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The Effects of Integrating Concept Mapping into Computer Assisted Instruction in Biology at a Comprehensive High School

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Abstract- The purposes of this study ~~aimed to examine the~~ effects of integrating concept mapping into computer assisted instruction in Biology class at a comprehensive high school as well as to understand students' academic achievements and their learning retention. The research method of the study was a qasi-experimental design. The 39 subjects of this study were obtained from a single class in a comprehensive high school. The subjects were divided into high and low proficiency levels after pretest. The experimental instruction lasted for seven weeks. A post-test was administered to assess subject students' biology academic achievements. In addition, they were requested to fill out the learning satisfaction questionnaire. One month later, all subjects' learning retention was tested. The major findings of the study are briefly stated as follows. Speaking of the instructional strategy, the effect of integrating the concept mapping into computer assisted instruction was positive on academic achievements of learning biology subject. It was also helpful for learning retention and raising cognitive ability of the biology subject. In addition, there was the same influence on students' academic achievements regardless of their genders. Furthermore, subject students possessed an affirmative attitude toward integrating the concept mapping into computer assisted instruction. Finally, subjects suggested that the software was a good material for assisting instruction in the biology class.

Key words: Concept Mapping, Computer Assisted Instruction, Comprehensive High School.

1. Introduction

The rising and development of the comprehensive high school originated in the United States of America. In 1918, National Education Association suggested that all high schools ought to transform into comprehensive high schools. Up to 1991, a total of 98.4% of students enrolled in comprehensive high schools in the states. In Taiwan, a experimental high school curriculum was proposed and was legitimized in the High school Act in 1999. Although the purpose of legitimizing the new act was admirable, the related auxiliary measures were insufficient, including school-running model, curricula, teaching materials, teachers, and personnel. Thus, many schools encountered a certain wonders and difficulties while implementing the new school system. In addition, the public was not able to understand the new school system's future orientation and development directions. Under the situation of issues cannot be solved in a short period of time, how to implement effective teaching method to enhance students' learning achievements has become the motive of this study.

Many prior studies suggested that integrating concept mapping strategy into teaching had significant influence on student's learning effectiveness[1][2][3][4][5]. In addition, due to the rapidly development of technology, the fast increase of knowledge, and the popularity of computers and interne, the computer assisted instruction has played an important role in the teaching domain. Some studies indicated that the computer assisted instruction certainly can enhance students' learning effectiveness[6][7] Thus, this study aimed to integrate concept mapping into computer assisted teaching in biology class in a comprehensive high school and expected to gain more new breakthroughs in biology teaching as well as to approach the goals of education and assist students' learning.

2. Purpose of Study

Based on the motives stated above, the purposes of this study include:

(1) Developing teaching materials for integrating concept mapping into computer assisted instruction.

(2) Exploring students' learning effectiveness and differentiation of integrating concept mapping into computer assisted instruction in biology class.

(3) Investigating students' learning attitudes toward integrating concept mapping into computer assisted instruction in biology class.

(4) Examining the relationship between students' learning effectiveness and attitudes.

3. The developing procedures of teaching materials for integrating concept mapping into computer assisted instruction

3.1 The developing procedures of teaching materials

The developing procedures of teaching materials consist of the following five stages, including preparation stage, software design and development stage, data integration stage, software testing and revision stage, and software completion stage

3.2 Introduction of the teaching material

The teaching material software contains the contents and animations of the first volume of biology textbook for Taiwan comprehensive high school.

3.2.1 The display of concept mapping

The conceptual figure of the whole unit of the teaching material is shown in the starting page as shown in Figure 1. Concepts with animation illustrations are shown in different colors. When the mouse moves to the texts, the scripts will display different colors to remind users to click on animation assisted description. When the user clicks on the animation assisted description, the animation assisted material for the concept shows. If the user wished to terminate the exercise, just click on the leave button on the right hand side corner to quit.

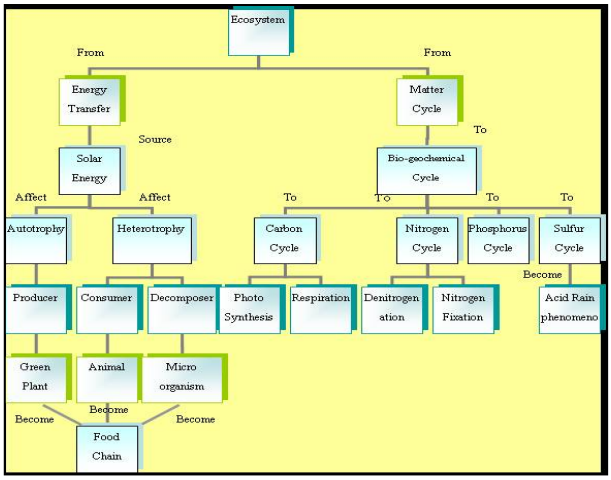

Fig. 1 An example of the instruction unit homepage

3.2.2 Display of the Animations

Figure 2 shows the animation of the concept of autotrophy, presenting the growing procedure of

autotrophy, when the broadcast of the animation is terminated, the user can click on the one more time button to repeat it as needed. If the user wants to go back to the homepage of the conceptual figure, just click on back button on the upper right side corner.

