The Effect of Multimedia Computer Assisted Instruction and Learning Style on Learning Achievement

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Abstract: - The main purpose of this study is to investigate the effect of multimedia computer assisted instruction on student learning achievement using the high school curriculum entitled "molecules that dominate secret of life" from high school biology. The results show that when compared to traditional models of instruction, students using the multimedia computer assisted instruction model scored significantly better in learning achievement assessments. Secondly, the study also discussed the combined effect of instruction model and learning style on student learning achievement. The results show that students exposed to a converging learning style with traditional instruction perform significantly better than those exposed to three other learning styles. Nonetheless, students exposed to these same three other learning styles performed better when exposed to the multimedia computer assisted instruction model. As a result, under the influence of multimedia instruction, students exposed to the four learning styles (Diverger, Assimilator, Converger, and Accommodator) do not shown any significant difference.

Key-Words: - Multimedia Computer Assisted Instruction; Learning Style; Instruction Model; Learning Achievement

1 Introduction

Instructors often encounter difficulty or even inability when attempting to teach certain phenomenon. Such phenomenon might be too hazardous to conduct actual experiments and some others can only be observed in really long or really short intervals of time. Moreover, some phenomena are dynamic and require repeated observation whereas others are microscopic and thus are difficult to demonstrate. The multimedia computer assisted instruction model combines text, sound, graphics, and animation to truly and graphically communicate those abstract and personally unperceivable phenomena that are difficult to be

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observed in real life. In comparison with the traditional instruction model based on texts and graphs alone, the multimedia computer assisted instruction model can further motivate students using a lively approach and thereby active learning. As a result, learning achievement will increase [1-8].

This study will observe the effect of instruction model on students from a particular high school in order to determine whether student learning achievement increases when the multimedia computer assisted instruction model is applied to the instruction of "the factors that dominate the secret of life," a high school biology curriculum. The choice of this unit is based on the multiple abstract concepts found within. For example, the three-dimensional structure of DNA, DNA replication, and the processes of transcription and translation are difficult topics for instructors to express in words and students can hardly observe these phenomena in real life.

There are a variety of studies that propose theories explaining the different learning styles that individuals seem inclined to [9-17]. Many of these studies suggest that student learning styles are the key factor that affects learning achievement when adopting the multimedia computer assisted instruction model or (hypermedia) the web-based learning instruction model [18-22]. Other studies argue that there is no significant difference in student learning achievement when students with different learning styles embrace the multimedia computer assisted instruction model or (hypermedia) the web-based learning instruction model [23-25]. It is suggested that under the hypermedia-based learning instruction model, the teachers taking into consideration of the preferred learning strategies for students with different learning styles when making multimedia instructional design will help students attain similar learning effects despite of their learning styles [23]. In addition to investigating the effect of different instruction models on student learning achievement, this study also discusses the effect of different learning styles on student learning achievement and the combined effect between instruction model and learning style in an attempt to provide further support for studies on learning styles.

2 Background

This study emphasizes the advantages of the multimedia computer assisted instruction model with the following introduction to the design production and completed works of multimedia courseware. Section 2.1 describes the four stages in producing multimedia courseware. Section 2.2 explains the reason for choosing the "factors that dominate the secret of life" curriculum from high school biology as the design object for the multimedia courseware. Section 2.3 compares the difference between the completed production of multimedia courseware and traditional teaching resources.

2.1 Editing and Production of Multimedia Courseware

This study combined various media including text, sound, graphics, and animation in the design of multimedia courseware. The production process consisted of the following four stages:（Figure 1）

Stage1 "Curriculum Introduction"：

After selecting the "factors that dominate the secret of life" from the high school biology curriculum, we had to obtain the content and establish the curriculum framework of Sharable Content Object Reference Model according to the instructor's curriculum planning and teaching objectives before submitting to biology teachers for review. Sharable Content Object Reference Model (SCORM) is the standard Advanced Distributed Learning (ADL) formulated by the United States Department of Defense which provides common norms for the production and content development of digital courseware.

Stage 2 "Curriculum Planning"：

This stage included designing the user interface of SCORM and the interaction design between text, graphics, sound, and animation which required submission to the biology instructor for review.

Stage 3 "Curriculum Courseware"：

We obtained the text, graphics, sound, and animation required. The material was edited and placed into the teaching resources of SCORM according to the curriculum plan and then submitted to the biology instructor for review.

