to the multiple-choice questions. The pre-test rang included three
chapters of the textbook, and the post-test range included three chapters. The KR 20 reliability coefficients of these instruments were 0.86 and 0.84, respectively. The subjects were asked to complete both tests in three hours, under test conditions.

**Empirical Results**

Table 1 lists the descriptive statistic of students’ learning achievements for four groups. Table 1 shows that for the clustered CECM group, the average scores in the pre-test were 57.99 and the average scores in the post-test were 80.22. For the hierarchical CECM group, the average scores in the pre-test were 56 and the average scores in the post-test were 78. For the BWCM group, the average scores in the pre-test were 60.48 and the average scores in the post-test were 71.19. For the TLM group, the average scores in the pre-test were 60.58 and the average scores in the post-test were 63.27.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Samples</th>
<th>Average scores</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Clustered CECM</td>
<td>23</td>
<td>57.39</td>
<td>80.22</td>
</tr>
<tr>
<td>Hierarchical CECM</td>
<td>25</td>
<td>56.00</td>
<td>78.00</td>
</tr>
<tr>
<td>BWCM</td>
<td>21</td>
<td>60.48</td>
<td>71.19</td>
</tr>
<tr>
<td>TLM</td>
<td>26</td>
<td>60.58</td>
<td>63.27</td>
</tr>
</tbody>
</table>
A two-way analysis of covariance (ANCOVA) in which the pre-test scores of the four groups were the covariates, the groups (clustered and hierarchical CECM, BWCM, and TLM), students’ learning styles and their interaction were the independent variables and the post-test scores were the dependent variables was conducted. Table 2 shows that the groups effect was significant, $F(3, 78)=14.05, p < .01$, which indicates that with the exclusion of pre-test and learning style scores, the four groups achieved significantly different scores in the Statistics achievement.

Table 2 ANCOVA analysis of Statistics achievement for four groups

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>7957.10</td>
<td>16</td>
<td>497.32</td>
<td>6.10**</td>
</tr>
<tr>
<td>Groups</td>
<td>3438.77</td>
<td>3</td>
<td>1146.26</td>
<td>14.05**</td>
</tr>
<tr>
<td>Learning style</td>
<td>151.93</td>
<td>3</td>
<td>50.64</td>
<td>0.62</td>
</tr>
<tr>
<td>Groups*learning style</td>
<td>636.45</td>
<td>9</td>
<td>70.72</td>
<td>0.87</td>
</tr>
<tr>
<td>Pre-test</td>
<td>2999.67</td>
<td>1</td>
<td>2999.67</td>
<td>36.77**</td>
</tr>
<tr>
<td>Error</td>
<td>6362.90</td>
<td>78</td>
<td>81.58</td>
<td><strong>p &lt; .01</strong></td>
</tr>
</tbody>
</table>

**p < .01**
A post hoc comparison using the LSD (least squares means) method showed the hierarchical CECM, clustered CECM and BWCM groups did better on the post-test scores than the TLM group, $t(78) = 5.14, p < .01$; $t(78) = 5.70, p < .01$; $t(78) = 2.98, p < .01$. The results indicate that the concept map materials worked significantly better in improving the students’ learning achievements than traditional linear materials. Additionally, the results showed that clustered CECM and hierarchical CECM groups did better on the post-test scores than the BWCM group, $t(78) = 2.28, p < .05$; $t(78) = 2.37, p < .05$, indicating that color enhancing concept map materials can better improve students’ learning achievements than only black-and-white concept map materials. Finally, there were no significant difference in post-test scores between clustered CECM and hierarchical CECM, $t(78) = 0.21, p = 0.84$.

There were not statistically significant difference in post-test scores for the learning style variable and the interaction of groups and learning style, $F(3, 78) = 0.62, p = 0.60; F(9, 78) = 0.87, p = 0.56$, indicating that there were no significant difference in Statistics post-test achievements for students with different learning styles.
Table 3 A post hoc comparison for Statistics achievement between different groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Difference in means</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustered CECM-Hierarchical CECM</td>
<td>0.72</td>
<td>0.21</td>
</tr>
<tr>
<td>Clustered CECM-BWCM</td>
<td>8.26</td>
<td>2.28*</td>
</tr>
<tr>
<td>Hierarchical CECM-BWCM</td>
<td>7.54</td>
<td>2.37*</td>
</tr>
<tr>
<td>Clustered CECM-TLM</td>
<td>17.48</td>
<td>5.14**</td>
</tr>
<tr>
<td>Hierarchical CECM-TLM</td>
<td>16.76</td>
<td>5.70**</td>
</tr>
<tr>
<td>BWCM-TLM</td>
<td>9.22</td>
<td>2.98**</td>
</tr>
</tbody>
</table>

* p < .05  ** p < .01

**Conclusion**

This study compared the effects of four teaching materials including clustered color enhancing concept maps, hierarchical color enhancing concept maps, black-and-white concept maps and traditional linear materials, on learning Statistics, and explored whether the effects can be influenced by students’ learning styles.

The results showed that no matter what students’ learning styles were, two type color enhancing concept map materials can better improve students’ Statistics learning achievements than black-and-white concept map and traditional linear materials. The results also appeared that concept map materials can significantly enhance students’ Statistics learning achievements than traditional linear materials, and their effects can not be influenced by students’ learning styles.
Reference


