

**THE DEVELOPMENT OF A SUPPLEMENTARY READING
BOOK ON SOLAR ENERGY FOR ELECTRICITY
GENERATION FOR THE UPPER SECONDARY
SCHOOL STUDENTS**



**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
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Thesis
entitled

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THE DEVELOPMENT OF SUPPLEMENTARY READING BOOK ON SOLAR ENERGY FOR ELECTRICITY GENERATION FOR THE UPPER SECONDARY SCHOOL STUDENTS

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ABSTRACT

This study was experimental research with the objective to develop a supplementary reading book on the topic of “Solar Energy for Electricity Generation” to complement the study topic “Life and Environment” for upper secondary school level 4. Research methodology was composed of construction of the book and determination of efficiency of learning with an achievement test. The book’s development was aided by three preliminary trial runs with upper secondary school level 4 of Triam Udom Suxsa Patakarn Rachada, Huay Khang District, Bangkok, who were not in the subsequent sample group. The constructed book was improved and corrected according to the recommendations of a thesis advisory committee and experts, and was tried out with a sample group totaling 60 students from the same school. The group was divided into sub-groups as 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. The results were as follows:

1. The achievement scores of the post-test experimental group were higher than the pre-test score at the level of statistical significance of 0.0001.
2. The achievement scores of the post-test experimental group were higher than the post-test score of the control group at the level of statistical significance of 0.0001.
3. The level of satisfaction with the constructed book was evaluated by students as very good and good.

It can be concluded that the supplementary reading book on the topic of “Solar Energy for Electricity Generation,” is appropriate to promote knowledge and understanding of the worth of solar energy for electricity generation to upper secondary school students. Moreover, it can be used for all informal, non-formal, and lifelong education systems.

Recommendations from the study are that research into extensive use of solar energy and education to promote knowledge of untapped resources should be given a budget for serious research. Public knowledge of the benefits of solar energy could be boosted through videotapes, computer assisted instruction utilizing animation for enhanced comprehension.

KEY WORDS: DEVELOPMENT / SUPPLEMENTARY READING BOOK / SOLAR ENERGY / ELECTRICITY GENERATION / UPPER SECONDARY SCHOOL STUDENTS

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การสร้างและทดลองใช้หนังสืออ่านเพิ่มเติมเรื่อง “พลังงานทดแทนจากแสงอาทิตย์ เพื่อผลิตไฟฟ้า” สำหรับนักเรียนมัธยมศึกษาตอนปลาย (THE DEVELOPMENT OF SUPPLEMENTARY READING BOOK ON SOLAR ENERGY FOR ELECTRICITY GENERATION FOR THE UPPER SECONDARY SCHOOL STUDENTS)

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ศษ.ม. (สิ่งแวดล้อมศึกษา)

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อสร้างและทดลองใช้หนังสืออ่านเพิ่มเติมเรื่อง “พลังงานทดแทนจากแสงอาทิตย์ เพื่อผลิตไฟฟ้า” ประกอบวิชาวิทยาศาสตร์เรื่อง ชีวิตกับสิ่งแวดล้อม สำหรับนักเรียนชั้นมัธยมศึกษาปีที่ 4 หลังจากการสร้างหนังสืออ่านเพิ่มเติมเรื่อง “พลังงานทดแทนจากแสงอาทิตย์ เพื่อผลิตไฟฟ้า” และหนังสืออ่านเพิ่มเติมที่ผ่านการปรับปรุงแก้ไขตามการประเมินของผู้เชี่ยวชาญแล้ว นำไปทดลองใช้กับนักเรียนชั้นมัธยมศึกษาปีที่ 4 ของโรงเรียน เตรียมอุดมศึกษาพัฒนาการ รัชดา ในเขตห้วยขวาง จังหวัดกรุงเทพมหานครที่ไม่ใช่กลุ่มตัวอย่างจำนวน 3 ครั้ง หลังจากได้แก้ไขปรับปรุงแล้วตามคำแนะนำของคณะกรรมการควบคุมวิทยานิพนธ์และผู้เชี่ยวชาญ จึงนำไปใช้กับโรงเรียน เตรียมอุดมศึกษาพัฒนาการ รัชดาจำนวน 60 คน แบ่งเป็น 2 กลุ่ม คือ กลุ่มควบคุมและกลุ่มทดลอง กลุ่มละ 30 คน โดยใช้รูปแบบการทดลองแบบสองกลุ่มวัดก่อนและหลังการทดลอง แล้วนำมาวิเคราะห์โดยใช้ค่า t-test

ผลการวิจัยพบว่า นักเรียนกลุ่มที่ได้อ่านหนังสืออ่านเพิ่มเติมมีผลสัมฤทธิ์ทางการเรียนเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.001 และสูงกว่ากลุ่มควบคุมที่ไม่ได้อ่านหนังสืออย่างมีนัยสำคัญทางสถิติที่ระดับ 0.001 จึงสรุปได้ว่า หนังสืออ่านเพิ่มเติมที่สร้างขึ้นสามารถช่วยเพิ่มพูนความรู้ ความเข้าใจ “พลังงานทดแทนจากแสงอาทิตย์ เพื่อผลิตไฟฟ้า” ให้แก่นักเรียนชั้นมัธยมศึกษาปีที่ 4 ได้เป็นอย่างดี นักเรียนประเมินความพึงพอใจหนังสืออ่านเพิ่มเติมในระดับดีและดีมาก

ข้อเสนอแนะควรทำการวิจัยที่ส่งเสริมการวิจัย ประดิษฐ์คิดค้น การนำพลังงานแสงอาทิตย์มาใช้ประโยชน์ให้เกิดประโยชน์อย่างกว้างขวาง ด้วยการสนับสนุนทุนวิจัยในเรื่องดังกล่าวอย่างจริงจัง และ ควรสร้างสื่อในรูปแบบอื่นที่เสริมความรู้ในเรื่องพลังงานทดแทนจากแสงอาทิตย์ เพื่อผลิตไฟฟ้านี้ เช่นการสร้าง ในรูปแบบวิดีโอเทป คอมพิวเตอร์ช่วยสอน ซึ่งมีภาพเคลื่อนไหว ทำให้มีความเข้าใจง่ายขึ้น น่าสนใจมากขึ้น รวมทั้งควรมีการเผยแพร่แบบทดสอบเพื่อให้ผู้อ่านได้ประเมินตนเองอีกด้วย

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CHAPTER I

INTRODUCTION

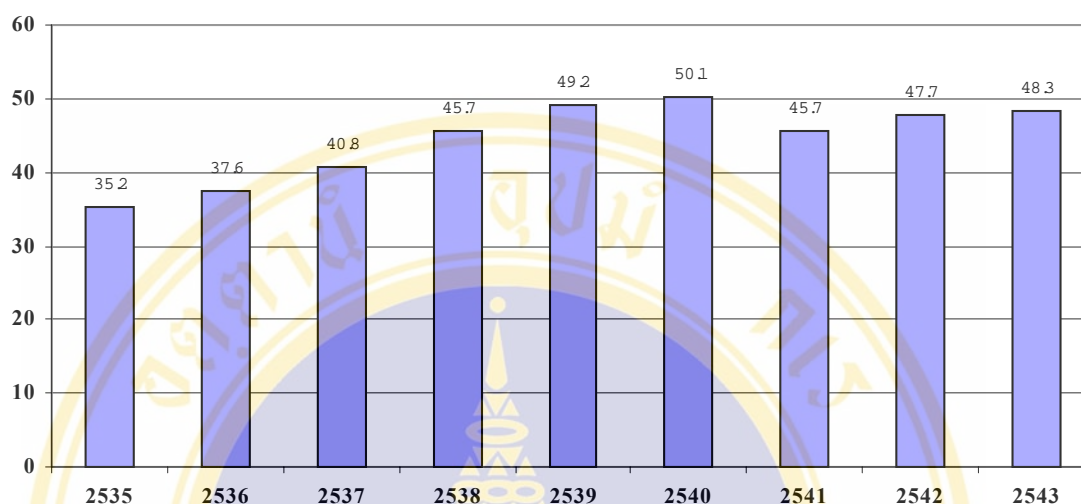
1.1 Rationale and Justification

It was expected that at the present the major energy as petroleum, natural gas, and charcoal will be shortage in 21-22 century, as well as these fossil fuel will be impacted to environment universally (Wongwaisayawan, U.1993:81).

1.1.1 The Situation of Energy in Thailand

Energy is an essential factor to respond the basic beds of people, and it is an important factor for production both in business and industrial sector as well. Therefore the government must manage energy to provide for population in a sufficient amount and appropriate prize, together good quality to be relevant to the demand of consumer. There is having not a large amount of energy source in term of business in Thailand. The major energy has relied on the foreign energy. In 2000, Thailand needed to use total energy when compared with the amount of raw oils was 48,339 thousand tons. This made to import the oil from abroad 39,730 thousand tons of raw oil. It was increased 1.3 percent when compared with same period in year 1999 or the imported oil equaled to 47.6 percent of total demand (Energy report of Thailand 2000 by Department of Energy Development and Promotion). The payment for imported oil was 313,816 million baht. The burden of money has been increased while the Baht money was weak or the prize of oil in the world market was higher (The Energy Nation Policy Committee Office 1999).

Chart 1 The Amount of Energy Utility of Thailand During 1992-2000 (Unit: million ton of raw oil)



Source: Energy report of Thailand 2000 by Department of Energy Development and Promotion (Unit: million ton of raw oil)

Table 1 The Proportion of Utilization of Fuel and Electricity During 1996-2000

(Unit: Percent)

Type	Year				
	1996	1997	1998	1999	2000
Petroleum Products					
-Petrol	53.8	54.1	53.6	52.3	50.8
- Liquid Petroleum Gas	3.9	3.8	3.9	4.0	4.5
Natural gas	1.9	1.9	1.9	2.4	2.8
Coal and Lignite	9.0	7.9	7.1	8.1	7.5
Electricity	13.4	14.0	15.0	14.6	15.5
Biomass	18.0	18.3	18.5	18.6	18.9
Total (Percent)	100	100	100	100	100
(Million ton in term of raw oil)	49.25	50.13	45.70	47.70	48.34

Source: The Energy Nation Policy Committee Office 1999: 2-2

From Table 1, when considering according to the type of utilization of fuel in 2000, the Petroleum Products was 55.3 percent (that were petrol, Liquid Petroleum Gas, aviation fuel, kerosene, diesel, and fuel oil), subsequences were (biomass that were charcoal, fire wood, husk, and remained cane), electricity, coal, and natural gas respectively (The Energy Nation Policy Office 1999: 2-2).

**Table 2 Utilization of Energy Classify by Economic of Thailand During 1996-2000
(Unit: Percent)**

Economic Sector	Year				
	1996	1997	1998	1999	2000
Transportation & Communication	40.8	42.7	41.3	39.8	38.6
Industry	35.5	33.4	31.51	33.8	34.6
Household and Business	19.4	20.1	22.4	21.2	21.8
Agricultural sector	3.6	2.8	4.1	4.5	4.5
Others	0.7	3.8	0.7	0.7	5.0
Total (Percent)	100	100	100	100	100
(Million ton in term of raw oil)	49.25	50.13	45.70	47.70	48.34

Source: The Energy Nation Policy Committee Office 1999: 2-2

The energy utilization in industrial sector was considered that were transportation and communication (38.6 percent), industry (34.6 percent), household and business (service and governmental sector were included) was 21.8 percents. The transportation and communication was the sector that used the energy highest and it has a tendency to increase in the future (The Energy Nation Policy Committee Office 1999: 2-2).

From the estimation of situation and implementation of energy during the passed time, there was an expectation of the trend of energy utilization of Thailand in the future. It may be concluded that the dependence on imported energy will increase from 47.6 percents to 52.0 percent in 2006. Therefore to prepare the national policy during 2002 to 2011, it should aim to implement in the energy conservation aspect in order to decrease the amount of imported oil for business purpose, and to decrease the

increasing rate of energy consumption to be lower than the rate economic growth by improving the efficiency of energy consumption. In addition, development of renewable energy in the country sources must be done. Moreover, to promote the private sector to invest for energy conservation, and use of renewable energy must be done increasingly (The Energy Nation Policy Committee Office 1999: 1-1).

1.1.2 The Present Energy Utilization Source

Currently, the demand of energy consumption has increased according to the growth rate of population and technological progression has played an important role for human living increased. This main energy is essential for use in daily life activities such as electrical energy, natural gasses, other natural resources that were introduced to used for energy production has been gradually exploited due to the natural production could not keep up with demand. In present, the energy sources was employed has the majority from natural resources. The energy sources in present society can be classified as follows:

1. Oil decreased gradually, and the result of this type of energy has caused the problem of pollution.
2. Natural gas, at this moment, the demand was in the high rate as well because some part was used in place of oil. It was expected that the rate of consumption would be increasingly so the natural gas would be exhausted from the world in the near future.
3. Coal is the first fossil fuel that was used since the industrial revolution age and its role in the industrial society decreased since the oil was known to be used, because the burning of coal fuel caused of smoke, dust, and toxic gas to impact the environment.
4. Other sources of energy, besides mentioned above, the human society at current is also use the some energy from other sources in small amount such as nuclear energy, heat under the ground, and stone oil for instance. These sources of energy are not distributed widely since there are numerous obstacles such as

acceptation of people, problem of safety and environmental risk, and lack of the appropriate technology to develop for utilization (Vijitra Kongpool, 1981: 100-105).

5. The natural energy source in hereby meant the sunlight, hydro energy, wind energy, and plant transformation energy for instance. These energy sources will be useful if they are well managed. Hence they are used these energy instantly, because they are limited amount. The natural energy sources are the last hope for human society in this age.

