CHAPTER V

CONCLUSIONS, SUGGESTIONS AND SUMMARY

5.1 Conclusions of the study:

**Objective No 1;** To find out the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX and,

**Objective No 2;** To analyze the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX

These are based on the responses to the questionnaires and the personal interviews by fifty-two science teachers and three hundred forty-five grade IX students in English medium secondary schools in Thailand. Both the teachers and students have positively responded to the use of new instructional tool of self-instructional computer assisted program (SICAP) is beneficial for teachers who need not tell their learners but will facilitate their learning. It is beneficial for students as they become free to choose their course and mode of learning.

**Objective No.3:** To develop Self-instructional computer – assisted program (SICAP) for students based on Biotechnology and Biodiversity topics of science grade IX

The study is based on the performance of the three try-out groups. The first try-out of individual student, the second try-out of a small group of three
students and the third try out of the field trial of ten students have been conducted.

1. The first try-out was conducted on individual students. The mean score of pre-test was 42.23%. The mean score of post-test was 56.67%. The scores show the improvement of mean scores by 14.44%. The student’s comment; changing of topic each unit too difficult because the closing of current topic before opening the program for studying the new content. The researcher should relate content of different unit together, so that the students may open the content without closing the program.

2. The second try-out was conducted on a small group of students. Their mean score of pre-test was 41.3%. Their mean score of post-test was 70.74%. The improvement of mean scores of 29.44% is obviously remarkable. The student’s comment; the content that are difficult and more than specification of learning and utilize time in understanding. Therefore, the researcher should modify the lesson and also the test again before testing in next step.

3. The third try-out was conducted on a large group of students. Their mean score of pre-test was 42.23%. Their mean score of post-test was 82.90%. The improvement in mean scores of 40.67% is noticed. The student’s comment; the scores obtained from doing the test may be incorrect. The researcher has modified by giving add the command to deleted scores to be zero before doing the test the next time.

The conclusion is that in three try out the improvement in performance in terms of percentage is of 14.44%, 29.44% and 40.67% which leads to conclusion that SICAP is an effective tool both for teaching and learning.
Objective No.4: To test the effectiveness of Self-instructional computer – assisted program (SICAP).

The conclusion is based on the improvement in the mean scores of the experimental group and the control group. The experimental group was administered self-instructional computer assisted program (SICAP). The control group was instructed through the traditional method. In the case of the experimental group the improvement from the pre-test mean score (10.10) to the post-test mean score (24.54) is of 14.44 points. In the case of control group the improvement from the pre-test mean score (10.36) to the post-test mean score (21.70) is of 11.34 points. It is evident that there is additional improvement of 03.10 points in the performance of the experimental group. This leads to the conclusion of the study that students are enabled to learn on their own at their own pace, at their own convenience with as many repetitions, as many backward and forward movement and for practice, for exercises and for self-improvement through the computer technology assisted instructional media.

The present studies are confirmed through the supportive evidence. The conclusions are;

1. Improvement in the learners’ performance,
2. Enabling the learners to learn on their own,
3. Liberation students from rigid classroom schedules in self-instructional strategies,
4. Facilitating students to learn most effectively through computer technology assisted educational device, and
5. Establishing the effectiveness of the computer program as successful educational technique.
This leads to the validation of the hypothesis of the study which is the summary of the hypotheses of the present study: Students of grade IX students who learn through self-instructional computer assisted program (SICAP) have performed significantly better than those students who learn through traditional method. The hypothesis is validated and therefore the null hypothesis stand rejected and research hypothesis accepted.

5.2 Suggestions for improvement

5.2.1 Suggestions for Teachers

1. Teachers will train themselves to become the producers of self-instructional computer assisted program (SICAP) for all the units of their courses.

2. Teachers will have to play the role of controller of the technology assisted program by designing, producing, introducing, conducting, and implementing the programs and will act as monitors of self-instructional computer assisted program (SICAP).

