CHAPTER THREE

METHODOLOGY

3.0 Introduction

The primary purpose of this study was to investigate the effect of the Biology Web-based Constructivist Learning Environment (Bio-WebClen) on learning among students of differing learning styles. The Bio-WebClen was used to facilitate learning on one topic in Biology entitled "Vitamins". The learning activities in the environment were designed with special consideration to individual learning preferences. The study was carried out to evaluate the suitability of the learning environment by examining its effect on learning and content acquisition among students of different modality preferences, namely, auditory, visual and tactile. The effect of the Bio-WebClen on student learning was assessed based on scores and frequency of students' responses in the collaborative constructivist learning environment. The study also used the pretest and posttest design to investigate the effectiveness of the Bio-WebClen in promoting content acquisition. In addition, the nature of the learning processes in the collaborative constructivist learning environment and the perception of the students towards the Bio-WebClen were also examined.

Four major methods were employed in gathering data, namely, learners' documents and records scoring; pretest and posttest scores analysis; observation and questionnaire analysis. This chapter describes the sample, instruments, research venue, pilot study, procedures and methods of analyzing data.

3.1 Sample for the Study

The sample in this study was randomly selected from eighty-four Form Four students from S.M.K. Kampung Nangka, Sibu, Sarawak. The eighty-four students were tested using the Learning Style Inventory (Appendix A). Of these, eighteen were selected based on their learning styles (auditory, visual and tactile), ethnicity and gender. Of the eighteen learners, six comprised of auditory learners, six visual learners and six tactile learners. These learners were requested to seek approval from their parents/ guardians (Appendix C) prior to participation in the online learning process which was held from 4th November 2000 to 5th November 2000. All of them attended the first meeting on 3rd November 2000 during which they were informed of their grouping. They were divided into groups of two with each group comprising students of either auditory, visual or tactile modality (see Table 3.1).

Table 3.1.

Subjects who participated in the study.

Learners' Learning Styles	Group	Group Members	Gender
Auditory	3	Norzaina	Female
		Nurhaslina	Female
	6	Ling	Female
		Hetty	Female
	7	Bryan	Male
		Waheida	Female
Visual	1	Wong	Female
		Goh	Female
	8	Jeremy	Male
		Tan	Female
	9	Chieng	Male
		Rio	Male
Tactile	2	Mohd Shalan	Male
		Khaizul	Male
	4	Umee	Female
		Khatijah	Female
	5	Siew Hing	Male
		Rickardo	Male

3.1.1 Learning Style Inventory

The learning style inventory (Appendix A) used in this study was adapted from the learning style inventory by the Honolulu Community College (Appendix B) which was made available as an online version at the following URL:

http://www.hcc.hawaii.edu/intranet/commi.../FacDevCom/guidebk/teachtip/lernstyl.htm. This learning style inventory was formulated based on the Barsch Learning Style Inventory and Haynie's Sensory Modality Checklist. The Barsch Learning Style Inventory is a commonly used instrument for determining an individual's learning style (Families first idea book: A teacher to teacher resource for adult basic educators, 1998). It is one of the three most commonly referenced learning style inventory (Butler, Card, Quellette & White, 2000). Davis, Hafsah and Sophia (1994) have translated this (Barsch) learning style inventory into Bahasa Indonesia and used it to identify the learning style of teacher students at the Institute of Teacher Training and Education, Hasanuddin University, Indonesia. The Barsch Learning Style Inventory was used to screen learning disabled adult learners for their learning styles in an effort to design curriculum to assist and motivate them (Molek, 1990). The same inventory is recommended by Steurer (1994) to be used before instructions to assist the teacher in planning instructions.

For this study, the learning style inventory adapted from the Honolulu Community College was translated into the national language to suit the needs of the students. The translated version (Appendix A) of the learning style inventory was validated by a language teacher. As in the original version, the translated version consisted of 24 items based on the Likert-type scale of 1 to 5 as below:

Often (5 points), Sometimes (3 points), and Seldom (1 point)

The 24 items were categorized into three subscales, namely auditory, visual and tactile. The students were to check each item against the three ratings: often, sometimes and seldom. The subscale that the students scored the highest indicated his/ her preferred learning style.