The situation of energy problem is facing at present; it inclines to be shortage and disaster in the ahead day. It is essential to have appropriate practical guideline for both government and people levels by covering the two essential issues that are economization of use, and searching for the renewable energy sources in the country for compensation the energy shortage for upcoming.

1.1.3 Energy Utilization and Environmental Problem

At present, the energy is used for different activities in our society with the target of creating the happiness for life but in another facet the result of energy consumption causes the negative impact. It can be considered as least into two levels that direct degradation, and the impending degradation. The direct degradation is different accidents of energy utilization and production process, and the toxic wastes, including the degradation of physical environment unavoidably. The degradation of energy use has various imminent effects that are 4 features as follows (showed in table 3):

1. Cause the sickness and death
2. Degrade of objects and natural resources
3. Destroy the environment and living creature
4. Destruct the natural beauty such as causing of chaotic state(Vijitra Kongpool, 1981: 135)

Table 3 The Different Damages Causes by Energy Utilization

Accidences	Toxic Wastes	Degradations to Environment
<ul style="list-style-type: none"> - Accidences in mine - Oil tank explosion or burn - Oil ships hit each other in the sea - Damp broken - Distilling plant burn - an atomic reactor cracked - Leakage of radioactive substance from storage - Electrical Power plan burn - Gas tank explosion in building - Car Accidences 	<ul style="list-style-type: none"> - Air pollution caused by incompletes burn - Toxic gas occurred by general burn such as sulfur oxide, nitrogen oxide - Radioactive wastes - Toxic substance such as heavy metal, radiation, salts - different rays - loud noise - thermal discharge to water and air 	<ul style="list-style-type: none"> - Ground subsided due to mine, and oil pierce - Soil surface and plants destructed by mining - Water stream changed from damp construction - Natural scenic destroyed by untidy of electric wire and pole transported the electrical current to user

Any damage can cause the four imminent effects in the same time such as the oil combustion inside the engine causing nitrogen oxide occurred. This toxic substance can cause the human sickness of respiratory tract, damage to animals and plants. It adds the acidity to rain, and is a principal to cause the water vapor and smoke to be fog that cause the bad visibility. It is the obstacle for sailing, transporting, and flying (Vijitra Kongpool' 1981: 134).

1.1.4 Environment and Education

Currently, it is well known that there is increased demand of energy consumption. The natural resources as energy sources are going to be exhausted in impending. There are searching for renewable energy for compensation are occurred both in the country and foreign countries. In the Ninth national Economic and Social Development Plan B.E.2545-2549 aimed to have energy security providing and energy conservation by conserving the energy and promoting the development of recycling energy and renewable energy. There is promotion and supporting to develop the electrical production by solar cell, which is clean energy (Green World Foundation: Thai Environment Situation, 2001).

From the aforementioned situation, the researcher made up her mind that it should produce the supplementary reading book on the topic of “Solar Energy for Electricity Generation for Upper Secondary School Students” in order to be congruent to teaching-learning subject of Science (Biology) at upper secondary school level according to curriculum of upper secondary school level B.E. 2544 in the content about life and environment on the topic of “Natural Resources and Environment” by having to two standards as follows:

Standard 1: Understand about local environment, the relationship between environment and living thing, the relations among living creatures in the ecological system, having process of searching knowledge, and psychological communication on learning and knowledge utilization.

Standard 2: Understand the importance of natural resources, natural resource utilization in the local, natural, and global levels, having process of searching knowledge, and psychological communication on learning and knowledge utilization for management of natural resources and environment in locality sustainably (Department of Curriculum, 2001: 5).

In addition, standard of learning for Science subject of life and environment in the at upper secondary school level has aims to let student to have knowledge and understanding about analysis, discussion, and explanation of changing and succession of living thing, importance of biodiversity of ecosystem, its balancing. The survey,

analysis of environmental problem situation, and natural resource utilization in local, national, and global levels are included. Simultaneously, the students are able to analyze the cause of problem, planning, practicing to collaborate with communities to prevent, solve problem, observe, conserve, and develop the natural resources and environment (Department of Curriculum, 2001: 11-12).

During the passing time, management of teaching- learning of environmental education in Thailand, has been successful as it should be. There is an important cause that is the lack of books, document, and media of content for teaching- learning, together with lack of appropriate supplementary leading book (Ratana Nuankaew, 1992: 3).

The aforementioned problem is an important obstacle that makes the teaching of environmental education not reach the goal according to the defined curriculum. So the guideline for solving this problem is to introduce the appropriate learning media to assist in order to decreases the facing problem. This was found by the experiment and searching of academic persons showed that the tool to assist to create the competency for leaching-learning was learning-teaching media and activities. It can assist leaching-learning to accomplish the objectives of defined education ((Department of Curriculum, 1962: 1).

The learning book of Science subject on the topic of life and environment in the issue of natural resources and environment, there is no supplementary learning book that consisted of content about renewable energy from solar energy for electricity generation. This subject is compulsory subject that every upper secondary students must learn. Therefore to construct a supplementary reading book for electrical generation, it should be useful for upper secondary students to gain more knowledge and understanding increasingly

Book is classified as an important medium in term of language that is able to communicate meaning to human to learn, to understand, and raise the conscious in problem or concept in any issue. Book is more valuable than other mass media (Department of Curriculum: 1962: 12).

Department of Curriculum, Ministry of Education, Department realizes to the importance of learning-teaching media in book style that it provides a change to students to investigate the additional knowledge by themselves besides they learn from teacher in the classroom according to the book content only. In order to arrange the experience for students, they would widely learn so there is a project to produce an additional book or supplementary reading book. The supplementary reading book is classified as a media in book style that is very important and benefit that aims to promote learning and as source for searching knowledge beside the defined learning book by expanding the content from any part of curriculum or having more details to be appropriate with age, and capability of reading of children (Chaiyos Ruangsuwan, 1990: 159).

From the study, it was found that the supplementary reading book would decrease the teaching-learning problem of teachers and students, including lack of media as aforementioned. Besides when the teacher wants the learners to study and search any content or issue wider and more detail than the school textbook, then the students can do by themselves. For instance, the supplementary reading book of Sornchai Moonkam (Sornchai Moonkam, 1998: 82), constructed the supplementary reading book on the topic of “Greenhouse Effects” for upper secondary students, and Salinee Rungkupant constructed the supplementary reading book on the topic of “We Love Environment” for primary school student al level 5. For that reason, the researcher is interested to construct the supplementary reading book as documentary style in order to use for complementary teaching-learning. Particularly, the content about renewable energy for solar energy, makes the students to gain knowledge, and understanding about content of environment and natural resources of subject of Science on the topic of “Life and Environment” increasingly by using the topic of book as “Renewable Energy From Solar Energy For Electricity Generation”. It will tried out for teaching-learning in order to promote and distribute knowledge on renewable energy from solar energy that is counted as other renewable energy.

In the construction of the supplementary reading book, its characteristics will be description of knowledge of renewable energy from solar energy by using pictures. Its

feature is a descriptive picture that will make the learner to gain more knowledge and understanding according to content in the curriculum about the guideline to search other energy sources to substitute electrical energy and advantage of solar energy, which is a natural resource. The knowledge is brought from different sources such as Electricity Generation Authority of Thailand, the Metropolitan Power Board, the National Energy Policy Committee Office, The Institute of Promotion of Teaching-Learning of Science, and different knowledge sources to combine to construct as complementary reading book.

1.2 Research Objectives

1.2.1 To construct the supplementary reading book on the topic of “Solar Energy for Electricity Generation”, is complementary for subject of Science on topic of “Life and Environment” for upper secondary school level 4 according to curriculum of upper secondary school B.E. 2544.

1.2.2 To tried out and evaluate the quality of supplementary reading book on the topic of “Solar Energy for Electricity Generation” that is constructed in the aspects of content, language, book arrangement, and complementary pictures.

1.2.3 To evaluate the satisfaction of student towards the constructed supplementary reading book in the aspects of content, language, book arrangement, and complementary pictures.

1.3 Research Questions

In order to be guideline for searching the answers to be relevant to the defined objectives, the researcher defined the research questions as follows:

1.3.1 The constructed supplementary reading book is tried out by upper secondary school level 4 that will make the students have learning achievement increased or not.

1.3.2 The constructed supplementary reading book is appropriate for teaching-learning supplement according to criteria by evaluating of experts or not.

1.3.3 The satisfaction of students towards the constructed supplementary reading book is in which level.

1.4 Research Boundary

1.4.1 The constructed book is a supplementary reading book for subject of Science on the issue of “Life and Environment” on the topic of “Natural Resources and Environment” at level 4 of upper secondary school according to curriculum of upper secondary school B.E. 2544.

1.4.2 Sample group is 60 students at level 4 upper secondary school under Department of General Education, academic year 2003 by dividing into 30 students for control group and 30 students of experimental group.

1.5 Research Hypothesis

1.5.1 The students of experimental group learn with the supplementary reading book on the topic of “Solar Energy for Electricity Generation”, will receive knowledge increasingly with statistically significant at level of 0.05.

1.5.2 The posttest scores of students of experimental group after learning will have knowledge more than control group statistically significant at level of 0.05.

1.6 Primary Assumption

1.6.1 The sample group is used for efficiency of constructed book having similar attributes to control group and experimental group.

1.6.2 The experimental result from learning achievement test is the result of reading the supplementary book on the topic of “Solar Energy for Electricity Generation”.

1.7 Definitions Terms

1.7.1 Supplementary Reading Book means school book that the Ministry of Education consent to use in the school by not defining as school textbook but it is book that causes the advantage in facet of education of self-learning, and assisting for adding knowledge and understanding for subject content of curriculum extensively.

1.7.2 Substitutive Solar Energy means solar energy that is applied to use for advantage by changing the solar energy to thermal energy or electrical energy in place of non renewable energy such as fossil fuel energy.

1.7.3 Supplementary Reading Book on the topic of “Solar Energy for Electricity Generation” means the book is constructed for teaching-learning supplement for teaching on the subject of Science on issue of “Life and Environment” and issue of “Natural resources and Environment” for students at level 4 upper secondary school under Department of General Education, academic year 2002.

1.7.4 Learning Achievement means learning results of students that obtain from the knowledge measurement test after learning by supplementary reading book constructed.

1.7.5 The Effectiveness of Supplementary Reading Book means attributes of supplementary reading book that passed the evaluation of experts and students who read the supplementary reading book finished will give learning achievement with higher knowledge than before reading.

1.7.6 Knowledge means the intellectual ability of students on learning about “Solar Energy for Electricity Generation” by testing with the test of learning achievement after reading the constructed supplementary reading book.

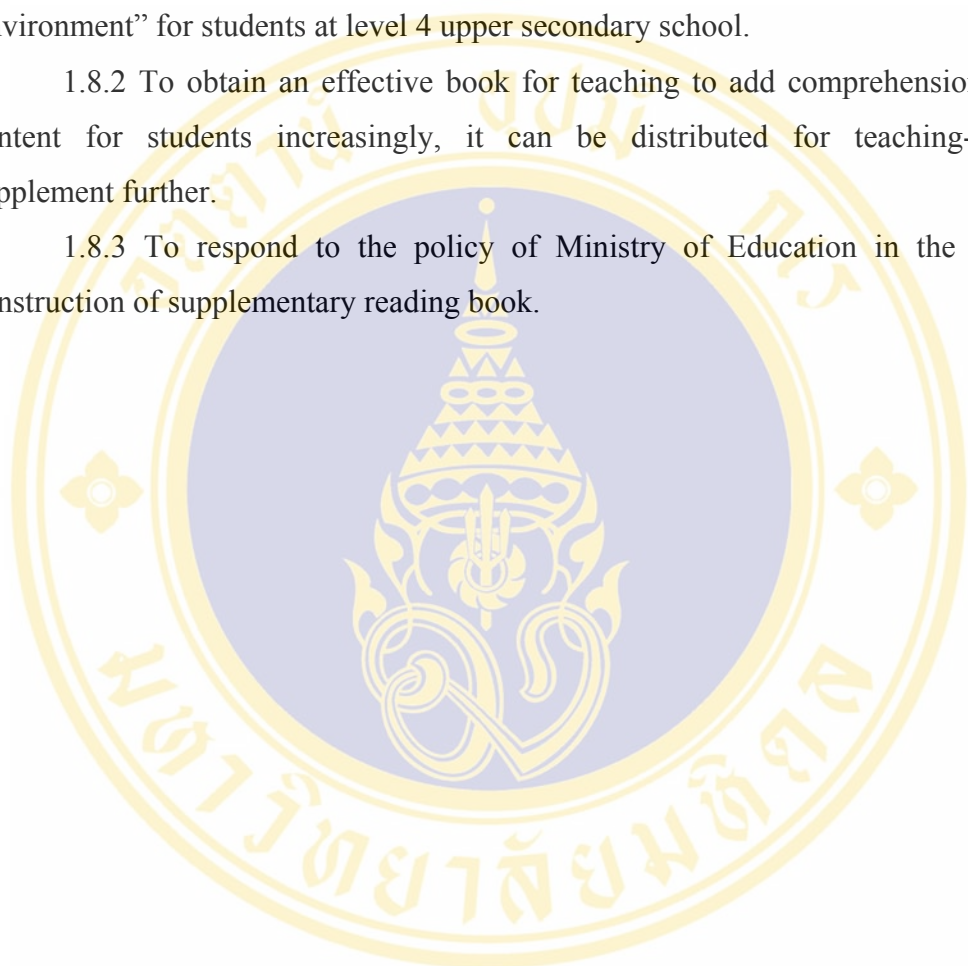
1.7.7 Satisfaction of Students means results obtained from the evaluation after reading the constructed supplementary reading book on the topic of “Solar Energy for Electricity Generation” that is in which level by measuring with the satisfactory evaluation form that constructed by researcher.