3. Teachers will make use of the instructional material to be used before self-instructional computer assisted program (SICAP) is implemented. The preparation, and distribution of the material will be carried by the teacher and they will have to encourage the learners to form the habit of preparation before hand in case of every learning units.

4. Teachers will be required to revise the computer program by adding more contents, by changing through new techniques, and through innovative strategies.
5. Teachers will have to undergo in service training as many times as possible because the teachers will have to train himself in the preparation of self-instructional computer assisted program (SICAP) and also in its application, constant revision, through implementation and its effective implementation. Teachers will be required to learn handling new technologies.

6. Teachers will have to equip themselves to play completely different roles such as a facilitator in learning a monitor of programs, a producer of self-instructional computer assisted program (SICAP), a co-ordinator of different activities and a controller of teaching and learning situations. Teachers will give up the role of being a ‘lecturer’ who tells things as just telling is not teaching.

7. Teachers will co-ordinate the evaluation strategies in such a manner that the learners will be evaluated immediately, transparently and objectively by devising the testing schedules of ‘online’ format.

5.2.2 Suggestions for Students

1. Students will enjoy full freedom in deciding their learning strategies through self-instructional computer assisted program (SICAP)

2. Students will have to acquire the skills of time management to reap the maximum advantages of self-instructional technology assisted program.

3. Students will have to identify their needs so that revisions and improvements are self-instructional computer assisted program (SICAP) are carried to suit the learners’ requirements.

4. Students will have formed the habit of preparing the learning unit before it is introduced. Before hand preparation has been expected even in the
days of printed texts but more computer lesson units can be used as many times and in whatever way the learner desires to use.

5. Students will have to adopt the ‘do it yourself’ approach in learning. The best strategy is therefore self help which is the gateway to learning things.

6. Students will recognise the fact that the entire educational process is learner-centred and therefore they will have to understand the fact that education is now for the learners, of the learners and by learners themselves through self-instructional strategies.

7. Students will be required to undertake the responsibility of close interaction with their teachers and the policy makers by tendering their responses and expressing their opinions freely and fearlessly.

8. Students will have to be aware of the fact that education holds the key to the all round development of their potentials as individuals and as members of the global community. They will gain maximum returns from the prevalent systems of education and strive to develop those too fully.

5.3 Areas of Further Research

1. The topic selected for the present study is a pointer and its effectiveness further examined in other science content areas such as Biology, Chemistry or Earth Science.

2. It would be interesting for further to investigate into the effects of self-instructional computer assisted program (SICAP) on the other levels and subject, and probable be considered in all education research.

3. The study should be extended into a larger sample. This would allow results to be generalized to the population. If the focus is on lower or higher academic institutions utilize SICAP learning in Science, a larger
representative sample of lower key stage or higher education will be preferable.

The topics listed above are some the pointers and it is not claimed that the list above is fully exhaustive as many more areas and many more topics can yet be explored by prospective researchers.

5.4 Summary of the study

The research work has applied the Self-Instructional Computer Assisted program (SICAP) to the teaching of the higher level concepts of science in the topics related to Biotechnology and Biodiversity for students of grade IX. For teaching of these concepts of science, the researcher has developed a program and has carried out the three phased trial and has implemented the program. The effectiveness of the program is measured through the scores of the learners in the pre-test, and the post-test. The study has briefly introduced the formal features of research methodology, these formal features include the rationale for the study, statement of the problem, operational definitions of key terms, objectives, hypothesis of the study along with the null hypothesis, assumption of the study, scope and limitations of the study and significance of the study. The background and rationale of the selection of the topic and the formal features of the present study are presented in the first chapter of the study.

The second chapter offers the review of literature of the past. The first section of this chapter presents the history of educational development in Thailand; the educational system in Thailand is characterized by first six years of primary education and the next six years of secondary education. The second section shows how during the present reform of the Basic Education started in
1996 and how National Education Act was launched in 1999 and how in 2001 Basic Education Curriculum has been formulated. The third section offers the main content areas of the course related to Biotechnology and Biodiversity prescribed for the grade IX students in Thailand. The next four sections bring out the contributions by eminent scholars, to the development of the program, and the studies related to effectiveness of the Self-Instructional Computer Assisted program (SICAP). The next section deals with the teaching of the concepts in science. The second chapter is concluded with the appropriated remarks.