Stage 4 "Curriculum Completion"：

Completed courseware required online testing and was applied to practical instruction only when it contained no errors.

2.2 Unit Selection for Multimedia Courseware

The "factors that dominate the secret of life" curriculum was selected as the design object for this multimedia courseware due to the multiple abstract concepts and the processes that are difficult to be observed in daily life or requires special instrument and equipment. Topics relating to the structure of

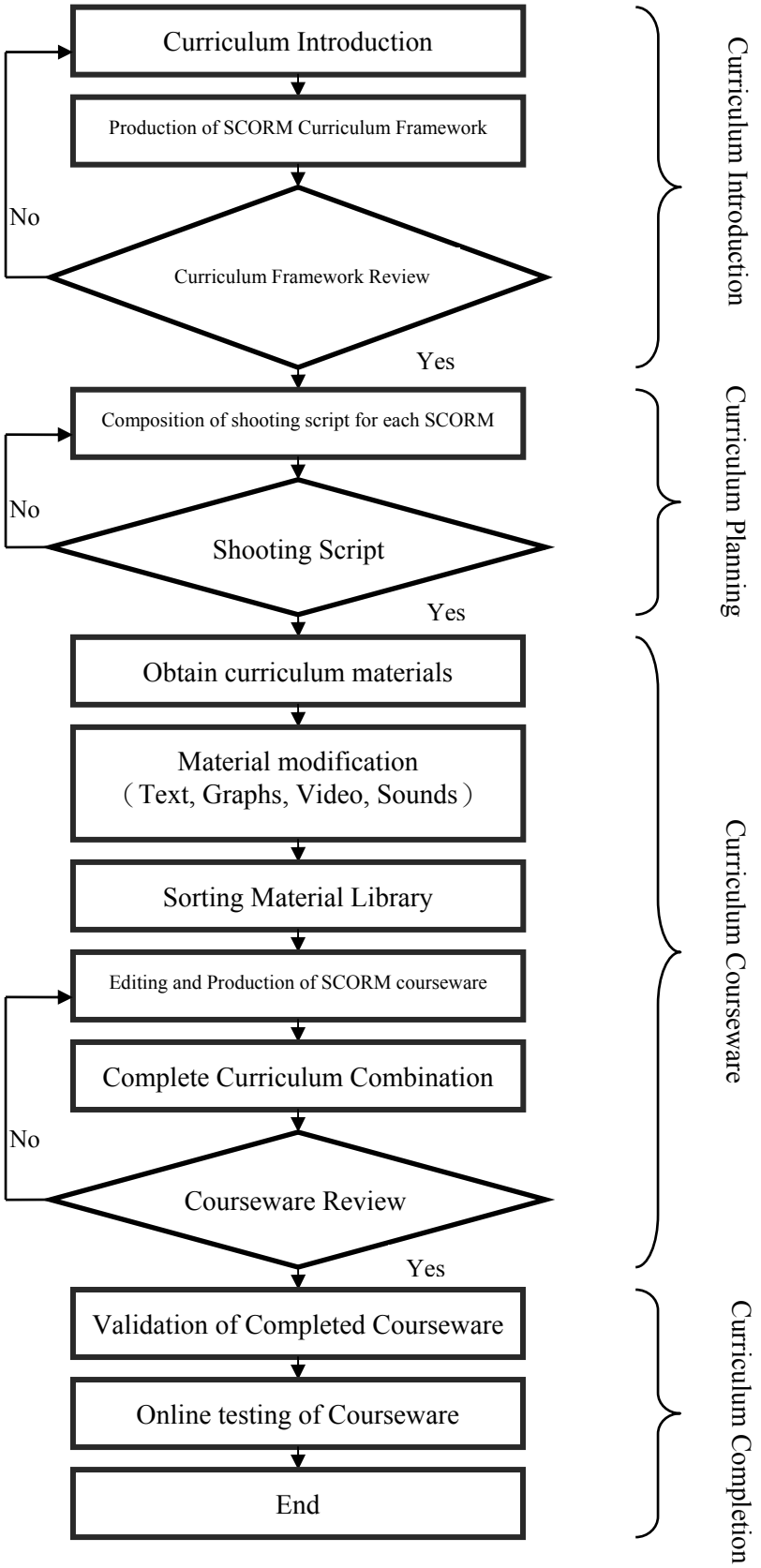

Figure 1 Flowchart of Multimedia Courseware Editing and Production

DNA and the processes of transcription and translation are examples of such. Instructors often encounter difficulty in presenting the curriculum content when instructing this unit using traditional teaching resources and students commonly find the subject difficult to comprehend. The use of multimedia courseware may aid in presenting these abstract concepts and simulate the transcription process in a more specific approach in order to achieve the desired outcomes of situation teaching.