1.8 Contribution of Research

1.8.1 To obtain a “Solar Energy for Electricity Generation” for teaching-learning supplement for teaching the subject of Science on the issue of “Life and Environment” for students at level 4 upper secondary school.

1.8.2 To obtain an effective book for teaching to add comprehension on the content for students increasingly, it can be distributed for teaching-learning supplement further.

1.8.3 To respond to the policy of Ministry of Education in the facet of construction of supplementary reading book.



CHAPTER II

LITERATURE REVIEWS

The documents and related literatures on this research about construction and trial on supplementary reading book on the topic of “Solar Energy for Electricity Generation” for teaching-learning supplement for teaching on the subject of Science (biology) on issue of “Life and Environment” for students at level 4 upper secondary school, composed as follows:

- ⊙ Documents Related to about Solar Energy
- ⊙ Documents Related to Situation of Substitutive Energy
- ⊙ Documents Related to Environmental Education at Level of Upper Secondary School
- ⊙ Documents Related to Construction of Supplementary Reading Book
- ⊙ Related Literatures

2.1 Documents Related to about Solar Energy

2.1.1 Solar Energy

The sun is the biggest source of thermal energy and light energy in Thailand that locates in the area near to equator line or the line that separate world into two parts so it receives the rather high energy from the solar energy. To use the solar energy is in two features as transforming to electrical energy when the sun light falls and reflects on the solar cells. Then it is changed from solar energy to electrical energy that is able to use by the electrical appliances. The another form of solar energy utilization is transformed to thermal energy by letting the sun light radiates

through the received plate to falls and reflects to black surface then the heat will increase at the above of surface. The thermal energy can be utilized in different attributes such as hot water production, water distillation, dehydration of agricultural products (Document on the issue of Substitutive Energy, Department of Energy Development and Promotion, 2000).

2.1.2 Substitutive Energy from Sun Light

2.1.2.1 What is the substitutive energy?

The substitutive energy is energy use to substitute oil fuel that is the main energy sued in the present. It can be renewable to use again and it is interesting to be studied and it is appropriate to be used since it is able to solve the problem of energy shortage in the future, and to decrease the pollutions that occurred due to energy currently consumption. It can be classified into 2 types that are the substitute energy that are non-renewable such as coal, natural gas, and the substitutive energy that are renewable such as wind, biomass, and water.

2.1.2.2 Energy Utilization of Sun Light

Energy utilization of sun light is able to decrease the world natural resource utilization and it is not cause the pollution. Department of Development and Energy Promotion, Ministry of Science, Technology, and Environment developed solar energy utilization in different forms in order to use the energy from sun light with highest efficiency, convenience, and minimum cost. Even though, currently, energy fro sun light utilization is not the best and complete answer but it is a guideline of utilization of substitutive energy in the future. If there is research and development continuously and seriously, it can be believed that it will be an important and valuable answer for substitutive energy (Document on the issue of Substitutive Energy, Department of Energy Development and Promotion, 2000).

2.1.2.3 Transformation of Solar Energy to Electrical Energy

The system of electrical production with solar energy in our country, is the form depending on the working system of solar cell by the voltaic process. The electron moves through the contact surfaces with the front and back of solar cells so the electrical current will flow to external current that will direct current. The electrical current produces by solar cell will not regular because it depends on the amount and intensity of sun light that receives in each period. Therefore it must be kept in the battery, then the electricity must be passed through the control equipment and electrical transformer in order to change the direct current (DC) to be alternating current (AC) for utilizing with the general electrical appliances. In some case it may transform to be the current of the Provincial Electricity Authority (PEA) or the Metropolis Electricity Authority (MEA) in order to distribute to household directly. It is no need to storage in the battery prior.

The small production plant of solar energy will distribute the electrical current to community directly. This should be able to solve the electrical energy shortage. Owing to it is in the remote region such as the up country area so the wiring and pole standing are not able to implement because it costs high investment or it can be implemented in some area of country. Therefore there is solar energy production by storage in the battery in order to use the stored current to use with electrical appliances. The current is direct current so the electrical appliances must be only direct current electrical appliances. A battery with 80-100 Amperes will use 1 day for charging. It can be used for one fluorescent lamp with 18-20 Watts to give light for 15-18 hours.

2.1.2.4 Transformation of Solar Energy to Thermal Energy

The process of solar energy transformation to be thermal energy, it can be used for various advantages in different term such as:

- 1). Dehydration of agricultural products by constructing the cabinet or box that upper side with transparent material in order to let the sun light to radiate to the black bottom, which will be good absorbed and transferred heat when the area above the black surface has high temperature its density will be decrease and float

through the agricultural products. The vapor or humidity will be evaporate from the products that is placed for dehydration.

2). Hot water production with solar energy, can be done by having solar cells with the black color on the upper side, which will absorb the heat from sun light and then the heat will transfer to copper tube contained water and it makes the flowing water inside to have higher temperature. It becomes hot water, and it will be used for work. The evaluation of the cost of hot water production by solar energy, it was found that the production cost to obtain the hot water at 40-70 Celsius degree would is about 9 satangs/liter.

3) Water Distillation with solar energy, the distilled box is opaque with the upper side in style of roof or butterfly wing. It made of the transparent plastic place inclining with 10-20 degrees, and the bottom side colored with black color or the black ashes or husk used for absorbing the solar energy and emitting the heat so the water flows through the distilled box. Particularly, the surface of water will receive the heat and evaporate to vapor, then it will touch with the upper plastic, which is colder so it will be drop of water to flow to the a groove inside the distilled box, then it will flow to outside . Generally, the distilled box of solar energy has the area about 1 square meter, it can distill about 4 liters/day (Document on the issue of Substitutive Energy, Department of Energy Development and Promotion, 2000).

2.1.3 Substitutive Energy from Other Natural Sources

Presently, there is an attempt to research and develop the substitutive energy in different forms in order to be beneficial and convenient utilized for energy saving and decreasing the expenditure by basing on the base of energy dependence in the local source and inside the country source. It will lead to accomplish sustainable energy utilization. It is a mean to decrease the natural resources degradation tremendously and vigorously at present that will maintain the natural balance. Thoroughly, decreasing the problem of pollution making to environment, it is a harmful threat to globe and humanity. The substitutive energy is a way of solving crisis of energy and environment of the world.

2.1.3.1 Wind energy is a general power and a renewable energy. The average of wind current in Thailand will be at moderate to low levels with the speed of lower than 4 meters/second. We uses the energy from wind power for whirling turbine for water pumping. Over all Thailand, there are about 5,800 sets. There are inventing and developing to use the wind turbine for electricity production in numerous areas in the country. Particularly, at Promthep Cape at Puket Province, The wind turbine is utilize for electricity production by cooperating with solar energy.

2.1.3.2 Hydro power, we can build the damp or keeping it in the high level and let it to flow according to pipe line to hydro turbine to push the blade of turbine to move to turn axle of hydro turbine that connected to electric generator to make it turn together so it induces inside electric generator. The production of the electric current from hydro power, it may be produce from the large size dam, medium size dam, or small size dam for use in the small community. In 1996, the electrical hydro power plant in Thailand had the total power production was 2,909.5 Megawatts.

2.1.3.3 Biomass Energy, the biomass is the thing obtained from the living creatures such as trees, cane, charcoal, fire wood, husk, and weeds or even though the garbage or dung. The biomass is brought to use as energy that can be done into 2 attributes that are the process of heat given such as bringing the charcoal, fire wood to burn in order to make the heat for utilization for different benefits. It has been developed the technology to up date such as development and oven production in order to be high efficient by easy lighting, few smoke, save the fuel. It has development of high efficiency oven for small industry in the rural area such as evaporated oven for a savory wrapped in tea leaves (A kind of local food in the North region of Thailand), evaporated oven for the paper mulberry (*Broussonetia papyrifera*), burned oven for brick. For the fuel aspect, there is invention of production of pressed biomass block or green fuel by using the plants or weeds to be chopped and pressed to be a bar. Then it will be dried by sun light and dehydrated with oven. The pressed biomass block is easy for lighting and gives the high heat. Besides, production or by-product of plant as a type of starch and sugar such as rice, corn, cane, remained sugar

cane are brought to produce ethyl alcohol, including cassava to be burned by controlling the heat in order to get the biomass gas as fuel. The another attribute is biological process that bringing the dung, garbage, and wastewater to be fermented in anaerobic condition. The decomposition process would occur then it will produce the biomass gas as fuel for cooking, lighting, machine working, or generating electricity.

2.1.3.4 The Geothermal Energy, it is a natural energy that occurs due to movement of earth cover is cracked so the some part of water will flow and absorb into under the surface of earth, and it accumulated and received the high heat of rock, the water became the spring hot water or hot vapor water, boil mud and gas. The hot water under the ground is able to transfer heat to liquid or substance with low melting point so it is easy to boil and become steam to whirl the turbine to push the electrical generator to move. Besides, after the spring hot water has been used to product the electricity, its temperature will decrease to about 80 Celsius degree. It is able to used as energy for dehydration of agricultural products, and to be energy for frozen room, and air conditioner (Document on the issue of Substitutive Energy, Department of and Energy Development and Energy Promotion, 2000).

2.2 Documents Related to Situation of Substitutive Energy

2.2.1 Importance of Energy

Energy is a basic need that is importance to respond the elementary demands of people, and it is fundamental factor for production in business and industrial sectors. Therefore, it must to provide energy to supply in the adequate amount, appropriate prize, and good quality to be relevant to the basic needs of population, and to respond the demands of utilization in production activities sufficiently.

The word “Energy” means the capability to work that is existing inside objects that can give work by moving or transforming the object or mineral. The object can move because it has force or energy to move it from one place to another place. Energy or competency of work, besides the living thing will use energy in form of

food substances for living directly. They still need it to use in other features that involved to daily living in different terms such as light, heat, electricity for instance.

At present, the energy utilization is divided into two main types that are non-renewable energy and renewable energy. The non-renewable energy is exhausted energy that are coal, stone oil, sand oil, raw oil, fuel oil, and natural gas, but renewable energy means the energy got from fire wood, remained cane, biomass, water, sun light, wind and wave.

2.2.2 The Direction of Substitutive Energy in Thailand

At present, Thailand still needs to rely on imported energy in the high proportion in order to create the security of energy supply to be adequate the demands of country. The way of energy development of the country must be regarded to utilizing the existing limiting resources by mean of energy conservation and promotion to develop the renewable energy or other substitutive energy. In order to make the target of energy development of the country, has security and it is relevant to the energy situation and economic circumstances. In addition, supporting the national economic activities of the country, it established the target of energy conservation during the Ninth national Economic and Social Development Plan B.E.2545-2549 as follows:

2.2.2.1 Improve the efficiency of energy utilization by decreasing the amount of energy utilization in each economic sector of the country.

2.2.2.2 Support on bringing the bio gas technology from dung, wastewater from factories to be used as fuel for heat/electricity production replaces of about 24.8 million kilograms per year of LPG utilization.

2.2.2.3 Develop the biomass energy utilization that exists in the country about 395 thousand tons per year to be fuel for heat/electricity production.

2.2.2.4 Let utilize the solar energy in the stand alone area that has no wiring system for use in different works such as water pumping, solar cell house, mini grid in the primary school, sanitary office, and light sign, blinking light with total target of 6.8 Megawatts.

2.2.2.5 Promote and support the factory, building, household, and government place to produce electricity with solar cell. Particularly, in the remote area that the electrical production system, can not reach in order to use for themselves, and to supply for the area that has grid connected with the total target of 6 Megawatts.

2.2.2.6 Strengthen the security for the terminal of wire of high voltage system.

2.2.2.7 Support for solar energy utilization, system of heat technology in the industrial sector and commercial building in order to substitute of LPG utilization with 4.92 million kilograms within 2006.

2.2.2.8 Bring the wind energy for use in electricity production about 4.7 Megawatts within 2003 (Green World Foundation: Thai Environmental Situation during 1999-2000, 2001: 10-11).

2.2.3 Hypothesis for Defining the Target of Energy Conservation of Thailand During 2002-2011

From the evaluating of the sector that utilizes the highest energy and has high potential to decrease the amount of energy utilization that is communication-transportation sector, production industry, household, and business sector. It is complement with the crisis of oil prize increasing due to diverse factors. Therefore, the selection of renewable energy that is not exhausted has existed within the country and it has less impact to environment so it is an another alternative way that must be accelerated by giving the importance for competent development and creating the confidence of energy utilization from sources inside the country in order to decrease the risk of reliance on commercial energy (The Energy Nation Policy Committee Office 2002: 2-2).

2.2.4 Hypothesis for Defining the Target of Promotion of Renewable Energy from Solar Cell

2.2.4.1 Promote to produce the electricity from energy of sun light

Since the trend of demand for solar cell equipment, complemented with decreasing prize continuously, and the predicted value of prize of electrical production

system of solar cells of Sacramento Municipal Utility District (SMUD) as base for forecasting the prize of system of Thailand in the 10 years forward, it was found that the prize of Thai system will be equal to the system of SMUD that is beyond about 3 years. This is the Thai prize in 2003 will be equal to prize of SMUD system in 200, and the Thai prize in 2004 will be equal to prize of SMUD system in 2001. It will be this manner sequence continuously (presented in table 4) (The Energy Nation Policy Committee Office 2002: 4-18).

