THE DEVELOPMENT OF A COMPUTER ASSISTED INSTRUCTION PROGRAM ON WATER FOR LIFE AND HEALTH FOR SECONDARY SCHOOL STUDENTS

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF EDUCATION
(ENVIRONMENTAL EDUCATION)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2003

ISBN 974-04-4075-4

THIS RESEARCH IS FUNDED
BY THE BUDGET OF 2003
OF DEPARTMENT OF EDUCATION
BANGKOK METROPOLITANT
ADMINISTRATION

Thesis
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was submitted to the Faculty of Graduate studies, Mahidol University
for the degree of Master of Education (Environmental Education)
on
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ACKNOWLEDGMENT

This research could not be possible without generous helps from Assoc.Prof.Surasee Chingtin, my major advisor. His advice and suggestions throughout the research, is essential in preparing and carrying out this work. Assoc.Prof.Waraporn Srisupan and Asst.Prof.Kasem Kulpradit my co-adviser must also be credited for providing valuable advice through out.

I wish to express my sincere gratitude and deep appreciation to Dr.Ing. Kaseamsan Suwannarat, Ms. Napaporn Thungphubet and Mr. Fuangasak Kongareon. Their contribution as experts of content was critical in reviewing the content of CAI.

I would like to thank Mr Sompong Choosuwan ,Mr.Shusak Phiboonphiragana and Mr.Chagetha Teamphet for helping me on technical aspect of producing instruction program. I am also grateful to all staff at Watsawettachat School for the generous assistance and cooperation.

I would like to thank my friends for their support and help during the entire research. Gratitude must also be extended my mother for her encouragement, which have made the achievement of my thesis possible.

Should there be any usefulness or benefits derived from my thesis on the future, I would like to credit them to those acknowledged above.

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THE DEVELOPMENT OF A COMPUTER ASSISTED INSTRUCTION PROGRAM ON WATER FOR LIFE AND HEALTH FOR SECONDARY SCHOOL STUDENTS

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ABSTRACT

This study was an experimental research with the primary objective of developing computer assisted instruction (CAI) for secondary school students. The CAI was constructed as a tutorial, student satisfaction was evaluated, and the efficiency of the learning achievement test was determined. The development of CAI was based on three separate experiments with secondary school students of Watsawettachat School, a school under Bangkok Metropolitan Authority (BMA). The CAI was tried out with a sample group totaling 60 students. The group was divided into two sub-groups an experimental group and a control group, each with 30 students. The t-test was used to test the difference between pre-test and post-test scores of the experimental group and the control group.

1. The post-test score of the experimental group was significantly higher than the pre-test score at a level of 0.05.

2. The scores of the experimental group were significantly higher than that of the control group at a level of 0.05.

3. Student satisfaction with CAI was found to be at a high level.

It can be concluded that CAI on water for life and health is appropriate in enhancing knowledge and understanding of secondary school students on the value of water resources. In addition, it was able to reinforce awareness on the necessity of protecting water resources. Moreover, it can effectively contribute to self-learning in both informal and non-formal education system.

More researches on other forms of CAI such as games, simulations, and problem - solving activities are recommended. Attempts should be made to adapt CAI for special needs students who may have difficulty in conventional learning.

KEY WORDS: COMPUTER ASSISTED INSTRUCTION / WATER FOR LIFE AND HEALTH / SECONDARY SCHOOL STUDENTS

111 P. ISBN 974- 04 - 4075 - 4

การพัฒนาบทเรียนคอมพิวเตอร์ช่วยสอน เรื่อง น้ำเพื่อชีวิตและสุขภาพ สำหรับนักเรียนระดับชั้นมัธยมศึกษาตอนต้น (THE DEVELOPMENT OF A COMPUTER ASSISTED INSTRUCTION PROGRAM ON WATER FOR LIFE AND HEALTH FOR SECONDARY SCHOOL STUDENTS)

น้ำฝน อยู่ดี 4237457 SHED / M

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บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาบทเรียนคอมพิวเตอร์ช่วยสอน เรื่อง น้ำเพื่อชีวิตและสุขภาพ สำหรับนักเรียนชั้นมัธยมศึกษาตอนต้น โดยสร้างในลักษณะของบทเรียน และประเมินความพึงพอใจของนักเรียนก่อนที่จะนำไปทดลอง การศึกษาประกอบด้วยการพัฒนาบทเรียนคอมพิวเตอร์ช่วยสอน โดยนำไปทดลอง 3 ครั้ง กับนักเรียนมัธยมศึกษาตอนต้น โรงเรียนวัดเศวตฉัตร สังกัดกรุงเทพมหานคร หลังจากนั้นจึงทดลองกับนักเรียนกลุ่มตัวอย่าง จำนวน 60 คน แบ่งเป็นกลุ่มทดลอง 30 คน และกลุ่มควบคุม 30 คน การออกแบบการวิจัยมีการวัดผลสัมฤทธิ์ก่อนการเรียน (Pre-test) และวัดผลหลังการเรียน (Post-test)แล้วนำเปรียบเทียบกัน โดยใช้ค่าสถิติ t-test ผลการวิจัยพบว่า

1. คะแนนผลสัมฤทธิ์หลังการเรียนบทเรียนคอมพิวเตอร์ช่วยสอนของกลุ่มทดลองสูงกว่าคะแนนก่อนการเรียน อย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05

2. คะแนนผลสัมฤทธิ์หลังการเรียนบทเรียนคอมพิวเตอร์ช่วยสอนของกลุ่มทดลองสูงกว่าคะแนนหลังการทดลองของกลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ 0.05

3. ความพึงพอใจของนักเรียนต่อบทเรียนคอมพิวเตอร์ช่วยสอน อยู่ในเกณฑ์พึงพอใจมาก

ดังนั้นจึงสรุปได้ว่าบทเรียนคอมพิวเตอร์ช่วยสอนที่สร้างนี้มีความเหมาะสมในการเสริมสร้างความรู้ ความเข้าใจ เรื่องน้ำเพื่อชีวิตและสุขภาพ ให้กับนักเรียนชั้นมัธยมศึกษาตอนต้น นอกจากนี้ยังพัฒนาความตระหนัก และความจำเป็นในการคุ้มครองทรัพยากรน้ำ รวมทั้งสนับสนุนการเรียนรู้ด้วยตนเองทั้งในระบบและนอกระบบอย่างมีประสิทธิภาพ

การวิจัยบทเรียนคอมพิวเตอร์ช่วยสอนควรมีในรูปแบบอื่น เช่น เกม การจำลองแบบ และการแก้ไขปัญหา รวมทั้งควรจะมีการสร้างบทเรียนสำหรับเด็กที่เรียนช้าด้วย

111 หน้า ISBN 974-04-4075-4

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CHAPTER I
INTRODUCTION

1.1 Rationale and Justification

Rapid growth of world population, scientific and technological progress and the lack of social responsibility and awareness are the major factors that contribute to exploitation of nature resources. Water is one of the most essential natural resources for all creature livings. The challenge for meeting future demand for water is of utmost critical to human survival and can only be tackled with means that ensure maximization of water usage. This problem can no longer be over look. Therefore, every sector at international, national, and local levels have now cooperated on protecting water resources, including by strengthening public recognition knowledge and understanding on the problem and encouraging appropriate public action on the issue.

A 2002 report of Department of pollution on water quality in 49 major tributaries and 4 static reservoirs on found that water quality in 40 % of the reservoir were good, while those classified as moderate, low and very low accounted for 25, 32 and 3 percents respectively. These results were derived from the survey between the month of January - October 2002, with details as presented in table 1.

From the report, the main problem of water quality are the high contamination of both fecal coliform and coliform bacteria, particularly in major cities with dense communities, and in municipalities without effective water treatment system. High level of the contamination is known to increase the risk of the diarrheas, typhoid, cholera and other disease. (Department of pollution, 2002:1-3)

Table 1. The water quality during January to October 2002

Water Quality	North	Middle	East	Northeast	South	%
Good	Bueng-Boraped, Ing, Mae-Jang, Kwan-Payoa	Kwae-Noi, Kwae-Yai, Upper Petburi, Kuibyri, Pranburi	Waeru Trad	Nhonghan, Lumchee, Lumpao, Mool, Saew, Songkram, Oon	Upper Tapi, Lungsuan, Pattani, Talenoi, Trang, Klonthepa	40
Moderate	Lee, Ping, Kuang	Upper and Middle Tha Chin, Lopburi, Pasak	Prachin, Nakorn-Nayok	Upper Pong, Chee	Chumporn, Saiburi, Pumduang	25
Low	Kok, Yom, Wang, Nan		Bang-Pakong, Rayong, Pungrad, Prasae, Chantaburi	Lower Pong, Upper Lumtakong	Pakpanung, Lower Tapee, Thaleluang, Thalesab-Songkha	32
Very Low		Lower Chao Phraya, Lower Tha Chin				3

A report by The Harbor Department in 2001 identified Lower Tha Chin River and Lower Chao Phraya River as tributaries with the lowest water quality. Average dissolve oxygen in the rivers was found to be approximately 1.4 and 3.2 mg/l for

lower Tha Chin and Lower Chao Phraya River respectively. The report also classified Bang Pakong, Pasak, Rayong and Pungrad River as river with low water quality Ave. to relatively high level of BOD estimated at 2.5, 2.3, 3.7, and 3.5 mg/l respectively.

Another study by Thailand Development Research Institute (TDRI) found that urban areas contribute about 75 percents of wastewater the directly discharged into sections of Chao Phraya River and its tributaries in Bangkok jurisdiction. Of this, 54 percents derived from daily household activities. Such pattern can be found in other areas especially in major cities through out the country. Therefore, primary treatment wastewater in each household could play important role in mitigating water pollution.(Department of Environmental Quality Promotion, 1998: 9).

The change of water quality at sources appeared obviously such as the river mouth area or the river nearby the fresh market, or community located close to river. The color of rivers would be different turbid water with green color, dark brown, or back. A research by Department of health (2000:3) found that many natural reservoirs had become catchments of human waste for several years. The contaminator has exceeded capacity of the reservoirs in maintaining. Their balance and resulted in water pollution are impacting human, plants, and animals alike.

The impact of water to quality of life and the environment. (Office of Public Prosecution and Environment, 1998: 14-15).

1. Causing undesirable colors, odor, and taste, as well as making water harmful for consumption, and unusable for cultivation.
2. Decreasing oxygen concentration to the level that survival of aquatic plants and animals is no longer possible.
3. Increasing amount of toxicant in aquatic animals, making them unsafe to eat.
4. Posing direct threat to public health by accommodating spread of serious disease the like of dysentery, diarrhea, cholera, and typhoid.

5. Reducing quality of the raw water for waterworks service, increasing the cost and price of such service.
6. Creating unpleasant environment with bad odor, threat from serious disease and removal of natural scenery and public recreation areas.

To prevent the impacts, everyone must be aware of the need to ensure adequate quality of natural reservoirs. Promoting such awareness is especially effective in early stage of life, including in formal and non-formal education system. However learning about "Water for Life and Health" would required introduction of environment education. Because it is process to give knowledge systemically. Particularly the technological education is also employed for give knowledge to every person of every level.(Kasem Chankaew, 1993:71)

In this study, the researcher had selected formal system due to need for systematic evaluation of out come (Cited in Malinee Jutharop, 1994: 116). Secondary school students aged between 13-15 years old were uses as target group because the children of the age are known to possess abstract thought, child is able to abstract thought, capable of rational thinking. Content of the latest basic curriculum for the group was also found to be appropriate for the topic of the study.

Conventional educational achievement requires introduction the teaching media such as slide, tape, still picture, movie, and video. Learner knows these as one - way communication because they do not allow prompt response. Computers have been extensively introduced to education, business, scientific, and technological development for some time and some educators have a acquired. Such tool as learning aid or computer assisted instruction (CAI). Wuticha Prasansouy, (2000:1) described CAI as an instructed media influenced by the concept of behaviorists where teaching with prior objective is believed to be most appropriateness to each learner by presenting knowledge in sequence of sub-units. This would enable continuation in gaining experience and achieving expectation, leading to self-learning.

CAI can be introduced as a tool for delivering knowledge on complex issues, such as the environment to students. Its integrates presentation with text graphic, animation, and sound effectively stimulates the interest of learners and fosters their comprehension of the issues. Interaction between learner and computer allow leaving at the pace most appropriate to individual learner and enable evaluation of learning achievement and progression automatically.

Therefore, consideration on the importance topic of “Water for Life and Health” and the advantage of CAI made the researcher to selected in creating a learning tool for secondary school students. The tool was prepared, as a tutorial comprised with frame of content followed by the frame of question. Providing right answer congratulated with positive feedback and removed with progress to next learning frame. Providing wrong answer open a revision frame with more detail information and new questions which must be answered correctly before proceed to the next frame. The researcher is hopeful that the CAI would become a viable opinion in learning about this problem, particularly by school where it can be integrated into regular teaching.

1.2 Research Objectives

1.2.1 To construct and develop CAI lesson on the topic of “Water for Life and Health” for secondary school level.

1.2.2. To study the learning achievement of the students after learning the constructed CAI lesson on the topic of “Water for Life and Health”.

1.2.3 To study the student satisfaction the constructed CAI lesson on the topic of “Water for Life and Health”.

1.3 Research Questions

What does the secondary student achieve after learning the constructed CAI lesson on the topic of “Water for Life and Health”? And Is the lesson effective for teaching?

1.4 Research Hypothesis

The uses of CAI lesson on the topic of “Water for Life and Health” significant increases the secondary school knowledge at of 0.05.

1.5 Research Scope

1.5.1 The CAI lesson on the topic of “Water for Life and Health” covers content that is relevant to in the group of content and learning standard in the range of 1-3 secondary school levels, which is relevant to topic of “Water for Life and Health”.

1.5.2 A sample group of secondary school students (grade 9) in a school under BMA with computer.

1.6 Definitions

1.6.1 **CAI** meant Computer Assisted Instruction on the topic of “Water for Life and Health” that depend by the researcher as tutorial with Authorware version 6 to present content exercise and feedback of learner and to enable computer to be used as media for self-learning.

1.6.2 **Learning Achievement** meant to measurement of knowledge of student by using the difference of mean scores between pre-test and post-test scores of learning with CAI lesson on the topic of “Water for Life and Health”. Measurement

was carried out based on behavioral objective statistically significant between the post-test scores and pre-test score was set at 0.05.

1.6.3 **Satisfaction of student** meant the satisfaction of student after learning with CAI lesson by evaluating the satisfaction on content and feature of learning lesson.

1.6.4 **Secondary School Students** meant the sample group consisting of 60 secondary school students at level 3 (grade 9) from Watsawetachat School, Klongsan District, Bangkok Metropolis.

1.7 Expected Output

1.7.1 CAI lesson on the topic of "Water for Life and Health" as quality teaching-learning media appropriate for curriculum B.E. 2544 in the group of content and learning standard in the range of secondary school levels.

1.7.2 The students who learnt the CAI lesson on the topic of "Water for Life and Health" had better knowledge and practical understanding on this issue.

1.7.3 The constructed CAI lesson can be applied for both formal education and informal education systems.

CHAPTER II
LITERATURE REVIEWS

In this study, the researcher conducted literature review of the academic documents and researches related to construction of CAI related to the topic of "Water for Life and Health" The review consisted of the following topics.

1. Problem about Water and Health
2. Principles and Concepts of Water Quality Management
3. Teaching-Learning on the topic of "Water for Life and Health" in the range of 1-3 secondary school levels.
4. Teaching Media
5. CAI
6. Other related researches

2.1 Problem about Water and Health

Water is an essential natural resource for all living creatures because it is the major component of body of plants, and animal. Besides for human being the fresh water is important daily activities. Metropolitan Waterworks Authority (2000:25) presented about information of water that it is important for human life because life needs the clean and clear water for drinking Particularly, for human being, there is 70 % of water by weight so it is the major composition of body. It is basic need for all living things, especially, human body lacks of water for 2-3 days. It causes dehydration that may cause fatality. Even though water has no food substance for energy generated but it plays for dissolving and carrying the substances and oxygen to the whole part of body in order to control the body temperature and to bring the excretion to expel from the body through the sweat and urine. In addition it functions as lubricant of joints and as medium for biochemical reaction in the body.

Moreover, there is utility in other aspects such as industry, agriculture, transportation, communication, tourism, and recreation for instance. Water is a valuable resource for social maintenance with various benefits. On the other hand it might be harmful for human health because it may be carrier of different diseases due to the contamination of toxic substances and germs, it will cause the dysenteric infection like as diarrhea, typhoid or toxic substance contamination. The mercury contamination will cause the Minamata disease, and cadmium will cause Itai-Itai disease. Nevertheless, before the water is used it must regard to quantity and quality.

2.1.1 Human and Water Utilization

From the water demand of community utilization was studied by Sumrit Thongsri (1999: 42-47). It was presented the water demand by classifying according to the type of utilization as follows:

1. Daily utilization is the water is used in daily life activities for drinking and other consumption. The consumption of community uses for general purpose that are drinking, bathing, watching, pouring plants, and expelling the dirty. The survey results were found that the majority of water was used for bathing and toileting up to 60 %. Besides it is used for other different activities. The rate of water consumption is changed and varied according to their living features and occupations. It is obviously seen that the rural people who have agricultural occupation will use the pipe water for consumption about 50 liters/person/day. It is not much because most of them use water from the natural sources directly for bathing and other activities mostly. It differs from the people who live in high density population in urban community in the big cities, the rate of consumption will be about 200 liters/person/day because they have no direct natural water sources like as the rural area.

2. Industrial utilization, it is used in the production process in the all types of industrial factories since it needs the water for certain activity such as use as raw material for production, for cleaning, cooling, and thermal discharge for instance. Usually, the quantity of water consumption for industry will be in rather high range, even though there are differences in accordance with the type of factory and size of

production power. Nevertheless, it is surface water or ground water, it must be appropriate to the type of industry and it must have enough amount such as industry of beer production. It needs the water without odor, taste, iron and manganese. Drug and cosmetic industry must also use the pure water as well. From the study also reported that water uses in the industry, 67% water is used for thermal discharge and condensation, and 28% is used directly for production as raw material or contact with raw material. Only 5% is used for boiling, watching and others. At each industrial factory, there is different process of regulation consistent with the characteristics of type of plant. The amount of water use of each type of each factory will be different as presented in table 2.

Table 2. Rate of Water Utilization of Different Type of Industrial Factory

Type of Industrial Factory	**Raw Material or Products**	**Amount of Water Utilization** (million cubic meter/ 1 ton product)
Brewery Factory	Malt	20-30
Canned Fish Factory	Fish	20
Slaughter Factory	Cow, Pig	5-15
Leather Bleaching Factory	Leather	20-140
Paper Fiber Factory	Paper fiber	250-800
Still Production Factory	Iron	300
Milk Package Factory	Milk	60-80
Whisky Factory	Whisky	250-800

Water sources for industry are the main rivers, natural stream and reservoir, irrigated canal, and ground water. Most of the industries in Thailand use the surface water as raw material for production when it is compared to other sources. It is obviously seen that at the sites of main river, natural stream and reservoir and sea shore, it is the location of various industries. The ground water has been excavated mainly. Bangkok area has been done the most, subsequences are Samutprakarn Province, Nonthaburi Province, and Pranakornsri- Ayutthaya Province. The pipe water is not popular to use due to the high cost when it is compared to natural ground water and surface water.