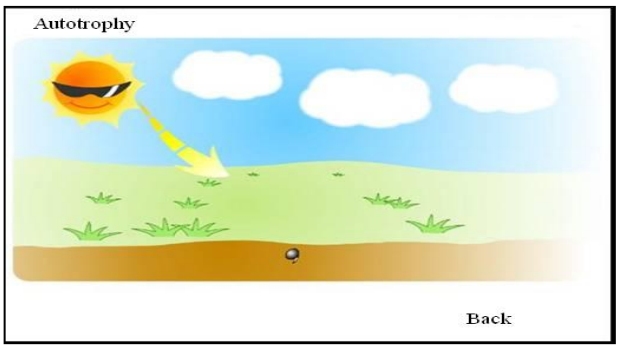

Fig. 2 Autotroph animated analysis (1)

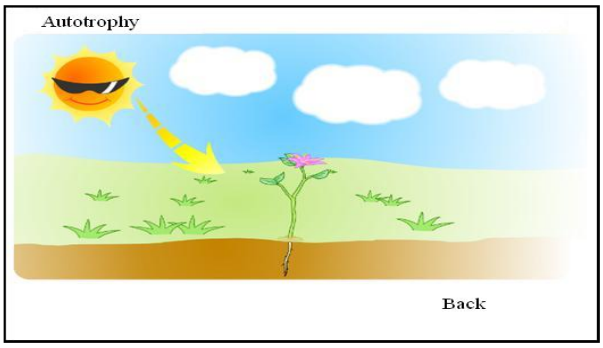

Fig. 3 Autotroph animated analysis (2)

4. Research Design and Implementation

4.1 Subjects of the study

There were a total of 39 subjects, 22 males and 17 females, as research subjects obtained from a comprehensive high school in Pingtung County. The experiment lasted 7 weeks, 2 periods of classes per week, for integrating concept mapping into computer assisted instruction.

4.2 Research framework

Based on the purpose of the study, the research framework is designed and shown in Fig. 4.

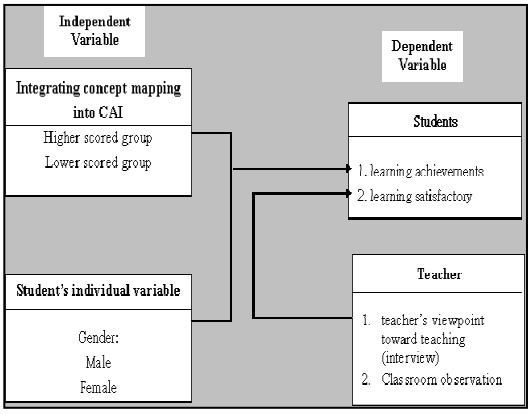

Fig. 4 Research Framework

4.3 Research instruments

The research instruments used in this study include:

(1) A pretest of biology subject for comprehensive highs school
(2) Quizzes and a concept framework test
(3) A post-test of biology subject for comprehensive high school
(4) Retention test of biology subject
(5) Self-edited "Student's learning satisfaction questionnaire"
(6) Self-edited "A semi-structured interview questionnaire for teachers"

5. Data process and statistical analysis

Subjects students were divided into the higher and lower scored group based on their pretest scored. Students who obtained pretest score higher than the mean were assigned to the higher scored group; the others were assigned to the lower scored group. The means and standard deviations of pretest scores are shown in Table 1. After 7 instructional weeks, a post-test was administered and a questionnaire on biology subject learning retention was administered one month later.

Table 1 The means and standard deviations of the pretest in biology subject for all students, higher and lower scored groups

Group	No of Students	Mean	Standard Deviation
All subjects	39	36.67	7.67
Higher scored	20	42.50	4.44
Lower scored	19	30.53	5.07

Note: the total scores for pretest were 100

5.1 Post-test and learning retention on biology subject learning

An independent sample t-test was employed to analyze the students' learning achievements (post-test) and biology subject learning retention between the higher and lower scored groups. The statistical results of the analysis are shown in Table 2.