3.2   Instrumentation

Four types of instruments, namely, learners' documents and records, pretest and posttest, observation checklist and perception questionnaire were used to gather information to answer the research questions.

3.2.1   Learners' Documents and Records

Documented evidence from students was used to provide evidence of learning outcomes. This documented evidence was in the form of hand-written answers, *MsWord* documents and online rubrics. There was only one source of hand-written answers, two sources of *MsWord* documents and six sources of online rubrics. The online rubrics consisted of online reports, online interpretation of images, FAQs submitted online, peer evaluation of FAQs, expert-learner conversation and online quiz.

3.2.2   Pretest and Posttest

A pretest (Appendix D) was administered to the students prior to the study. The aim was to identify if students already have knowledge of the content topic under study. The students have learned about vitamins in Form Two. In Form Four, the syllabus requires them to understand vitamins in greater detail. Fourteen objective questions and one structured question were formulated in the pretest. Of the 14 objective questions, 4 questions tested students' prior knowledge and 10 questions tested the content topic to be learned using the Bio-WebClen. The structured question was used to test students on the overall content topic to be learned. For the posttest (Appendix E), 10 objective questions and one structured question were set to assess students' understanding of the topic and the

achievement of learning outcomes. Measures were taken to ensure that both tests have similar level of difficulty.

3.2.3 Perception Questionnaire

The perception questionnaire (Appendix F) was adapted from Abtar (2001) and Maor (1998). It comprised of four sections: Section A, Section B, Section C and Section D. Section A sought to obtain demographic data of the students whereas Section B aimed at exploring students' experience in relation to computer and Internet technology. Section C comprised of 34 items of Likert-type scale. Among the 34 items, 4 items sought to obtain learners' perception on web-based constructivist learning environment; 18 items on learning activities; 5 items on collaboration; 4 items on online support; and 3 items on computer technology. Section D comprised of open-ended free text questions that sought to obtain suggestions from the students regarding Bio-WebClen in terms of preferred learning environments.

3.2.4 Observation Checklist

Students' time on task and their contribution to group discussion were observed to provide evidence of the extent to which they participate in the online learning process. Learners' time on task was recorded using momentary time sampling method adapted from Carey and Sale (1997). This method involved the observer coded a student's behavior as "attentive" or "inattentive". The "attentive" behaviors were those in which students appeared to be appropriately engaged according to the intent of the teacher. A student is classified as "attentive" if he is doing what the majority of his friends are

doing. For example, he is writing when others are writing, listening when others are speaking, moving about the room when instructed to fetch materials, talking with other students when instructed to engage in a discussion. A student is considered as "inattentive" when he is inappropriately talking, moving around, distracted by objects or other students, or not attending to the book, screen, person, or object intended by the teacher. An observation checklist (Appendix G) designed by the researcher was used for the coding of the behaviors.