3. Agricultural utilization, the water sources in Thailand are rain water, natural sources, surface water, irrigated water kept in dam, and reservoir, including the ground water is developed for royal rain production, which helps decrease the problem of lacking of water for cultivation during arid season. In consequence of agricultural technology use for increasing productions in the agricultural area caused them to cultivate for the whole year, it implied that there is water utilization increasingly. Detail illustrated in table 3.

Table 3. Water Utilization for Agricultural Activities in Thailand

Purposes of Water Utilization	**Area** (million rais)	**Amount of Water** (million cubic meter/ year)
Agricultural occupation area	148.8	-
Rainy season has irrigated area 18%		
Arid season cultivate the repeated	26.5	44,000
farm corps in the irrigated area	4.4	2,400

4. Water Utilization For Electricity Production, In Thailand water has been used as Electricity Production for water power upper of the 4,400 million kilowatt. Hour (million unit) as 9 percent of total production. It produced from 15 important dams and about 15 percent of natural water or 30,288 million cubic meters. However, the water as been sued for electricity production, it is able to use for other advantages such as irrigation, and industry.

5. Water utilization for pushing out the sea water and wastewater, the amount was used for pushing out the sea water and wastewater was very important since this amount of water help increase the amount of water in the river, and canal to be more diluted of toxic substance concentration and assist for increasing the power of driving the sea water intruded at the mouth of river, and pushing the wastewater out to to the sea faster. Department of Irrigation has allocated the water about 50,000 million cubic meter annually. For instance, water was allocated from Bhumiphol Dam, and Sirikit Dam for pushing the water in Chao Phraya River and Tha Chin River, water

from Vachiralongkorn Dam was used for pushing out water in Mae-Klong River, water from Pattanee Dam was used for pushing out water in Pattanee River etc.

6. Recreation Utilization, at present the water demand is employed for recreation and relaxation are more important whether it is sea shore, river bank, natural stream, swamp, lake, and cascade. They are all the recreation sites for relaxation of daily burdens splendidly

7. Communication and transportation utilization through river, canal, sea, and ocean are the necessary communication channels due to the connections of different part in the world. From past to present, it remains the important way for communication and transportation all over the world whether it is near or far. Moreover, it is able to transport the giant product with high weight, and with large amount of products, including its price is cheaper.

It can be concluded that water utilization, besides it needs to regard to its quantity and quality, and it must regard to water demand, and the readiness of water resource allocation to accomplish the maximized benefit for everyone as well.

2.1.2 Water Borne Disease

Water can be carrier of diseases by classifying according to the contaminated substances in water to cause the diseases as follows:

Bacteria caused the person who infected to be sick such as bacteria caused cholera, typhoid, dysentery, and diarrhea. This organism will be contaminated to human excretion as feces and it was drained to water sources so it will contaminate to drinking and utilized water.

Virus caused the person who infected to be ill such as hepatitis and polio. These virus will contaminate with the dirty thing such as wastewater, excretion from human body. The important cause of disease is due to drinking of contaminated water.

Parasite worm such as Schistosoma caused the Schistosomiasis, the epidemic is due to the dissemination of egg of this parasite grow to be larva in water, and the larva will penetrate through the skin to blood circulation to cause this disease.

Protozoa caused the unfenced person to be amoebic dysentery. This organism will be contaminated to the feces of sick people and it is spreading to ground or water.

Chemical substances, at present it was found that there is some kind of chemical substances will cause the harmful effect if it accumulates in the body for certain amount. It may be in form of mineral or compound substances that dissolved into the drinking water, and utilized water. According to the law of water pollution control of Thailand mentioned the substances that caused the danger to health as follows:

- Cadmium is distributed due to the plating of metal with battery electricity. It has the same color as copper, and zinc. The important impact is malfunction of kidney, and losing the calcium equilibrium, and bone degenerated.
- Cyanide is spread due to the plating of metal with electricity, oven, charcoal (gas from iron melting), chemical products, it will impact to human health because the toxic substance is respired into the body and it catches with the hemoglobin in red blood cell that obstructed the oxygen carrying so the body will lack of oxygen.
- Organic chlorine has origin of distribution from insecticides in the Organochlorine group. The important impact is toxic to nervous system.
- Lead has important origin of distribution are battery, lead, color bead, color, coated container, printing, lead brazing, and electrical metal plating. It impacted to health is anemia, and abnormal body.
- Cadmium with six valency, has important origin of distribution are electrical metal plating, and chemical products. The important impact to health is skin wound, digestive tract, destruction of nasal wall.
- Arsenic substance has important origin of distribution are chemical products, and mine. The impact to health is skin pigment, digestive tract, malfunction of liver, and skin cancer.

2.1.3 Harm from Substance Caused Water Pollution

The important substances caused pollution to impact to human health, life Cycle of aquatic plants and animal were as follows:

Microorganism is occurred from waste excretion such as feces, and urine, including other organisms contaminated in the water. It is a cause of wastewater occurrence, and microorganism spreading. The amount of microorganism is determined by the number of coliform bacteria. Aquatic microorganism caused the cholera, dysentery, and diarrhea.

Organic substance is excretion, garbage of food and starch from the production of noodle. The organic substance is decomposed by microorganism. It must use the oxygen in this process because it consumed the oxygen dissolved in water. Therefore, the plants and animal is impacted due to the amount of decreased amount of oxygen. Besides, there is microorganism that does not use the oxygen for fermentation of organic substance in water. It will cause the bad smell, and it is nor proper for drinking and utilization.

Inorganic substances cause water pollution. The importance are nitrogen, and phosphate.

- Nitrogen, it is substance that has nitrogen as component. It can be found in the nature or it occurred from decomposition of organic compound by bacteria. The impact is obviously seen is the child who consumed the high concentration of nitrogen in water, he will lack of oxygen, blue skin and may be died.
- Phosphate, it is phosphorus in nature, and wastewater.

Besides nitrogen, and phosphorus, it is fertilizer for some type of aquatic plants such as Java weed. The impact is the rapid growth of this weed causes the problem of water communication and increases the organic substances in the water so the amount of oxygen will decrease.

Heavy Metal and Insecticide

- Heavy Metal is the mercury and cadmium. The majority come from the industrial factory.

- Insecticide is chemical substance that eliminates insect and weed. Most of them come from agricultural sector.

The occurred impact of this pollutant is the accumulation in the body when it reaches at one level, it will show the sick symptom and it may cause fatality such as mercury caused Minamata disease, and cadmium caused Itai-Itai disease.

2.2 Principles and Concepts of Water Quality Management

The problem involved to water is the lack of it, flooding, lack of quality, so it must be treated before it will be used in order to be appropriate to demand and utilization. Additionally, it needs the cooperation of every sector for maintenance of the water source to recover according to the natural state.

2.2.1 Type of Water Source and Process of Water Treatment

Type of Water Source: The fresh water in the nature is used for drinking, and utilizing is divided into 3 types as follows:

1. Rain Water is the clean natural water if it must pass through the dirty thing such as dust, gas, and germ that suspend in the air. It must pass via the roof of building or different constructions, so it may make the rain water to be dirty. Therefore it needs to let it rain for a while until it is sure that roof or rain trough is clean enough.

2. Surface Water has the rain water as source to flow to swamp, marsh, canal, river, and sea. It is popular to be used for pipe water production by passing the process of water treatment and germ killed, but some place has germ and dirty thing contaminated such as solid waste, remains of plants and animal so it is not proper for drinking.

3. Ground Water is occurred by rain water, snow, or surface water in different parts flow through different layer of soil, and sand of surface soil to restore in the channel of rock that has pores. The ground water is cleaner than surface water but it may high hard or has the contaminated mineral harm to health.

Process of Water Treatment for Consumption

Before water is used in the households, it must be made it clean firstly. Boonsom Martin et al, proposed the method of cleaning water as follows:

- Boiling is a simple, convenient, economize and the most safe method because the germ will be destroyed entirely. It needs to let the water boil for 5 minute at least.
- Sieving is the method that let the water to flow through different layers of materials are fine sand, coarse sand, charcoal, fine pebble, coarse pebble, and broken brick for instance. The soil or dust and germ that suspended in water will be filtrated by these substances. The water will be clean and clear but it may have the germ contaminate so before it is drunk, it should prior be boiled
- Distill is method to clean water and it take the high expenditure, but it can be counted as the most purity. The principle is to boil it until it became water vapor, and let it passes through the cold tube the water vapor will become drop of water. It takes high expenditure. Therefore it is not popular to be used for drinking or cooking but it is used in the medical field for mixing with the injection drug or eating drug or in some industrial work.
- Sedimentation is the easy and popular mean by using alum for stirring in the containers and let half an hour. The dirt will coagulate to small piece, and it coagulates to accumulate at the bottom of container. The water will be clear at the upper but clear water is not clean and safe for drinking or cooking because it is still have germ or different minerals. Therefore it must be boiled before it will be used for 5 minutes boiling.
- Chemical substance use: to put some chemical substance into water to kill the germ. The chemical substance is employed as follows:

(1) Chlorine is appropriate for making the large amount of water and the water is clean chlorine powder with the or liquid. After water is put by chlorine. If there is smell of chlorine. It would be accepted. Let it for 30 minutes before use.

(2) Potassium alum (Potassium permanganate) is proper for cleaning the small amount of water or eliminate germ contacted with vegetable, fruit or washing wound by dissolving in water until become pink color is proper to use.

(3) Iodine Tincture, Iodine Tincture 7% concentration or 2% concentration 4-6 drops per 1 liter of water and let for 20-30 minutes, all germ will be eradicated. It can be drunk or cooked.

2.2.2 Process of Pipe Water Production

The example of process of pipe water production at Mahasawat water production Factory at first stage, and second stage had steps as follows:

1. The raw water is brought from the water sources to factory, at first stage, it is the surface water from Thajeen River at Bang-Lane District, Nakormprathom Province and it is drawn to the water production factory at the west bank. The distance is 35 kilometers by passing through Sainoi District, Bangbuathong District, Bangyai District, and Bang-Kuey District. Preliminary stage the factory will draw raw water about 400,000 cubic meter/ day into the pipe water canal, and it is increased to 800,000cubic meter/ day in further stage (second stage). There is arranging for additional raw water from Mae-Klong basin by digging the canal with 72 kilometers for raw water transport from upper of Vachiralongkorn Dam, Chanjanaburi Province to join to the previous canal at Thajeen River, Bang-Lane District, Nakormprathom Province.

2. Adding the amount of oxygen and chemical substances, the composition of this stage is to add the oxygen through contacting tower. The feature of contacting tower was designed to be similar to cascade by letting the water flow from the height in order to disperse and then it will flow to down like as ladder pattern.

The different chemical substances would be added with rate to be proper to the quality of raw water in each season. The added chemical substances are as follows:

- Alum is used for accelerate the coagulation of suspended substances
- Lime is used for adjusting the acid-base state, and hardness of water.
- Copper is used for control the growth of algae.
- Chlorine is used to kill germ, and treat ammonia that might contaminate in water and prevent the growth of algae.
- Gummunt Carbon is used for eliminating odor and color, and controlling the taste of water.
- Potassium alum is used for decreasing the amount of manganese dissolved in the raw water.
- Substance is used for helping of sedimentation in the step of stirring in order to accelerate for faster sedimentation.

1. Sedimentation, filtration, and control for acid-base state. The components of this stage are to add the chemical substances into the raw water. The sediment in raw water will react with the added chemical substance and it will become turbid. So it needs to pass the sedimentation process and filtration in order to make it clear. Then it is controlled for acid-base state.

2. Pumping for allocation of pipe water, After the pipe water is treated by the aforementioned process and pass the water quality examination. The clear water will be kept in the tank and it is ready to enter to pipe water system for distribution in order to go to the plant for pumping and distributing to household.

2.2.3 Wastewater and wastewater from Different Sources

"Wastewater" according to Act of National Environmental Conservation and Promotion meant the waste that is in the liquid state, and pollutant mixed or contaminated in that liquid.

Ratree Para (2000:209) gave the meaning of water pollution meant water that degraded or its quality deteriorated or its characteristic changed due to the contaminant caused the damage for utilization.

From the meaning mentioned above, it was found that the wastewater is the degraded quality water or changed characteristics from prior quality by having the

liquid state contained pollutant or contaminant, so it could not be used efficiently. From the handbook for prevention of wastewater of Department of Environmental Quality Promotion (1997: 6-7) explained that there are various causes of wastewater occurrences but all causes are arisen from the human activities. Wastewater had different sources as follows:

1. Community wastewater is the wastewater that is drained from households, hotel, food shop, hospital, and fresh food market for instance. It occurred due to water utilization for different activities and then it was drained to natural water sources. Generally, it can recover by natural process but the drainage water are composed of various dirty substances such organic and inorganic substances both solid and liquid state. Besides, it may contaminate with microorganism, parasite together. The wastewater is drained from residence both condominium or hotel, the majority is the wastewater from toilet, cooking. Most of wastewater come from food shop is numerous type of organic substances, and lipid. The wastewater from hospital is contaminated with the germ due to the excretion of patients and the laundry for patient for instance.

2. Industrial wastewater is water that is drained from different processes of industrial factory such as from washing, and cooling process. The factory may have different quality and type of contaminated substances such as

- Agricultural Industry such as factory for transformation of agricultural product, factory food for human being, and animal. This type of wastewater contained high amount of organic substances so it is dirtier when it is disposed to water sources and it causes decreasingly amount of oxygen in the water. Moreover some factory in the drainage had contamination of microorganism.

- Minerals or metals industry such as metal production or alloy production or metal transformation or metal melting, even through these types of factories, have few wastewater, but it contained a large amount of toxic substance of heavy metal contaminated.

- Chemical industry such as chemical substance production, fertilizer production, paper production, rubber production, and color production for instance. The wastewater from these type of factories have high density of dirt. Some has high

acid-base state, and it might have toxic substance mixed with drainage, or some might change the color, taste, or odor of water.

- Machine industry, and electrical instrument such as machine production factory, and electronic factory for instance. Most of wastewater from these type of factories is employed for washing so it contaminated with heavy metal and oil mixed.

3. Agricultural wastewater, agriculture is the main occupation of major population of country. At present, the modern technology is introduced for assisting the product increment, and it will be increased gradually. Therefore, the amount of wastewater will increase as well. It is drained from the agricultural area with mixing of numerous substances, including being the causes of water source degradation. Th major source of agricultural wastewater are as follows:

- Wastewater from cultivation comes from the used water of the cultivated areas. It composed of the extra-used fertilizer, so it affects to the rapid growth of aquatic plants such as algae, and Java weed. Moreover, the high concentration of excess of chemical substance use as insecticide will cause the fatality of aquatic animals additionally. Wastewater from cultivation and livestock activities, particularly, pig farm, it will compose of excretion, food garbage, and water used for farm washing will have high dirt of both quality and quantity.
- Wastewater from cultivation of aquatic animal, the majority will have area of cultivation nearby the water sources such canal, river, and sea. It is the fast return of benefit so it is popular occupation but the drained water contaminate with the different types of high amount of organic compound. It is occurred by food used for aquatic animal cultivation so the concentration of excretion makes the increasing amount of Oxygen concentration.

2.2.4 Water Source Maintenance for Drinking and Consumption.

The natural source of water is polluted by microorganism, organic compound, inorganic compound, toxic substance, and radioactive substance in the drained wastewater. These substances has different origins such as household of community, industry, agriculture, and hospital. Previously, the population was not high density like as present so the natural water sources can recover themselves by natural

process. Currently, the rapid growth of population cause the problem because the natural water sources can not recover themselves. These are the essential factors of the accumulation of wastewater problem. Particularly, the river has passed through the crowded community and growth of industrial production increasingly, it polluted tremendously due to daily activities of community people and the high density of industrial factories so it needs to maintain the water source in order to decrease the wastewater drainage.

2.2.5 Wastewater Treatment System for Household

Study was done on the practice manual of environmental leader, environmental volunteer of Department of Environmental Quality Promotion (Department of Environmental Quality Promotion, 1998: 108-113), it was found that there are numerous types that are appropriate for wastewater from household. There are available for selection as follows:

Trap Pond

It is a primary treatment that has the principle of treatment as sedimentation by separation the solid from liquid. A part of sediment is decomposed, and another part will float as thin film on the water surface, when the accumulation of sediment and film are highest. Its capability should have the size to keep wastewater not lest than 24 hours. The wastewater came from toilet and kitchen would be kept in the trap pond. The percolation system would help the wastewater in trap pond was diluted and make it work effectively in term of decrease the organic compound concentration (BOD) about 26-65 percents of suspended substance, and 40-80 of fat.

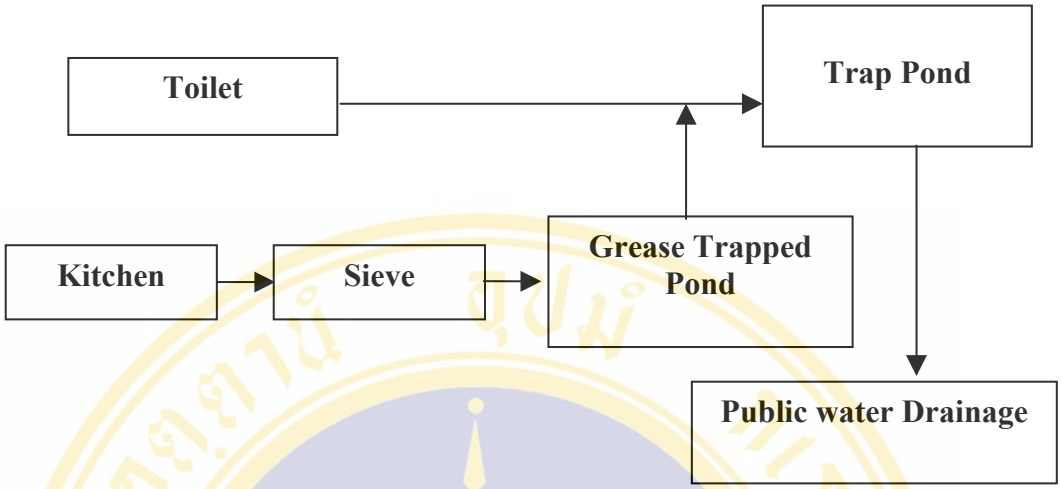


Chart 1 Principle of Work of Trap Pond

Anaerobic Filter Tank

It is the biological treatment process without air in the tank contained the filter media such as pebble, plastic, polyvinyl chloride (PVC), and nylon for instance. It has pore at the surface about 45 percents of the filter tank is able to keep wastewater at least 72 hours. To wash the clogged filter can be done by pumping the sediment from trap pond entirely. Then the cover of the filer tank would be opened and water was used for back washing. It should be done every 3-5 years. The anaerobic filter would work effectively if the wastewater had passed the some treatment system such as passing the trap pond. It is able to eliminate the organic compound (BOD) about 70-75 percent and suspended sediment 64-72 percents.

Percolated Pond/ Percolated Groove

It is an assistant system of water treatment by using the carrying capacity of soil as receptacle so it is not proper for the area that had clay-soil mixed with dregs and loose soil mixed with clay-soil. It is popular for small family or small building that has little area for drainage.

Mixed System

It is combined by trap pond and anaerobic filter tank so it is suitable for treatment wastewater from household, and restaurant.