The third chapter deals with research methodology used for this study. The use of survey method as well as experimental method has been made in the research design. Along with the use of mixed method, the present work is a product-oriented research. The theories of learning such as behaviourism, cognitive, and constructivism have been appropriately applied to the designing of the program. The sample population is of fifty-two teachers from fifty-seven English medium secondary schools and three hundred and forty-five students for survey method. The experimental and control groups of fifty students each are finally selected. The stages of developing the program, its actual production and evaluation have been described in sufficient details. The procedure of the main study has been presented through the fifteenth steps. The third chapter is concluded with the discussion of the statistical techniques used in the study.

The fourth chapter is devoted to the presentation of data and the application of the analytical procedure to the same. The first two sections deal with the data of the responses to the questions by fifty-two teachers in response to the questionnaire specially designed for the teachers of science in English medium secondary schools and the data of students’ responses to the questionnaire designed for students. The third stage is the creating and developing of Self-Instructional Computer Assisted program (SICAP). The
fourth stage describes the try-out trial of the program. The fifth stage is the actual implementation and the assessment of effectiveness of the program. All of stages have been duly discussed in necessary details.

The fifth chapter of the study begins with the synoptic summary of the study. It is followed by the presentation of the findings of the study, the conclusions and the suggestions for improvement. Some of the topics for further research in the area have been listed. This synoptic summary of the study brings out the features of the present work.

5.4.1 Background

In the traditional method of teaching, the teacher does all the work— all the telling as the obvious choice of conveying all the information. The learner is reduced to the role one who must merely comprehend, interpret and remember with limited opportunity to ask questions, resolve doubts and clarify ideas. The traditional method of teaching is also known as the chalk and talk method as the teacher uses the blackboard and chalk to support his teaching through the lecture method. The teacher plays an active role of giving lectures and explaining and students play a less active role and just passive hasteners. The discussion about learning objectives, the experimentation in which the students carry out the experiments as explained in the practical handbook and the conclusion in which the students give answers to the provided question are three steps of the traditional method of teaching science subject.

On the other hand, self-instructional method is a teaching strategy which allows a student to pursue a learning objective through a prepared, self-contained sequence of instructional activities at his own pace. It provides students with alternative learning objective sequences of instructional activities
from which he selects a path in which he is most comfortable. Hence, self-instructional computer assisted program (SICAP) is that in which the individual learners learn by using ideas presented in the teacher authored computer programs. The provision of exercises, activities a self-assessment question is the authoring in the programs. Through these the key objectives associated with a teaching text are realized and students are allowed to get more practice in the area concerned. The subject-matter is revealed to the student in a self-instructional approach which the computer assisted program guides to learn. The students who learn through self-instructional method by computer assisted program can move as slowly or as quickly as they like through a program.

If the students want to repeat some task material in a self-instructional computer assisted program, the students can do so as many times as the students choose. The students can skip over a topic, it that information is already known, making the learning process more efficient with self-instructional using computer assisted program. The students can decide what they want to learn and in what order. The students have different learning styles and use different learning strategies. When the students can learn in a way that suits them, improvements in the effectiveness of the learning process normally ensue. Computer programs encourage learning as they provide a stimulating environment and promote enthusiasm. Computers may help a reticent student who is afraid to make mistakes in a classroom situation through the self-instructional method.