The "factors that dominate the secret of life" curriculum from high school biology is divided into six teaching activities：

Activity1 ： The topic is "The Discovery of Genetic Material, DNA", emphasizing the types of experiment used when scientists proved DNA was the genetic material.

Activity2 ： The topic is "The Structure of Nucleic Acids", emphasizing the type and structure of nucleic acids, the discovery process of DNA structure and the structure of RNA.

Activity 3 ： The topic is "DNA Replication", emphasizing the method and process of DNA replication.

Activity 4 ： The topic is "Genes," emphasizing the performance of genes.

Activity 5 ： The topic is "Transcription," emphasizing on the process of DNA transcription into RNA, the modification of RNA into mRNA and the process where three nitrogenous bases forming one codon.

Activity 6 ： The topic is "Protein Synthesis," emphasizing the translation of RNA into proteins.

2.3 Multimedia Courseware vs. Traditional Teaching Resources

2.3.1 Multimedia Courseware

The second teaching activity is used to demonstrate the difference between multimedia courseware and traditional teaching resources. The multimedia courseware shown in Figure 2 introduces nucleic acids. The image is designed with simple text and animation so that the students may clearly acquaint themselves with the two different nucleic acids, namely DNA and RNA, and to understand that nucleic acids are the small unit composition of nucleotides.

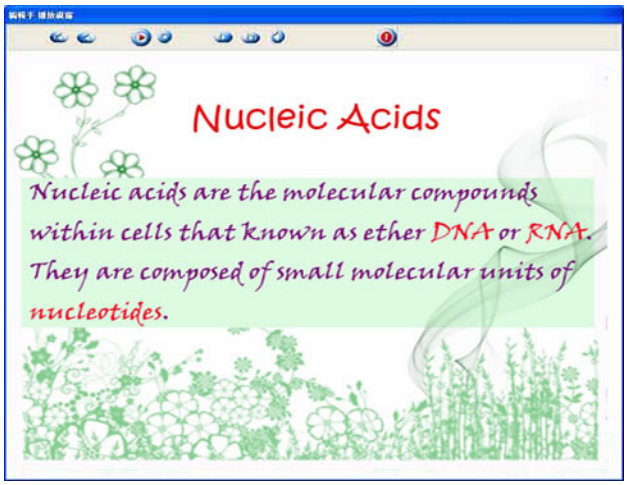

Figure 2 Multimedia Courseware – Structure of Nucleic Acids

Figure 3 shows the multimedia courseware that introduces nucleotides. Much of the text is hidden in this screen and only simple images and corresponding text is given to help learners easily comprehend the relationship between nucleotides and molecular structure. The screen also contains many interactive designs (Figure 4). For example, when students move the cursor to the pentose, pentose containing deoxyribose and ribose will appear overtop of the pentose. The inherent characteristics of multimedia are able to present abstract concepts more specifically and thus help students to integrate knowledge and avoid an excessive word cognition load.

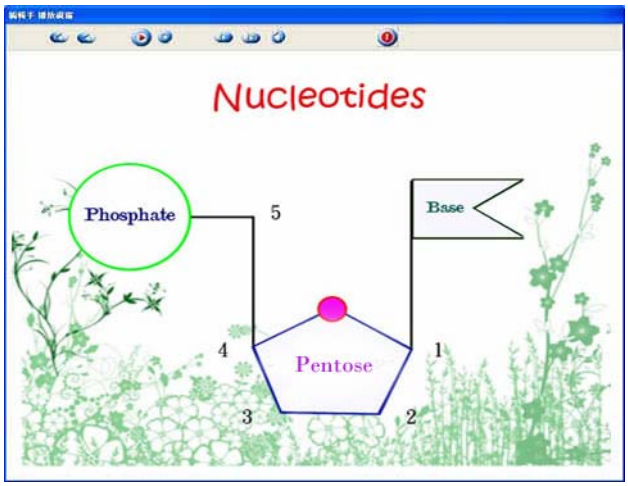

Figure 3 Multimedia Courseware - Nucleotides (1/2)