Table 4 A Comparison of Solar Cell System Prize between SMUD and Thai

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Prize of solar cell system of SMUD (baht/Wp)	200*	177	153	130*	126	121	117	113	109	104	100*	97
Prize of solar cell system of Thai (baht/Wp)	-	-	240	200	177	153	130	126	121	117	113	109

* Prize of System of Electrical Production of Solar Cell in the Year that SMUD predicted by method of Logarithm

Source: The Energy Nation Policy Committee Office 2002: 4-18

The rate should be supported to invest for break even point for the life time of solar cell is 25 years when there is different rate of interests by calculating from the amount of electrical energy production from solar cell in Thailand is 1,300 unit/highest/year. The benefit gain from electricity sale is 3.22 baht/unit (increase 3 % per year). When the rate can be set for supporting to promote for establishment by using different measures such as supportive money (according to rate of promotion), so it can buy electricity in the high prize (by defining according to the rate of supporting per unit of electricity that expects to produce for each year/ number of years will buy).

Besides, it should support in term of low rate of interest and promote for research and development of solar cell production and complementary equipments in Thailand together with promotion of setting in order to decrease the rate of import, thoroughly, for development of personnel in the aspect of solar cell energy (presented in table 4) (The Energy Nation Policy Committee Office 2002: 4-19).

Table 5 Target of Implementation of Electrical Production of Solar Cell Set in Off-grid in 2002-2006

System	Size	Area Set	Unit	Total kW
Solar Home	0.15 kW/unit	Remote Village	500 villages	3,000
	1 kW/unit	Health Station	200 sites	200
	5 kW/unit	Remote School	400 sites	2,000
	1.5 kW/unit	Remote Primary School	309 sites	463.5
	1 kW/unit	Non-formal Education Center	108 sites	108
	3 kW/unit	Forestry	210 sites	630
Stand Alone	0.075 kW/unit	Remote Public Light	5,000 system	375
	0.225 kW/unit	Operating Station of Soldier and Police	300 sites	67.5
	0.1 kW/unit	National Park/ Ranger Station	20 sites	2
	4 kW/unit	Adding Oxygen in Shrimp Pond	4 sites	16
Hybrid	40 kW/unit	Combined with	10 sites	400
Minigrd	3 kW/unit	Islands	170 sites	510
Solar Pump	3 kW/unit	Water Pumping for Agriculture	50 sites	250
	130 kW/unit	Water Pumping for Agriculture (Large size)	1 site	130
During 2002-2006 Set the Solar Cell System Off-grid				

Source: The Energy Nation Policy Committee Office 2002: 4-19.

2.2.4.2 Promote the heat production with solar cell energy

The measures will be supported by government in the primary phase is in form of loan with low interest rate, and promotion for research and development to decrease the prize increasingly. The targets of implementation are water heater, system of hot water production, machine for extraction of insecticide machine, and dry machine (The Energy Nation Policy Committee Office 2002).

2.3 Documents Related to Environmental Education at Level of Upper Secondary School

2.3.1 Meaning of Environmental Education

Kasem Chankaew, (1993: 17), gave the meaning of environmental education that was the process of giving knowledge systemically and orderly in development of skill, attitude, and experience to create the concept of being thinking about the relation between human, culture, and environment to maintain the good quality of environment.

Vinai Veeravarananond,(1996: 4), presented the definition of environmental education that was the process that emphasized on the knowledge about physical environment in term of both of subjective and objective that caused the change of environmental circumstance and it impacted to human in order to create attitude, behavior, and value to conserve or develop the environmental quality, life quality of themselves, and human as holistically

Temduang Ratanathusnee, (1998:171), stated about the meaning of environmental education that was educational process to grow consciousness for people to be aware to environmental problem occurring to rise the responsibility to cooperate to solve the problem, thoroughly stressing on knowledge given, and understanding about environment and systemic relationship between human and environment in order to prevent problem and to develop for raising the level of environmental quality together with development for raising the quality of life

From the above concepts, it is obviously seen that environmental education that was is importance to every human society because it is the process of transferring various passed experience and knowledge to create knowledge and comprehension truly about the system of relations among things that is surrounding human being. It will be guideline primary decision making about environment correctly that will raise

the awareness and realize in the importance of system in order to raise the quality of life to be balancing to the development of society further.

2.3.2 Objectives of Environmental Education

Environmental education aims to make human to know how to live together with nature by being able to bring the nature to facilitate for living appropriately and harmonizingly with nature. To arrange the education in the environmental aspect to accomplish the effectiveness, it needs the different sectors to collaborate in order to reach the required achievement. In the international workshop of environmental education at Belgrade, Yugoslavia, the forum that gave the definition of 6 objectives of environmental education as follows: (UNESCO, 1976:2)

2.3.2.1 Awareness: In order to make the person to always aware and alert to related environmental problem.

2.3.2.2 Knowledge: In order to understand the base of the whole environment, including the related problem.

2.3.2.3 Attitude: In order to have value to participate for prevention and improvement the quality of environment seriously.

2.3.2.4 Skill: In order to have skill for solving the environmental problem.

2.3.2.5 Evaluation ability: In order to knowledge how to evaluate the practice of environment, including studying about the relating to ecological, political, economic, ethics, and educational aspects

2.3.2.6 Participation: In order to develop the sense of responsibility to search the appropriate method to solve the occurred environmental problem.

2.3.3 Policy of Environmental Education of Thailand

In 1989, Ministry of Education defined the frame of guideline for development of environmental education as follows: (Department of Curriculum, 1991: 22-24)

2.3.3.1 Allow to arrange the environmental education for youth and people in order to give knowledge, thinking, consciousness, responsibility, and the appropriate guideline for practice in the issue of environment for bringing knowledge for use wisely, and worthily, and maximum benefit for oneself and next generation.

2.3.3.2 Arrange the education for youth and people to learn the environmental state on the important base of country and world by emphasizing on the state of local environmental problem, and being aware to importance and relation of environmental quality that is valuable to life, emphasis is done on having consciousness, and participation on responsibility for environmental conservation by arranging as follows:

- 1) Develop the curriculum of teaching-learning of environmental education in every level, every type of education both in and out school, including the general people.
- 2) Develop the pattern of teaching-learning process and arrange activity of environmental education by stressing on giving direct experience to be pertinent to learner.
- 3) Arrange and develop teaching-learning media for of environmental education to have quality and efficiency to be relevant to, up date to the present event.
- 4) Develop the personnel related to of environmental education to be aware of role and function, and to participate for implementation of environmental education aspect.

2.3.3.3 Promote and support to have research and development, arrangement of information system, analysis, monitoring the problem, creating and developing the personnel in the of environmental education aspect for cooperation on of environmental education facet within the country and with the international country.

2.3.3.4 Promote to have activity for environmental conservation both in the Ministry of Education and in other work units of government and private sectors.

2.3.3.5 Arrange for the action plan for environmental education of Ministry of Education clearly, and permanently, in both short and long terms. There is cooperating with other units of government, and private, including monitoring, evaluating, and making public relation on the implemented work of Ministry.

Besides, in 1990, Department of Curriculum, Ministry of Education, implemented the project of production of supplementary reading book about the natural resource conservation, and environmental education at level of secondary school for promotion of teaching-learning by using media as book style in order to effectively implement by having the target of production as follows: (Department of Curriculum, 1990: 4).

Group of Science	12 books
Group of Social Study	5 books
Group of Occupation	6 books
Book for reading promotion related to resources and environment	3 book

The government in the age of year 1994, had realized on the importance of environmental education by packing in the policy and plan of environmental management B.E. 2537 and had established the curriculum of environment in every level and ever branch of education, training, and transferring environmental technology.

2. 3.4 Curriculum of Environmental Education at Level of Upper Secondary School on Subject of Science about Life and Environment

For Thailand had brought the environmental education to be arranged to develop in the curriculum of every level by the institute of Promotion of Teaching of Science and Technology had developed the curriculum of science (biology) on the issue of “Life and Environment”, unit of “Natural Resource and Environment” according to basic curriculum B.E. 2544. The details are as follows:

2.3.4.1 Learning content of Science

Learning content is defined as main of basic science that every student must know that composed of content, concept, principle of science, and process.

The content is body of knowledge of group of content of learning science composed of 8 main contents as follows:

Content 1 Living Thing and Process of Living

Content 2 Life and Environment

Content 3 Substance and Attribution of Substances

Content 4 Force and Movement

Content 5 Energy

Content 6 Process of changing f the World

Content 7 Astronomy and Space

Content 8 Nature of Science and Technology

2.3.4.2 Explanation of subject of learning content of basic science at level of upper secondary school, subject of Science with 60 periods 1.5 units.

Analysis study on the structure of cell membrane, the movement of substance through cell membrane, maintenance of cell equilibrium, process of genetic transferring, equilibrium of water, mineral, and temperature in the body of human and animal. Human immune response system, process of genetic transferring, a variation of genetics, mutation, biodiversity, biological technology, ecosystem, natural resources, utilization of natural resources with maximum advantage, and conservation and sustainable development of natural resources by using scientific process, survey, examination, observation, information investigating, discussion, and conclusion, is learnt in order to crate knowledge, ideas, understanding, communication about learnt knowledge, to have ability to make decision. The knowledge is applied for the learner's life, he can takes care himself and other living things, including surveillance, and developing environment sustainably, having scientific soul, ethics, moral and value.

2.3.5 Guideline of Environmental Education Arrangement in Subject of Science

Science is issue that is learning about nature by human uses the process of observation, survey, examination, and experiment about the natural phenomenon, and the results were brought to systemically organize as principle, concept, and theory. Therefore, scientific teaching-learning aims to stress the learners to learn and discover by themselves as much as possible. That is child will obtain both process and body of knowledge since the preschool age, being student, and after leaving school to work.

2.3.5.1 Arrangement of teaching-learning of science in the education institutes have important targets as follows:

- To understand the principle, theory that are the scientific fundament.
- To understand the scope, nature, and limitation of science.
- To have the important skill for study, investigation, and invention on science and technology.
- To develop the thinking process, and imagination, and ability of solving problem, and managing, including having skill for communication, and ability of decision making.
- To be aware the relation among science, technology, humans and environment in approach of influence and impact each others.
- To introduce knowledge, and comprehension about science, technology to be utilize for society and living.
- To make learn to have scientific mind, moral, ethics, and value for utilization of science and technology creatively.

2.3.5.2 Learning unit of biology subject at upper secondary school level (presented in chart 2).

Unit 1

Learning unit Maintenance of Life Equilibrium

- Structure of Cell
- Movement of Substance through Cell Membrane
- Maintenance of Plant Equilibrium
- Maintenance of Animal Equilibrium
- Maintenance of Human Body Equilibrium
- To Build Immune Response

15 hours

Unit 2

Learning unit Genetic Characteristics Transferring

- Structure and Function Genetic Substance
- Mechanism of Genetics Characteristics Transferring
- Mendel Law
- Variation of Genetics
- Genetics and Environment

15 hours

Unit 3

Learning unit Biodiversity

- Factors Affecting to Life Survival
- Life Survival and Biodiversity
- Advantage of Biological Technology
- Biological Technology and Biodiversity

10 hours

Unit 4

Learning unit Ecosystem

- Survey of ecosystem in locality
- Succession
- Energy transferring
- Relationship in Ecosystem

- Maintenance of Equilibrium of Ecosystem

10 hours

Unit 5

Learning unit Natural Resources and Environment

- Environment and Natural Resources
- Utilization and Limitation of Natural Resources
- Conservation and Development Natural Resources and Environment

10 hours



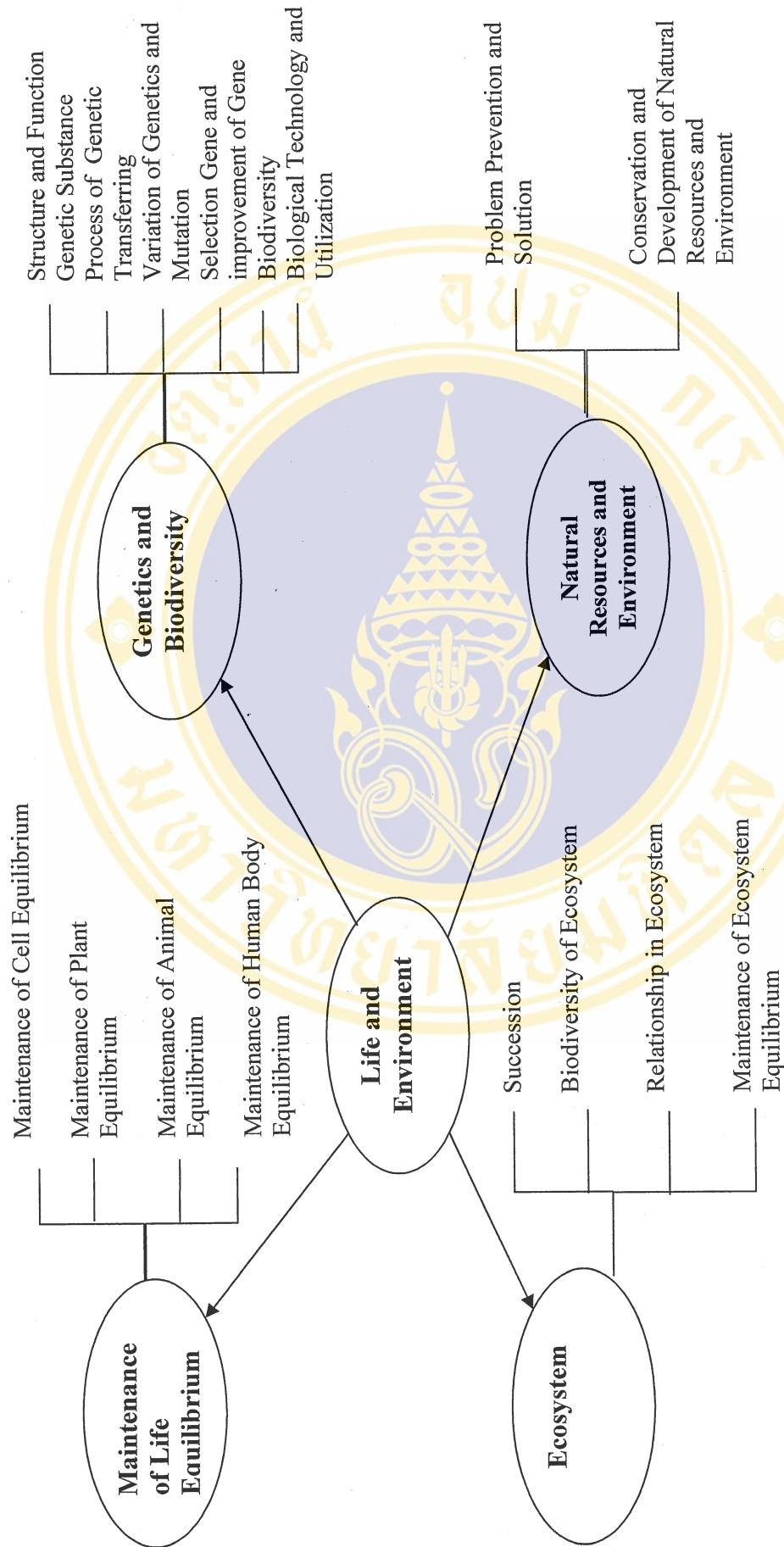


Chart 2 Concept of Learning Content of Basic Science (Biology) at level of upper Secondary School