This research study is an attempt to provide a meaningful and practical instructional strategy for grade IX students in Thailand I learning same higher level concepts in the scientific areas of Biotechnology and Biodiversity. Science gives an opportunity for creative thinking and constructive imagination. Moreover, science is a subject in which ideas can be experimented upon and verified. The learner develops the habits of searching for the truth. These
qualities affect the pattern of behavior of the learner. The significant aspect of science is that whatever the student learns has immediate application in the world around him. This is educationally every sound. One of the very useful outcomes of learning science is the development of problem-solving skills. In this study, the researcher would like to reveal the importance of the self-instructional computer assisted program (SICAP) in teaching science for secondary school grade IX students in Benchamaratrungsarit II School in Thailand. The present study attempts to present the preparation, the production and implementation of the self-instructional computer-assisted program in Biotechnology and Biodiversity and the response to the questions given by the teachers and students in Thailand. The development and effectiveness of the program is the main focus of the present study. The need of the present study is determined by the significance of the self-instructional computer assisted program as an advanced educational technology, its application and advantages for teachers, students and for science education in general and the cultivation of scientific temperament and problem-solving skills among the students. The necessity of undertaking the present study makes it a justified research activity.

5.4.2 Statement of the problem

“Development of Self-Instructional Computer-Assisted program (SICAP) on Science of Grade IX & its Effectiveness in Thailand”
5.4.3 Objectives of the study

1. To find out the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX
2. To analyze the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX
3. To develop Self-instructional computer – assisted program (SICAP) for students based on Biotechnology and Biodiversity topics of science grade IX
4. To test the effectiveness of Self-instructional computer – assisted program (SICAP).

5.4.4 Research Hypothesis

There is significant difference in the mean achievement scores obtained teaching of science by using Self-Instructional Computer – Assisted program (SICAP) instead of traditional method for grade nine students

5.4.5 Null Hypothesis

There is no significant difference in the mean achievement scores obtained teaching of science by using Self-Instructional Computer – Assisted program (SICAP) instead of traditional method for grade nine students

5.4.6 Assumptions

1. Teachers and students know how to operate computer.
2. Teachers use different teaching methods for teaching science.
3. Teachers use different innovative techniques for teaching science.
4. Students use computer and internet for work and references.
5.4.7 Scope and Limitations

5.4.7.1 Scope

This research is useful for all secondary English medium schools teachers, students of Grade IX in Thailand.

5.4.7.2 Limitations

1. The effectiveness of Self Instructional Computer Assisted program (SICAP) was based on total involvement of selected schools in Thailand.
2. The effectiveness of Self Instructional Computer Assisted program (SICAP) was based on response given by students to pre and post tests.
3. The researcher had no control on socio-economic status of Thailand and psychological factors.

5.4.8 Delimitations of the study

1. The students of Grade IX at Benchamratrungsarit II School from English medium with computer facility were population from study in Thailand.
2. This study was limited to the schools following content of science by the basic Education Core Curriculum A.D 2008 in Thailand.
3. The sample was delimited to one English medium School.
4. 345 students selected for survey and interview and 100 students selected for experiment (experimental group of 50 and control group 50 students.) of Grad IX student.
5. This study was limited to Biotechnology and Biodiversity topics from science subject of grade IX in sub-matter topics: (I) Biotechnology; (i) Genetic engineering, (ii) A genetically Modified Organisms GMOs, (iii) Cloning, (iv) Deoxyribonucleic acid DNA, (v) Benefits of Biotechnology,
(vi) Public opinion on Biotechnology, (II) Biodiversity; (i) Definition of Biodiversity, (ii) Classification of Animal, (ii) Classification of Plants

5.4.9 A pilot study

The sample group was tested as pilot group with grade IX students studying the topics. They are not selected as the same experimental group and control group. These were three steps to try out. The three steps of pre trials were as follows.