The trap pond and anaerobic filter tank used the principle of organic decomposition process in wastewater without air. The wastewater from toilet and kitchen from household drained to trap pond. In this pond the heavy dregs was separated from light dreg, therefore the clear water would flow to the anaerobic filter tank. The anaerobic bacteria in the media would digest the residual organic compound again. The treated water would flow out at the upper part of tank to the public water drainage. The efficiency of system is able to eliminate the dirty in term of organic compound (BOD) about 75 percents.

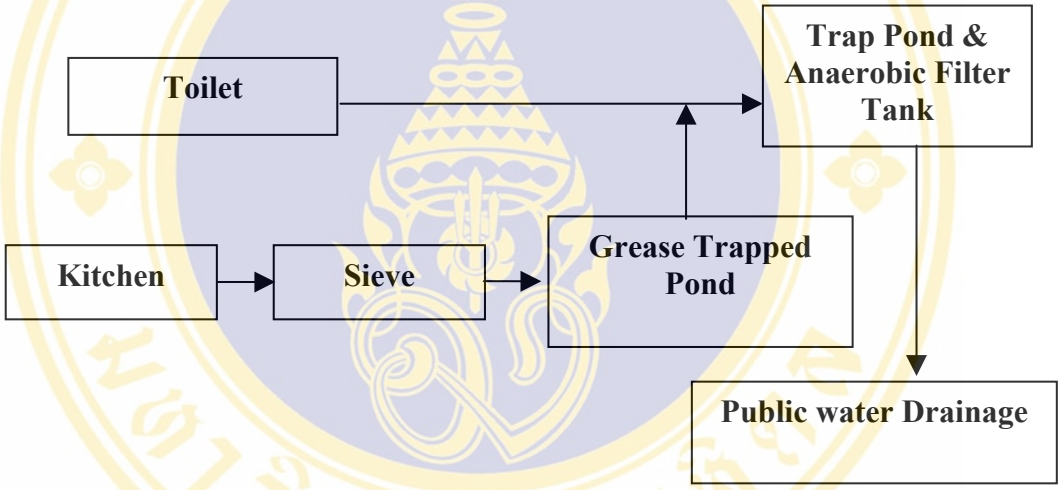


Chart 2 Principle of Work of Trap Pond and Anaerobic Filter Tank

Grease Trapped Pond

It is designed for separating fat, and oil from wastewater before draining to public water drainage. These fat and oil came from cooking or washing the kitchen wares of restaurant, household etc. The grease trapped is in form of knock down that is easy to build, or to be built by oneself. Garbage trapped pond and grease trapped pond together. The equipment for garbage trapped may be filter so it must be frequently observed since when it is accumulated a large amount of garbage the ware would be difficult to flow so it must be regularly collected.

2.2.6 Wastewater Treatment Project of Bangkok Metropolis

The prevention of impact of wastewater towards environment needs to treat wastewater before draining to natural water sources. The case study of Bangkok Metropolis, it is the implemented for wastewater problem solving continuously by Office Water Drainage (1999: 21-25). It was found that Bangkok Metropolis office has implemented incessantly. The office had implemented since 1978, and it would be developed to practice for wastewater problem solving. The projects of His Majesty Initiation of the Wastewater Treatment was implemented in order to alleviate the crisis of wastewater in Samsaen canal, Sansaeb canal, and Ladprao canal were the project of improvement of Makkason swamp and the project of Wastewater Treatment Rama 9 marsh. They can solve the problem at one level. Besides, Bangkok Metropolis started to implement the small project for wastewater treatment in order to alleviate the wastewater at particular area such as On-Nuch Wastewater Treatment Plant and Bhuddhamonthon Number 2, including transferring 13 wastewater treatment plants from National Housing Authority to be under control of Bangkok Metropolis since 1990. It was able to treat about 24,700 cubic meters/ day that was came from population 128,315 persons. It was accounted for wastewater problem solving for small community properly.

There were 6 large projects of wastewater treatment according to the plan of Bangkok Metropolis, they were able to carry the wastewater about 992,000 cubic meters/ day in term of area totally.

Table 4 Information of Large Project of Wastewater Treatment

Name of Project /Plant	**Area Covered** (Square Kilometer)	**Service Area** (district)	**Size of Wastewater Treatment** (cubic meters/day)	**Location**
1. Si-Praya	2.7	Pomprabsattrupai, Sampamthawong, some part of Banghrak	30,000	Pakklong-Padungkrungkasem, Sipraya
2. Ratanakosin	4.1	Pranakorn	40,000	Ban Panthom, Bang Lampoo
3.Ding-Daeng	37	Pomprabsattrupai, Sampamthawong, Pratumwan, Rachthewee, some part of , Pranakorn, Dusit, Prayathai, Dingdaeng	350,000	Nearby Bangkok Metropolis Office 2
4. Chong-Nonthree	28.5	Bangrak, Sathorn, Yannawa, Bangkholaem	200,000	Chonnonthree canal, Rama 3 road
5. Nhongkhaem-Pasicharoen-Ratburana	5.1) 44 5.2) 42	Nhongkhaem and Pasicharoen Ratburana	157,000 65,000	5.1)Garbage disposal Nhongkhaem, 5.2) Pracha-Utid, Thungkru
6. Jatujak	33.4	Dusit, Prayathai, HuiKhang, Jatujak	150,000	Intramara Soi 35

The future plan for implementation has established the additional work plan of large scale wastewater treatment in the development plan of Bangkok Metropolis copy 6 (B.E.2545-2549). There will be further constructing 2 places that will be Kliong-Taey and Dhonburi.

At present, Si-Praya Wastewater Treatment Plant, Chong-Nonthree Wastewater Treatment Plant, Chong-Nonthree Wastewater Treatment Plant, Thungkru Wastewater Treatment Plant, Nhongkhaem Wastewater Treatment Plant finished the implementation and it has started the already working system. Bangkok Metropolis expends 220 million baht annually. Therefore the people should participate to burden the expenditure of wastewater treatment in the area that had treatment system already. In the case of household or community locates in the area outside the central wastewater treatment system, they needs to search the mean to treat the wastewater before draining to public water drainage for instance.

2.3 Teaching-Learning on the Topic of "Water for Life and Health" in the Range of 1-3 Secondary School Levels

In basic educational curriculum B.E.2544 that is the core curriculum is the frame and guideline for school to develop learners in accordance with the curriculum objectives. There are defining the content and standard of learning for 8 subject group that are learning management for content group, Thai language, mathematics, science, social studies, culture, public health and physical education, art, occupation and technology, and foreign language, and the standard of range of level such as primary level 1-3, primary level 4-6, lower secondary level1-3, and secondary level 4-6. How are the main content, standard, and standard of range of level arranged in the curriculum?, and how is it introduced for arrangement of teaching-learning activities?. How are the media and source of knowledge used? How much the time is used? It would be taught in which class and how to evaluate according to the standard and established standard of learning. It is the responsibility and decision of educational institutes.

The content in the aspect of environment and natural resources on the topic of "Water" are presented in the content group of science, and social studies about religion and culture are as follows:

The content group of science

- The second content: Life and environment
- The sixth content: The process of world changing

The example of learning content such as occurrence of rain, measurement of amount of rain, water source on the global surface and ground water source, the state of environmental problem and local nature, and sustainable natural utilization

The content group of social studies, religion, and culture

- The fifth: geography

The example of learning content such as natural resources in Thailand, local resource and environment, conservation of natural resource and environment, and environmental problem solving.

From the basic educational curriculum B.E.2544 comprise the core curriculum of nation as the frame and direction for curriculum management. It is able to use for education management for formal education, informal education, and informal education. These made the researcher to have concept to product the teaching media on the topic of "Water for Life and Health" contained content of importance of water, water cycle, natural water source, food source in water, wastewater, and characteristics of wastewater from different sources, making clean water, and wastewater treatment in order to promote the learner to be able to survey, analyze the problem, realize the value of prevention and maintenance of water source, and their health. In this study the researcher selected interactive media that is CAI because it will stimulate the interest, and create the inspiration for leaner by using the still picture, animation, and sound to sustain the attention of learners. The slow learner can learn according to his ability freely and he would not be shy the teacher or others when he gave the wrong answer. He can select to learn according to This topic content is relevant to prior experience of learner both related content and knowledge about computer use in the lower secondary school level.

2.4 Teaching Media

2.4.1 Classification of Teaching Media

Teaching-learning media are the tools that facilitate teacher's teaching to leaner. They are divergent types. To select media, it is the responsibility of teacher to select these media to proper for learning.

Edgar Dale (cited in Chaliya Limpikorn, 1997: 44-49) proposed the step of learning experience and each type of media using in the learning process. The details presented in chat 3.

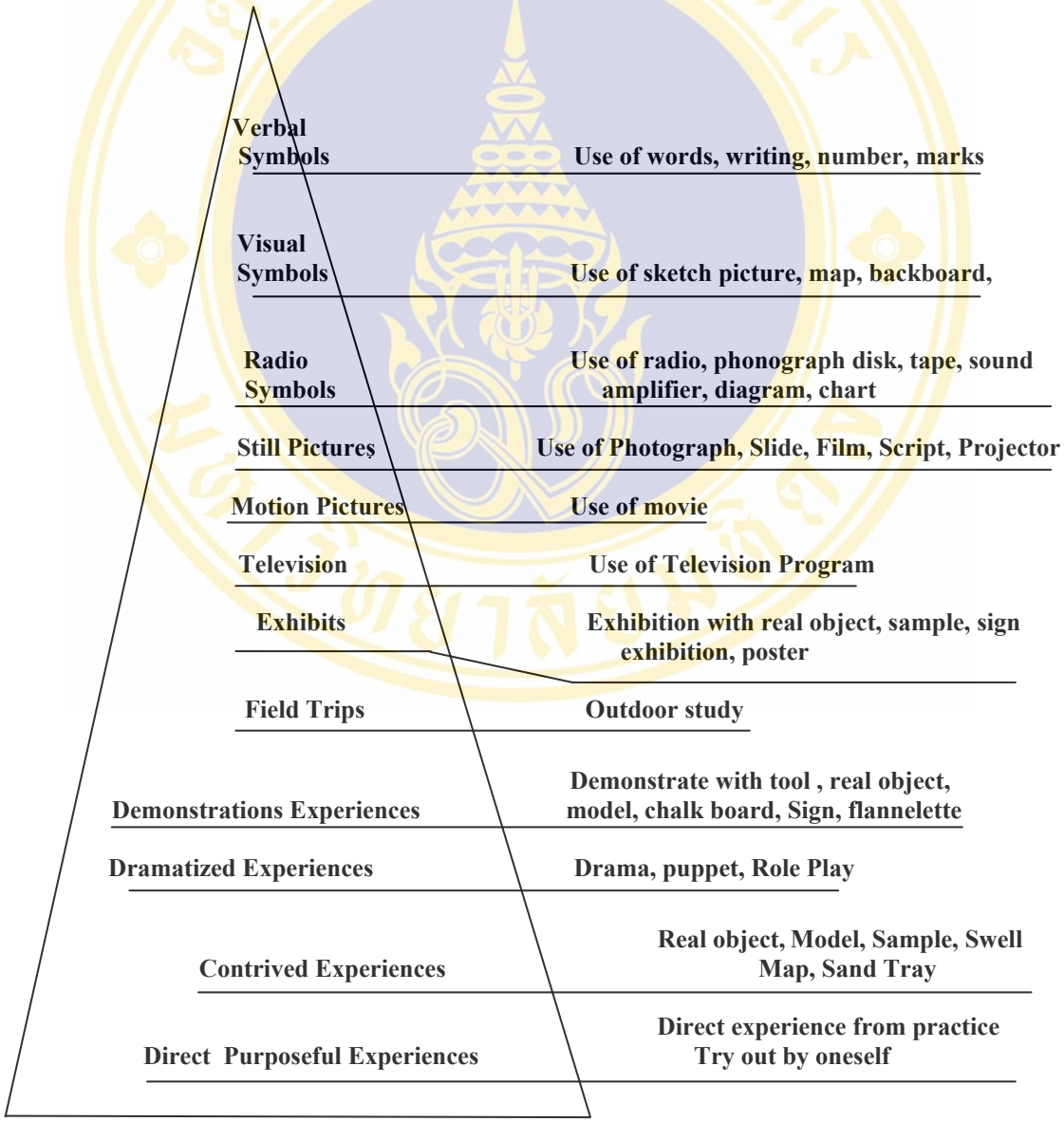


Chart 3 Experience Cone (Dale)

Meaning of Experience Cone

1. Direct Purposeful Experiences Edgar Dale can be found at the base of cone it and could be defined as self-acquisition of direct experience such as trial out in the laboratory, or work in the field. It includes experience that is obtained by doing actual work, realizing practical problems and self-discovery of solutions. This allows both training and building of skills in working and problem solving.

2. Contrived Experiences are required when direct experience can be rarely obtained, difficult to created or too dangerous. In such cases, substitutes the like of models or stimulation could be needed. This necessitates more imagination and abstract in learning.

3. Dramatized Experiences are more subjective since the construction or supposition may be diverge from the real situation such as emotion but it is compensated experience for some experience in the past or intricate to find so it was use drama, role play, dump drama, and puppet show for this type of experience.

4. Demonstrations is the experience of instructor to show or try out for leaner as example in the demonstrated practice so the learner will get experience by seeing and hearing and participating by asking or answering the question, but they had no change to practice by himself in that time. To give the experience by this mean, Edka Dale accounted that this is more subjective because the learner decreased their roles from participation to seeing, hearing, and monitoring.

5. Field-Trips means to go out to study by having the specific objective but the nature of field trip had diverse constraints that learners can not define as their full requires such as lecture of the owner, the topic is not pertinent to topic that is studied so it is only supplement. All are the limitations that caused field-trip to be subjectively.

6. Exhibitions is more subjective due to materials set to show so the learner has a change to do activity by himself. Most of them must study or interpret from the model by him so the learner must think and create understanding by himself.

7. Television and Motion Pictures, hereby it means the media in style of continual and movable picture. The experience in this class is far from the reality or direct experience since it is the experience is recorded through media is film or

through television screen, while the exhibition is able to see the real object directly. Therefore it is recorded through the medium, it would be vary from the real experience such as color, size, situation, and particularly about the dimension.

8. Still Picture, Recordings and Radio are high subjective because the learner can not see the movement or it is recorded sound and radio. The learner used only touch system is ear to be used for hearing and imagine by him that the learner may miss.

8. Visual Symbols include chart, diagram, plan, statistics, cartoon and other drawing. These drawings communicate with line, cartoon and descriptions and therefore are abstract in nature. Interpretation skill of learners is required.

10. Verbal Symbols consist of speaking language, writing language, digit, and Other symbols. Absences of intermedia medium to this symbol necessitate the need for high level at imagination and literature skill, regarding as the highest level of abstract experience.

The research was interested in teaching by using CAI as media for teaching-learning for lower secondary student on the topic of "Water for Life and Health". The researcher had learnt from teaching program that introduced the various media in term of multimedia according to Edgar Dale had classified the sequence, and step of experiences involved each other. Therefore, the constructed CAI should make teaching-learning effectively. From experience cone that Edgar Dale had classified teaching media as three types (cited in Oranuch Limtasirii, 2000: 77-78) as follows:

Software or Small Media is small media that called material that meant the media kept knowledge in itself. It can be divided features as follows:

1.1 Material that can not transfer knowledge by itself, it needs to use the other equipment to assist such as movie film, slide, transparent for instance.

1.2 Material that can transfer knowledge by itself, it no needs to use the other equipment to assist such as picture, real object, model, map, and chart for instance.

1. Hardware or Big Media means the media as medium by making the information or knowledge record in the material that is able to transfer by seeing, or hearing such as movie projector, slide projector, and over head projector for instance.

2. Techniques and Methods means media that has feature of concept, or form of step for teaching-learning by being able to use the material and equipments aid for teaching such as field trip, brainstorming, games, simulation, demonstration, and micro-examination.

The researcher selects software for production of CAI by having hardware in the lesson by having letter, picture, animation, and sound. There is planning and technical introducing, and method of presenting in diverge form that increased the motivation for learning.

2.4.2 Teaching Media and Learning in Term of Communication

Generally, learning occurred from teacher (sender) has information (content) to transmit and media (Channel to send) for sending the information to student (receiver) and it make the learner to perceive. It was as follows:

1. Teaching Media is introduced learning in form of one-way communication that means teacher sends the lesson content to learner such as movie projection, using teleconferencing, or hearing the radio. The learner can not respond to teacher immediately but there is feedback to leaner afterward. Therefore teacher should explain meaning of content for students to understand and interpret correctly.

2. Teaching media is used for learning in form of two-way communication that means teacher is information sender by sending the lesson content to learner by discussion or using teaching machine such as CAI. The learner receives the lesson content and interprets content and respond to teacher. Therefore the learner would become sender to send the feedback to teacher.

From the form of communication, the researcher had opinion that to use CAI is the two-way communication because the constructed lesson will interact between learner and computer, and learner is able to knowledge the result of learning such as additional explanation, and reinforcement that is useful for learner.

2.4.3 Selection of Teaching Media

Teaching Media is medium to assist the communication between teacher and learner is effectively.

There is principle of consideration for media selection as follows:

(Cited in Montree Yamkasikorn, 1983: 80) gave the opinion that there is no single teaching media has the best attribute and is most appropriate for all types of teaching.

Oranuch Limtasirii, 2000: 80 proposed the principle of media selection for teaching media as follows:

1. The media and experience is selected is relevant to content, objective, and behavioral objectives.
2. It is media to stimulate the learner to be interested in, and has the response, and change their behavior as expectation.
3. It is medium that is appropriate to age, class, knowledge, competency, individual difference.
4. It is a medium that is used conveniently for use, method of use is not too complicate, and it is easy to find. It is not necessary expensive.
5. It will be considered on the specific attribute of each media since each type of media has value in itself. It is depended on the selection of appropriate situation.

From these findings, the research could not to conclude that what type of media is appropriate for teaching learning for each subject. The research used the aforementioned principle to be guideline for learning experience arrangement by constructing CAI media. Even through the prize of computer and expenditure and involved is expensive but at present the prize is rather cheaper than the past., it is widely used in the school and household widely.

2.5 Computer Assisted Instruction (CAI)

2.5.1 Meaning of CAI

Boonkua Kuanhavech (2000:65) gave meaning of Computer Assisted Instruction (CAI) that is a mean of teaching for individual by using the capability of program lesson prepared appropriately. CAI is instrument to assist the instruction (teaching) is employed by learner to learner by himself, and he must perform different activities that showed on the screen through key board or mouse.

Sirichai Sa-NguengKaew (1991: 173) explained the meaning of CAI that was the application by using the computer for assisting instruction by developing program for presentation of various contents in different forms such as tutorial, simulation, and problem solving for instance. The presentation was done through the computer monitor and learner replied via mouse or key board in order to give a change for learner to participate. Teaching material is Courseware by keeping in the disc or hard disk that is available all time to be used. Sometimes the learner must type or response or answer the question while the his reaction will be evaluated or presented the learning result or present the further learning step. All these process is an interaction between learner and computer.

Khanittha Chanont (1989:6) stated that CAI meant to introduce the computer to be teaching aid by developing the content in term of text, and graphic that is able to ask question and to receive the answer and present the feedback for learning results to learner.

Wutthichai Prasansoi (2000:10) uttered to Computer-Assisted Instruction: Computer-Aid Instruction: CAI had meaning that it was program for teaching-learning by using computer as medium to transfer the knowledge to learners.