Source: Department of Curriculum, Ministry of Education, 2001:94

2.3.6 Learning Sources of Science

Arrangement of teaching-learning of science, it must promote and support the learner to be able to learn all the time and every place, and lifelong learning from diverse learning sources. Learning sources for science subject is not limited only in classroom, scientific laboratory in school or school textbook. It includes learning sources both in and out school as follows:

- Printing media such as textbook, referent book, complementary book, newspaper, and journal
- Electronic Media that are multimedia CAI, Videotape, and science topic through the radio, television, CD-ROM, and internet
- Learning sources in school such as Science activity room, botanic garden, ground garden in classroom, library
- Local learning sources such as national Park, Botanic Park, Zoo, Science Museum, industrial Factory, Research Unit in Locality etc.
- Personal learning sources such as local wisdom local philosopher, community leader, teacher, lecturer, scientist, researcher etc.

Nevertheless, arrangement of science teaching-learning, it must let student have main textbook for learning and activities supplement, so teacher should considers to use the diverse referent book. Utilization of learning sources to be congruent to contents and learning standard, and it must regard to the maximum advantage for learner to develop in the aspects of knowledge, thinking, skill, process, attitude, morality, ethics, and value. From these learning knowledge, it will affect to learner to have a chance to develop their full competence (Department of Curriculum, 2001: 249).

For the content of human and natural resources in the subtopic of energy; utilization, problem, and management, is studied about human living, including, involving the consumption and production that need to use energy as an important

factor for basic living, industry, and facility for various convenience. Particularly, there is increasing demand of energy consumption due the rapid population growth, and the progress of science and technology. Therefore, it needs to search different energy to supply such as petrol oil, natural gas, coal, lignite, hydro energy, and heat energy from under ground for electricity production.

Production and utilization of energy by using the natural energy such as coal, raw oil, natural gas, it causes the environmental impact and quality of life of people. For the electricity production also causes impact for land utilization, forest management, and wildlife. Therefore there are numerous attempts try to seek the sources of substitutive energy for electricity production in order to decrease the problem of pollution that are nuclear energy, solar energy, and wind energy. Besides every people should be aware and cooperate for energy saving in the household by using the energy with maximum efficiency. It is possible to implement for Thailand and it can do promptly because it needs no high technology and it casts minimum cost.

2.3.7 Teaching Media of Environmental Education

The importance of media for of environmental education teaching in the arrangement of education according to the curriculum, one important thing to make the curriculum to reach the aim is teaching media. For teaching-learning for making the student to have knowledge, and comprehension about environment, so they can utilize the benefit for living correctly and suitably by passing through direct experience in order to let students to face with the real state of problem. Sometimes it is difficult to do so, therefore it must introduce the media of teaching and various technologies to assist for promotion to change the learners' behaviors permanently (Chom Pumipak, 1983: 15).

Teaching-learning environment, it needs to use different media. Currently, the trend to use teaching-learning media in Thailand, it has been recognized and it is used extensively due to the exception that teaching media is an instrument for learning

promotion, and attractive for learner, and help for rapid learning, and it will be in memory longer. It is supporter for teacher to be able to explain the complicate and difficult thing to be more easier to understand because the learner has used the different sensory organs. It is arranged the experience that closest to direct experience in stead of hearing only lectures (Nipon Sukpreedee, 1978: 3). Ministry of Education had realized the importance of utilization of teaching media for environmental education supplement. As it was presented in the master plan of environmental education project (B.E.1991-1996 that defined strategy and method of environmental education teaching by having the media production on awareness raising for every level of personnel (Department of Curriculum, UNESCO, 1991: 25).

2.3.7.1 Value of Media

The utilization of teaching-learning media is able to used by teacher and learner as Kidanant Malithong (1988: 81-82), state about the worth of teaching media for teacher and learner as follows:

a. Media and Teacher

1. Utilization of Materials and Equipments as teaching-learning supplement will assist the learning atmosphere to be more interesting because it helps the teacher more fun than the previous method that is only lecture given. It also creates self-confident increasing.

2. Teaching media will help to decrease the burden of teacher in the aspect of content preparation since sometimes the learner can study content by himself.

3. It always stimulates the teacher alert. In preparation and production of new media to utilize as teaching media, thoroughly, inventing the various techniques to make learning more interesting.

b. Media

1. It is aide to make earning efficiency because it helps leaner to

understand the complicate content of lesson in a short period and to be able to create a concept in that issue correctly and quickly.

2. Teaching media will help to stimulate and create the attention to learner to be amusing and not boring about learning.
3. Media Utilization will make learners have the same comprehension and have shared experience in that subject.
4. It assists learner to participate in teaching-learning activities increasingly, and to have good relationship among learner and teachers.
5. It assist to build the good attributes of learning in studying, investigating, and creating from those media.
6. It assists to solve the problem on the issue of personal difference by arranging medium for individual teaching-learning.

Carlton W.H. Erickson, (cites in 1984: 29, Sukhothai Thammathirat Open University), concluded the function and importance of teaching media that it can assist teacher and students as follows:

1. Assist to arrange and to learning experience of students.
2. Assist teacher to teach content that has meaning towards life student.
3. Assist teacher to advise and control students to interact in the desired way by use different media.
4. Assist student to be able implement activity that differs according to the content subject.
5. Assist teacher to be able teach quickly and correctly.

It can be concluded from worth and importance of teaching media as aforementioned that if it is used in the education for creating knowledge and awareness on environment. It should be another way of warning the student to be aware about environment and problem occurrence. The learning nature will be happened easily it that learning is meaningful to learner, and learner is interested that

thing so it will be remembered. As a result to construct the supplementary reading book in the environmental aspect in order to be used as educational media, it will assist the students in the age of upper secondary level to have knowledge, comprehension, and awareness raising in the environmental problem and to able to use in the real life. It will be very useful.

2.4 Documents Related to Construction of Supplementary Reading Book

The supplementary reading book is a type of book of additional experience book that the Department of Curriculum had given the meaning of supplementary experience book that is the teaching-learning media for primary school and secondary school level in the printing media style that Department of Curriculum had produced in form of production of private printing office and presenting to the department to examine in order to allow to use in the school in order to use for teaching-learning supplement and to develop the learner to grow in the aspect of intelligent, society, emotion, and spirit.

2.4.1 Type of Supplementary Experience Book

According to the order of Ministry of Education Vor Kor /1978 on the issue of the guideline for practice about book for student in the primary school and secondary school level, the supplementary experience book is classified as follows:

1. Outside reading book is the book that Minister of Education defined to use for learning any subject according to curriculum beside learning book, it is regard to that the learning activity about this book is a part of learning according to curriculum.

2. Supplementary reading book is the book that has content refer to the curriculum for students to educate for searching additional knowledge by himself according to the appropriateness and reading ability of individual. This type of this book is ever to be called complementary reading book.

3. Explanation book is book for searching, reference about learning, and compiling of this type of book is academic approach or someplace it is called reference book.

4. Promoting reading book is a book is produced with objectives to promote the reader to have skill of reading and habit of love to read increasingly. It may be documentary book, novel, and tale that have the characteristics that not be conflicted culture, tradition, and good moral to have knowledge, principle, and advantages.

From the concept about the construction of this supplementary reading book, there is person who gave importance and paid attention to construct it for reading promotion for students for learning by themselves and as teaching tool for teacher, and lecturer numerous stories. Such as Department of Curriculum produced it in series of Conservation of Natural Resources and Environment at secondary level on the topic of “ Scenic Pollution” compiled by Ithipol Rasrikraingkrai for giving knowledge the toxic of seeing the dirty geographical feature due to that wastes or dirty from nature itself, and the human performance. It impacts both psychological and physical health, besides it provided the way of solving and preventing to decrease the cause of pollution problem in order to let everyone in society to live together among the pure environment (Department of Curriculum, 1999).

Institute of Promotion Teaching of Science and Technology had produced the supplementary reading about series of “This Electricity has Prize” for teacher and students for teaching-learning supplement on the issue of “Environment” for secondary school level and the general people who is interested in that issue will assist to solve and prevent the harm that may cause by the toxic environment. Inside the composed of content, pictures, charts, table of activities, question for thinking, and answers at the end of the book. Moreover, there is a information table for calculation of electrical energy loss (Institute of Promotion Teaching of Science and Technology, 1985).

Textbook on the topic of “Solar Energy” was wrote by Chanchai Ajinsamajarn in 1993 about knowledge on energy that human got from sun light in different forms. Since human has used the fossil fuel for long time and not has been extravagant so these natural resources has been exhausted rapidly but the human demand of energy consumption is increasingly. Therefore the age of technological energy from the solar energy as important energy for human being will be come certainly soon in the near future because the sun light is still shine for long time. How human will use solar energy , this book will give the answer (Chanchai Ajinsamajarn, 1993).

These books is occurred from the concept of to make the learner and the interest of people who want to obtain additional knowledge for fundament of comprehension raising about the content that was written for teaching-learning supplement of increased and clarified the existing knowledge for that person.

2.4.2 Meaning of Supplementary Book

Department of Curriculum (1991: 67), presented the meaning it is a book that has the content refers to curriculum for student to read to study for searching additional knowledge by himself according to appropriateness of age, and individual reading capability. This type of book had ever called complementary reading book.

Supatra Chumkate (1979 : 115) said that the supplementary reading book is a book that the Ministry of Education suggests the school to buy for student to read as complement together school textbook in order to increase students knowledge and experience extensively. It will make the children be more understand the subject that they learn increasingly because knowledge on the learning lesson was learnt in the limited time because the curriculum will limit the learning time. Moreover the supplementary reading book has characteristic of narrow and deep content that refers each issue specifically, not mention generally by covering widely like as textbook. Therefore supplementary reading book may have various numbers but each book will mention subtopics that make student have more understanding about the lesson better.

Nisa Chutoet al (1981: 69-70), gave the meaning of supplementary reading book is a type of school textbook but it is not compulsory to use but only, the Ministry of Education identified in the command of Ministry of Education on the issue of defining school textbook for selection for school to provide in the library. This type of book was ever called supplementary reading book. This additional reading book has content referring to curriculum but it has more detail and attractive content for reading more than school textbook so it will be written that it is proper for which level of child, and which subject so the school can not command student to buy it.

From the meaning of aforementioned supplementary reading books, it can be concluded that it is book that Ministry of Education has allowed to use for teaching-learning supplement but it is not defined as school textbook. Scholl should provide this type of book for teachers and students for increasing knowledge besides the knowledge in the curriculum that extends the content scope to be more wider and deeper, including adding the experience of children to be fun and to use the free time wisely.

2.4.3 Needs for Utilization of Supplementary Reading Book

The supplementary reading book is necessary for teaching-learning according to curriculum, and the academic persons gave the opinions as follows:

Bunlue Pruksawan (1978: 58), mentioned the necessity by concluding that

1. Help to extend some issues in the school textbook widely to let leaner understand easier.
2. Make learner to have skill for use the wording and language more extensive.
3. Building the habit of loved reading more than school textbook.
4. Strengthen the habit of loved searching and developing before reading.
5. The supplementary reading books is story to compensate the defect mind of children.

Ministry of Education (Department of Curriculum 1977: 5-6) uttered about the needs of the supplementary reading books in two issues as follows:

1. For teacher, he plays his role in teaching and assists the student to have knowledge consistent with the defined curriculum or the content in the school textbook so he must search additional knowledge from other books to prepare for teaching, answering the question, and giving suggestion to student to study additionally in different issue in order to let students to learn by himself extensively according to the objectives of curriculum. Therefore teacher should know the others book much enough in order to know that which book is difficult or easy so it will be appropriate to read and understand by himself.

2. For student, if the student reads only one book for one subject, the knowledge obtaining may be too narrow because the book contained the advantage content according to defining of curriculum. Its outcome is expected only at the moderate level so to study by searching by himself, thoroughly, exchanging of learnt knowledge, and transferring of thinking each other, will assist the students to reach the target of curriculum easier.

Besides, the Department of Curriculum (1991: 68), stated that the supplementary reading books beside it is tool for promotion of teaching-learning according to curriculum of Ministry of Education, it still has important roles as follows:

1. Promote knowledge because the content about knowledge or skill, concept, principle or theory in one issue or numerous issues that are benefit for readers for living, learning, and creating the progressing and developing in different aspects.