Table 2 The statistical results of subjects' learning achievements (post-test) and biology subject learning retention between higher and low scored groups

	Mean		Standard Deviation		t value	p value
	Higher	Lower	Higher	Lower		
Post-test	72.45	60.68	9.08	12.51	3.374**	.002
Learning retention	68.00	60.21	9.45	10.74	2.408*	.021

Note: the total scores for post-test and learning retention were 100 * p<.05 ** p<.01

5.2 The recognition of learning achievement test

In order to understand students' learning achievements and learning retention between the higher and low scored groups, questions of the post-test were divided into 4 cognitive levels, including knowledge, comprehension, application, and analysis levels. Then an independent sample t-test was administered to obtain the statistical results (shown in Table 3).

Table 3 The statistical results and analysis on the 4 cognitive levels between higher and lower scored groups

	Mean		Standard Deviation		t值	p值
	Higher	Lower	Higher	Lower		
Knowledge Level						
Post-test	23.70	21.32	3.63	4.68	1.783	.083
Learning retention	23.70	21.42	4.11	3.76	1.805	.079
Comprehension Level						
Post-test	39.10	31.63	4.66	7.62	3.716**	.001
Learning retention	35.60	31.16	6.08	7.21	2.083*	.044
Application Level						
Post-test	6.25	5.16	1.86	2.32	1.628	.112
Learning retention	5.90	5.84	1.68	2.06	.096	.924
Analysis Level						
Post-test	3.00	2.26	1.34	1.48	1.630	.112
Learning retention	2.70	1.79	1.49	1.32	2.019	.051

Note: * p<.05 ** p<.01

5.3 Statistical results of quizzes

During the 7 instructional weeks, there were 2 general quizzes and 3 concept mapping quizzes implemented in order to understand the performance of the two group subjects. The statistical results of the quizzes are shown in Table 4.

Table 4 The statistical results of the quizzes between higher and lower scored groups

	Mean		Standard Deviation		t value	p value
	higher	lower	higher	lower		
Scores of 2 general quizzes	57.03	52.82	9.00	9.43	1.426	.162
Scores of 3 concept mapping quizzes	15.33	16.98	7.17	12.17	-.519	.607

Note: the total scores of each quiz and concept mapping quiz were 100

5.4 The analysis of the genders

In this section, an independent sample t- test was administered to examine the relationship between student genders and performances in order to understand the differentiation among genders, post-test, biology subject learning retention test, scores of quizzes, and scores of concept mapping quizzes. The statistical results are shown in Table 5.

Table 5 The statistical results of the analysis of student genders and learning achievements

	Mean		Standard Deviation		t value	p value
	Male	Female	Male	Female		
Post-test	68.41	64.53	14.21	9.17	.978	.335
Learning Intention	65.14	63.00	11.91	9.14	.612	.544
2 general quizzes	58.75	50.09	8.18	8.62	3.204**	.003
3 concept mapping quizzes	15.17	17.39	9.68	10.18	-.697	.490

Note: The total scores of post-test, learning intention, general quizzes, and concept mapping test were100.
* p<.05 ** p<.01

5.5 The results of teacher's interview and classroom observation

In this study, the biology teacher showed a positive attitude toward integrating concept mapping into computer assisted instruction. The results of interviewing the biology teacher and classroom observation are summarized as follows.

- ✓ The font of text display needs to be improved but the arrangement of picture colors is appropriate.
- ✓ The display of animations attracts students' attention and enables to understand the concept.
- ✓ Integrating concept mapping into computer assisted instruction may allow teachers to express the meaning of the concept clearer than the traditional ways of instruction.

- ✓ Audio-visual instruments increase the teaching efficiency but the hardware learning facilities need to be improved.
- ✓ Students need longer time to be familiar with the evaluation system of concept mapping.
- ✓ The display and use of computer multimedia materials can stimulate students' learning motivation.
- ✓ Students showed great interests in learning biology by integrating concept mapping into computer assisted instruction and hope to continue use this way of instruction in the near future.
- ✓ Use of integrating concept mapping into computer assisted instruction contributes to the teacher's teaching goals.