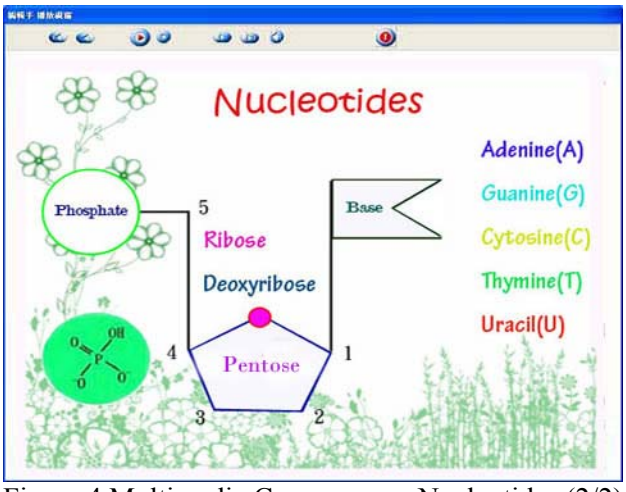

Figure 4 Multimedia Courseware - Nucleotides (2/2)

Figure 5 shows the multimedia courseware that introduces the three-dimensional structure of DNA where students may link to pre-set websites through a hyperlink in IE or other browsers and directly manipulate the three-dimensional structure of DNA. They can spin, enlarge, or observe the DNA structure through different angles in addition to presenting DNA in various patterns. It is difficult to observe the three-dimensional structure of DNA in daily life. Although instructors may present solid modeling of the DNA structure using the traditional teaching model, the limitation of equipment numbers makes it difficult for each student to get hands-on experience and observation. M ultimedia computer assisted instruction can solve this problem. Each student can manipulate a DNA structure according to his or her learning pace.

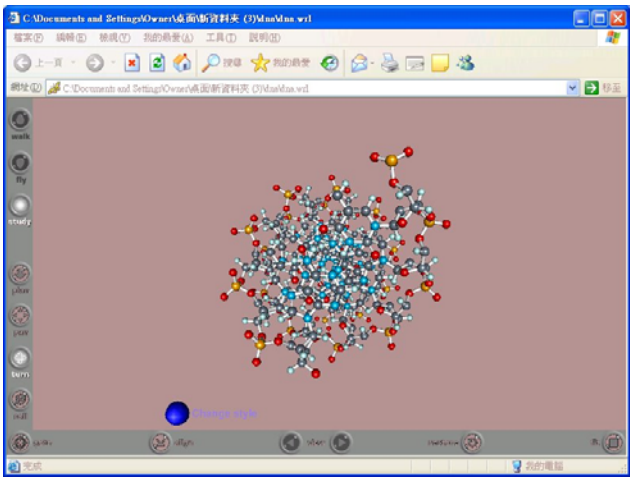
Figure 5 Multimedia Courseware – 3D Structure of DNA

2.3.2 Traditional Teaching Resources

Figure 6 shows the traditional teaching resources for the introduction of nucleic acids. These can only be presented through text and 2D images. The 3D structure of DNA cannot be presented specifically. It may not be difficult for students with better spatial and abstract capability to ascertain the 3D structure in their minds, however most students cannot imagine the corresponding 3D spatial structure from the 2D images.