From the above-mentioned definition, the researcher had decided to construct CAI with different forms of media including text, still picture, animation and narration, presenting as both lesson and exercise. The CAI was developed as a

self-learning tool, accommodating individual student's preference and revision's requirements.

2.5.2 Types of Computer-Assisted Instruction

Academics and educator have divided computer-assisted instruction into several types, Boonkua Kuanhavech (2000:65-68) had classified CAI into the following categories.

1. Tutorial – a program created as a lesson that presents knowledge in sub-unit. It is a convention form of instruction, consisting of an introduction; content including theories, lows and explanations. And teaching technique in delivering text, picture, and sound. Questions are used at the end of each tutorial to evaluate levels of understanding and provide feedback for revisions or progress to the next tutorial. This is also used in documenting student's academic achievement, providing data for organizing additional lessons for particular students.

2. Drill and Practice – This drill and practice is usually used as a supplement when the teacher has already taught a lesson, and the learners will practice the exercise at the computer to measure their comprehensive level or let learners practice until at an acceptable level. The popular exercise of these types of lessons will consist of matching for indicating right or wrong , and questions and answers. The learns need to practice. The program for practice and skill training can be used not only to assist the learner know how to remember but it also to stimulate students to be able to think because the computer will often ask the learners to answer.

3. Simulation – this type of program is a simulation of the real situation and is as close as possible to the real situation. It is important and essential for image creation. The experiment in the laboratory of teaching-learning is important but there are various subjects can not be done to see the reality, such as to see the motion of a canon or the travel of light, chemical reactions, or scientific experiments that need many days The computer is able to simulate the real things and let learners see and understand easily. Some simulation assists for decreasing the cost for materials and equipment for laboratory. It help to decrease time consumption, and harmful effect.

4. Educational Game – computer games used for education is very stimulating for students. These programs are a special type of simulation, where there is a situation of competition that can be played by the learner himself or with other people. It will assist learner to obtain knowledge and get fun in the same time. There are scores, winning, and losing. The main goal of educational game is to help learner to know as important theme. Nevertheless, care is needed when writing these programs, to let them have educational value, objectives, content, and be appropriate

5.Demonstration – demonstrating by the computer is rather like the demonstration of a teacher, but computer demonstrations are more interesting because the computer can present many colors and sounds. The teacher can use the computer as a means of demonstrating about science. It is a good mean for teaching that the teacher can use particularly, teaching the scientific, and mathematics. This type of teaching the teacher will demonstrate for learners. Demonstration was done by using computer to illustrate the travel of planet in the solar system, the structure of atom for instance.

6. Testing – using computer-assisted instruction usually includes testing as a means of measuring achievements of learners. The creator needs to consider various principles in the creation of the test, arrangement, testing, giving scores, analysis, making many tests, and letting learners randomly get into the tests.

7. Inquiry – computer-assisted instruction can be used in finding the truth, concept, or useful information. Computer-assisted instruction will have a source of useful information that can be shown when students need it with a simple system. The students can access this by pressing a number or code; doing this will make the computer-assisted instruction display information that will answer the learners' questions.

8. Problem-solving – this type of computer-assisted instruction will focus on thinking and decision making, with a set of regulations that the students consider. Scores or weights are given to each condition such as scientific, mathematics subjects that the learners needs to know and understand, and able to solve problem.

9. Combination – computer-assisted instruction creates many new ways of teaching. These many different methods come from setting objectives in learning,

the students, or the factors and various topics. The computer-assisted instruction may have features of tutorial, gaming, inquiry, and problem solving.

In this study, the researcher decided to use tutorial as a format in constructing the CAI. Thus, the CAI was to be divided into sub-units and presented with the use of text, still picture animation and sound. Exercise and feed back were to be included also.

2.5.3 Characteristics of CAI Lesson

CAI has principle likes the other program lesson is to present the contents, questions, answers, including activities in the lesson for leaner to learn by himself by dividing into the frame of knowledge. Kidanan Malithong, (2000: 124-125) proposed that at present the popular used program had 2 patterns as follows:

1. Linear Program had the principle to construct the learning lesson by holding the principle of content dividing as sub-step in each frame together with the question but let the learner answer in two approaches by constructing the answer in the defined space or providing the choices for selecting.

1.1. The lesson that let the learner to construct the answer by himself. It resulted from the concept of behavior theory of Skinner. The lesson was divided the content into 2 steps as follows:

a.) To construct the answer of learner made the learner so each step needed the short content and small step to assist the learner to answer correctly, and they can remember for long time. To learn little by little made the learner to easily understand and assist to give the wrong answer.

b.) When the learner could answer question correctly, they would have willpower likewise the reward received and they would success in learning but if they gave a lot of wrong answers. It can cause the learner to be depressed and do not want to learn further.

1.2 The lesson that let the learner to choose the answer, the program was designed according to the Pressey's principle that if the learner gave the right answer. Subsequence would offer the next stimulant. If the learner chose the wrong answer,

they must to go back to study the preceding frame again, then they can select the new answer until they can select the right answer then they would receive the reward or reinforcement, and they would learn from the right answer

2 Branching Program was the concept of Crowder that the feature of lesson would be similar the choice selection of Pressey but its different point was that each selection would lead learner to study in another frame or another further page. The sequences of step or frame and it can be not in order. If the learner can answer the question in that frame correctly, therefore they can skip some frame to learn another frame or as the lesson defined. If the learner gave the wrong answer they would receive the explanation the reason or cause of wrongdoing and they might receive the additional lesson from the sub unit. So the learner should follow the suggestion in each frame strictly.

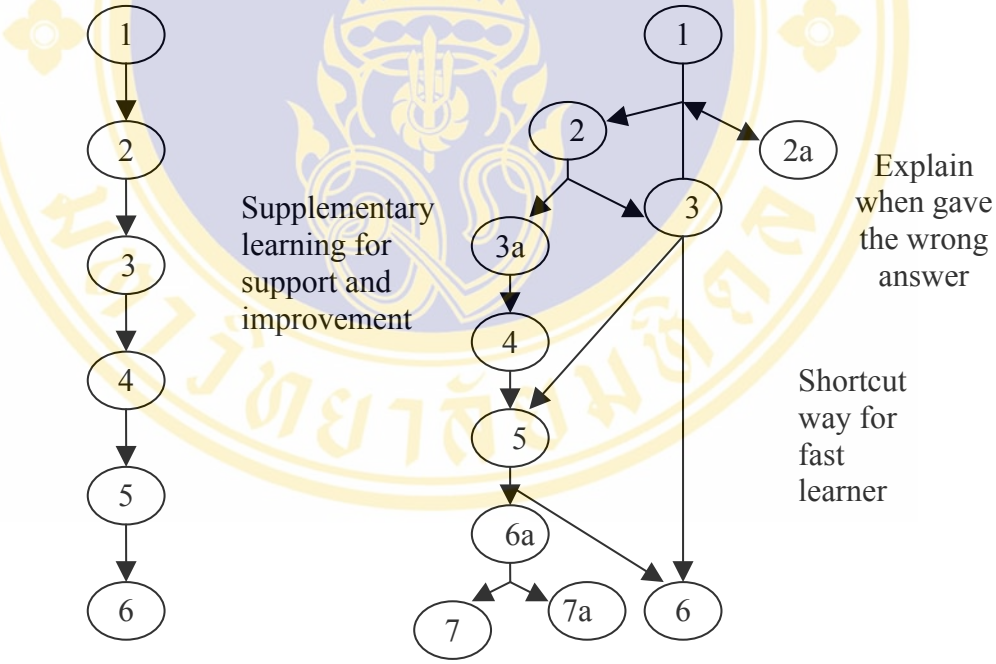


Chart 4 Comparison between Linear Program and Branching Program

The emphasis was placed on the importance of intellectual difference of individual learner. In this study the researcher would select the branching program for CAI lesson construction for in place of printing materials because it help to

decrease of problem occur during use the CAI lesson such as to present the content to student for faster searching the answer and stimulate their interesting letter, graphic picture, and a variety of sounds, and the animation was included by covering the answer and reinforcement with admiration for instance. The production of CAI lesson was constructed with frame of content provided the information consistent with frame of question. Each frame of question would had branches according to the choices. If the learner gave the right answer, he would move to new frame of content, but he gave the wrong answer they would go to the additional frame for correction before went back to the wrong question.

2.5.4 Learning Psychology for CAI Production

Chettha Tiampetch (12-14) proposed the learning psychology for CAI production as follows:

1. Stimulus-Response by defining the stimulus to be interesting, and beauty, it must be relevant to the characteristics or adoring to learner. The stimulus hereby, is in term of easy question to answer in order to let them answer before learning the new content, it is content that is designed to be suitable with the natural attribute of content such as arranging the sequence by starting from the easy content to difficult content, by ordering for the complicated content. Allis accounted as stimulus as well. In addition, title, and menu are included. It needs to have the principle for designation about stimulus. The mean of response is defined to be suitable for this stimulus such as defining the beautiful learning list for selection by using the picture in that content. Then it is click to select the picture to learn the sub-content or by defining the various button for learner to react appropriately in order to stimulate the learner to pay attention to enter to the lesson and study until finish. That is the response to lesson.

Combination of graphic and sound on title pages was used in stimulating student's initial interest on the CAI. This follows by menu where students can choose subjects they like.

2. Repeat and practice would help the learner' knowledge more compact and going long term memory. It would emphasize the learner to learn little by little, and to understand step by step. It may repeat the content in some part if they think the learner do not understand or misunderstand about content by considering on answer of learner during learning There is objective to revise the content in each period of learning.

Research constructs CAI lesson, it consists of content and exercise. If the student answer correct. They will be congratulated with positive feed back and reward with passage to the next learning frame. If the students give wrong answer, they will be required to complete a revision frame before moving forward.

3. Learner receives immediately feedback whenever the lesson define the learn to interact to lesson in different forms and the lesson must showed result of response immediately such as lesson define the learner to select learning by pushing the button so when the learner press the button the lesson must showed the result immediately. In the case of lesson has defined learner to answer the question before learning the new content. Therefore after the learner has answered the question according to the lesson defining such as select choice, type the statement or check the answer. The lesson must showed the result immediately that it is right or wrong, yes or no, get or not or tell in other form such as increasing the score or decreasing the score or not changing or using the right mark or cross mark. It may use other characteristics such laugh / cry or other sounds that are understandable. The picture/symbol can communicate. The form of response should be selected to proper to each group of the learner such as age, education level, and culture.

The constructed CAI will give the feedback information and the reinforcement to learner by using text, picture, and sound. In each lesson will record the score in order to report self-progression. In case the learner gives the right answer, he will receive the admiration and study in the next frame. If the learner gives the wrong answer, he will be informed and the supportive content will be provided and let the learner to answer again.

4.Guiding is provided for learner to make him reach the highest successful because to learn from CAI is done by oneself. It needs to regard to the learner that he is interested, and willing. There is no obstruction to make his interest decrease or do

not study or finish to study further. Therefore to design the lesson must be done without making the learner to be anxiety or to feel that it is to difficult to learn. It may be done by making the condition that the learner can interact easier. The pattern of guiding has different form. They are in term of description, letter, or other conditions. The amount of guiding will be large at the beginning, subsequently it decreased gradually. It is accounted that the learner has knowledge and interest in certain level to study further until finishing.

The constructed CAI in this study will present sound and picture that are relevant to the content by using the simple explanation and understandable that may make the learner to interest and receive the concept from the lesson.

5.To receive the necessary knowledge before learning the content, CAI lesson has the attribute like other media as another choice for learner to choose to study. Hence the learner mat select the multimedia to study in order to obtain the complete knowledge such as study from textbook/ teaching documents together with learning with CAI. Particularly, CAI has restriction by itself such as restriction of hardware, danger from the radiation caused harmful effect to health for long term of learning because in each topic can not present a large amount of content but it stresses on the pattern of presentation, designation, and interaction to lesson so it can not present a large amount of content like other different media. Therefore the learner must study the content from other media together, he can use the CAI lesson more completely.

The constructed CAI in this study will be another choice of learning that the learner is able to learn together with the class taught by teacher because CAI may have the content not have detail much like as teaching by teacher in the classroom.

6. Learner uses the mean of learning in accordance with his aptitude, since there is diversity of learning patterns exercise, study in the simulation, different style of presentation, form that define the learner to interact that is relevant to his aptitude and characteristics of learner.

The constructed CAI will make the learner to learn according to their aptitude so the learners can select to learn according to their satisfactions and they can use the time as mush as the require.

7. Teaching-learning that is pertinent to the capability, natural characteristics, and interest of learner will be relevant to the principle that if the learner is satisfactory, and like, he will success for learning since he learns in the interesting content and the content is benefit to learner or it is the content that he has prior learning background before. Therefore CAI has diverse content.

The constructed CAI has diversity of contents. Learner is need not to wait or be hurry to keep up together with classmate. It create the positive attitude for learner to that subject because he can learn whenever he wants so it provide the high change to success and he is not shy if he gives the wrong answer.

8. To do the activity that is meaningful for himself such as answered the question, selected to learn, and there is an interaction with lesson by himself. The constructed CAI will able to learn according to his convenience and he is able to revise as much as they want.

The constructed CAI in This study, the students is able to learn or revise repeatedly without the limitation of the time and according to his requirement. It is able to increase his knowledge.

2.5.5 Assisted Program for CAI Construction (Authorware)

There are different types of program for CAI construction. Each program had dissimilar and disadvantage, and limitation. It depended on the level of skill of each constructor to be familiar with what type of program.

Chettha Tiampetch (105-106) presented the prominent characteristics of Authorware as follows:

1. Icon will be used as cooperated command with the planning of program structure in order to be able to test the command easily. It can construct the complicated program quickly.
2. It works under Microsoft Windows and Macintosh, and it was able to send the information from program to under Macintosh to under Windows

3. It supports the development of interaction learning and was able to contact with the user in different terms such press the bottom, add the text, move the picture, including the variables and function to gather and analyze the data of lesson.
4. It has instrument to gather data whether picture, sound easily.
5. It has media manager system that is able to keep data as library by separating from work.

In order to accomplish, each piece is able to use data in the library together to decrease the size of file of that work and it is able to work under the network system of computer conveniently.

It is able to employed for construct the work in different forms such as construction the exercise or reviewing content or new learning content.

6. It is able to record the learning results of users.

In this stud, the researcher selected the program of Authorware version 6as tools for constructing the lessons. This program is Authorware System for developing the lesson or work emphasized on the capability of interacting to learner and to present the graphic pictures, sounds The numerous command in form icons were taken on the flow line and worked by step of program. It is an easy and convenient program.

2.5.6 Advantage and Restriction of CAI

Boonchom Sri-Sa-Ard (2537:123-124) and Kidanan Malithong (2531: 173-174) presented the advantage of CAI for learner and teacher. It can be concluded as follows:

Advantage

a. Advantage of CAI for learner,

- Learner can learn independently according to the rate of his knowledge and ability. He can select to learn as his desire or to be appropriate for him.
- It assists the learner to learn faster and better than usual learning.
- Learner will receive the feedback immediately in order to stress this comprehension of learning.

- It is able to teach the skill about risk such as to drive the airplane.
- Learner is interested in the learner increasingly because the computer has technique for learner's attraction with different means such as use color, and animation.
- For the complicated activity, it needs the simulation for learner to try out with diverse type and form of data in order to solve that complicated problem.
- It assists the learner to have good attitude for that subject because the learner is able to know the success of learning by himself and if he answers the wrong question he will not feel shy.
- Learner does not get the pressure during learning since the computer can not express the bored sign.

2) Advantage of CAI for Teacher

- It decreases the job of teacher, and there is content in the system of CAI so he can use the time to prepare other lessons.
- Teacher has an opportunity to have creative thinking and develop the teaching media more effectively.

Wutthichai Chanmorn, (1996:36) stated about the benefit of CAI for teaching-learning as follows:

1. It is able to present the content rapidly in stead of reading the book by opening one by one page, but the CAI lesson can be used by pressing the button on the key board.

2. It is able to present the animation that is very useful, particularly for the complicated lesson or the event that would like to be stressed.

3. It has sound supplement for attraction, and it is able to increase language learning ability.

4. It is able to keep information more than book with a variety folds such as CD-ROM 1 disk keeps 680 million letters. For the book contained 300 pages has about 300,000-400,000leeters. Therefore I disk of CD-ROM is able to keep 200 books.

5. It is able to react with learner while the book cannot do it.

6. It is able to be carried to learn any place that has the computer without the time, and place constraints but in the school it is limited for time.

7. It is appropriate to teaching and learning through the distance communication such as distance learning via satellite or other communication channels.

Restriction of CAI

Chettha Tiampetch (2000: 24-25) illustrated the restriction of CAI as follows:

1. To design the effective CAI, it needed a lot of time and ability since the teachers who knew the content but they were not able to build the CAI by themselves but they needed the one who knew and had ability to construct. In Thailand, there were few persons who had the knowledge about CAI construction so it was problem of searching for CAI lesson.

2. The attitude of teacher towards learning from CAI, they do not like to use the CAI content since some of them believed that he can teach better than CAI. Even though there are some CAI is effective enough to give knowledge because they think without regarding to the other aspect that it is a good change for student to learn by different means. Moreover, some teachers is able to accept but he lacks of confidence to use it or he might be scare to involve the job that deals wit the computer since he is computerphobia.

3. The program of CAI is rather expensive, particularly, the foreign program having high capability to work more delicate than general because it can work wide variety and more details. It is the obstacle of lesson development. Besides to construct one topic, it needs other program to join such as program of picture construction, animation, sound so it cause the high cost for construction.

4. The changing of computer technique is very fast. Both hardware, and new lesson program use these technologies for construction CAI lesson to be more interested. So the institute/ learner must prepare and improve the equipment to be congruent to new learning form. Otherwise, he can not gain the highest advantage from the lesson such as amplifier must increase the speed and capacity of computer. It is the problem of different institute and learners because the equipment had can not be used

with the program because the equipment is not upgrade to match with the modern program.

5. It lack of the flexible CAI lesson and high quality because most of the constructed CAI are not assured. It is used in the small society. It could not be used diversely, and lack of standard lesson that is accepted by acceptable standard. Most of lesson had defining about the kind of hardware but they forget to regard to the learner requirement. Most of CAI lesson the first age is constructed by the programmer more than educators. The lesson is rather big, and beauty but it is not used for teaching and learners do not receive content.

As with other interactive media, The CAI does have both strength and weakness in communicating with users. Experience with personal computers as desirable prerequisite is perhaps one of such weakness. The researcher was required to selectively choose students for the sample group in order to ensure that the chosen are acquainted with personal computers. Another weakness is the fact that interactive presentation can be readily understandable by all to equalize their understanding of the system. A hand book was also prepared for this end also.

2.6 Other related researches

Vilawon Chatan (1994: Abstract), studied on the topic of The Effect of Computer Tutoring in "Human Digestive System" on Student Science Achievement in Mathayomsuksa 3. The results and conclusion of this study were as follows : 1) there was significant differences (p=0.000) on the science achievement between the experimental and the control group, it could be concluded that the "Human Digestive System" Courseware could help students to gain more knowledge; 2) the students in the experimental group had positive opinions towards computer assisted instruction.

Sichol Kuanmetta (2000: Abstract) researched on the application of Computer Assisted Instruction on topic of “Mangrove Forest for Student at Secondary School Level”. The CAI was good level for the knowledge about Mangrove Forest. Simultaneously the students used an assessment form to evaluate satisfaction with CAI lesson. The results were good and excellent levels.