Table 5.1: The three trials of the pilot study

<table>
<thead>
<tr>
<th>Trial steps</th>
<th>Pre-test (%)</th>
<th>Post-test (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual (1)</td>
<td>42.23</td>
<td>56.67</td>
</tr>
<tr>
<td>A small group (3)</td>
<td>41.30</td>
<td>70.74</td>
</tr>
<tr>
<td>Field group (10)</td>
<td>42.23</td>
<td>82.90</td>
</tr>
</tbody>
</table>

A. Students’ comment of SICAP tried out;

- Individual trial; Changing of topic each unit too difficult because the closing of current topic before opening the program for studying the new content.
- A small group trail; The content that are difficult and more than specification of learning and utilize time in understanding
- Field group trial; The scores obtained from doing test may be incorrect
B. Pilot study-Suggestions:

- The researcher has modified SICAP according to the suggestions given by the experts and research guide
- SICAP needs improvement that the content should be adjusted for clarity creating the interest in student and motivation in learning.
- In using program it is convenient, estimation if the result is appropriate which different, most importantly do the learners get an immediate feedback of their result

5.4.10 Methodology of the study

In design, used a mixed method of research is used that includes the survey method, the product-oriented method and the experimental method. The survey method is used to collect data for the preparation of designing tools and then to analyze the data collected. The product-oriented method is used for the construction and development of instructional media based on computer technology to prepare the self-instructional program for grade IX learners from the English medium secondary schools in Thailand. The experimental method is used to test the effectiveness of the designed tools and a comparison is attempted of the achievement score of the experimental group and the control group.

The present study is a product oriented research. This type of research involves the production of new knowledge and is related to the production of new objective. Its main motivation and goal is of using are learning and teaching. It combines the application of theories of learning and techniques of designing educational materials. There are three main categories of philosophical framework under which learning theories fall.
1. **Behaviorism;** Behaviorism is an orientation in psychology that emphasizes the study of observable behavior. It grew out of an attempt by early psychologists to make the study of behavior more objective. The concept of Skinner (1968) \(^{A-26}\) studied strongly emphasized positive reinforcement throughout his writings. Early studies indicated that punishment only temporarily suppressed behavior. In general, a combination of strong positive reinforcement for a correct response and mild punishment for an incorrect response has been found to provide optimal support for learning

2. **Cognitivism;** based on information-processing models. These are concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. Gange’s learning theory (1979) \(^{A-13}\) approach has been applied by identifying learning objectives providing learning experiences to develop knowledge, skills and attitudes, which will result in effective learning according to the educational objectives. Gange’s learning theory (1979) \(^{A-13}\) encourages students to have direct experience in learning the subject-matter and to be enthusiastic in furthering their studies.

3. **Constructivism;** looks beyond behavior to explain brain-based learning. Constructivism views learning as a process in which the learner actively constructs or builds new ideas or concepts. The concept of Trowbridge and Bybee (1996) \(^{A-30}\) is what human beings have created in their minds by trying to make sense or construct meaning out of events or experiences by using their former knowledge, beliefs, and expectations in interpreting meanings and understanding all things. Consequently, knowledge is new reality but only attainable through reasonableness and best concurrent knowledge.

The fundamental psychological principle involved in the product oriental research is that the researcher has to focus on the students’ need by developing
them holistically. Based on the constructivism, the product oriented research has organized learning as such a manner that students can construct knowledge by themselves. These learning theories have been applied to self-instructional computer assisted program (SICAP) which is the research tool in this study.

5.4.11. Population and Sample

5.4.11.1 Population

The population in this study is all science teachers and students who are engaged in grade IX students teaching and learning in English medium secondary schools in grade IX students. The totals are fifty-seven secondary schools with Government recognition in English medium in Thailand. All the fifty-seven teachers and two thousand five hundred grade IX students are teaching and learning in secondary schools in English medium.

5.4.11.2 Sample

Table 5.2: Number of Teachers and Students for survey method

<table>
<thead>
<tr>
<th>No.</th>
<th>Groups</th>
<th>Number of Population</th>
<th>Number of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teachers</td>
<td>57</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>Students</td>
<td>2500</td>
<td>345</td>
</tr>
</tbody>
</table>
Table 5.3: Number of experimental method for sample of students in the two groups

<table>
<thead>
<tr>
<th>No.</th>
<th>Groups</th>
<th>Number of students</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>50</td>
<td>Traditional method</td>
</tr>
<tr>
<td>2</td>
<td>Experimental</td>
<td>50</td>
<td>SICAP</td>
</tr>
</tbody>
</table>