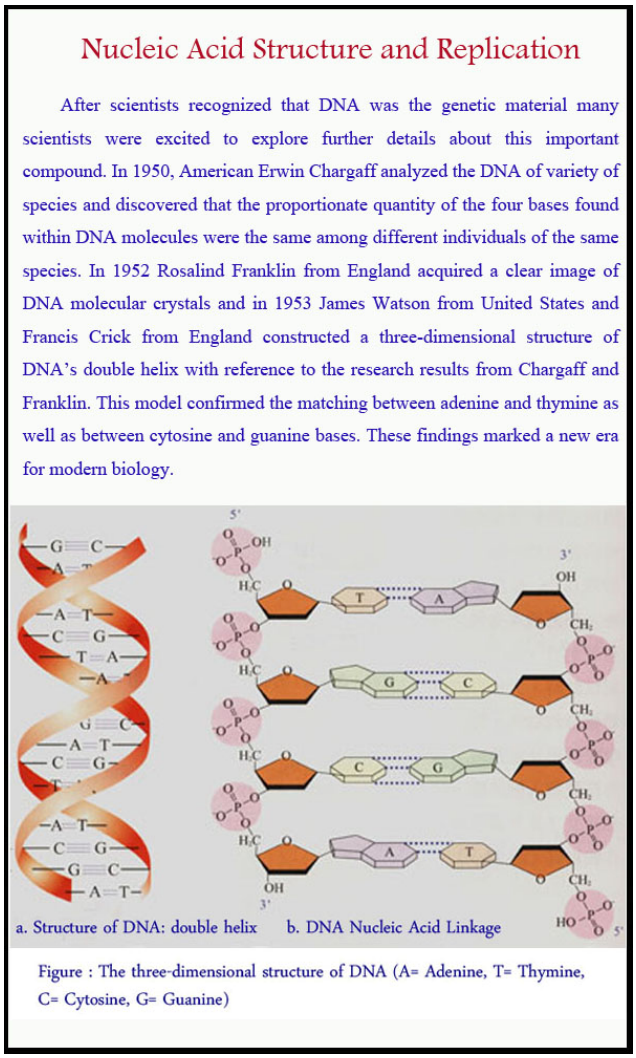

Figure 6 Traditional Teaching Resources – Structure of Nucleic Acids

3 Research Methods

3.1 Experimental Design

This study consists of four steps with respect to experimental design：（Figure 7）

Step 1： To inspect whether the high school students participating in the experiment understand the "factors that dominate the secret of life" curriculum without significant difference, a pretest was conducted before carrying out the experiment. The questions on the pretest were prepared by the biology instructor with materials selected from the

introductory content to the "factors that dominate the secret of life" from the biology curriculum of a year previous. The pre-test scores were collected as the "prior knowledge" scores.

Step 2： This study adopted the "Kolb Learning Style Scale, Third Edition" prepared in 1976 and modified in 1999 [26-27] to divide the learning styles of the students into one of four types: Diverger, Assimilator, Converger, and Accommodator. Divergers tend to reflect observation and specific experiences, Assimilators tend to reflect observation and abstract experiences, Convergers prefer active experiments and abstract experiences, and Accommodators prefer active experiments and specific experiences. The students must go through the specific experience, abstract experience, reflection of observation and active experiment aspects from the Kolb Leaning Style Scale. After calculating their responses, the students were classified into one of the four learning styles. The reliability test results of the scale showed that Cronbach's α coefficient fell between 0.74 ~ 0.85 with excellent reliability. The validity of test results for the scale showed that the factor loading of specific experience, abstract experience, reflection of observations, and active experiment aspects were 0.82, 0.83, 0.73, and 0.78 respectively, with excellent construct validity.

Step 3： There were 108 students from five classes selected throughout the high school and the total effective sample size was 95 people after removing 13 students with absence during the experimental period and invalid questionnaires. The study classified the students into 8 groups with