2. Promote the proper attitude because besides it presents the content that is knowledge and strengthen the intelligence and it integrates the concept to assist the reader to raise appropriate attitude.

3. Promote the intelligence by providing the opportunity to reader to develop the skill in observation, interpretation, giving and explaining the reason, analysis, and evaluation.

4. Promote the comprehension because the content is presented in accordance with content structure, development of the cognitive Domain of reader, and giving the proper example.

5. Promote to search knowledge by himself.

2.4.4 Principle to Construct the Supplementary Reading Book

Chaweewan Kuhapinant (1984: 4-21), mentioned about the good attributes of book for children, including the step and general method good book production as follows:

2.4.4.1 Good attributes of book for children

Book for children means the book that is written or produced children directly. At present, the book for children only and having the good quality in the Thai market is very few. The features of good book for children, it should compose of

1). The good content, and appropriate to age, experience, knowledge, comprehension, and intelligence, reading capability of children, if it is a book for small children, the content should be content about environment surrounding the children such as pet in the house, tree, and flower. When they grows up the content will be story is far from themselves, it is the story that they are interested to know and see but the content should not be too difficult, and too long, or confuse but it must be in sequencing. For the documentary book for upper primary school or the age before teenage, and teenage, the content will be sequential by starting from easy to difficult or sequencing in order of events properly in order to be easy to understand and be continued, and easy to remember without learning by heart.

2). Writer is an important person that must have techniques and special ability to write the book for children to be interested in, and they can use it as friend so the writer must have knowledge, and comprehension about children such as child psychology, know the demand and interest of child that which age of child will be interested to which kind of book. Besides, the writer should have affective mind to love child truly and is not greedy for money but he/she realizes to the importance of children that they are valuable human resource and is the hope of nation for country

development in the future so the writer should know how to integrate the good thing and knowledge for creating the child.

3). The plot of the story must be sequent and not be complicated or confused, strange and attractive.

4). Theme or core of story, it means the concept of story that the writer integrates in the plot of story and content of each book, most of the theme for child book will be the story that is obviously seen, simultaneously, teaching child to be a good, brave, honest, and economized, helpful person for instance.

5). Illustration, the complementary picture of book will attract the child's attention because child book should be attractive for children to be interested to read, and the color of picture should be bright, unclear, and not blurred color, because they don't like the dull color such as blue, and gray color but they like the hot color such as red and yellow. The picture can be a photograph or drawing picture. If it is line drawing picture, it should be clear. The number of picture will be more or less it is up to the age of children. The number can be decreased in proportion to age of child.

6). Illustrator, the complementary picture drawer should learn about the psychology of child's attention and demand, including color and attributes of picture that children like. Therefore he should consults with the writer regularly in order to get the picture that is pertinent the requirement of writer, and be relevant to the content and authentic principle.

7). Book form arrangement, form of page, picture arrangement, and description or layout of book, it should be arranged having appropriateness in consequence with artist style by not placing too much pictures or description until it has no space because it will make child be bored. It should have some space in order to let the reader rest the eye, and it should have artist style presentation.

The numerous of arranged means of Illustration and description are as follows:

1). Illustration and description is on different page, illustration

may be on the right page according to the principle of attention of people that will look at the right side first.

2). Illustration is on the same page with letter, description, it can be above or under the picture, or mix together so it may place above and beneath or distributed on the space area.

3). Illustration and description are distributed on the both two pages so it is clear since most of it is a big picture. It will be an interesting illustration since it makes the picture bigger and wider.

4). Wording and literary style should be simple and appropriate to the age of child, particularly, for explanation, should use the difficult vocabulary, so it should be proper to the intelligence, reading ability and comprehension of child and with the familiar idiom.

5). Character should be the same age with child or close to the child, and it should not have a lot of character because it will make child be confused.

6). Technique or style of writing, it should have the technique of presentation the sequence of story should be make fun so it should use teaching style. Therefore it should be semi narrate and teaching. Technique of conducting story, it should be surprised, and be attractive to continuously follow the story with interesting and exciting.

7). Format is not certainly defined but it should not too big and is convenient for children to pick it up to read so the format should be small, in order to have cheap prize. The letter must be big and clear. The format may be strange or as pocket book size (7''*4''). The format had two characteristics with proportion of 4:3 that is vertical line (4''*6'', 8''*6''). The paper should be good quality with smoothness and thick. It should be white or light color, and high strength and durability. The cover may use the soft paper or rather soft so it is not necessary to be hard cover because it costs the high expenditure.

8) Cover can be soft or hard. The hard cover will be more expensive but it is strong and durable. On the cover should have picture that is pertinent to the content and it should be attractive the child's attention to read when he/she looks at the picture. They can guess that is about what story.

9). Letter should be large and clear so the small child like to read the big letter and wide spaces between words in order to be easy to read when they grow up it can be decreased size. Until the teenage book that can be used the regular size (19 and half points, 1 point is equivalent to 1/72 inches). The letter should not be elaborated letter because it is difficult to read.

10). Number of page, child with age before teenage by starting about 30-100 pages for upper primary level, and 100-200 pages for teenage.

The child book with age between 10-20 years (before teenage to teenage), this age they can read fluently so the reading is more necessary increasingly. The book for this age of child should have the features as follows:

- 1). Size of letter will be regular size.
- 2). Have the color and black and white color with proper number (the number can be decreased) the content about 70% and illustration about 30%.
- 3). Use the easy language and idiom that it is popular used by the teenage but it should not a slang.
- 4). The content is good and look real and it is the story of children in the same age. The book should have both amusement and knowledge. The content is interesting for teenage. It should not be teaching style but suggestion and giving the example.
- 5). Aim to create the imagination and creation
- 6). It has the pocket book style.
- 7). Cover with the attractive illustration, and artist style.
- 8). The content should be 150-200 pages up.

2.4.4.2 Step of book production for child

1). Study about book production for child

1.1). Study from the good book for child that received the rewards both Thai book and foreign book in order to use as guideline for each type

of book production, including the plot and theme of story, written style, language use, the prominent characteristics, and the defect point of each book.

1.2). Study knowledge from the various textbooks, documents, and research works, the attention of reading of child, the feature book is preferred by child, including, asking the scholars people who has knowledge and capability, interviewing the reading interest of child, and practicing writing regularly.

1.3). study about the works of the famous writers for childboth Thai and abroad.

2). Write the plot, content, give name for the story, define the theme of story, after he finished writing, it should narrate or let the child read in order to know their opinions whether they like or dislike and how much. If the children like the written story should be O.K., so it means the written story is able to use. If the children give the comment and criticize the writer should not angry because the children will give the facts.

2.1). Write the plot for documentary book for child, the outline must be written about the details of subtopic of that story by sequencing in order to be mean for writing the content that it should be composed by what in the plot and there should have theme as well.

2.2). Summarized content s writing the abbreviated content of the written story in order to let reader know what is the content involved the summarized content will give more details than the plot. It is obviously seen that the plot has the almost similar characteristics because the plot will be included in the summarized content The content will make the reader be fun and enjoyable or make more understanding the content . The summarized content can be written short or long.

2.3). Write the script is to bring the story from plot or summarized content to write in order to tell the step of content and picture arranging, it tells that each page of book by starting at the front cover, lining, inside front cover to last page will have what illustration and description should be arranged in what part of book. To write the script will be the guideline for illustration and form book arrangement by telling that in each page it will compose of what picture and

description, and how many pages to have. There are different style of script writing such as telling the detail in each page that it should be composed of what pictures, and description or writing the script by drawing the supplementary picture and description together.

2.4). Dummy preparation means to simulate the child book with small book , the details from scripts will be write and draw in the dummy book by starting at cover to last page. The picture will be drawn and the description will be write if can not draw it can be draw a circle to represented and tell that it is what illustration.

2.5). Format is the real book production such as drawing, description, including layout the book appropriately by looking from the dummy. There are numerous sizes of book. The most popular is 13*18.5 cm. or octavo with size 14.6*21 cm. or sixteenmo, the book will lay in the upright. The book will be stitched at the middle or at the edge.

2.6). Give the topic of the interesting, exciting, and attractive following story, it can be guessed that the story is about what. The writer know how to use the idiom to attraction for children, it is a mean or technique. The named topic should be create the children imaginations.

Chintana Baisukaye (1991: 96-99), The Head of Book Center of Department of Curriculum, Ministry of Education presented the guideline for construction of supplementary reading book for child as follows:

Step 1 Define the objective, topic, and format of content writing by emphasizing on the knowledge content, simultaneously, the outline of story will be clear and the content is written proper to age of child.

Step 2 Write the detail of content, set illustration for drawing, the content is written on the paper and synchronized with setting the illustration until completely. In each picture composed with description or content.

Pinyo Sathorn (1978: 253-254), stated that the principle that was employed for consideration supplementary reading book as follows:

1. Contents of book should composed of the criteria as follows:
 - 1.1 Be a book that extend the students' experiences in term of intelligence and emotion.
 - 1.2 Be interested in approach of students' thinking
 - 1.3 If it is the book to give the knowledge or information, so it must be Correct, up date, and assist to increase knowledge for children.
 - 1.4 Be strange from other book that students have.

2.5 Related Literatures

Mile A. Tinker and Constance M. Culloug, (1968: 317) concluded the research results of that Mackinton Mackinton who studied on the reading of 628 children at grade 1-8 as follows:

- 1). Children will be interested in the book that gives the fact of different stories.
- 2). Children like to read the tale about the real more than speaking animal.
- 3). Children from grade 2 will be interested in the country story or remote area, including the way of life of people in those countries.
- 4). Children learn lower than grade 5 will be interested in occupation.
- 5). Children from grade 5 will be interested in occupation.
- 6). Children will be interested in science, particularly the development of Science.
- 7). Children from grade 5 will be interested in biography, particularly the biography of famous persons.

Campbell, A., 1979, researched by asking the graduate learner to select the materials or textbook that is the easiest that they use as supplement for one subject. They selected the Philosophy of teaching of Le Francois. The components that was

employed for selecting the easiest reading book was format, and feature As a holistic view, it was interesting, good design, the letter is not too tight, having complement with the cartons distribution, and the flowchart was most relevant to the content. In addition other important variables were using the humor emotion, and linking the subjective concept to the familiar situations of reader.

Fasco, 1983: 219, studied the relationship between develop of learning level and reaction to the literature of children by using the sample group of Shorchan Wading River Middle School by letting the student read the freely selected books. It was read and analyzed by using literature analysis for education. After the data of comparison of the group was collected, it was found that the student had reactions to different stories by response to story that was able to match with the learning better. Age and sex had a little relationship to learning of student. The topic that was the most meaningful for students' learning was the story that ked them to be successful. Besides, development of learning of students from reading the literature would be depended on level of students' intelligences as well.

Pairat Kulvachirawan (1986: 105), researcher on “Construction and Try out the Supplementary Book as Short Story Style for Population Education at The Upper Secondary School Level”, it was found that the students had the satisfactions on the amused and interesting content. Including knowledge content was congruent to the current present, the students wanted to read the supplementary reading book in other subject as well.

Rabeab Kitimakulnoradet (1991: 112) studied on “The Construction and Experimentation of Supplementary Comic Book on “Water Pollution” for Pratomsuksa Three Students. It was found that the book can enhance in terms of students' knowledge and awareness on “Water Pollution”, and that the students were satisfied with the Comic book on the picture format, the layout, the content and the style of language. The pretest and showed that there is different statistically significant

at 0.01 level, the difference between experimental group and control at the same level as well.

Siwaporn Malila (1992: 149) researched on “The Development and Experiment of Supplementary Cartoon Book on “Wildlife Conservation” for Pratom Sixth Students. It was illustrated that the students were satisfied with the book on the picture format, the layout, the content and the style of language. The research achievement demonstrated that the posttest scores of students of the experimental group had higher than the pretest scores, and the scores of control group with the statistically significant at 0.01 level.

Ratana Nuankaew (1992: 104) constructed and tried out the supplementary book on the topic of “ Before Too Late” for for Pratom Sixth Students for Pratom Sixth Students. There were 30 students of experimental and control groups. The research results illustrated that the achievement of posttest scores of experimental group was higher than pretest scores and control group with the statistically significant at 0.05 level.

Nattaporn Kraithape (1995: 79) studied on “A Construction and Tryout of Supplementary Reading Book on the Conservation of Mangrove Forest for Prathonsuksa Six Students”. Thirty three students were selected purposely to be the experimental group and thirty two students were control group. The Pre and Post testing were carried out for both groups. Besides the experiment, this book was also evaluated by students and experts. The results of this research revealed that:

1. The posttest scores of the experimental group were higher than of the control group with the statistically significant at 0.05 level.
2. The experts and most of students rated their evaluation of this book as satisfaction. The book should be considered and used as a media or supplementary reading book for Prathonsuksa Six Students.

Konkanok Latthnand (1996: 53) researched on the development and implantation of an environmental supplementary book on “The Story of Forest”. The book quality was evaluated by experts. The subjects for this research were randomly selected from Baan Hua Khunjae Community School. Which was one of those schools joining the projects of “Elementary & Secondary School Cooperative Roles in Keeping Conserved Forest”. The research results showed that The mean scores of learning achievement of the experimental group after reading the book was statistically significant higher than before reading, and the control group at 0.05 level.

Orathai Sinprakob, (2000: Abstract) researched on the topic of “The Development of a Cartoon book on “ River and Survival” for complementary use in environmental study of at level 6 of Primary School. It was found that the students had knowledge increased after reading the carton book statistically significant at 0.01 level, besides the students were satisfied with cartoon book at the good level to excellent level and they gave the opinions that after reading this book they had knowledge and understanding about river and they were able to use the knowledge for daily life benefits.