Trironk Pimpa (1994: Abstract) researched on "The Construction and Evaluation of Computer Assisted Instruction for the Public Health Officers in the Environmental Sanitation". Results of the study indicated that Post-test score was significantly higher that pre-test score. The sample group students of used about 1-3 hour for learning.

Chatree Jindamanee (1998: Abstract) did a research on the development of computer-assisted instruction lessons about "Kids and Creative Ideas about Helping the Environment" for junior high school students. The sample group consisted of 60 students in junior high school at Banharn Jaem Sai Witaya School 5, Amphur See Phi Nong, Supanburi. The research results was found that mean scores of knowledge in the post-test of the experimental group was statistically significant at the level of 0.01 when compare with the pre-test of the experimental group, and mean scores of knowledge in the post-test after learning with constructed CAI lesson of the experimental group was higher than the mean scores of control group who did not learn by CAI lesson statistically significant at the level of 0.01.

Worawit Khankaew (1999: Abstract) studied on Development computer-assisted instruction lessons about "World and Changing" for Mathayomsuksa 2. The results was found that Constructed Computer-Assisted Instruction was effective, and convenient to use, and response the stimulants with learner. The learner is able to learn or revise repeatedly without the limitation of number of times, time, chance, and according to his requirement. It is able to increase their knowledge.

Sodsai Choracroyakul (2000:Abstract) study about "The development of Criteria for Multimedia Computer Assisted Instruction Program" The result fell into five categories as follow:1) the evaluation criteria for the content of program 2) the evaluation criteria for the instructional 3) the evaluation criteria for multimedia techniques 4) the evaluation criteria for learning assessment 5) the evaluation criteria for usage

The above examples all contain steps for measuring academic achievement and evaluation on content, multimedia technique and student's satisfactory of the lesson. These features were adopted in construction of the CAI in this research.

CHAPTER III
RESEARCH METHODOLOGY

To research on the development of CAI on the topic of "Water for Life and Health" for secondary school, there was implementation as follows:

1. Construction of CAI
2. Construction of Tool for Evaluation of Quality of CAI
3. Development of CAI
4. Try out for Evaluation of Quality of CAI lesson

3.1 Construction of CAI

3.1.1 Literature review

The following literatures were reviewed in the study:

1. The basic educational curriculum B.E.2544, particularly the content on science, and social studies, religion and culture for secondary school students. The curriculum was used as a guideline in developing CAI in order to ensure its consistency with the curriculum.

2. Academics information such as quality of water sources, sanitary of drinking water, and consuming water, water pollution, and guideline of participation about prevention of occurred problem were used to define content and concept of environmental education in order to be relevant to curriculum, make the interesting content, and complete content.

3. The features of computer of target school and program Authorware version 6 in order to be used with computer in school was studied.

4. Technique of construction of CAI such as form, content arranging and learning psychology for CAI production is studied to construct CAI to be appropriate to the age and education level of learner.

3.1.2 Define the Topic and Important Content of Lesson

The researcher defined the content by considering on learning content group, standard, and learning in range of lower secondary level 1-3 that had content to be harmonious to water for life and health. Then the content was defined and let the thesis advisory committee and experts to examine the appropriateness and correctness, afterward it was improved according to their recommendation.

The constructed CAI can be divided the content into 6 unit of learning, and each unit was divided into short section by sequencing the content to be continual.

Unit 1: importance of water.

Unit 2: water cycle, and natural water source.

Unit 3: food resource in water

Unit 4: consumed water becomes wastewater.

Unit 5: making water to be clean

Unit 6: wastewater treatment

3.1.3 Presentation of Content of CAI

The presentation was presented as a lesson with 6 separated unit. In each unit, frame of content followed by the frame of question. Providing right-answer is congratulated with positive feedback and rewarded with passage to the next learning frame. Providing wrong answer to open a revision frame with move detail information and new question, which must be answered correctly before proceed to the next frame. When completed, the CAI returns to the main menu in order to learners to proceed to the next unit. In this study, The sample group was asked to complete all units, from unit 1 to 6.Details of the presentation are as show on chart 5.

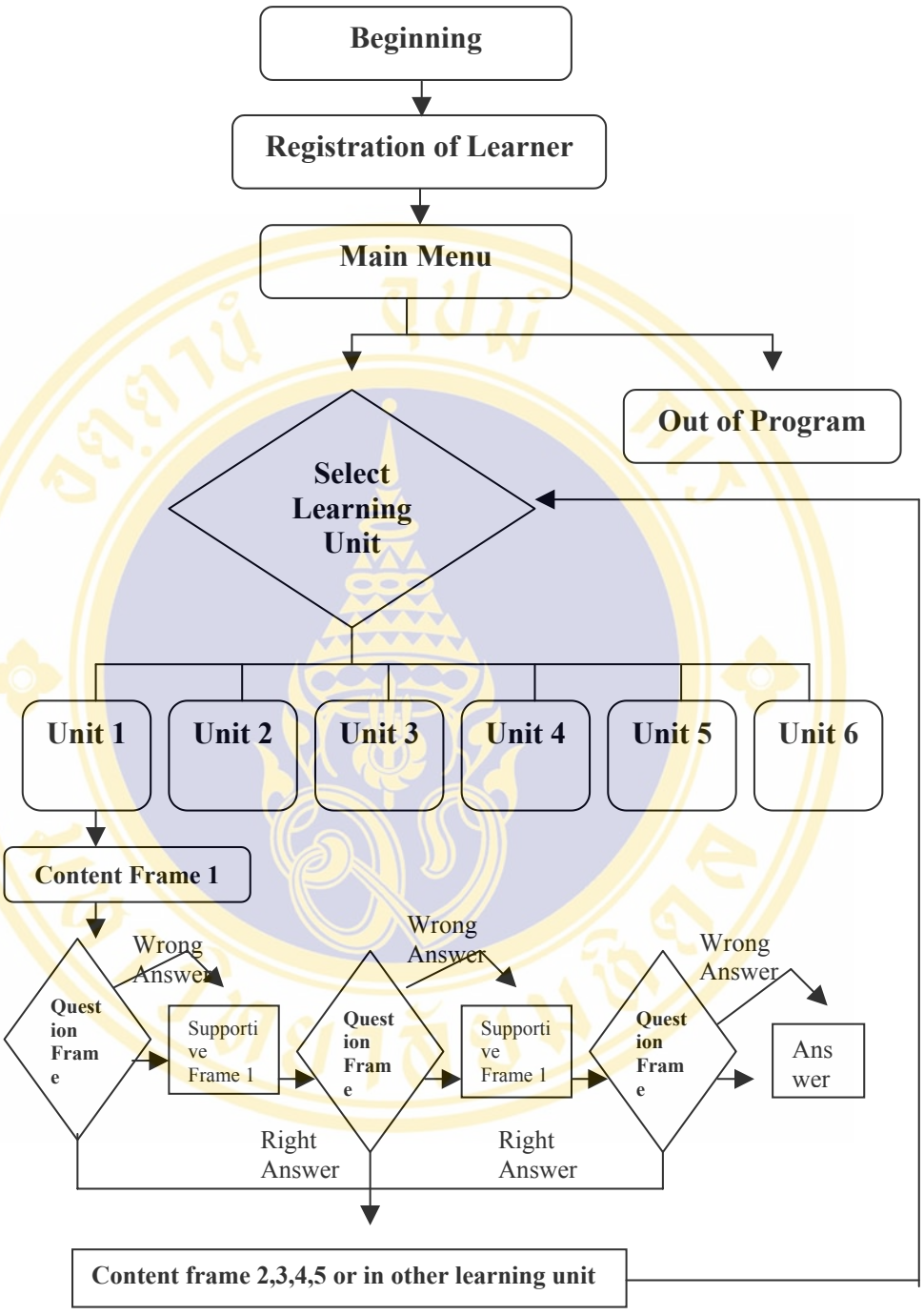


Chart 5 form of presentation of CAI on the topic "Water for Life and Health"

Remark: Unite 2,3,4,5,and 6 have the same structure with Unite 1.

3.1.4 Construction of Story Board

The content was defined to be lesson in each learning unit, and form of presentation of CAI. The story board was story of lesson that composed content divided in the various frames according to objectives. It presented knowledge, understanding, and use, including defining the characteristics of letter, and color on screen. After it was constructed, then it was introduced to construct the CAI lesson further.

3.1.5 Implementation of Lesson Production

1. To design the trial of CAI in attribute of ray radiation of around the main screen and every information in the second level was accessed directly at the main screen. The details presented in chart 6.

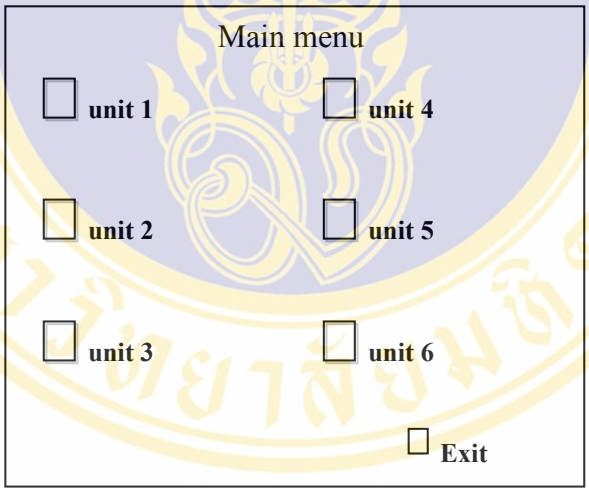


Chart 6 Design of Trial of CAI on the topic of Water for Life and Health

2. Program was employed for CAI construction after the story board was constructed and code was entered, picture was drawn or photograph was taken, and sound was introduced together. Using Authorware version 6 did construction of CAI on the topic of "Water for Life and Health".

3. The record was entered into computer was step to record into the disk for the thesis advisory committee and experts to examine the quality, and after it was corrected according to their recommendation, it was tried out further.

3.1.6 Construction of Manual for CAI Use

Construction of manual for CAI use on the topic of "Water for Life and Health". Details of manual composed of objectives, target group, characteristics of equipment used with lesson, mean of program installation. The recommendation and regards of lesson

3.2 Construction of Tool for CAI Evaluation

3.2.1 CAI Evaluation by Experts

The evaluation was carried out by 2 groups of experts.

1. 3 experts conducted evaluation on content of CAI. Criteria for the evaluation were set at 4 levels; very good, good, moderate and need improvement. In the study, the experts to make asked the researcher some improvement to the CAI before it was used with the sample group. Therefore, there was adequate quality control of the CAI.

2. 3 expert conducted evaluation on educational technology of CAI. Criteria for the evaluation were set at 4 levels; very good, good, moderate and need improvement. The researcher based on recommendations of the experts also made improvement on the aspect education technology.

3.2.2 Examination of Learning Achievement

Evaluation of learning achievement by pre-test and post-test utilized 30 multiple choice questions each with 4 choices. The examination was aimed to determine achievement in learning, comprehension and adoption to knowledge. The advisor reviewed the tests. Implement was made based on their recommendation before using the test with 30 non-sample group students of secondary school students at level 3.

Kelly's Technique of 27 percent (Kangoal Thengkantansh,1977:117) was used to in finding the difficulty level and discrimination power, as follow:

The test was determined the level of difficulty by dividing the score into two groups as high score group and low score group, the 27% technique was used, the formula being as follows:

$$\text{Difficulty level (P)} = \frac{P_H - P_L}{n}$$

$$\text{Discrimination power (r)} = \frac{P_H - P_L}{\frac{n}{2}}$$

P_H = the students who got right answer belong to high group

P_L = the students who got right answer belong to low group

n = all of the students belong to high group and low group

General testing for usage should have level of difficulty between 0.22-0.80 (Kangvol Thengkantansh, 1997: 119). The Section were regarded as suitable.

For the selection of that items should have Discrimination power 0.20-1.00 and those regarded as the efficient items. (Kangvol Thengkantansh, 1997: 122).

3) Reliability

Bring 25 items were selected to determine the reliability by the Kuder-Richardson 20 (KR-20), with the formula as follows (Boontam Kijpreedeeborisut, 1994:246):

$$r = \frac{K}{k - 1}\left\{1 - \frac{\sum pq}{s^2}\right\}$$

P = proportion of respondents who provide correct answer in each question.

q = proportion of respondents who provide wrong answer in each question.

S^2_x= deviation of total score

The formula for variance was as follows:

$$S^2 = \frac{n\sum X^2 - (\sum X)^2}{n(n-1)}$$

S^2 = Variance of total scores

n = Number of sample

$\sum X$ = Sum of tests scores

$\sum X^2$ = Sum of tests score square

3.2.3 Evaluation of Satisfaction for CAI Lesson

Evaluation for CAI satisfaction of the student towards CAI lesson by establishing the criteria for satisfaction evaluation as 4 levels were 4 levels were very good, good, adequate, and must be improved and the open ended questionnaire was provided. The improvement of quality of lesson was done according to the recommendations of the thesis advisory committee. It was used for student to evaluate both in the process of tried out for lesson development and experiment with the sample group. Percentage and mode were used for data analysis.

3.3 Development of CAI

Before the constructed CAI was employed in the experiment with sample group, it was developed the quality by the expert and students who were not sample group to evaluate as follows:

3.3.1 Evaluation of CAI Quality by Experts

There were experts in the aspects of content and educational technology as follows:

1. Experts of Content, after the CAI lesson was constructed. All lessons were printed for 3 experts to examine the correctness of contents and let them evaluate.

2. Experts of Educational Technology, after the CAI lesson was constructed. All lessons were recorded for 2 experts to examine the quality of media and evaluated the lesson quality.

3.3.2 Sample Group in the Research

After CAI lesson was constructed and it was evaluated by the thesis advisory committee and experts. Then it was improved, and lesson was tried out with the secondary school students at level 3 of WatSawettachat school that comprised girl and boy. The students were good grade, moderate, and low grade mixed together. The research selected to define the form of media development according to Oranuch Limtasiri, (2000: 161-163). There were the steps of tried out as follows:

3.3.2.1 The first trial consisted of individual try out and revision. After construction of CAI the trial was conducted individually with a group of 3 students who were rated below moderate learning level. This was aimed to determine the CAI 's effectiveness in tackling their learning problem. The students were asked to complete pre-test before undertaking the try out. The researcher constantly observed the student's reactions through out the trial, documenting difficulty the students found in the CAI and other opinions they had. This information was later used for improving the CAI after the trial, the students were also asked to complete post-test.

3.3.2.2 The second trial, it was the group tryout and revision by using 7 students who had the learning result at moderate grade, and not be the students in the first trial. At beginning process it needs to explain to students that they were the consultants to assist to improve the learning lesson to be better. The pretest was done before learning. The researcher recorded for calculate about average time consumption of the group. The posttest was done in order to measure whether the learning was achieved according to the objectives set or not. Then the research would ask about the problems that they faced during learning the CAI lesson. The improvement was done according to the data collection.

3.3.2.3 The third trial, it was field tryout and revision. The improved CAI lesson would be used for try out with 30 students. The pretest and posttest were employed. The students in these groups were not the students in the first and second trial. In this trial let them do the test in order to determine the effectiveness of lesson and the satisfaction was done as well. The improvement was done according to the data of evaluation.

This process is as shown in chart 7

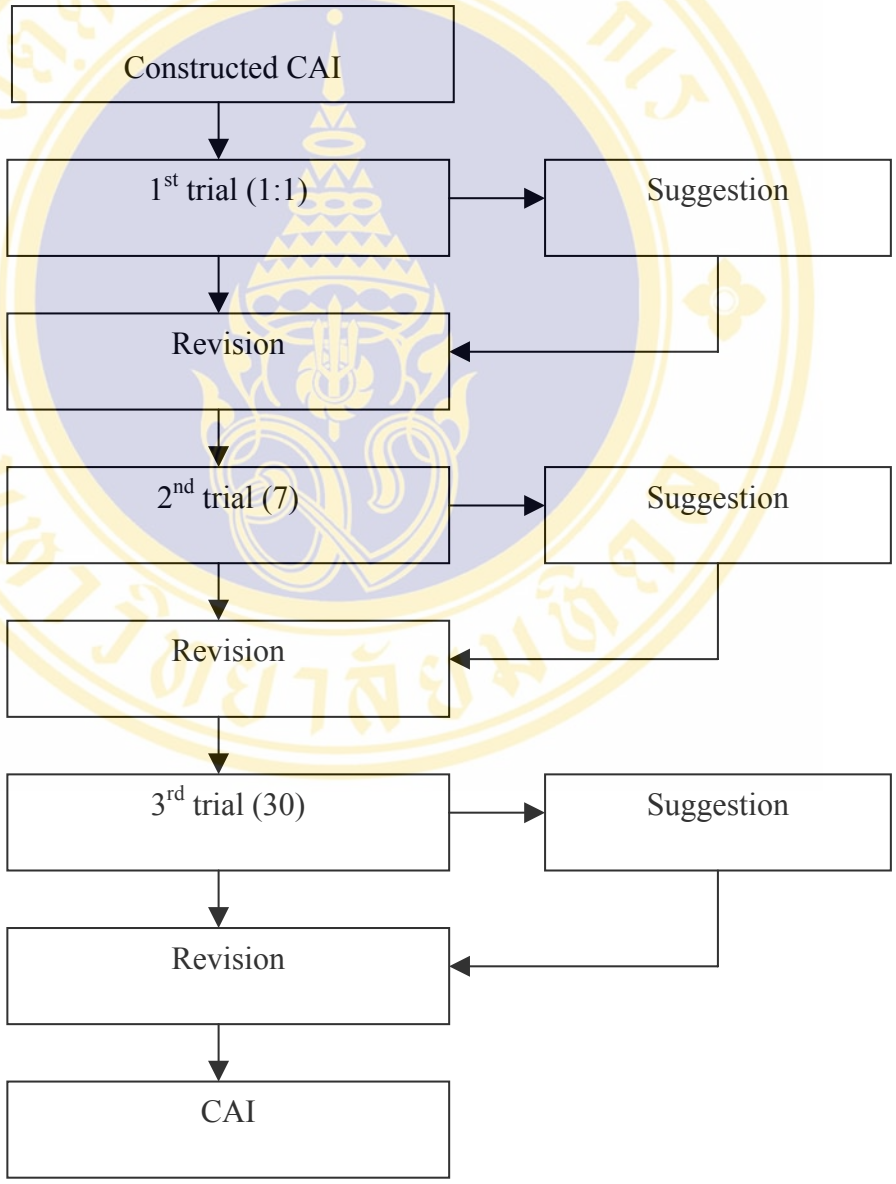


Chart 7 type of CAI development

3.4 Try out for Evaluation of Quality of CAI lesson

3.4.1 Sample and Population

The population in this research was the student at the secondary School level 3 of the school under the Bangkok Metropolis. This school had the computer for teaching-learning. There was a limitation about the computer, which was instrument in this study. Therefore, the purposive sampling was employed for randomization by selecting the school that were the teaching-learning center of computer, and there were instructors who were readiness to support for experiment. That was the student of at the lower secondary school level 3 of academic year 2003 of Wat Sawettachat school, Klongsarn District, Bangkok Metropolis. The sample group of 30 students per group was randomized by drawing label was employed to select for experimental group and control group.