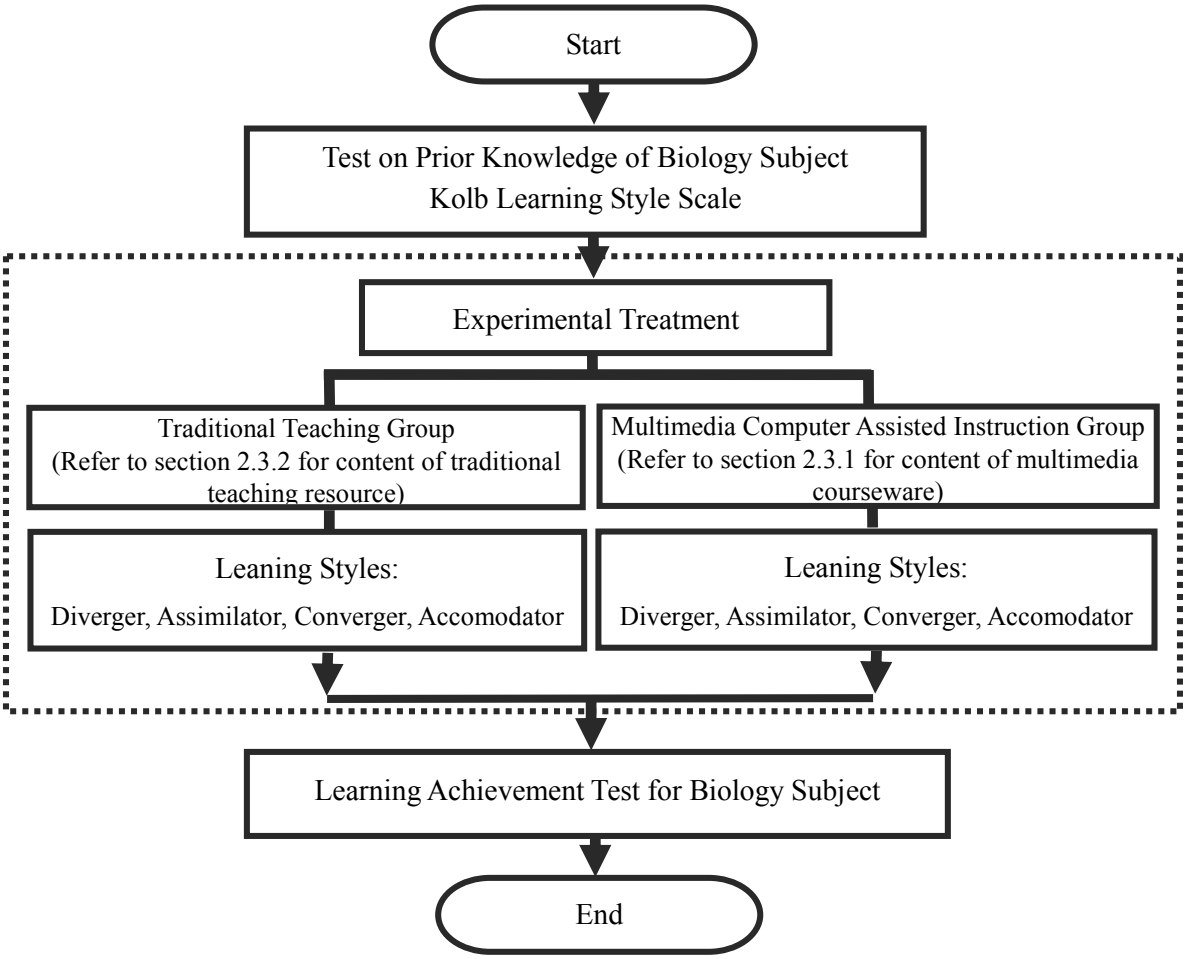

Figure 7 Experimental Steps

codes from A to H (as shown in Table 1) according to two indicators: learning style (Diverger, Assimilator, Converger, or Accommodator) and teaching model (multimedia computer assisted instruction model or traditional teaching model).

Multimedia Computer Assisted Instruction Model：The class took place in the computer room where the multimedia courseware is used as the teaching tool to assist teachers with instructions. The interactive design of the multimedia courseware helps learners to learn through computer assisted multimedia courseware where the role of the learners changes from passive learning to active learning.

Traditional Teaching Model：The class takes place in an average classroom where traditional teaching resources are used as teaching tools to assist instructors with descriptive teaching. The limitation of the venue and the characteristics of the teaching resources all result in passive learning where the students can only accept the knowledge and concepts provided by the instructors.

Step 4： The experiment lasted for two weeks. The multimedia computer assisted instruction model and traditional teaching models were used in the instruction of "factors that dominate the secret of life", a high school biology curriculum. At the end of experiment the biology instructors administered a test based on the content taught. The post-test scores were collected and called "learning achievement" scores.

3.2 Research Hypothesis

3.2.1 The Effect of a Different Teaching Model on Learning Achievement

Studies concerning the effect of web-based instruction models suggest the advantages of such models [28-30]. In the case of teaching accounting, for example, students who were taught using the web-based collaborative learning methodology scored significantly higher and demonstrated greater business creativity than those students who were taught by traditional lectures [28]. Moreover, incorporating web-based interactive methodologies into a neurology clerkship enhanced the teaching of seizure disorders to 3rd-year medical students. In this case the web group obtained better scores than the traditionally taught group [29]. When teaching a dental hygiene course in gerontology offered both on the web and in the traditional classroom setting, students enrolled in the web-based course demonstrated a greater motivation and learning success as evidenced by final course grades, completion of assignments and knowledge retention over time [30]. Web-based instruction models and the multimedia computer assisted instruction model make use of text, sound, graphics, and animation that can be added to increase the comprehension and liveliness of the curriculum in addition to stimulating students with active learning endeavors. This study expects that the student learning achievement of those taught using the multimedia computer assisted instruction model will be significantly higher than those students taught using the traditional instruction model.