3.3   Venue of the Study

The study was conducted in the Training Room of Sarawak Information System Sdn. Bhd. at Taman Damai, Jalan Tun Haji Openg, Sibu, Sarawak. The setting of the room is as depicted in Figure 3.1. There were 12 units of computer with Internet connection. However, only 9 computers were used in this study, with each computer being occupied by two students. The computers being used were C1, C2, C3, C4, C5, C6, C7, C9 and C10. There was a unit of computer connected to liquid crystal displays (LCD) for the teacher.
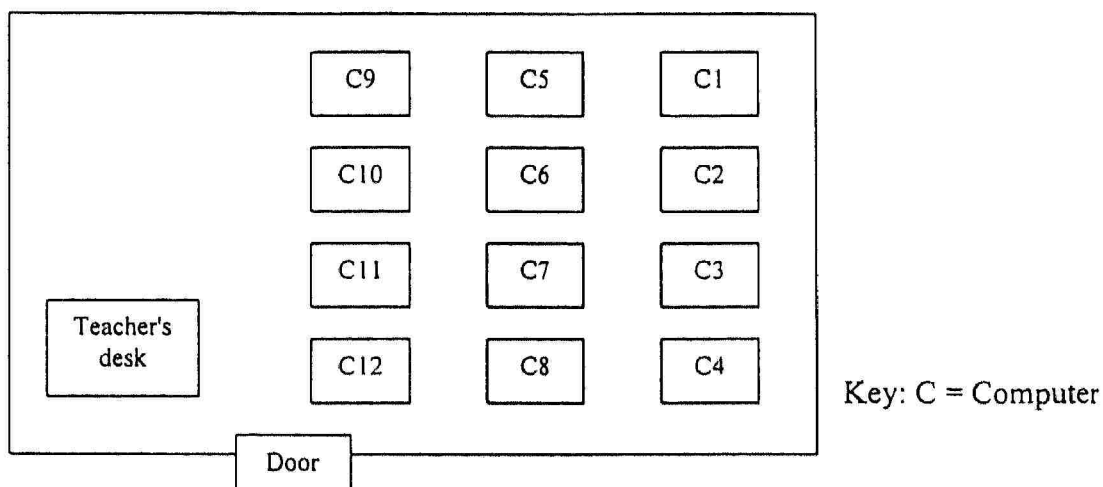
Figure 3.1. Layout of the training room at Sarawak Information System Sdn. Bhd., Sibu.

3.4 Pilot Study

The initial evaluation of Bio-WebClen by students and experts (content experts) was carried out during the pilot study. Data was generated from three sources: (a) perception questionnaire for students, (b) a questionnaire for content experts, and (c) researcher's notes.

The students' evaluation was undertaken with five Form Four students (not involved in the field study) from S.M.K. Kampung Nangka, Sibu on 26th October 2000. Each student used the Bio-WebClen and then completed the perception questionnaire. The perception questionnaire used was the same as that for the real study. The questionnaire for the content experts (two Biology teachers) were distributed on 11th October 2000. The questionnaire for the experts also comprised of Likert-type questions and open-ended free text questions. But the questionnaire for the students and experts have only an approximately 60% overlap for the Likert-style questions. This was the case because some questions are more appropriate to students than to experts.

3.5   Procedure of the Study

The study was carried out for 2 days from 4th November 2000 to 5th November 2000. Each group of students was allocated a unit of computer. Each student in turn was provided a file folder containing a conceptual map of the topic to be learned (Appendix H), learners' tasksheets (Appendix I), learners' worksheets (Appendix J) and short notes so as to carry out the learning activities in the Bio-WebClen. Printed resources such as reference books, printed materials and a dual-language dictionary were provided for references. The whole learning process comprised of three phases: pre-learning, learning and post-learning phase. The pre-learning phase and part of the learning phase was carried out on the first day; the learning phase continued on the second day after which was followed by the post-learning phase. The main activities for the two days are depicted in Table 3.2.

During the two-day learning period, the researcher - the teacher engaged a neutral observer to help in recording students' time on task using the observation checklist and observing students' interactions during learning.

Table 3.2.

Major online activities for students during the two-day Bio-WebClen session.

Day	Activities during the day
Day 1	**Pre-Learning Phase** (1 hour) • Introduction to Internet, the WWW and electronic mail. • Introducing tools for supporting searching and learning. • Administered pretest. **Learning Phase** (4 hours 30 minutes) • Completed six main activities in the "Center" of the Bio-WebClen.
Day 2	**Learning Phase** (3 hours 30 minutes) • Proceeded with supplementary learning activities in the "Media" of the Bio-WebClen. • Completed Supplementary Activity 1. • Completed experiment. • Completed posttest. **Post-Learning Phase** (30 minutes) • Completed Perception Questionnaire.

As shown in Table 3.2, the pre-learning phase occupied the first hour of the day. This phase began with a brief introduction of the Internet, the WWW, the electronic mail and the Bio-WebClen by the teacher. The pre-learning provided an opportunity to students with no experience in computer or Internet technology to get accustomed to the usage of the technology. The pretest was administered during this time to identify students' prior knowledge of vitamins.