3.4.2 Tools for Research

Computer, which was the equipment for learning should be 486 Dx2 66MHz Up and mouse with the operation system of Windows 95 or higher, including CD-Rom Drive, Video Adaptor Card (high color 16 bit, sound amplifier, and CAI lesson on the topic of “Water for Life and Health”. The program of Authorware version 6 was used operation system, Microsoft Windows 95/98. Photo shops program was used for picture decoration, and construction of special letter. Flash MX, Swish version 2.0 program was employed for construction of graphic picture with animation style.

1. Tool for Quality Evaluation

-Test for learning achievement contained 25 items, and multiple choices with 4 choices, and there was only one correct answer. Experiment time was 30 minutes.

-Form of satisfaction of students towards CAI lesson

3.4.3 Implementation of Experiment

The experimental design was done by using the Pretest-Posttest Control Group Design, and the form was as follows:

R	O_1	X	O_2	**Experimental Group**
	O_3	(X)	O_4	**Control Group**

Where R = Random Sampling

X = The experiment was done by learning the CAI

(X) = There was no experiment was done by learning the CAI

O_1 , O_3 = Result measured before experiment (Pretest)

O_2 , O_4 = Result measured before experiment (Posttest)

The Experimental implementation were as follows:

1) The sample group was tested for 30 minutes by the two groups of experimental group and control group lesson (Pretest) in order to measure their knowledge in the content before learning the CAI.

2) One week after the pretest was done, the experimental group learnt the CAI lesson on the "Water for Life and Health". The experimental group learnt CAI in the laboratory room and one student per one computer, but and the control group did not learn the CAI lesson.

3) The evaluation of satisfaction for CAI was done by experimental group who learn CAI lesson…

3.4.3 Data Collection and Data Analysis

1) Study the learning achievement by comparing the mean scores of pretest and posttest between experimental group and control group were determined by t-test as the following formula

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(n_1 - 1)S_1^{\,2} + (n_2 - 1)S_2^{\,2}}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where $\overline{X}_1$ = Mean scores of Experimental group

$\overline{X}_2$ = Mean scores of Control group

S_1^2 = Variance of scores of Experimental group

S_2^2 = Variance of scores of Control group

n_1 = Number of student in the Experimental group

n_2 = Number of student in the Control group

df = $n_1 + n_2 - 2$, it was red from the table

2) To determine the efficiency of lesson by comparing the mean scores of pretest and posttest of the same group of both experimental group and control group were determined by t-test as the following formula.

$$t = \frac{\sum D}{\sqrt{\frac{n\sum D^2 - \left(\sum D\right)^2}{n-1}}}$$

$\sum D$ = Total sum of the difference between average scores of pre-test and post-test

$\sum D^2$ = Total sum of the difference between average scores of pre-test and post-test, squared

D = The difference between scores of pretest and posttest of each sample

n = Total number of students

CHAPTER IV
RESULTS

A study on development of CAI on the Water for Life and Health for secondary school students was carried out with the student of the secondary school level 3 of Watsawettachat School. Results of the study were analyzed and can be summarized under the following heading.

1. CAI Construction
2. Effectiveness of Learning Achievement Test
3. CAI Development
4. CAI Evaluation by Experts
5. CAI Trial

4.1 CAI Construction

CAI on the topic of "Water for Life and Health" was constructed by researcher was branching program with Authorware program version 6. It was an assistant tool for teachers since the constructed lesson was the lesson could not replace teacher totally. i.e. same part be taught by teachers while same parts be self-learning or the teacher taught the whole content and the students reviewed the lessons from CAI lesson.

The CAI lesson was constructed and it had objectives as follows:

To strengthen Knowledge on : The importance of water for living
: Water cycle and the importance of natural reservoirs
: The important food source of world, and aquatic food source of Thailand

: Sources of wastewater and primary minimization
: Wastewater treatment in household and community
To build skill on : Identification of different uses of water
: Simple water treatment techniques
To foster positive attitude : To use water with efficiency and minimizing wastewater

The constructed lesson consisted of lesson, thinking practice form, and supplementary lesson. The learner was able to choose any unit as priority. It was divided into 6 learning units as follows:

Unit 1 The importance of water, stressing value of water for survival of plants, animal and human being and its roles in public as health, economic recovery, infrastructure, and economy.

Unit 2 Water cycle reservoirs which cover all 3 sources of natural water, atmospheric, surface, and ground water.

Unit 3 Reservoirs as food source, emphasizing importance of natural reservoirs in the global food demand and contribution made by marine and freshwater fishery in Thailand

Unit 4 Wastewater, identifying 3 major sources of wastewater ; urban area, industry and agriculture, and impact of wastewater on fishery sanitation water, consumption, and natural beauty as well as means for resolving the problem.

Unit 5 Water treatment, covering all conventional mean for de-contamination Including filtering, caking, distilling and disinfecting and treatment of surface and ground water by waterworks service.

Unit 6 Wastewater treatment, consisting of wastewater treatment in household using grease trapped ponds, trap ponds, and anaerobic filter tanks, and sats tanks as well as community wastewater treatment, including average treatment at Rama 9 wastewater treatment , and Chong Nonthree wastewater treatment plant.

To use the CAI lesson, the researcher had arranged user manual by explaining the method of program use, method of learning, and method of question answering as follows:

1. Switch on the computer, and wait until the operational system of windows is already to work. In order to accomplish the highest perfect working, the monitor should be adjusted to be fine screen as mode 800x 600 pixels.
2. Put the CD Rom into the computer driver.
3. Wait foe a while, the program would open automatically, and the learner typed the name and surname, and it would be registered, and would record the scores of exercise done.
4. There were 6 learning units. The learner starts to click and select any unit. In each unit would provide thinking practice form for answering. If the learner gives the right answer, he/she will learn next lesson.
   - If he gives the right answer, he will receive 3 scores. If the he gives the wrong answer he must go to the supplementary lesson (set 1).
   - If he gives the right answer, the learner will receive 2 scores. If he gives the wrong answer he must go to the supplementary lesson (set 2).
   - In case of he has learnt the supplementary lesson second time, and if he can give the right answer, he will receive 1 score. If he gives the wrong answer he will receive the correct answer. Then he learns the next lesson.
5. There are 4 buttons in the learning lesson that are main menu button, forward button, backward button, and exit button. The learner can click as he desires.

4.2 Effectiveness of Learning Achievement Test

The learning achievement test consisted of 35 questions, which were considered for the appropriateness of content, and it was tried out with 30 students of

the secondary school level 3 of academic year 2003 of Watsawettachat School.the test were examined and were given the scores by sequencing the scores and dividing into 27 percent for low group and high group. Therefore each group composed of 8 students, subsequently, it was determined for difficulty level, discrimination power, and reliability. For the criteria in choosing questions, a difficulty level is between 0.2 – 0.8 and a discrimination power is not least 0.2 (Boontam Kijpreedeeborisut, 1994: 171).

From 35 questions test analysis, it was found that there were 25 questions were in the range of setting criteria. The reliability was determined by the Kuder-Richardson 20 (KR-20) technique. The reliability value is equaled to 0.74 so it was accounted at the high level according to Chusri Wongwatana (1982: 229) stated that the reliability of test that had value between 0.70-1.00 (the detail of results of learning achievement measurement presented in table 14 of Appendix).

4.3 CAI Development

The development of constructed CAI lesson, there were 3 steps as follows:

Step 1 Individual trail for Improvement

As previously mention, the individual trial was conducted with a group of 3 students who rated below moderate learning level. The students were subject to tests previous and after the trial (pre-test and post-test). The students took between 60-90 minutes to complete the trial. They were then questioned about the text, language, picture and difficulty of the lesson. Some descriptions in the lesson were found by the student to be too lengthy while some pictures were hard to interpret. They also found that some technical shortcoming such as some un operational buttons. Revision was made to the lesson based on these comments.

The total score of learning achievement test was 25, In the first trial, the mean scores ($\overline{X}$) of pretest was 14.00 scores, while mean score ($\overline{X}$) of posttest was 17.67 .

Step 2 Small group trail

The second trial was carried out as a group tryout and a revision. The CAI, which had been revised with information from the first trial, was tested with a group of 7 students who were rate at moderate learning level and had not taken part in the first trial. Before the trial, the researcher asked the students to identify themselves as consultants and welcomed any of their views and opinions that might better CAI. The students were asked to take complete a pre-test before undertaking the try out. During the trial, the researcher recorded time each student used in completing the CAI, which later used in calculating average time. The students were again asked to take a post-test which was used as an indicator to determine the students' learning achievement. Students were also questioned about problems and their opinions on the CAI in order to make improvement to the lesson. The students took between 45-110 minutes to complete the trial. They were then questioned about the text, language, picture and difficulty of the lesson. Volume of the sound in the lesson was considered by the students to be too low, making it difficult to listen. The students also annoyed by slow presentation of same picture and preferred to have move cartoon affiliated contents. Revision was made to the lesson based on these comments.

The total of learning achievement test was 25, In the second trial mean scores ($\overline{X}$) of pretest was 16.85, while mean score ($\overline{X}$) of posttest was 21.42 scores.

Step 3 Filed Testing and Improvement

The third trial consisted of a field tryout and a revision. The revised CAI was tested with a group of 30 students. The students were again asked to compete pre-test and post-test as well as a questionnaire on satisfactory. Information obtain from the trail was further used in improving the CAI. The students took between 45-80 minutes to complete the trial. They were then questioned about the text, language, picture and difficulty of the lesson. The students identified some incorrect text in the lesson,

including in answer to several questions. They also preferred background music throughout the lesson. The researcher took note their comment and used them in further revision of the CAI.

The total score of learning achievement test was 25, In the third trial mean scores ($\overline{X}$) of pretest was 15.80, while mean score ($\overline{X}$) of posttest was 19.43. Satisfaction of students was evaluated as show in table 5.

Table 5 Satisfactory Evaluation of CAI on " Water for Life and Health" by Secondary Student Level 3

Evaluated Items	Very High	High	Moderate	Low	Mode
Content					
1) Lesson content	12	18	-	-	High
2) length of lesson	7	23	-	-	High
3) language	5	20	5	-	High
Test form					
1) Question relevant to content	5	25	-	-	High
2) Number of question	7	23	-	-	High
3) Clear question and answer used the clear language	6	24	-	-	High
Picture					
1) Size of pictures and text	11	17	2	-	High
2) Color of picture and text	9	15	6	-	High
3) Attractiveness and comprehensible of picture	7	23	-	-	High
Sound and other complements					
1) Animation for better comprehension	10	15	5	-	High
2) Attracting attention with sound	9	21	-	-	High
3) Encouragement	11	19	-	-	High
4) Easy interaction	12	18	-	-	High
5) Overall opinion about CAI	5	25	-	-	High

From table 5, the results of Satisfactory Evaluation of CAI on " Water for Life and Health" was done by secondary student level 3

4.4 CAI Evaluation by Experts

The researcher defined scope of content from basic educational curriculum B.E.2544 about learning content group, science, social studies, religion and culture in the range of secondary school level 1-3. The opinion of 20 students of Warsawettachat School, in addition the agreement of thesis advisory committee, and expert in the content aspect (details presented in table 6)

Table 6 Content evaluation of CAI by Content

Evaluated Items	Very Good	Good	Moderate	Improved	Mode
Story Flow					
1. Content was relevant to the objectives	2	1	-	-	Very good
2. Introduction to content	2	-	1	-	Very good
3. Correctness sequences of content	2	1	-	-	Very good
4. Preciseness	1	2	-	-	Good
5. Continuation	3	-	-	-	Very good
6. The exercise was relevant to content	2	1	-	-	Good
Pictures					
1. Comprehensible of picture	3	-	-	-	Very good
2. The continuity of pictures	1	1	1	-	Very good
3. The relevance to content	3	-	-	-	Very good
4.The appropriateness to learner	3	-	-	-	Very good
Language use					
1.Correctness	2	1	-	-	Very good
2. Appropriate to age and class level	2	1	-	-	Very good

From table 6, the experts rate satisfactory of the CAI on "Water for Life and Health" at very good- good level. However, one expert recommended change in the use of language with more spacing between sentences and clearer pronunciation and

adding more pictures. The researcher took note of the suggestions and revised the lesson accordingly.

For the evaluation of CAI lesson quality in the aspect of educational technology, they were 3 educational technology experts evaluated (details presented in table 7).

Table 7 Quality Evaluation of CAI by Educational Technology Experts

Evaluated Items	Very Good	Good	Moderate	Improved	Mode
Content					
1. Introduction	1	2	-	-	Good
2. Continuation	1	2	-	-	Good
3. form and presentation	-	2	1	-	Good
The characteristics of Pictures					
1. Size	1	2	-	-	Good
2. Color and attractiveness	2	1	-	-	Very good
3. Resolution	1	2	-	-	Good
4. The continuity of pictures	-	3	-	-	Good
5. Relevance to content	1	1	1	-	-
6. Comprehensible	-	3	-	-	Good
7. Presentation	-	3	-	-	Good
8. Styles	-	3	-	-	Good
Text					
1. Size	2	1	-	-	Very good
2. Font	-	1	-	-	Good
3. Clear and readable	1	1	1	-	-
4. Position	1	1	1	-	-
5. Style	-	1	2	-	Moderate
Sound					
1. Sound track	1	1	1	-	-
2. Narration	-	2	1	-	Good

From table 7, the results of Satisfactory Evaluation of CAI on " Water for Life and Health" was done experts were in the very good and good level. Two experts

recommended that soundtrack should continue through out the lesson. They also suggested faster presentation between pages, larger font for the responded word "registered" and music for pages without text. The recommendations was noted and used in revising the lesson.

4.5 CAI Trial

After revising the CAI on the topic of "Water for Life and Health". They were used in experiment with two target groups who was the student of the secondary school level 3 of academic year 2003 of Watsawettachat School by using Pre-test Post-test Control Groups Design.

4.5.1 The Learning Achievement of Pretest of Experimental Group and Control Group

Before experiment was done, the researcher let the students do the learning achievement test. The results illustrated that experimental group had mean score equal to 15.90, variance was 7.68, and the control group had mean score equal to 15.89, variance was 9.84. The mean scores of two groups were tested the difference between group with the t-test, and it was found that t-value was 1.01, which was lesser than t-value from table that was 2.000, so there was no statistically significant difference between experimental group and control group at level 0.05.

It meant the students of two groups had no difference of the prior knowledge before learning with CAI (details presented in table 8).

Table 8 A Comparison of Knowledge before Learning CAI between Two Groups

Group	(N)	$\overline{X}$	SD	t
Experimental Group	30	15.90	7.68	1.01
Control Group	30	15.86	9.84	

4.5.2 The Learning Achievement of Pretest and Posttest of Control Group

Before experiment was done, the researcher let the students in the control group do the learning achievement test for 30 minutes. The next week the control group who did not learn CAI lesson did the test again. The results illustrated that mean score of pretest and posttest of control group had the close values that were 15.86 and 15. The mean scores of two times were tested the difference with the t-test, and it was found that t-value was 0.19, which was lesser than t-value from table that was 2.045, so there was no statistically significant difference between pre-test and post-test at level 0.05 and df=29. It can be concluded that the prior knowledge of pre-test and post-test of control group were equal (details presented in table 9).

Table 9 A Comparison of Knowledge of Pretest and Posttest of Control Group

Control Group	(N)	$\overline{X}$	SD	t
Pre-test	30	15.86	9.84	0.19
Post- test	30	15.76	11.56	

4.5.3 The Learning Achievement of Pretest and Posttest of Experimental Group

The researcher let the students in the experimental group do the learning achievement test for 30 minutes. The 7 day later, the experimental group who learnt CAI lesson did the post-test for 45-70 minute again. It was found that mean score of pretest and post-test of experimental group were 15.90 for pretest and 19.60 (Appendix) The mean scores of two times were tested the difference with the t-test, and it was found that t-value was 13.41, which was more than t-value from table that was 2.045, so there was statistically significant difference between pre-test and post-test at level 0.05 and df=29. It can be concluded that the experimental group knowledge increased after learning with CAI lesson (details presented in table 10).

Table 10 A Comparison of Knowledge of Pre-test and Post-test of Experimental Group

Experimental Group	N	$\overline{X}$	SD	t
Pre-test	30	15.90	7.68	13.41
Post- test	30	19.60	5.28	

4.5.4 The Learning Achievement of Post-test of Experimental Group and Control Group

A comparison of knowledge of experimental group after learning CAI lesson and control group that did not learn CAI lesson, it was found that that experimental group had mean score equal to 19.60, variance was 5.28, and the control group had mean score equal to 15.76, variance was 11.56. The mean scores of two groups were tested the difference between group with the t-test, and it was found that t-value was 3.26 which was lesser than t-value from table that was 2.000, so there was no statistically significant difference between experimental group and control group at level 0.05 df=58. It can be concluded that the experimental group knowledge increased due to learning with CAI lesson when compared with control group that did not learn CAI lesson actually (details presented in table 11).

Table 11 A Comparison of Knowledge of Post-test between Experimental Group and Control Group

Group	N	$\overline{X}$	SD	t
Experimental Group	30	19.60	5.28	3.26
Control Group	30	15.76	11.56	

4.5.5 Results of Satisfactory Evaluation of CAI Student of Experimental Group

After the experimental group had learnt CAI lesson, they evaluated the satisfaction of CAI by using the criteria of very high, high, moderate, and low, it was found that they satisfied the constructed CAI at a level of high (details presented in table 12).

Table 12 Satisfactory Evaluation of Experimental Group towards CAI

Evaluated Items	Very High	High	Moderate	Low	Mode
Content					
1) Lesson content	14	16	-	-	High
2) length of lesson	14	16	-	-	High
3) language	13	17	-	-	High
Test form					
1) Question relevant to content	12	16	2	-	High
2) Number of question	9	20	1	-	High
3) Clear question and answer used the clear language	15	15	-	-	-
Picture					
1) Size of pictures and text	13	15	2	-	High
2) Color of picture and text	13	15	2	-	High
3) Attractiveness and comprehensible of picture	14	16	-	-	High
Sound and other complements					
1) Animation for better Comprehension	10	18	2	-	High
2) Attracting attention with Sound	12	17	1	-	High
3) Encouragement	10	20	-	-	High
4) Easy interaction	14	15	1	-	High
5) Overall opinion about CAI	12	18	-	-	High

CHAPTER V
DISCUSSIONS

The ever-worsening environmental situation has now forced every sector to cooperate in resolving environmental and natural resources problems. Particularly, the water that is an essential resource has been shortage allover the world or it could not be utilized at maximum profit. One of trues means is environmental education with introduction of interactive media as an additional tool for learning. The researcher had interested in investigating effectiveness of the media and decided to adopt a principle on developing such media by Oranuch Limtasiri for construction of an appropriate interactive lesson.

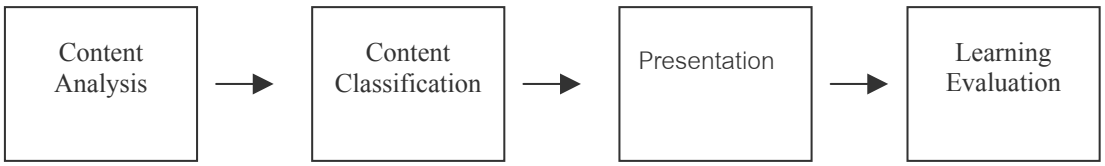
In this study, the researcher decided to construct a computer assisted instruction program (CAI) that is capable of building and understanding on "Water for Life and Health" for secondary school students. Such tool would expose the students to a variety of media such as animation, standstill pictures, narration, and soundtrack, presenting together in an interactive manner, which is appropriate for individual, self–review. Results of the study are discussed under the following heading.