5.4.12. Procedure

The procedure used the survey method to find out and to analyze the higher level concepts on Biotechnology and Biodiversity topic from science. Then the researcher studied product method for preparation of self-instructional computer assisted program (SICAP). After that the researcher designed the experimental method. The study designed two equivalent group design; one control group and one experimental group to test effectiveness of the self-instructional computer assisted program (SICAP). This research was divided into three stages, with details below;

1) Stage I (Survey method): - To find out and analyze the higher level concepts from Biotechnology and Biodiversity topics from science for Grade IX students.

2) Stage II (Product-Oriented method): - For development of Self-instructional computer – assisted program (SICAP) on Biotechnology and Biodiversity in science for Grade IX students.

3) Stage III (Experimenter method): - Equivalent groups design - one control group and on experimental group: - To test the effectiveness of Self-
instructional computer – assisted program (SICAP) on Biotechnology and Biodiversity. The study has the procedure as follows

Figure 5.1: The procedure of study

- Finalization of the problem of study
- Finalization of objective
- Review of the related literature regarding
  - To find out the higher level concepts on Biotechnology and Biodiversity in Science
    - For grade IX students
  - To analyze the higher level concepts on Biotechnology and Biodiversity in Science
    - For grade IX students
- Developing a Self-Instructional Computer-Assisted program (SICAP)
- Science test for sample selection based on previous knowledge
  - 1 control gr. 50 sts and 1 experimental gr. 50 sts. : sample 100 students
- Pre-test
- Control group (50sts.) → Experimental group (50sts.)
- Implementation of the Self-Instructional Computer-Assisted program
- Post-test administration for 2 groups
  - 1 control gr. 50 sts and 1 experimental gr. 50 sts.
- Data collection
- Statistical analysis and interpretation
- Conclusions and Suggestion
5.4.13. Tools to be used in the collection of data

A: Research tools

1. Questionnaires and interview: - For teachers and students. To find out, and to analyze the higher level concepts of science subject

2. Pre-test and Post-test:- For students.

3. Self-instructional computer – assisted program (SICAP):- For students.

B: Statistical tools

1. Mean
2. Standard Deviation(S.D)
3. t-test

5.4.14. Findings of the study

Objective No 1; To find out the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX and,

Objective No 2; To analyze the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX

A. teachers’ questionnaire and interview

The data obtained in teachers’ questionnaire and interview. The responses of fifty-two teachers who have responded to the questionnaire and whose interviews were conducted by the present researcher have been presented
the information through the responses from which the opinions of these fifty-two teachers are expressed. Section A of five responses is about the personal information of the teachers. Of all fifty-two Science teachers, 36.5 percent were male and 63.5 percent were female. Approximately teaching experience, 11.5% were between 1-5 years, 42.3% were 6-10 years and 46.2% were over 10 years. Bachelor degree holders made up 75.0%, while 25.0% held master’s degrees. In terms of teaching load, 32.7% taught less than 20 hours per week, 51.9% had load between 20-24 hours per week and 15.4% taught more than 24 hours per week. Section B of fifteen responses queries makes the next group of responses. Most of the teachers are found to be genuinely interested in science, use lecture-cum-demonstration method follow the easy to difficult mode of teaching, repeat for clarifications, are motivated to teach, are confident of their up to date information understand before they teach, discuss with other teachers, find it easy to teach and clarify higher level concepts, enthusiastically clear the doubts, prepared to answer, prefer brain-storming sessions, use creativity to explain, are confused of tense while teaching higher level concepts and desire to enhance knowledge. The ten responses to Section C show that most of the teachers have used computer program have its knowledge and experience, use the new technology, and use new instruction media of computer programs. They have used it for tests and practice, for learning and teaching, for enhancing knowledge and for self-instructional strategies. Section D Interview the higher level concepts on Biotechnology and Biodiversity topics that the respondents need for teaching and learning in science. The interview of the teachers was used as an opportunity to survey the opinion of the teachers about the course. The teachers have to assist instruction efficiently on Biotechnology & Biodiversity and SICAP is a new way for them. They gave list of difficult of clarifies on topic that; (I) Biotechnology; (i) Genetic engineering(15%), (ii) A genetically Modified Organisms GMOs(15%), (iii) Cloning (15%), (iv) Deoxyribonucleic acid DNA (15%), (v)
Benefits of Biotechnology (20%), (vi) Public opinion on Biotechnology (20%), (II) Biodiversity; (i) Definition of Biodiversity (30%), (ii) Classification of Animal (35%), (ii) Classification of Plants (35%)