Upon completion of the pretest, the learning phased began. The goal of learning was to achieve multiple perspectives of vitamin knowledge through activities that involved collaboration and interaction with the content. The teacher gave a brief

overview of the topic with the aid of a concept map (Appendix H). Major concepts

related to the topic were explained. This was then followed by whole class discussion

relating to the learning activities. The students then proceeded to complete the learning

tasks, with each group advancing at their own pace but they had carefully planned their

time within the time limit suggested by the teacher. The students accessed the learning

activities in the "Center" (*Pusat*) of the Bio-WebClen at the following URL:

http://mdc.um.edu.my:88/Biologi/Vitamin/lamangeo.nsf.

The students then searched for the necessary information from the related web-

sites listed in the "Link" (Appendix K). Each group was required to discuss within the

group or among groups to help them successfully complete the activities. They were

advised to use the worksheets (Appendix J) provided in the file folder to record the

information they needed prior to electronic writing. They were allowed to interact freely

with their friends or to consult their teacher when they encountered problems. The

teacher then moved from group to group to provide the necessary support. After the

students have acquired the required information, they were to use the Word Processor

(E.g. *MsWord*) and the workspaces in the web-template of the Bio-WebClen to save the

product. Throughout the online learning sessions, the students read their peers' product

and compare their peers' perspective with their own view. They were also encouraged to

evaluate rationally their peers' work. In times of doubts, they can contact an online expert

by using the online conversation tool in the web-template. After the students have

completed the main activities and the supplementary activities in the Bio-WebClen, the

teacher had a whole class discussion relating to students' work and some observed

phenomena during the learning process. Some of the products of learning were highlighted and discussed.

The students' understanding on the topic were enriched by an experiment. The experiment was carried out to determine the vitamin C content of a type of fruit. The teacher demonstrated the major steps in carrying out the experiment. The students then proceeded to complete the experiment, to record their findings and draw conclusions from the findings. This was then followed by whole class discussion to clarify findings on the experiment. After having completed all the online and off-line activities, the students were required to prepare a conceptual map depicting the concepts they have learned.

At the end of the learning session, students were required to do group reflection and individual reflection by describing their experiences in learning about vitamins in a cooperative and collaborative web-based constructivist environment. The whole online learning process ends with the students answering posttest questions and completing a perception questionnaire.

3.6 Data Analysis

Data in this study comprised of online data and off-line data. Online data was generated from *Ms Word* documents and online tasks while off-line data was derived from learners' hand-written records, pretest and posttest, observation record and perception questionnaire.

3.6.1 Online data

The online data originated from *MsWord* documents and online sources. The online sources were online reports, online description of images, student generated FAQs, peer evaluation of FAQs, expert-learner conversation and online quiz.

(i) Learners' *MsWord* Documents

There were two learning activities in the Bio-WebClen that needed students to prepare their answers in *Word* documents. The first learning activity dealt with the identification of food sources containing vitamins. As this activity required students to generate simple and precise solutions, assessment was then based on conciseness and preciseness of answers. A greater point value was given for a precise answer whereas a lesser point was given for a less precise answer. No points were given for imprecise answers. As such, the score varied from a maximum of 6 to a minimum of 0.

The second learning activity concerned the application of vitamins in daily human activities. This activity required students to describe the role of vitamins in biological systems, chemical industry and food industry. Assessment was based on the comprehensiveness of the report. Reports with precise description of applications and substantiation by examples were given a maximum score of 12. The scores varied according to the number of examples presented in the reports. Reports without substantiation was given a score of 2. No points were given when no attempt was made.

(ii)   Online Reports

The main learning activities required the students to complete three online reports. A numerical scale was developed to assess the reports. The first report was assessed based on the preciseness of the answers. Greater point value was given to answers that were precise and substantiated and fewer points for answers which were less precise and not substantiated. No points were given when no attempt at all was made. Based on the mentioned criteria, the scores varied from a maximum of 8 to a minimum of 0.

The second report was assessed based on the comprehensiveness of the report. More points were given for report that utilized scientific thought processes, vocabulary and relevant images; and lesser points for content which stayed on the subject and have fewer vocabulary and images. Similar to the first report, the scores varied from 8 to 0.