1. Construction of the CAI on the Topic of "Water for Life and Health"
2. Learning Achievement
3. Student satisfaction
4. Possible Development and Enhancement Based on the Study.

5.1 Construction of the CAI on the Topic of "Water for Life and Health"

The construction of the CAI can be divided into 3 steps, construction of teaching process, presentation design and lesson development.

5.1.1 Construction of teaching process consists of steps show in chart 8

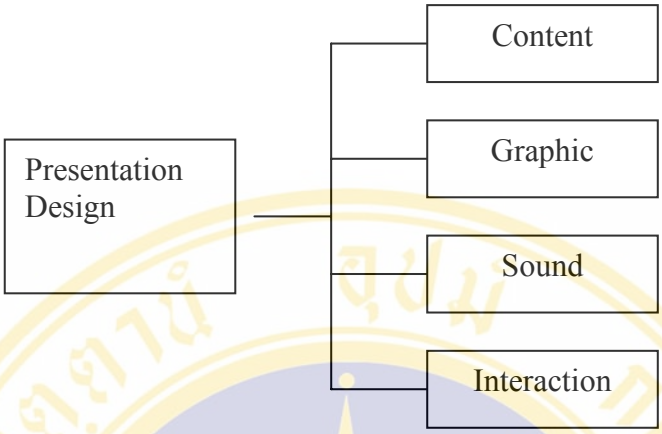


Analysis was carried out on compiled contents of the 2001 basic curriculum for secondary school students that are related to the topic “Water for life and Health”. Such contents were found in the lesson on science module and sociological study module of the curriculum. The analysis was not only restricted to books endorsed by Ministry of Education but also extended to relevant scientific information in order to ensure highest quality. The contents were further discussed with the secondary school level 9 for comments and possible additions of topics at their interests. After the content for the CAI was finalized, it was divided into 6 unit, each with 2 sub-units, before adopted in designing presentation. The lesson consists of both text and questions. If the students answered correctly, they will be congratulated with positive feed back and rewarded with passage to the next learning frame. If the students give wrong answer, they will be required to complete a revision frame before moving forward. Screen interaction of the lesson is connected to the use of mouse and responds with encouraging feedback. Learning achievement is evaluated with a set of question at the end of each unit.

The lesson initially contained only pictures and text. After consultations with the advisor’s, animations and narration were added. Improvement was also made on interactive aspect of the lesson by lessening time of responds and by moving distributing questions through out the unit (instead of placing all the end) in order to stimulate learner’s interests and enable move immediate revision of lesson.

From the construction of the CAI, the researcher found that the design of the lesson should let the learners have an opportunity to make a decision. On the technical aspect, the researcher discovered that interactive responds were most effective when shown in the same frame. Results of answer that is shown with the question do act as encouragement for learner.

5.1.2 Presentation design was carried on as shown in chart 9



As described in the diagram, there were 4 component in designing the presentation, content, graphic, sound and interaction.

On the content, fashionable forms of letters were used for both headings and messages, Sizes of letters were used do varied between topics due to different lengths on each message.

Only the most relevant and comprehensible pictures were included. Some could be considered too small due to limited availability of their originals.

Researcher recorded her own voice for the narration of the CAI. The recording was undertaken with expert advisers to ensure proper spacing and clear pronunciation.

After the initial design, the following improvements were made base on recommendation of the experts

1. Changing the letter to a single conventional typing font in accordance to a recommendation made by :rietpong Leksiriratana (cite in Sodsai Chirachariyakul, 2002:28) who had found such font to be the easiest in reading.
2. Lessening time-lag between each screen
3. Re-recording narration to ensure clearer sound
4. Adding return button to encourage move revision

Lesson learn from presentation design of the CAI includes the need for Attractive presentation of short but accurate content, dividing up lengthy message into a number of shorter and move conclusive text. In addition, graphic should be presented in appropriate size, simple and relevant as recommended by Sodsai Chirachariyakul (2002:28) The experts also recommended adding soundtrack to non-textual pages in order to prevent boredom and designing buttons that fit particular learning activities.

5.1.3 Lesson development consisted of steps show in chart 10

A story board was created to divided content into each frame, to determine steps in presenting text, graphic and sound and to develop presentation technique through out the lesson. When completed, the CAI was created with Authorware before tested 3 time with sample groups. The results were evaluated by the experts, who later recommended revision of the lesson. The revision included…

1. Providing move details and rearranging sequence of the presentation
2. Introducing animation in the presentation with the use of Swish version 2.0 and Flash MX.

Content experts educational technology experts examined the constructed CAI, the results were at very good and good level. This certified the lesson as an appropriate media for the experiment.

Problem concerning the CAI

- Reduction in anxiousness and interest of students once. They became increasingly acquainted with personal computers as found by a study of Kritsmat Watananarong (2536:139) on limitation of computer.
- The lack of researcher's own knowledge on animation making software

as shown by limited use of Swish version 2.0 and Flash MX software. This is as found by Chagetha Teamphet (2543:24-25) who discovered that the good of CAI must use many program.

5.2 Learning Achievement

The experiment was conducted with pre-test and post-test of 2 group, experiment group and a control group. The experiment revealed that average post-test score of the experiment group is significantly greater than obtained from the pre-test of the same group (statistically difference at 0.05). This indicates acquisition of knowledge through the use of the interactive lesson by the students. In addition the average post-test score of the experiment group was found to be higher than that of the control group. This is consistent with fining of several researches on development of interactive teaching tools including a study on academic achievement from the use of interactive lesson for learning digestion system by the secondary school students level 3 Virawan Chatan (1994:Abstract) a research on application of computer aid in learning about mangrove forest by Sishol Kuanmetta (2000:Abstract) and a research on development of interactive aid on the topic "Kid and Creative Idea about Helping the Environment by Chatree Jindamanee (1998: Abstract).

5.3 Student Satisfaction

The over all satisfactory of 30 students in the experiment group towards CAI on the topic of "Water for life and Health" was found to be relatively high. The student expressed their satisfaction with content, graphic, sound and feedback and their devise for adoption of such interactive media in other disciplines. This is consistent with studies of Vilawan Chatan(2537:83) Worawit Khankaew (2542:94) which reveals student's positive attitudes toward the interactive media and called for support on developing such media for each subject in school's curriculum.

5.4 Possible Development and Enhancement Based on the Study

5.4.1 Feedback on wrong answer in the CAI does act as disincentives to users at certain extend. The reply “incorrect” “may be too strong and could perhaps be changed to more encouraging wording such as “you are close” or try again”.

5.4.2 The interactive lesson could stimulate more interest it the producer (the researcher) is capable of integrating more animation.

5.4.3 Development of interactive lesson may be time-consuming in structural preparation and programming. However, ability in making unlimited copies of the software making the CAI a post-effective and easily distributed teaching media for students.

5.4.4 In addition, the interactive media does have considerable flexibility and can easily accommodate more update content with re-programming. 5.4.4 In addition,

5.4.5 Better recording of sound is needed, through the use of proper-recorded studio.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

This study was to research on the development of CAI on the topic of "Water for Life and Health" for secondary school students. It was tried out with the students of the secondary school level 3 in order to determine the learning achievement after learning with CAI, and whether the CAI is effective enough for teaching or not, including evaluating the student satisfaction on CAI. The research resulted can be concluded as follows:

1. Construction and Development of CAI
2. Trial of CAI
3. Recommendation from the Research
4. Recommendation for Further Research

6.1 Construction and Development of CAI

To construct this CAI , the researcher had constructed the content by studying and searching the related documents in order to be relevant to the basic educational curriculum B.E.2544 in the range of secondary school level 1-3, and inquired the information from students that what they want to know additionally. The content was improved according to the recommendations of thesis advisory committee, and experts.

The constructed CAI on the topic of "Water for Life and Health", its content can divided into 6 learning units as follows:

Unit 1 Topic of the importance of water

Unit 2 Topic of water cycle, and natural water source

Unit 3 Topic of food resource in water

Unit 4 Topic of consumed water becomes wastewater

Unit 5 Topic of making water to be clean

Unit 6 Topic of treatment of wastewater

The researcher implemented the construction of CAI by defining the lesson content, and designing the flowing of lesson. Then CAI was produced by using Authorware program version 6.0. After the CAI was constructed, its quality was examined the by thesis advisory committee and experts, and it was corrected and improved the lesson.

The development of CAI was tried out 3 times, and it was improved after every time of trial.

The first time was individual testing, it was tried out by 3 students who had learning at result at weak moderate level, and test was done before and after learning.

The second time was small group testing, it was tried out by 7 students who had learning result at moderate level, and test was done before and after learning.

The third time was field testing, it was tried out by 30 students who had learning result at moderate level, and test was done before and after learning, and satisfactory evaluation was included.

It was presented to thesis advisory committee, then it was evaluated about its quality by 3 experts of the content aspect, 3 experts of educational technology aspect and it was corrected and improved the lesson. According to their recommendations

6.2 Trial of CAI

The improved CAI was tried out with the sample group who were the 60 students of the secondary school level 3 of Watsawettachat School, Bangkok Metropolis. They were divided into 30 students per group of experimental group and control group. The sample group both experimental group and control group were tested their knowledge level before learning with CAI. The next week the experimental group learnt the CAI but the control group did not learn. Afterward both group were tested with the same test. The satisfactory evaluation of CAI was done by the experimental group. The results can be concluded as follows:

6.2.1 The learning achievement of the experimental group who learnt CAI had the mean score of posttest higher than the mean score of pretest statistically significant at level of 0.05, and it was higher than the mean scores of posttest of control group the experimental group according to the set hypothesis.

6.2.2 results of Satisfactory Evaluation of CAI was done students of experimental group who learnt CAI lesson , it was found that they satisfied in different aspects at a good level.

6.3 Recommendation from the Research

In the research of construction of CAI on the topic of "Water for Life and Health" for secondary school students, the research had recommendations from the research as follows:

1) To construct the CAI, the researcher must pay attention to the form of letter and orthography because it was constructed as tool assistant for teachers. In this study the research designed the letter according to the student popularity but it was difficult to read. Even though the students satisfied but thesis advisory committee and some expert suggested to change this style of letter because the letter according to the student popularity was difficult to read and was not follow orthography, and it was combined with the policy of education of Bangkok Metropolis that implemented the project of beautiful hand writing as Thai style since 2000 to present time. This policy has emphasized to every student in Bangkok Metropolis to have beautiful hand writing according to orthography. Therefore the letter style must be corrected before try out in the experiment. The by-product from the CAI constructed that is the students will be grow for writing letter orderly and according to orthography, simultaneously, being cultural conservation of national language. Therefore, changes were made to fonts in accordance to the policy, consistent with Technology Department guideline on presentation design of interactive media. Under the guideline, content is considered the main components of such media. Font size and type should be easily readable and appropriate for students. The satisfactory

evaluation of letterform was done by students was at good level, it may due to the adjusted presentation such as letter moving for instance.

2) To use color, to move the picture, and musical sound may be the stimuli for students to eager to learn or do activities in the lessons.

3) The constructed CAI must provide an opportunity for learner to choose and to make decision such as input data through the button.

6.4 Recommendation for Further Research

In order to be benefit and guideline for further research, the researcher would like to give the recommendations as follows:

1) It should have the experimental research on CAI lesson in branching program in other forms of games, simulations, and problem solving, in order to give a change for learner to select the learning lesson according to the appropriateness and to be relevant to the learning subjects as most as possible.

2) In the research, even though, there is manual for CAI using, the researcher should demonstrate and give suggestion for computer using in order to make learner to be familiar, and to be facile for using and decreasing the anxiety before experiment starting.

3) It should be promoted to use CAI gradually more, and supported to research on the construction of CAI for children who have problem of retarded learning and need to revise the learning lesson.

4) An experiment on the use of interactive learning tools without teacher supervision should be conducted to investigate actual self-learning and academic achievement when students are not subjected to time constrain of classroom.

5) Software of the interactive lesson can be adapted for development of a new lesson. For example, by copying flow line from Authorware and making change to content, graphic, presentation and sound.

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APPENDIX A

LIST OF EXPERTS

รายนามผู้ทรงคุณวุฒิในการประเมินผลคุณภาพบทเรียนคอมพิวเตอร์ช่วยสอน

ผู้ทรงคุณวุฒิในการประเมินคุณภาพบทเรียนคอมพิวเตอร์ช่วยสอนเรื่อง น้ำเพื่อชีวิตและสุขภาพ ประกอบด้วยผู้ทรงคุณวุฒิด้านต่าง ๆ ดังนี้

1. ผู้ทรงคุณวุฒิทางด้านเนื้อหา
   1) ดร.เกษมสันต์ สุวรรณรัต
      วุฒิทางการศึกษา วศ.บ., Master of Science (วิศวกรรมสาธารณสุข)
      ปริญญาเอกวิศวกรรมศาสตร์ (Dr.Ing)
      ตำแหน่งหน้าที่ ประธานกรรมการองค์การจัดการน้ำเสีย
      สถานที่ทำงาน องค์การจัดการน้ำเสีย
   2) นางสาวนภาภรณ์ ตั้งภูเบศร์
      วุฒิทางการศึกษา กศ.บ.
      ตำแหน่งหน้าที่ อาจารย์ 3 ระดับ 8
      สถานที่ทำงาน โรงเรียนวัดเศวตฉัตร
   3) นายเฟื่องศักดิ์ กองเจริญ
      วุฒิทางการศึกษา กศ.บ., น.บ.
      ตำแหน่งหน้าที่ ศึกษาธิการเขต
      สถานที่ทำงาน ฝ่ายการศึกษา สำนักงานเขตตลิ่งชัน
2. ผู้ทรงคุณวุฒิทางเทคโนโลยีทางการศึกษา
   1) นายสมพงษ์ ชูสุวรรณ
      วุฒิทางการศึกษา พ.ม.
      ตำแหน่งหน้าที่ อาจารย์ 2 ระดับ 7
      สถานที่ทำงาน ศูนย์คอมพิวเตอร์โรงเรียนวัดเศวตฉัตร
   2) นายชูศักดิ์ พิบูลย์ไพโรจน์
      วุฒิทางการศึกษา ศศ.ม. (พละศึกษา)
      ตำแหน่งหน้าที่ รักษาการในตำแหน่งผู้ช่วยอาจารย์ใหญ่
      สถานที่ทำงาน โรงเรียนวัดใหม่ยายนุ้ย

3) นายเชษฐา เทียมเพชร์

วุฒิทางการศึกษา	ค.ม.(โสตทัศนศึกษา)
ตำแหน่งหน้าที่	อาจารย์ 2 ระดับ 7
สถานที่ทำงาน	วิทยาลัยพณิชยการอินทราชัย

APPENDIX B

TABLE OF ANALYSIS

การวิเคราะห์ข้อมูล

ตารางที่ 13 ค่าระดับความยากง่ายและค่าอำนาจจำแนกของแบบวัดผลสัมฤทธิ์ทางการเรียน โดยนักเรียนชั้นมัธยมศึกษาปีที่ 3 ที่ไม่ใช่กลุ่มตัวอย่าง

ข้อที่	จำนวนผู้ตอบถูกในกลุ่มสูง(P_H)	จำนวนผู้ตอบถูกในกลุ่มต่ำ (P_L)	ค่าความยากง่าย (P)	ค่าอำนาจจำแนก (R)
1. *	8	7	0.9375	0.125
2.	8	3	0.6875	0.625
3.	8	3	0.6875	0.625
4.*	8	8	1	0
5.*	7	6	0.8125	0.125
6.	5	2	0.4375	0.375
7.	6	3	0.5625	0.375
8.	5	2	0.4375	0.375
9.	8	3	0.6875	0.625
10.*	8	7	0.9375	0.125
11.	6	3	0.5625	0.375
12.*	7	7	0.875	0
13.*	7	6	0.8125	0.125
14.	6	2	0.5	0.5
15.	8	4	0.75	0.5
16.	8	3	0.6875	0.625
17.	7	4	0.8875	0.375
18.	5	2	0.4375	0.375
19.	8	3	0.6875	0.625
20.	6	2	0.5	0.5
21.*	8	8	1	0
22.	6	2	0.5	0.5

ตารางที่ 13 (ต่อ) ค่าระดับความยากง่ายและค่าอำนาจจำแนกของแบบวัดผลสัมฤทธิ์ทางการเรียน โดยนักเรียนชั้นมัธยมศึกษาปีที่ 3 ที่ไม่ใช่กลุ่มตัวอย่าง

ข้อที่	จำนวนผู้ตอบถูกในกลุ่มสูง(P_H)	จำนวนผู้ตอบถูกในกลุ่มต่ำ (P_L)	ค่าความยากง่าย (P)	ค่าอำนาจจำแนก (R)
23.	6	3	0.5625	0.375
24.*	8	7	0.9375	0.125
25.	5	2	0.4375	0.375
26.	7	3	0.625	0.5
27.*	8	7	0.9375	0.125
28.	8	3	0.6875	0.625
29.*	8	6	0.9375	0.125
30.	7	3	0.625	0.5
31.	5	2	0.4375	0.375
32.	8	4	0.75	0.5
33.	5	2	0.4375	0.375
34.	7	3	0.625	0.5
35.	8	3	0.6875	0.625

หมายเหตุ * ข้อที่ไม่ผ่านการวิเคราะห์คุณภาพ
ค่า P ที่ใช้ได้ คือ 0.20-0.80
ค่า R ที่ใช้ได้คือ 0.20 ขึ้นไป

ตารางที่ 14 การหาค่าความเชื่อมั่นของแบบทดสอบวัดผลสัมฤทธิ์ทางการเรียน โดยใช้สูตรคูเดอร์ ริชาร์ดสัน 20

ข้อที่	P	q(1-p)	Pq
1.	0.63	0.37	0.2331
2.	0.63	0.37	0.2331
3.	0.60	0.40	0.1440
4.	0.63	0.37	0.2331
5.	0.56	0.44	0.2464
6.	0.63	0.37	0.2331
7.	0.60	0.44	0.1440
8.	0.63	0.37	0.2331
9.	0.66	0.34	0.2244
10.	0.70	0.30	0.2100
11.	0.70	0.30	0.2100
12.	0.50	0.50	0.2500
13.	0.66	0.34	0.2244
14.	0.63	0.37	0.2331
15.	0.60	0.40	0.1440
16	0.53	0.47	0.2491
17.	0.63	0.37	0.2331
18.	0.56	0.44	0.2464
19.	0.66	0.34	0.2244
20.	0.63	0.37	0.2331
21.	0.66	0.34	0.2244
22.	0.73	0.27	0.1971
23.	0.56	0.44	0.2464
24.	0.63	0.37	0.2331
25.	0.66	0.34	0.2244
K=30			Σpq 5.5073

ดังนั้น หาค่าความเชื่อมั่นได้จากสูตร คูเดอร์ ริชาร์ดสัน 20 ได้ดังนี้

$$r = \frac{K}{k-1}\left\{1 - \frac{\sum pq}{s^2}\right\}$$

$$= \frac{30}{29}\left\{1 - \frac{5.5073}{19.29}\right\}$$

$$= 0.74$$

ตารางที่ 15 แสดงคะแนนวัดผลสัมฤทธิ์ทางความรู้ก่อนและหลังการทดลองของนักเรียนกลุ่มควบคุม