3.2.2 The Effect of a Different Instruction Model and Learning Styles on Learning Achievement

Previous studies of the interactive effect between instruction model and learning styles differ somewhat. Some studies have noted that when using the multimedia computer assisted instruction model or (hypermedia) web-based learning model, individual student learning styles will have a

Table 1 Group codes and distribution of students after grouping according to instruction model and learning styles.

Learning Styles / Instruction Model	Diverger	Assimilator	Converger	Accomodator	Total
Multimedia Computer Assisted Instruction Model	10 people (A)	4 people (B)	10 people (C)	24 people (D)	48 people
Traditional Teaching Model	13 people (E)	5 people (F)	9 people (G)	20 people (H)	47 people
Total	23 people	9 people	19 people	44 people	95 people

significant effect on the learning achievement. However there is no consistent conclusion as to what kind of learning style will help students to obtain a higher learning achievement [18-22]. Other studies suggest that there is no significant difference between the learning achievement of students with different learning styles when being taught with a multimedia computer assisted instruction model or (hypermedia) or a web-based learning model [23-25]. It is suggested that the teachers taking into consideration of the preferred learning strategies for students with different learning styles when making multimedia instructional design will help students attain similar learning effects despite of their learning styles. [23]. This study aimed to discuss the effect of different learning styles on learning achievement and the interactive effect of different instruction model and learning styles on learning achievement. We will do this without proposing a hypothesis but instead through exploratory research.

3.3 Research Methods

This study tested the effect of different instruction models on learning achievement using ANCOVA to determine whether there is a significant difference of learning achievement between testing with a multimedia computer assisted instruction model or a traditional teaching model. The independent variable of the test was the different instruction model while learning achievement was the dependent variable.

This study examined the effect of different instruction models and learning styles on learning achievement using MANCOVA to identify the significant difference of learning achievement within grouped students. The independent variable of this test was the different instruction model and learning styles while the dependent variable was the learning achievement.

4 Research Results

4.1 The Effect of Instruction Model on Learning Achievement

This study divided the high school students into groups according to instruction model and administered a pre-test and a pos-test. Within the experimental group there was no significant difference (F value = 0.137, P value = 0.712) between students with prior knowledge of the "factors that dominate the secret of life" unit of the biology curriculum for both students taught using the multimedia computer assisted instruction model and students taught using the traditional instruction model. However, the results show a significant difference (F value = 4.972, P value = 0.028) in learning achievement after just two weeks of instruction using the multimedia computer assisted instruction model compared to the traditional instruction model. The average score of learning achievement for students who received multimedia computer assisted instruction was greater than that of those students who received traditional instruction with an average difference to 7.847 and a 95% significant level.

4.2 The effect of Instruction Model and Learning Style on Learning Achievement

This study divided the high school students into eight groups according to their learning styles and instruction models. A pre-test and post-test were carried out in each group. The results demonstrate that the eight groups of students did not show a significant difference (F value = 0.38, P value = 0.914) in their prior knowledge of the "factors that dominate the secret of life" previous to conducting the experiment. However, the results demonstrate that the eight groups of students did show a significant difference (F value = 2.75, P value = 0.047) in their learning achievement for the "factors that dominate the secret of life" unit from the biology curriculum after two weeks of differing teaching models.

4.2.1 The Effect of Instruction Models on Learning Achievement based on Learning Style

The results shown in Table 2 demonstrate that the learning achievement for students with the learning styles of Diverger, Assimilator and Accommodator are all significantly higher under the multimedia computer assisted instruction model than the traditional instruction model.

4.2.2 The Effect of Learning Style on Learning Achievement under the Multimedia Computer Assisted Instruction Model

The results shown in Table 3 demonstrate that there is no significant difference in student learning achievement for students with the learning styles of Diverger, Assimilator, Converger, and Accommodator when taught with the multimedia computer assisted instruction model.

Table 2 Test Results Demonstrating the Effect of Instruction Models on Learning Achievement based on Learning Style

Learning Style (I)	Learning Style (II)	Mean Difference (I-II)	Standard Error	P value
A(51.796)	E(36.836)	14.960	2.17895	0.03207**
B(48.535)	F(29.330)	19.205	1.88588	0.06269*
C(45.767)	G(55.599)	-9.832	-1.24372	0.21698
D(44.303)	H(34.883)	9.420	1.81603	0.07285*

Remark: The students are categorized into groups A through H according to the instruction model and learning style. The figures in parentheses within the 1st and 2nd column are the average scores of learning achievement. ** refers to $p<0.05$; * refers to $p<0.1$.