Panida Chalernpornchai, (2003: 68) developed a learning book on Surveillance on the Rayong River for Subdistrict Administrative Organization. The research results revealed that the sample group had the mean score of posttest of the members higher than mean scores of pretest statistically significant at 0.05 levels

Nanthana Saensakorn, (1998: Abstract) researched on topic of “Opinions of Teachers and Students about Use of Teaching Media for Learning in the Cognitive Domain according to the Curriculum of Energy and Environment Conservation at Primary School level”. It was found as follows:

1. The teachers’ opinions about use of teaching media for learning in the cognitive domain according to the curriculum of energy and environment conservation, utilization of activity together with media in order to learn the cognitive domain. The most appropriateness was lecture combined with supplementary reading

book/ additional book, subsequences were discussion combined with supplementary reading book/ additional book, and real practice combined with supplementary reading book/ additional book respectively.

2. Comparison the opinion of teachers among the teaching level, experience in integration the content of energy and environment conservation, experience of training received about teaching-learning media, experience in the study about managing of teaching-learning in the aspect of energy and environment conservation, it was found that all of teachers had the opinions that it should use lecture combined with supplementary reading book/ additional book, subsequences were discussion combined with supplementary reading book/ additional book, and real practice combined with supplementary reading book/ additional book respectively.

3. The students' opinions about use of teaching media for learning in the cognitive domain according to the curriculum of energy and environment conservation, it was found that videotape was the most appropriate for use as teaching-learning media, subsequences were supplementary reading book/ additional book, school textbook, teachers or guardians, and Computer Assisted Instruction (CAI) respectively.

Division of research of Education, Department of Curriculum (1998: Abstract) researched on topic of "Situation of Production and Development of Book for Child" by asking from the sample group that were 28 printing offices, 6,981 students at level 6 of primary school student, 6,534 student guardians, and 35 school librarians, 129 book stores, and interviewed from the 4 policy makers, it was found that most of the printing offices operated their business in term of company limited, and the most published book was promoted experience child book. The research results habit of affective reading, it was found that most of children read the book that was not school textbook. The book that they like to read was pictured book, cartoon book, and newspaper. The first three range of regular reading book were cartoon book, general knowledge book, and newspaper.

The results of the above researches, it can be concluded that the supplementary

reading book is a medium to promote the teaching-learning to make children receive more and wider knowledge, and they will have the learning achievement higher and increase the learning efficiency of children better.



CHAPTER III

RESEARCH METHODOLOGY

This research was experimental research in order to construct and try out the using of supplementary reading book on “Solar Energy for Electricity Generation” for upper secondary school students for supplement for teaching on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school. The research design was the Pretest/ Posttest Control Group Design, and the implementation was as follows:

- ⊙ Construction of Supplementary Reading Book
- ⊙ Development of Supplementary Reading Book
- ⊙ Trial Supplementary Reading Book

3.1 Construction of Supplementary Reading Book

Construction of supplementary reading book was done according to the following steps (presented in chart 3):

3.1.1 Primary Data Study

3.1.1.1 Study the data was done by In-depth interview from 7 involved scholars and experts (Appendix E) about the need to construct the supplementary reading book, including the content using for constructing the supplementary reading book on the topic of “Solar Energy for Electricity Generation” .

3.1.1.2 Study the contents, concepts, and learning objectives from the curriculum of upper secondary school B.E. 2544, teaching plan, and hand book of

curriculum utilization B. E. 2544 subject of Science (biology) on issue of “Life and Environment” for students at level 4 upper secondary school of Ministry of Education.

3.1.1.3 Study academic data in the aspect of solar energy from the related documents in the issue of advantage of solar energy and introducing the solar energy as substitutive energy in various forms, impact of utilization of energy from different sources for electricity generation, and guideline for searching the other sources of energy for substitution.

3.1.1.4 Study technique and method of construction of supplementary reading book by studying from the related documents of book construction for children, construction of experience book as type of supplementary reading book in the issue of meaning, type, form, feature, principle of construction, and evaluation of results.

3.1.1.5 Consult with thesis advisory committee and experts in different aspects.

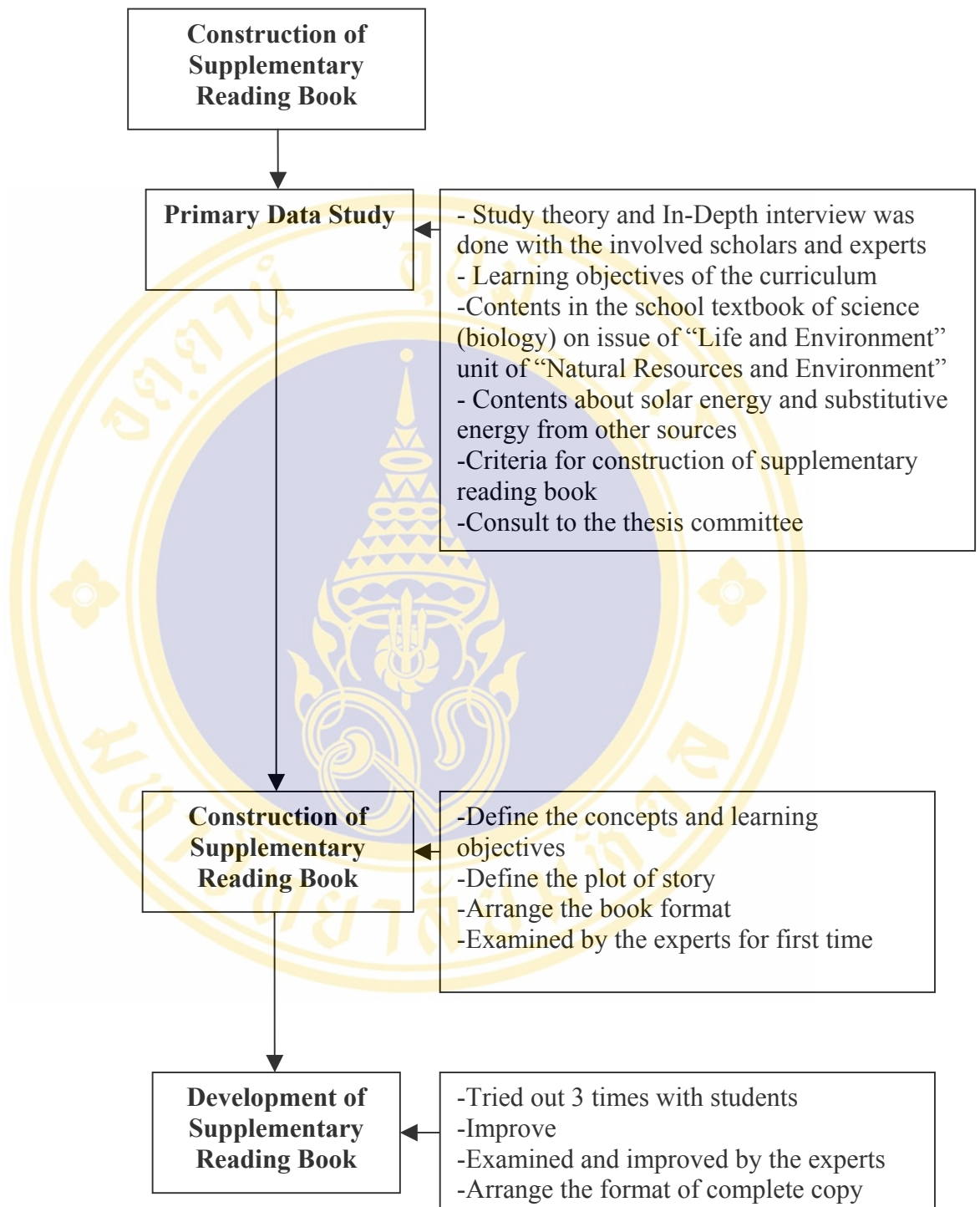


Chart 3 Steps of Construction of Supplementary Reading Book on the Topic of “Solar Energy for Electricity Generation”

3.1.2 Construction of Supplementary Reading Book and Tool for Measurement of the Book

3.1.2.1 Define the concepts, scope, and learning objectives to be relevant to the curriculum of upper secondary school B.E. 2544, and on the subject of Science (biology) on issue of “Life and Environment” for students at level 4 upper secondary school.

3.1.2.2 Define the plot of story by sequencing the contents in order to be easy to understand and be appropriate to the contents in the school textbook on subject of environmental science on the topic of “Energy”, the constructed supplementary reading book had the style of content writing in the term of sections as follows:

Table 6 Illustration of Defining the Story Plot of “Solar Energy for Electricity Generation”

Story Plot	Concept of Content
Introduction	It mentioned to the holistic view of construction of supplementary reading book on the topic of “Solar Energy for Electricity Generation”
Lesson 1 Come to Know Energy	It contained the contents referred to general energy that are non-renewable energy and renewable energy that can be used as substitutive energy.
Lesson 2 Energy Generation from Sun Light	It contained the content about energy generation from sun light and solar energy that world receives in different forms both accumulated in plants and cause of cycle.
Lesson 3 Energy from Sun Light for Electricity Generation	It contained the contents about advantage that solar energy is applied to electricity energy and thermal energy.
Lesson 4 Utilization of Solar Energy from Sun Light and Daily Life	It contained the contents of utilization, introducing of solar energy as substitutive energy in order to review the knowledge and understanding for reader after reading the whole contents.
Conclusion	It contained the contents of conclusion about the advantage of solar energy.

3.1.2.3 Write the story according to sequences of set plot, the supplementary reading book on the topic of “Solar Energy for Electricity Generation” was the documentary complemented with pictures. The plot had 4 lessons, and contained contents, format arranged for each page by defining the picture supplement to relate with concepts and content of each unit.

3.1.2.4 Define the format of the supplementary reading book by regarding to size of letter, picture arrangement, and language use at the front cover.

3.1.2.5 Arrange the draft, then it was brought to consult with the 6 experts in the aspect of education, construction of the supplementary reading book, environment, substitutive energy, solar energy and thesis advisory committee. It was the first improvement.

3.1.2.6 The construct the supplementary reading book was improved and examined for its readiness, then it was examined by the thesis advisory committee and 6 experts. Afterward it was tried out by 3, 9, and 30 students of upper secondary school at 4 level respectively.

3.1.2.7 It was improve and corrected according to the recommendations of thesis advisory committee and experts. Then it was produced for authentic experiment further.

3.1.2.8 Construct the table of content analysis of curriculum, behavior, and knowledge according to the principle of Bloom that divided into 6 aspects as knowledge, understanding, utilization, analysis, synthesis, and evaluation in order to obtain content validity.

3.1.2.9 Construct evaluation form of book quality for experts as evaluator, the criteria of quality evaluation was classified into 4 levels that were very good, good, moderate, should be improved, then it was examined by thesis advisory committee. The issues of evaluation were features of book and picture arrangement, characteristics of content, and characteristics of used language.

3.1.2.10 Construct the evaluation form of satisfaction toward the supplementary reading book for student as evaluators, the criteria of quality evaluation was classified into 4 levels that were very good, good, moderate, should be

improved by evaluating on arrangement of book format, illustration, and language use. Then it was examined by thesis advisory committee.

3.2 Development of Supplementary Reading Book

3.2.1 Development of Supplementary Reading Book

In order to obtain the supplementary reading book efficiency and tool efficiency for determination the construct book, before experiment, it was let the experts in the aspect of curriculum, construction of the supplementary reading book, environment, substitutive energy, and solar energy, to verify. Afterward it was tried out 3 times by students of upper secondary school at 4 level under the control of Department of General Education. The students who were not the sample group and had the similar attributes as sample group were employed. The method was as follows (Chaiyong Promwong, et al, 1978: 139):

The first trial let 1 student who had the learning result at moderate level read the constructed supplementary reading book, he was asked about the ease/difficulty of language, defect of book, and he evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve.

The second trial, after the book was improved, let 9 students who had the learning result at good, moderate, and weak level by dividing 3 students in each group, read the constructed supplementary reading book. After reading finished, they were asked about the content comprehension, defect of book, and they evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve at the second time.

The third trial, after the book was improved, let 30 students read the constructed book. It found that they took about 35-45 minutes to finish reading. They were observed and the speed check had done for reading time consumed. Then they

did the learning achievement test and evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve at the third time for experimental use.

Afterward the constructed book was improved according the above process, the complete copy will let the aforementioned experts examined again in order to obtain the complete constructed book before it was employed in the experiment with the sample group further.

3.2.2 Development of Tool for Learning Achievement

The researcher developed the tool for learning achievement of supplementary reading book or test. It was tried out the test by the 30 students after reading constructed supplementary reading book for 30 minutes. The 30 students with the combination of good, moderate and weak of learning results were employed for constructed of supplementary reading book qualification at third time of development of supplementary reading book. The test composed of 30 questions.

The results of quality of test determination was analyzed for the level of difficulty level, discrimination power, reliability for selecting the qualified items for the experiment, including the reliability of the test was determined as follows (Boontam Kijpreedeeborisut, 1988: 208):

1) Difficulty Level

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:

$$\text{Difficulty level (P)} = \frac{P_H + P_L}{2n}$$

Where P = Difficulty level

P_H = Number of respondents in the 25% high group

For the criteria in choosing questions, the researcher chose questions with a difficulty level between 0.2 – 0.8 and a discrimination power. If it was higher than 0.80 and lower than 0.02, it must be improved.

2) Discrimination Power

After to determine the difficulty level, then the Discrimination Power was determined by the following formula.

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

Where

r	=	Discrimination power
P _H	=	Number of respondents in the 27% high group
P _L	=	Number of respondents in the low group
n	=	Total number of respondents in both groups

For the criteria in choosing questions, the researcher chose questions with a Discrimination power at least 0.2 for the real test.