B. Students’ questionnaire and interview

The data obtained in students’ questionnaire. The respondents are three hundred and forty-five students whose responses to the gender indicate that 56% students are female and male students are about 46% and that there are 71% students who we average in their GPA scores. The remaining responses indicated that most students like the use of SICAP and are willing to make use of the same in their studies. The students who responded to the questionnaire have been interviewed. There is total approval for the use of new computer technology for information, for knowledge, for practical, for learning science as a modern media, as an instructional media, and for exercises. The students have stated that the following topics need to be developed and clarifications should be given on these topics. The topics are (I) Biotechnology (i) DNA and Gene (50%), (ii) Chromosomes (50%), and (II) Biodiversity, (i) Classification of animals (50%), (ii) Classification of plants (50%),
Objective No.3: To develop Self-instructional computer – assisted program (SICAP) for students based on Biotechnology and Biodiversity topics of science grade IX

Table 5.4: Result of the three trials of the pilot study

<table>
<thead>
<tr>
<th>Trial steps</th>
<th>Pre-test (%)</th>
<th>Post-test (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual trial</td>
<td>42.23</td>
<td>56.67</td>
</tr>
<tr>
<td>A small group trial</td>
<td>41.30</td>
<td>70.74</td>
</tr>
<tr>
<td>Field group trial</td>
<td>42.23</td>
<td>82.90</td>
</tr>
</tbody>
</table>

The results of the three trials shown that the effectiveness index of the Self-instructional computer assisted program (SICAP) on Biotechnology & Biodiversity of the field group trial was 82.90 after the individual trial and the small group trial.
**Objective No.4:** To test the effectiveness of Self-instructional computer–assisted program (SICAP).

**Table 5.5:** The students’ achievement of pre-test and post-test taught through traditional method.

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>mean</th>
<th>Std.Deviation</th>
<th>Std.Error mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>50</td>
<td>10.36</td>
<td>1.882</td>
<td>0.266</td>
<td>31.32</td>
</tr>
<tr>
<td>Post-test</td>
<td>50</td>
<td>21.70</td>
<td>1.374</td>
<td>0.194</td>
<td></td>
</tr>
</tbody>
</table>

$df= 49 , p <0.05$

**Table 5.6:** Pre-test of the students’ achievement taught through SICAP and traditional method.

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>mean</th>
<th>Std.Deviation</th>
<th>Std.Error mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>50</td>
<td>10.10</td>
<td>2.426</td>
<td>0.347</td>
<td>0.599</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>10.36</td>
<td>1.882</td>
<td>0.266</td>
<td></td>
</tr>
</tbody>
</table>

$df= 98 , p <0.05$
Table 5.7: Post-test of the students’ achievement taught through SICAP and traditional method

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>mean</th>
<th>Std.Deviation</th>
<th>Std.Error mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>50</td>
<td>24.54</td>
<td>2.252</td>
<td>0.318</td>
<td>7.613</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>21.70</td>
<td>1.374</td>
<td>0.194</td>
<td></td>
</tr>
</tbody>
</table>

df= 98, p < 0.05

Table 5.8: The students’ achievement of pre-test and post-test taught through SICAP.