Table 3: Test Results Demonstrating the Effect of Learning Style on Learning Achievement under the Multimedia Computer Assisted Instruction Model

Learning Style (I)	Learning Style (II)	Mean Difference (I-II)	Standard Error	P value
A(51.796)	B(48.535)	3.261	9.00777	0.33649
	C(45.767)	6.029	7.07210	0.39630
	D(44.303)	7.493	5.91948	0.36644
B(48.535)	A(51.796)	-3.261	9.00777	0.33649
	C(45.767)	2.768	9.02006	0.76732
	D(44.303)	4.232	7.85191	0.67239
C(45.767)	A(51.796)	-6.029	7.07210	0.39630
	B(48.535)	-2.768	9.02006	0.76732
	D(44.303)	1.464	5.99886	0.91338
D(44.303)	A(51.796)	-7.493	5.91948	0.36644
	B(48.535)	-4.232	7.85191	0.67239
	C(45.767)	-1.464	5.99886	0.91338

Remark: The students taught using the multimedia computer assisted instruction model are categorized into group A through D according to their learning style. The figures in parentheses within the 1st and 2nd column are the average scores of learning achievement.

4.2.3 The Effect of Learning Style on Learning Achievement under the Traditional Instruction Model

The results shown in Table 4 demonstrate that the learning achievement of students with the Converger learning style are significantly higher than those of the three other learning styles under the traditional instruction model.

5 Conclusion

This study observed students from one high school to explore the effect of different instruction models (multimedia computer assisted instruction model and traditional instruction model) on students learning achievement when being taught the "factors that dominate the secret of life" curriculum of high

Table 4 Test Results of the Effect of Learning Style on Learning Achievement under the Traditional Instruction Model

Learning Style (I)	Learning Style (II)	Mean Difference (I-II)	Standard Error	P value
E(38.836)	F(29.330)	9.506	8.07810	0.70777
	G(55.599)	-16.763	6.83725	0.00439**
	H(34.883)	3.953	5.64518	0.60494
F(29.330)	E(38.836)	-9.506	8.07810	0.70777
	G(55.599)	-26.269	8.68197	0.00947**
	H(34.883)	-5.553	7.49945	0.98864
G(55.599)	E(38.836)	16.763	6.83725	0.00439**
	F(29.330)	26.269	8.68197	0.00947**
	H(34.883)	20.716	6.25784	0.00043**
H(34.883)	E(38.836)	-3.953	5.64518	0.60494
	F(29.330)	5.553	7.49945	0.98864
	G(55.599)	-20.716	6.25784	0.00043**

Remark: The students under the traditional instruction model are categorized into groups E through H according to their learning style. The figures in parentheses within the 1st and 2nd column are the average scores of learning achievement. ** refers to $p<0.05$

school biology. The results show that students learning achievement under the multimedia computer assisted instruction model is significantly higher than that of the traditional instruction model. Such a result is consistent with the study's hypothesis whereas under the multimedia computer assisted instruction model instructors may utilize computers to present certain abstract concepts of the biology curriculum and various 3D structures that are difficult to present in textbooks. Multimedia computer assisted instruction provides students with specific experiences in observation and simulation. In addition, the interaction of digital learning materials allows students to learn through intuitive and trail-and-error methods and to repeatedly attempt to establish concept and models contained within course content. Therefore students are likely to obtain greater learning achievement.

Moreover, this study further explores the influence of learning styles to explore the joint effect of instruction model and learning styles (Diverger, Assimilator, Converger, and Accommodator) on students learning achievement. The results show that the learning achievement is greatest for students with the Converger learning style under the traditional instruction model. However, under the multimedia computer assisted instruction model the learning achievement of students within the three remaining learning styles shows significant growth. The learning achievement of students with the learning style of Diverger, Assimilator, Converger, and Accommodators do not show significant difference overall. This result is consistent with prior studies which have stated that students with a variety of learning styles will perform just as well under hypermedia web-based instruction models [23].

The experimental conditions of this study were designed for the instruction of biology curriculum. It is recommended that future researchers explore whether the use of the multimedia computer assisted instruction model will enhance student learning achievement in the instruction of other curriculums. In addition, the limitation of this study lies in the absence of taking into account the various instruction styles of individual instructors. Future researchers may want to include this factor in their studies.

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