The third report was assessed based on critical viewpoints presented in the report. Like the other two reports, the scores varied from 8 to 0.

(iii)   Online Interpretation of Images

As in online reporting, a numerical scale was developed to evaluate learners' description and comments on the images. A maximum score of 4 was given for descriptions that included all relevant observable features and related information; a score of 3 for descriptions that had some relevant observable features omitted but contained related information; a score of 2 for descriptions containing irrelevant observable features but with some related information; and a minimum score of 1 for descriptions containing irrelevant observable features and unrelated information.

(iv)   Student Generated FAQs

Students' FAQs served as an indicator of the attainment of thinking skills. Students of different perceptual preferences acquire information through different senses. This is believed to influence their perceptual process and subsequently the achievement of various levels of the Bloom's Taxonomy (Casey, 1997). To examine the extent to which the activities in the Bio-WebClen promote the achievement of lower or higher level thinking skills, the FAQs generated by the learners were categorized as lower-order or higher-order level questions as suggested by Goodwin et al. (2001). Each of these categories of questions was sub-categorised as "close" or "open" to enable the teacher to determine the extent of higher or lower level thinking. These were later analyzed according to the number of higher and lower as well as close or open questions with respect to the three learning styles groups. The group that has the most higher level and open questions indicates the suitability of the Bio-WebClen for that group.

(v)   Peer Evaluation of FAQs

Peer evaluation of FAQs serves as one of the collaborative learning strategies. Peer evaluations were assessed based on whether the feedback given by students was substantiated or not. Two points were given for feedback that is substantiated while one point was given for feedback without any substantiation.

(vi)   Expert-learner Conversation

Learners' participation in collaboration with the experts was assessed based on two aspects: frequency of participation and cognitive level of the questions posted to the

experts. The group of learners who participated most frequently and posted the most

higher-order questions indicated the suitability of this activity for that group.

(vii) Online Quiz

The online quiz offers a form of self-assessment for the students. There was only

one set of online quiz consisting of ten objective type questions. Each question held a 10-

point value. The students were to answer the questions, after which they were able to

check their score on their own by clicking the "selesai" button that followed.

3.6.2 Off-line Data

There were four sources of off-line data: learners' hand-written documents, pretest

and posttest, observation record and perception questionnaire.

(i) Learners' Hand-written Documents

Learners' hand-written documents were derived from the experiment they did

after completing online learning activities. The students reported on their findings from

the experiment. Assessment on the report was based on accurate calculation and

reporting. Points were given for major steps in the calculation. Each major step shown

was awarded a point. A maximum score of 5 points was given for every major step

shown and overall accurate reporting. The score varied from 5 to 1 depending on number

of major steps shown and overall reporting. One point was given for the data presented in

the report.

(ii)   Pretest and Posttest

Scores from the pretest and posttest were computed using percentages, nonparametric Wilcoxon signed-rank test and Kruskal-Wallis test. The Wilcoxon signed-rank test was used to examine if the students achieved better in the posttest as compared to pretest while the Kruskal-Wallis test was used to determine if there is any difference in posttest scores of the auditory, visual and tactile learners.

(iii)   Observation Record

An observation checklist was used to record learners' time on task during the online learning process. Data from the observation checklist was quantitatively analyzed using percentages. In addition, learners' interactions were recorded and the observer's notes were qualitatively described.

(iv)   Perception Questionnaire

Perception questionnaire was used to understand how comfortable students were with the Bio-WebClen. The perception questionnaire was used to gather two major types of information: learners' characteristics and learners' perception on the Bio-WebClen. This questionnaire thus contributed to nine categories of data: (a) learners' characteristics and computer/ Internet experience, (b) learners' perception on web-based constructivist learning environment, (c) learners' perceptions of learning activities in the Bio-WebClen, (d) learners' perception of collaboration, (e) learners' perception of computer technology integrated in the Bio-WebClen, (f) learners' responses to the learning activities suitable for learning, (g) learners' responses to enjoyable learning activities, (h) learners'

responses to the activities they dislike, and (i) learners' suggestions on activities to be incorporated into the Bio-WebClen. This data was analyzed to obtain frequency counts and percentages.