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>mean</th>
<th>Std.Deviation</th>
<th>Std.Error mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>50</td>
<td>10.10</td>
<td>2.452</td>
<td>0.347</td>
<td>39.81</td>
</tr>
<tr>
<td>Post-test</td>
<td>50</td>
<td>24.54</td>
<td>2.252</td>
<td>0.318</td>
<td></td>
</tr>
</tbody>
</table>

df= 49, p < 0.05

1. The results in Table 5.5 shown that the student traditional method has made a significant improvement in the students’ achievement.

2. The results in Table 5.6 shown that indicates of the students’ basis knowledge of the concepts science on Biotechnology and Biodiversity between the two groups before treatment.

3. The result in Table 5.7 shown that mean scores of post-test of experimental group is greater than the control group. The $t$-value between two means is found to be 7.613 which are significant at .05 level. Thus, there is a significant difference between experimental group and control.
group post-test of the students’ achievement scores taught through SICAP and traditional method.

4. The results in Table 5.8 shown that the student treated with SICAP has made a significant improvement in the students’ achievement.

5.4.15. Conclusions of the study

Objective No 1; To find out the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX and,

Objective No 2; To analyze the higher level concepts from Biotechnology and Biodiversity topics from science for grade IX

These are based on the responses to the questionnaires and the personal interviews by fifty-two science teachers and three hundred forty-five grade IX students from English medium secondary schools in Thailand. Both the teachers and students have positively responded to the use of new instructional tool of self-instructional computer assisted program (SICAP) is beneficial for teachers who need not tell their learners but will facilitate their learning. It is beneficial for students as they become free to choose their course and mode of learning.

Objective No.3: To develop Self-instructional computer – assisted program (SICAP) for students based on Biotechnology and Biodiversity topics of science grade IX

1. The first try-out was conducted on individual students. The mean score of pre-test was 42.23%. The mean score of post-test was 56.67%. The scores show the improvement of mean scores by 14.44%. The student’s comment; changing of topic each unit too difficult because the closing of current topic before opening the program for studying the new content.
The researcher should relate content of different unit together, so that the students may open the content without closing the program.

2. The second try-out was conducted on a small group of students. Their mean score of pre-test was 41.3%. Their mean score of post-test was 70.74%. The improvement of mean scores of 29.44% is obviously remarkable. The student’s comment; the content that are difficult and more than specification of learning and utilize time in understanding. Therefore, the researcher should modify the lesson and also the test again before testing in next step.

3. The third try-out was conducted on a large group of students. Their mean score of pre-test was 42.23%. Their mean score of post-test was 82.90%. The improvement in mean scores of 40.67% is noticed. The student’s comment; the scores obtained from doing the test may be incorrect. The researcher has modified by giving add the command to deleted scores to be zero before doing the test the next time.

The conclusion is that in three try out the improvement in performance in terms of percentage is of 14.44%, 29.44% and 40.67% which leads to conclusion that SICAP is an effective tool both for teaching and learning.

**Objective No.4:** To test the effectiveness of Self-instructional computer – assisted program (SICAP).

The conclusion is based on the improvement in the mean scores of the experimental group and the control group. The experimental group was administered self-instructional computer assisted program (SICAP). The control group was instructed through the traditional method. In the case of the experimental group the improvement from the pre-test mean score (10.10) to the
post-test mean score (24.54) is of 14.44 points. In the case of control group the improvement from the pre-test mean score (10.36) to the post-test mean score (21.70) is of 11.34 points. It is evident that there is additional improvement of 03.10 points in the performance of the experimental group. This leads to the conclusion of the study that students are enabled to learn on their own at their own pace, at their own convenience with as many repetitions, as many backward and forward movement and for practice, for exercises and for self-improvement through the computer technology assisted instructional media.

This leads to the validation of the hypothesis of the study which is the summary of the hypotheses of the present study; **Students of grade IX students who learn through self-instructional computer assisted program (SICAP) have performed significantly better than those students who learn through traditional method. The hypothesis posited is validated and therefore the null hypothesis stand rejected and research hypothesis accepted.**