คนที่	หลังเรียน (X_1)	X_1^2	ก่อนเรียน (X_2)	X_2^2	$(X_1- X_2)=D$	$(X_1- X_2)^2=D^2$
1	20	400	18	324	2	4
2	19	361	17	289	2	4
3	20	400	23	529	-2	4
4	17	289	18	324	-1	1
5	14	196	13	169	1	1
6	16	256	19	361	-3	9
7	15	225	15	225	0	0
8	14	196	13	169	1	1
9	18	324	21	441	-3	9
10	10	100	15	225	-5	25
11	11	121	10	100	1	1
12	20	400	20	400	0	0
13	16	256	15	225	1	1
14	18	324	19	361	-1	1
15	19	361	17	289	2	4
16	16	256	14	196	2	4
17	19	361	18	324	1	1
18	13	169	15	225	-2	4
19	11	121	10	100	1	1
20	17	289	16	256	1	1
21	22	484	20	400	2	4
22	11	121	14	196	-3	9
23	17	289	15	225	2	4
24	10	100	12	144	-2	4
25	14	196	14	196	0	0

ตารางที่ 15 (ต่อ) แสดงคะแนนวัดผลสัมฤทธิ์ทางความรู้ก่อนและหลังการทดลองของนักเรียนกลุ่มควบคุม

คนที่	หลังเรียน (X_1)	X_1^2	ก่อนเรียน (X_1^2)	X_2^2	$(X_1 - X_2)=D$	$(X_1 - X_2)^2=D^2$
26	18	324	16	256	256	4
27	10	100	12	144	144	4
28	14	196	14	196	196	0
29	17	289	18	324	324	1
30	17	289	15	225	225	4
N 30	ΣX_1 473	ΣX_1^2 7793	ΣX_1^2 476	ΣX_2^2 7838	ΣD -2	ΣD^2 110

ตารางที่ 16 แสดงคะแนนวัดผลสัมฤทธิ์ทางความรู้ก่อนและหลังการทดลองของนักเรียน กลุ่มทดลอง

คนที่	หลังเรียน (X_1)	X_1^2	ก่อนเรียน (X_2)	X_2^2	$(X_1- X_2)=D$	$(X_1- X_2)^2=D^2$
1	22	484	20	400	2	4
2	21	441	18	324	3	9
3	21	441	17	289	4	16
4	23	529	18	324	5	25
5	20	400	18	324	2	4
6	19	361	15	225	4	16
7	17	289	15	225	2	4
8	20	400	14	196	6	36
9	19	361	12	144	7	49
10	21	441	19	361	2	4
11	20	400	17	289	3	9
12	21	441	15	225	6	36
13	20	400	16	256	4	16
14	19	361	18	324	1	1
15	18	324	14	196	4	16
16	20	400	15	225	5	25
17	15	225	10	100	5	25
18	19	361	14	196	5	25
19	22	484	19	361	3	9
20	24	576	20	400	4	16
21	19	361	16	256	3	9
22	16	256	14	196	2	4
23	18	324	15	225	3	9
24	18	324	13	169	5	25
25	17	289	15	225	3	4

ตารางที่ 16 (ต่อ) แสดงคะแนนวัดผลสัมฤทธิ์ทางความรู้ก่อนและหลังการทดลองของนักเรียนกลุ่มทดลอง

คนที่	หลังเรียน (X_1)	X_1^2	ก่อนเรียน (X_1^2)	X_2^2	$(X_1 - X_2)=D$	$(X_1 - X_2)^2=D^2$
26	22	484	20	400	2	4
27	24	576	20	400	4	16
28	20	400	16	256	4	16
29	17	289	14	196	3	9
30	16	256	10	100	6	36
N	ΣX_1	ΣX_1^2	ΣX_1^2	ΣX_2^2	ΣD	ΣD^2
30	588	11678	477	7807	111	477

APPENDIX C

TOOL FOR THE STUDY

แบบทดสอบวัดผลสัมฤทธิ์ทางการเรียน เรื่องน้ำเพื่อชีวิตและสุขภาพ
สำหรับนักเรียนระดับชั้นมัธยมศึกษาตอนต้น
จำนวนข้อ 25 ข้อ

.....

คำชี้แจง:ให้นักเรียน X ทับตัวอักษร ก ข ค หรือ ง ในคำตอบที่ถูกต้องเพียงคำตอบเดียว
(25 คะแนน)

1. อาชีพในข้อใดต้องการน้ำมากที่สุด
   ก. ครู ข. เกษตรกร ค. คนขับรถ ง. ทนายความ

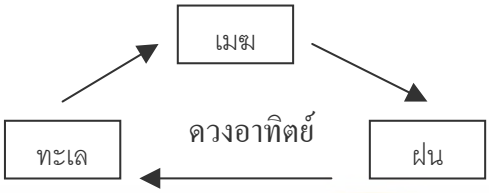
2. ประโยชน์ของน้ำมีต่อมนุษย์มากที่สุดคือข้อใด
   ก. การดื่ม ข. การอาบน้ำ ค. การซักล้าง ง. การพักผ่อน

3. ข้อใดเป็นการนำน้ำมาฟื้นฟูธรรมชาติ
   ก. นำน้ำมาใช้แล้วมาใช้ใหม่ ข. นำน้ำเสียรวบรวมลงท่อ
   ค. นำน้ำมาผลิตกระแสไฟฟ้า ง. น้ำดีไล่น้ำเสียและน้ำเค็ม

4. ข้อดีของการขนส่งทางน้ำคือข้อใด
   ก. ลดมลพิษทางอากาศ ข. ขนสินค้าได้ขนาดใหญ่ได้และราคาถูก
   ค. ขนสินค้าได้สะดวกและปลอดภัย ง. ขนสินค้าได้ทุกประเภทและรวดเร็ว

5. ในโรงงานอุตสาหกรรมนำน้ำมาใช้ในกิจกรรมใดมากที่สุด
   ก. ใช้ในการผลิตโดยตรง ข. ใช้ในหม้อต้มน้ำ
   ค. ใช้ในการหล่อเย็นและควบแน่น ง. ใช้ในการซักล้างและอื่น ๆ

6. จากรูปแสดงวัฏจักรของสิ่งใด



ก. วัฏจักรของน้ำ ข. วัฏจักรของทะเล
ค. วัฏจักรของเมฆ ง. วัฏจักรของลม

7. แหล่งน้ำข้อใดมีลักษณะเหมือนกับการกลั่น
ก. น้ำผิวดิน ข. น้ำในบรรยากาศ ค. น้ำในดิน ง. น้ำบาดาล

8. แหล่งน้ำในธรรมชาติข้อใดมีการเน่าเสียเร็วที่สุด
ก. น้ำในบรรยากาศ ข. น้ำผิวดิน ค. น้ำในดิน ง. น้ำบาดาล

9. การทรุดตัวของแผ่นดินเกิดจากข้อใด
ก. การสร้างถนนยกระดับหลายสาย ข. การสร้างนิคมอุตสาหกรรม
ค. การสูบน้ำบาดาลมาใช้มาก ง. การขุดอุโมงค์ลึกใต้พื้นดิน

10. ทะเลและมหาสมุทรให้สารอาหารประเภทใดมากที่สุด
ก. คาร์โบไฮเดรต ข. โปรตีน ค. ไขมัน ง.เกลือแร่

11. ผู้ผลิตเบื้องต้นในแหล่งน้ำคือข้อใด
ก. กุ้ง ข. หอย ค. ปะการัง ง. แพลงก์ตอน

12. เหตุใดคนไทยจึงนิยมรับประทานปลามากกว่าเนื้อสัตว์ชนิดอื่น
ก. ราคาถูกและหาง่าย ข. มีความอร่อยกว่าเนื้อสัตว์ชนิดอื่น
ค. มีคุณค่าอาหารครบถ้วน ง. สะดวกในการประกอบอาหาร

13. ข้อใดไม่ถูกต้องเกี่ยวกับเกลือสมุทร
    ก. การทำนาเกลือต้องทำใกล้ทะเล
    ข. น้ำทะเลมีเกลือโซเดียมคลอไรด์มากที่สุด
    ค. เกลือสมุทรบางทีเรียกว่าเกลือทะเล
    ง. ทำนาเกลือใช้วิธีการระเหยและการระเหิด

14. กิจกรรมใดที่ทำความเสียหายให้ป่าชายเลนมากที่สุด
    ก. การเผาถ่าน ข. การทำนาเกลือ
    ค. การทำนากุ้ง ง. การดักจับปลา

15. การเทผงซักฟอกลงแหล่งน้ำ ทำให้น้ำเสีย เพราะเหตุใด
    ก. แบคทีเรียใช้ออกซิเจนย่อยสลายสารอินทรีย์ในน้ำ
    ข. แบคทีเรียในน้ำตายเพราะสารฟอสเฟตในผงซักฟอก
    ค. ผงซักฟอกมีสารพิษทำให้พืชและสัตว์น้ำตาย
    ง. ผงซักฟอกทำปฏิกิริยากับน้ำ ทำให้ออกซิเจนลดลง

16. ข้อใดไม่ใช่ผลกระทบของน้ำทิ้งที่มีอุณหภูมิสูง
    ก. ปลาออกไข่นอกฤดูกาล ข. พืชน้ำไม่สามารถสร้างอาหารได้
    ค. พืชน้ำเจริญเติบโตได้รวดเร็ว ง. แหล่งน้ำขาดออกซิเจน

17. ข้อใดกล่าวไม่ถูกต้อง
    ก. สารฟอสเฟตทำให้พืชน้ำเจริญเติบโตได้ดี
    ข. พืชน้ำตายถูกย่อยสลายทำให้แหล่งน้ำขาดออกซิเจน
    ค. น้ำหล่อเย็นระบายลงแหล่งน้ำทำให้สัตว์น้ำตาย
    ง. น้ำทิ้งจากเหมืองแร่มีเชื้อโรคมากกว่าน้ำทิ้งจากคอกปศุสัตว์

18. ข้อใดเป็นการป้องกันและแก้ไขปัญหาน้ำเสียที่เป็นน้ำทิ้งจากโรงงานอุตสาหกรรมได้ดีที่สุด
    ก. การไม่อนุญาตให้มีโรงงานอุตสาหกรรมเพิ่มขึ้น
    ข. การให้ขยายโรงงานอุตสาหกรรมเท่าที่จำเป็น
    ค. การควบคุมไม่ให้โรงงานอุตสาหกรรมตั้งอยู่ริมน้ำ
    ง. การควบคุมคุณภาพน้ำทิ้งให้ได้มาตรฐานที่กำหนด

19. ขั้นตอนที่สำคัญของกระบวนการผลิตน้ำประปาคือข้อใด
    ก. การตกตะกอน การฟอกสี และการฆ่าเชื้อโรค
    ข. การฆ่าเชื้อโรค การตกตะกอน การฟอกสีและกลิ่น
    ค. การฆ่าเชื้อโรค การกรอง และการตกตะกอน
    ง. การตกตะกอน การกรอง และการฆ่าเชื้อโรค

20. การผลิตน้ำประปาโดยใช้น้ำบาดาลสามารถลดขั้นตอนการผลิตข้อใด
    ก. การกรอง ข. การเติมคลอรีน
    ค. การตกตะกอน ง. ถูกทุกข้อ

21. ในชีวิตประจำวันควรดื่มน้ำใดมากที่สุด
    ก. น้ำต้ม ข. น้ำกรอง ค. น้ำกลั่น ง. น้ำฝน

22. วิธีใดที่สามารถแยกสารเจือปนที่ไม่ละลายในน้ำได้ดีที่สุด
    ก. การเกรอะ ข. การกลั่น ค. การกรอง ง.การตกตะกอน

23. น้ำเสียที่มีการปนเปื้อนประเภทน้ำมันและไขมันในครัวเรือนควรต่อท่อเข้าข้อใดก่อนสู่ระบบบำบัดน้ำเสีย
    ก. ถังเกรอะ ข. ถังแซทส์ ค. บ่อดักไขมัน ง.ถังกรองไร้อากาศ

24. ระบบบำบัดน้ำเสียขนาดใหญ่ของกรุงเทพมหานครเป็นระบบใด
    ก. ระบบบำบัดน้ำเสียรวม ข. ระบบบำบัดน้ำเสียประจำอาคาร
    ค. ระบบบำบัดน้ำเสียในโรงงาน ง. ระบบบำบัดน้ำเสียติดกับที่

25. จากรูปใช้หลักการข้อใดบำบัดน้ำเสีย (โครงการบำบัดน้ำเสียบึงพระราม 9)

ก. การกรอง ข. น้ำดีไล่น้ำเสีย

ค. เติมอากาศในน้ำ ง. เติมสารเคมี

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เฉลยแบบวัดผลสัมฤทธิ์ทางการเรียน เรื่องน้ำเพื่อชีวิตและสุขภาพ

1.	ข	14.	ค.
2.	ก	16.	ข.
3.	ง	17.	ง.
4.	ข	18.	ง.
5.	ค.	19.	ง.
6.	ก.	20.	ง.
7.	ข.	21.	ก.
8.	ข.	22.	ค.
9.	ค.	23.	ค.
10.	ข.	24.	ก.
11.	ง.	25.	ค.
12.	ก.		
13.	ง.		

แบบประเมินคุณภาพบทเรียนคอมพิวเตอร์ช่วยสอน เรื่องน้ำเพื่อชีวิตและสุขภาพ
สำหรับผู้ทรงคุณวุฒิทางด้านเนื้อหา

คำชี้แจง โปรดเขียนเครื่องหมาย ✓ ลงในช่องทางขวามือให้ตรงกับความคิดเห็นของท่าน

เนื้อหาหัวข้อประเมิน	ดีมาก	ดี	พอใช้	ควรปรับปรุง
การดำเนินเรื่อง				
1) เนื้อหามีความสอดคล้องกับวัตถุประสงค์				
2) ความเหมาะสมในการนำเข้าสู่เนื้อหา				
3) ความถูกต้องในการลำดับเนื้อหา				
4) ความชัดเจนในการอธิบายเนื้อหา				
5) ความสอดคล้องของเนื้อหาในแต่ละขั้นตอน				
6) แบบฝึกหัดสอดคล้องกับเนื้อหา				
ลักษณะของภาพ				
1) สามารถสื่อความหมายได้				
2) ความต่อเนื่องของภาพ				
3) มีความสัมพันธ์กับเนื้อเรื่อง				
4) มีความเหมาะสมกับระดับผู้เรียน				
ภาษาที่ใช้				
1) ความถูกต้อง				
2) สื่อความหมายได้ ได้ใจความเหมาะสมกับวัยและระดับชั้นเรียน				

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แบบประเมินคุณภาพบทเรียนคอมพิวเตอร์เรื่องน้ำเพื่อชีวิตและสุขภาพ
สำหรับผู้ทรงคุณวุฒิทางด้านเทคโนโลยีทางการศึกษา

คำชี้แจง โปรดเขียนเครื่องหมาย ✓ ลงในช่องทางขวามือให้ตรงกับความคิดเห็นของท่าน

รายการประเมิน	ดีมาก	ดี	พอใช้	ควรปรับปรุง
เนื้อเรื่อง				
1. ความเหมาะสมในการเข้าสู่เนื้อหา				
2. การดำเนินเรื่องมีความต่อเนื่อง				
3. ความเหมาะสมในรูปแบบและวิธีการนำเสนอ				
ลักษณะของภาพ				
1. ขนาดของภาพเหมาะสม				
2. สีสัน สวยงาม				
3. ความคมชัดของภาพ				
4. ความต่อเนื่องของภาพ				
5. มีความสัมพันธ์กับเนื้อเรื่อง				
6. สามารถสื่อความหมายได้ดี				
7. การจัดภาพ				
8. ลักษณะการนำเสนอ				
ตัวอักษรประกอบ				
1. ขนาดเหมาะสม				
2. ความสวยงาม				
3. ชัดเจน อ่านง่าย				
4. การจัดวางตำแหน่ง				
5. ลักษณะการนำเสนอ				
ภาษาที่ใช้ในการบรรยาย				
1. ความถูกต้อง				
2. สื่อความหมายได้ดี ได้ใจความ				
3. เหมาะสมกับวัยและระดับชั้นเรียน				

แบบประเมิน (ต่อ)

รายการประเมิน	ดีมาก	ดี	พอใช้	ควรปรับปรุง
เสียงที่ใช้				
1. เสียงดนตรีประกอบชัดเจน เหมาะสม				
2. เสียงบรรยายประกอบถูกต้อง ชัดเจน เหมาะสม				

ข้อเสนอแนะอื่นๆ

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แบบประเมินความพึงพอใจของนักเรียนชั้นมัธยมศึกษาปีที่ 3 ที่มีต่อบทเรียนคอมพิวเตอร์ช่วยสอนเรื่องน้ำเพื่อชีวิตและสุขภาพ

คำชี้แจง โปรดเขียนเครื่องหมาย ✓ ลงในช่องทางขวามือให้ตรงกับความคิดเห็นของท่าน

ข้อความในการประเมิน	มากที่สุด	มาก	ปานกลาง	ปรับปรุง
เนื้อหาสาระ				
1) เนื้อหาของบทเรียน				
2) ความยาวของบทเรียนมีความเหมาะสม				
3) ภาษาที่ใช้เข้าใจง่าย				
แบบทดสอบ				
1) คำถามสอดคล้องกับเนื้อเรื่อง				
2) จำนวนคำถามมีความเหมาะสม				
3) คำถามและคำตอบใช้ภาษาที่ชัดเจน				
ภาพ				
1) ขนาดของภาพและตัวหนังสือที่ เหมาะสม				
2) สีของภาพและตัวอักษรเร้าความสนใจ				
3) ภาพช่วยให้เข้าใจเรื่องได้ดีและดึงดูดความสนใจ				
เสียงและส่วนประกอบอื่น ๆ				
1) การเคลื่อนไหวของภาพช่วยให้เข้าใจเรื่องได้ง่าย				
2) การใช้เสียงช่วยเร้าความสนใจ				
3) การเสริมแรงจัดให้เหมาะสม				
4) การตอบสนองง่ายต่อการทำความเข้าใจ				
5) ความเห็นโดยรวมที่มีต่อบทเรียนคอมพิวเตอร์ช่วยสอนเรื่องนี้				

ข้อเสนอแนะ……

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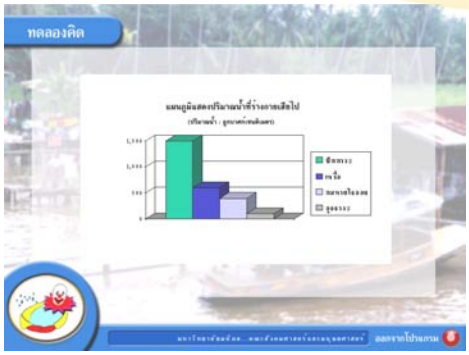
APPENDIX D

EXAMPLE OF STUDY



BIOGRAPHY

NAME	Miss.Namfon Yoodee
DATE OF BIRTH	20 June 1964
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTION ATTENDED	Chulalongkorn University (1982-1986) Bachelor of Education (Teaching of Specialized Subject: Business) Mahidol University 1999-2003 Master of Education (Environmental Education)
POSTION AND OFFICE	Personnel Personnel Division Office of Permanent Secretary for the Bangkok Metropolitan Administration