5.6 Path analysis of learning achievements (post-test) and learning attitude factors

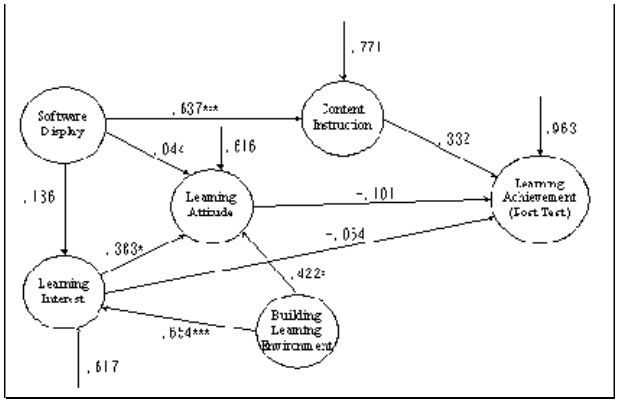

Fig.5 Path analysis of students' biology learning achievements (post-test) and learning attitude factors

Table 6 The effect analysis of path analysis of all subjects' biology learning achievements (post-test)

Path	Type of Effect	Coefficient of Path
Software display→content instruction	Direct effect	.637***
Learning interest→learning attitude	Direct effect	.383*
Building learning environment→learning interest	Direct effect	.654***
Building learning environment→learning attitudes	Direct effect	.422*
Building learning environment→learning interest→ learning attitude	Indirect effect	.654×.383 =.2505

6. Conclusions and Suggestions

The purpose of this study aimed to integrate concept mapping into computer assisted instruction in biology class in a comprehensive high school. The findings and suggestions of the study are concluded as follows.

6.1 Conclusions

(1) **The teaching strategy of integrating concept mapping into computer assisted instruction has a positive benefit for biology subject learning achievements and retention**: different groups of students received this teaching strategy showed significant differences on the learning achievements and retention. Particularly, all students in the lower scored group approached the requirement of a pass on the post-test and learning retention.

(2) **The teaching strategy could enhance comprehensive high school students' recognition ability on biology subject**: among the 4 levels of cognition, there was no significant difference on the pretest, posttest, and learning retention test between the two subject groups. Speaking of comprehension, there was significant difference between the two subject groups. That is, the higher scored group is superior to lower scored group.

(3) **There was no difference on genders by using the teaching strategy of integrating concept mapping into computer assisted instruction**: there was no significant difference on biology subject learning achievements and retention for different genders of students. That is, genders of students did not affect the results of integrating concept mapping into computer assisted instruction.

(4) **Students of the biology classes in a comprehensive high school possessed positive viewpoints and attitude toward the teaching strategy of integrating concept mapping into computer assisted instruction**: most of students showed a positive viewpoint toward this teaching strategy and hope that this strategy will be continuously implemented in the near future.

(5) **Path analysis**: all students suggested that the better the software displays, the greater instructional effectiveness can be approached. In addition, the better learning environment for students, the higher learning interest students would have. All students suggested that a great environment not only can enhance learning interest, but also increase students' learning attitude, particularly for the higher scored group.

(6) **The software of integrating concept mapping into computer assisted instruction can be a great auxiliary teaching material for biology class**: the results of classroom observation and interview indicated that the teacher possessed a positive attitude toward integrating concept

mapping into computer assisted instruction. In addition, teacher mentioned that the software is a great auxiliary teaching material and hope to use the similar software for teaching in the near future.

6.1 Suggestions

(1) **For the teaching aspect:**

- ✓ **To stimulate students' learning motivation**: teachers should be able to present the concept mapping of the unit to enable students know about what will be learned in this unit and enable teaching more systematic.
- ✓ **To guide students to utilize concept mapping**: small group cooperation can be administered in teacher's concept mapping instruction. Students can clarify wonders and doubts through the cooperative learning.
- ✓ **To be a reference for remedial teaching**: Teachers can understand how much students know about the subject content from students' concept map drawing and as a reference to design proper remedial courses. In addition, this software can be repeatedly viewed to reinforce students' memory and comprehension.
- ✓ **For building a learning environment:** students' learning was interfered by the audio-visual equipment during the teaching. In order to obtain good learning effectiveness, teachers ought to discreetly plan and choose the learning place and construct a better learning environment to increase students' learning interests and attitudes.

(2) **For Teaching material design aspect**

- ✓ **Cooperation and collaboration among teachers:** Generally speaking, not all teachers possess abilities in making computer assisted instruction materials. Thus, it is necessary for teachers to collaborate with each other to develop proper and useful computer assisted instruction materials.
- ✓ **Development of web-based instruction materials:** web-based instruction has become an important learning mode. It would be benefit to students if the instruction materials of this study can be put on the web for students to access after classes.
- ✓ **Increase of students' interaction:** in the future, the researcher can design some interactive software to increase the interaction between instruction materials and students. For example, design cloze test for concept mapping or online assessments for students and also give them appropriate feedback are positive reinforcement for students' learning.

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