3) Reliability

Bring 30 items were selected to determine the reliability by the Kuder-Richardson 21 (KR-21), with the formula as follows (Boontam Kijpreedeeborisut, 1994: 72):

$$r_{tt} = \left(\frac{k}{k-1} \right) \left(1 - \frac{\bar{X}(k - \bar{X})}{kS_x^2} \right)$$

Where

r_{tt}	=	Value of reliability of questionnaire
k	=	Number of questions
\bar{X}	=	Average score for the scores of total score
S_x^2	=	Deviation of the total score

3.2.3 Evaluation of Supplementary Reading Book Quality by Experts

In order to know the value and appropriateness of the constructed the supplementary reading book that was suitable to use for the supplementary reading for subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” according to the curriculum of upper secondary B.E. 2544 or not. After trial 3 times of the supplementary reading book with students already, the constructed book was printed and let the involved experts that were in the experts of curriculum, construction of the supplementary reading book, environment, substitutive energy, and solar energy evaluate by using the constructed form, and the results were concluded.

3.2.4 Construction of Tool for Determination of the Efficiency of Supplementary Reading Book

3.2.4.1 Construction of Test for Determination of Learning Achievement

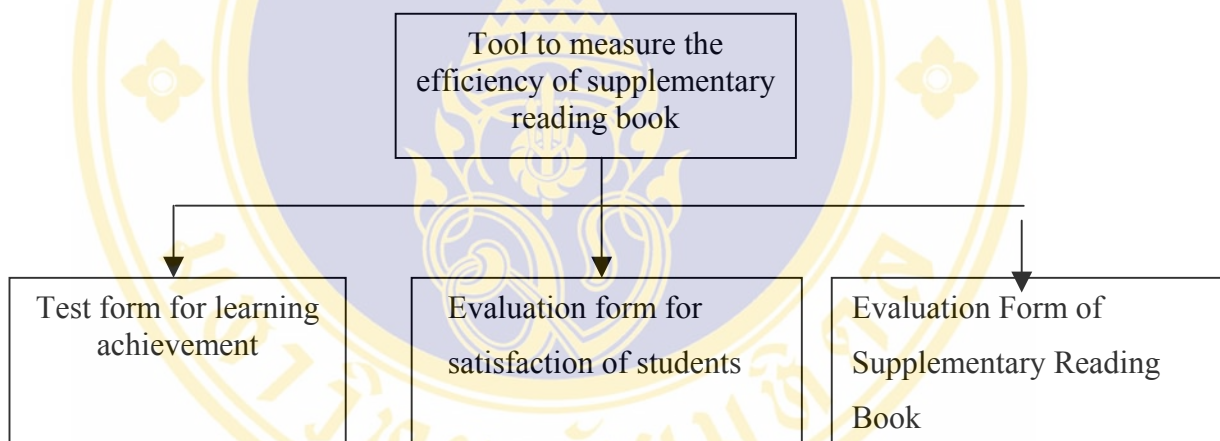
In order to evaluate the efficiency of the supplementary reading book on the topic of “Solar Energy for Electricity Generation”, the achievement test was constructed. The test was objective type test that composed of 30 questions with multiple choices with 4 choices by selecting only one correct answer. The time use for test was 30 minutes. The criteria of score grading was 1 score for 1 correct answer, and 0 score for the wrong answer and not giving answer. The step of construction of test was as follows:

1. Study the objectives of content of each subject that was used to construct the supplementary reading book on the topic of “Solar Energy for Electricity Generation”.
2. Construct table of content analysis, the content in the supplementary reading book was divided into 6 aspects of behavior measurement (Bloom, 1956: 90-100). The details presented in table 6.
3. Ask the suggestions from thesis advisory committee to consider for correctness according to content and appropriateness of question, and then it was improved.
4. The test of learning achievement was tried out with 30 students of upper secondary school at 4 level under the Department of General Education with the

combination of good, moderate and weak of learning results were employed for constructed of supplementary reading book qualification at third time of development of supplementary reading book. It was tried out the test contained 30 questions by the 30 students after reading constructed supplementary reading book for 30 minutes. The results were analyzed for reliability, difficulty level, and discrimination power.

3.2.5 Examination of Evaluation Form of Student Satisfaction toward Supplementary Reading Book

Evaluation form of student satisfaction toward supplementary reading book was examined by the experts and thesis advisory committee about the correctness of language and content.



- | | | |
|--|---|---|
| <ul style="list-style-type: none"> -Study the objectives and content of each subject used for book - Construct table of content analysis -Ask recommendation from Thesis advisory committee -Try out with students -Result was analyzed by item | <ul style="list-style-type: none"> - Study the construction of satisfaction form -Construct of evaluation - Ask recommendation from Advisory committee and be improved | <ul style="list-style-type: none"> -Study the construction of evaluation form of book quality -Construct the quality evaluation form -Ask recommendation thesis advisory committee and be improved |
|--|---|---|

Chart 4 Steps of Construction of Tool for Measurement of the Efficiency of Supplementary Reading Book on the Topic of “Solar Energy for Electricity Generation”

Table 7 Analysis of Number and Important Sequence of Test according to Content of Supplementary Reading Book on the Topic of “Solar Energy for Electricity Generation”

Behavior	Knowledge	Comprehension	Utilization	Analysis	Synthesis	Evaluation	Total	Important Sequence
Contents								
1.State of energy use and substitutive energy	2	2	-	1	-	2	8	3
2. Energy generation from sun light	2	3	-	-	-	1	8	4
3. Energy from sun light in different forms of substitutive energy	3	3	1	-	-	-	8	1
4.Conclusion of substitutive energy use from sun light and daily life	2	3	1	2	-	2	9	3
Total	9	11	2	3	0	5	30	
Important Sequence	2	1	4	3	6	5		

From the table of analysis of content of curriculum was constructed the tool for measurement of the learning achievement (test), had feature of objective type test with multiple choices of 4 choices, and it had 30 questions by selecting the most correct answer only one answer. The correct answer will be got 1 scores, and the wrong answer or not giving answer was got 0 score. This test was examined by the thesis advisory committee about being relevant to content, and appropriateness of questions, and then it was improved again before use. After the test was improved and corrected according to the recommendation, then it was determined the difficulty/ease, and discrimination power.

3.2.6 Construction of Evaluation Form of Satisfaction for Supplementary Reading Book by Student

It was divided into 3 sections as follows:

Section 1 Individual information

Section 2 The satisfaction for supplementary reading book was evaluated on feature of format arrangement, illustration, content and complementary picture utilization.

Section 3 The opinion about supplementary reading book

The criteria were used was divided into 4 levels that were very good, good, moderate, and should be improved or it was equivalent 4, 3, 2, and 1 scores respectively. The steps of evaluation form construction were as follows:

- 1). Study the feature of evaluation form of book construction about format arrangement, scope of content, illustration arrangement, and form of evaluation.
- 2). Construct the evaluation form of student satisfaction, it was considered about format arrangement, scope of content, illustration arrangement, and characteristics of used language.
- 3). Consult with thesis advisory committee to examine the evaluation form that covered all desired content, correctness, and suitability, it was improved the defects.

3.2.7 Construction of Evaluation Form of Supplementary Reading Book Quality by Experts

It was divided into 3 sections as follows:

Section 1 Individual Information

Section 2 The quality of supplementary reading book was evaluated

Section 3 The general opinion about supplementary reading book

The criteria were used was divided into 4 levels that were very good, good, moderate, and should be improved or it was equivalent 4, 3, 2, and 1 scores respectively. The steps of evaluation form construction were as follows:

1). Study the feature of evaluation form of book construction about format arrangement, scope of content, illustration arrangement, and form of evaluation.

2). Construct the evaluation form of student satisfaction, it was considered about format arrangement, scope of content, illustration arrangement, and characteristics of used language.

3). Consult with thesis advisory committee to examine the evaluation form that covered all desired content, correctness, and suitability, it was improved the defects.

3.3 Trial Supplementary Reading Book

3.3.1 Sample Group used in the Experiment

There was step of implementation as follows:

3.3.1.1 Selection of School The purposive sampling technique was employed for school selection. The upper secondary school level was designed as sample group, and the Triam Udom Suksa Patakarn Rachada, Huay Khang District, Bangkok Metropolis was the school that was selected because this school had arrangement of teaching-learning according to the curriculum of Ministry of Education, and had student at the level 4 of upper secondary school who learnt the subject of science (biology) on issue of “Life and Environment” as compulsory subject. Therefore it can be used as representative of the upper secondary school of the whole country that had the curriculum of teaching-learning according to curriculum of Ministry of Education. Moreover, teachers and administrators had far vision to open for receiving the new thing for developing teaching-learning in the school regularly because it is obviously seen that it received the reward of prize of excellent school of the academic year of 1983, 1984, and 1985 for 3 incessant years.

3.3.1.2 Selection of the Sample group for Research

The researcher selected the students of upper secondary school at level 4 as sample group for experiment by using Simple Random Sampling technique by drawing the name of 2 rooms by randomizing since there were 3 classrooms of students who learnt major of Science-Mathematic. These must learn the subject of environmental science as compulsory subject. The sample group were 30 students from each class that were experimental group and control group was selected by random drawing.

3.3.2 Tool Used in the Experiment

1. The Supplementary Reading Book on “Solar Energy for Electricity Generation”
2. Test for Learning Achievement Measurement
3. Evaluation form of satisfaction of the supplementary reading book was evaluated by 30 students after reading.

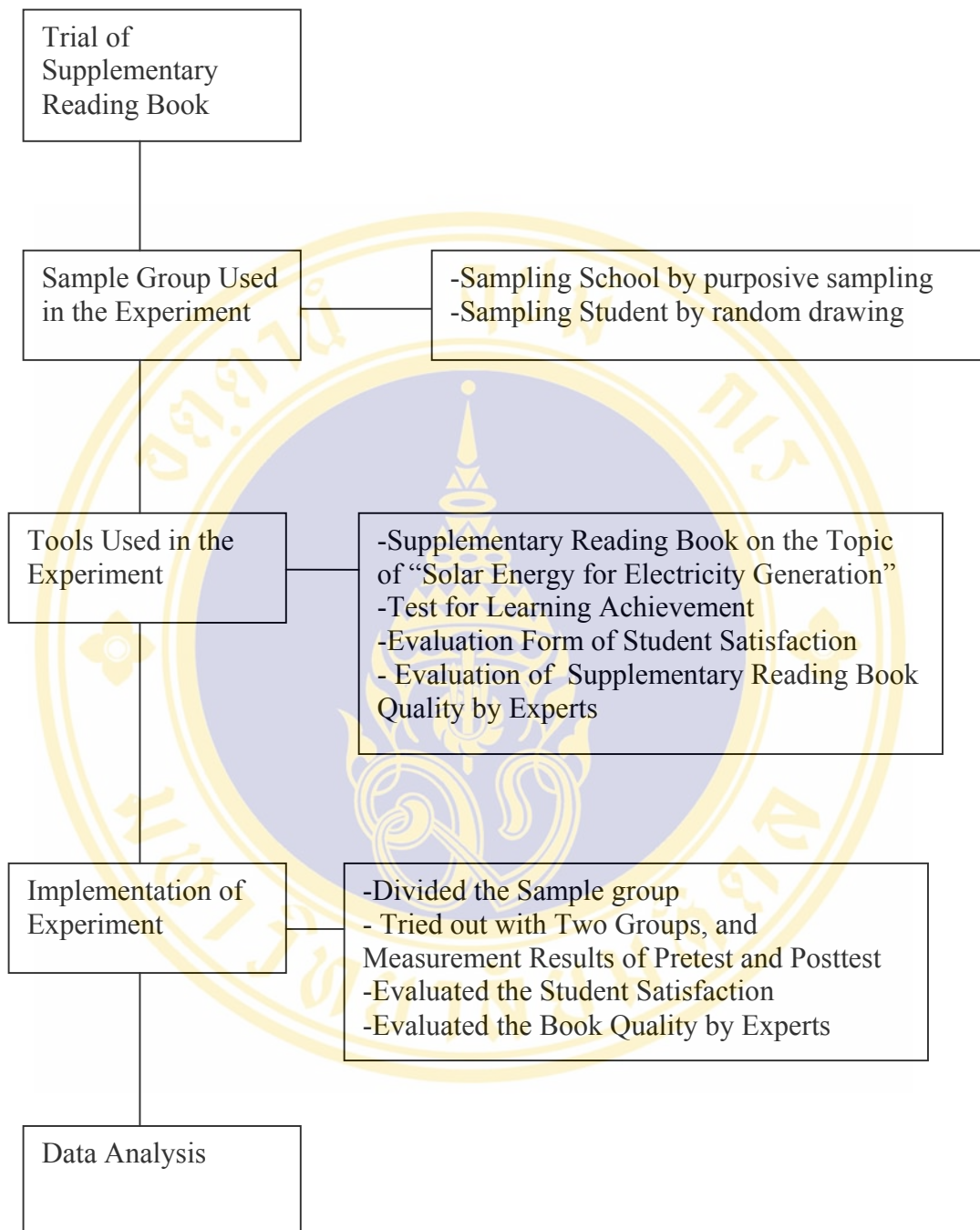


Chart 5 Step of Trial Use Evaluation of Supplementary Reading Book on the Topic of “Solar Energy for Electricity Generation”

3.3.3 Method of Experiment

The experimental design was the Pretest/ Posttest control group design that had the step of implementation as follows

3.3.3.1 Test was done by the experimental group and control group correspondingly.

3.3.3.2 Afterward let the experimental group read the supplementary reading book for 45 minutes, and the control did not read the book.

3.3.3.3 The prior test that were questions were alternating the sequence and the posttest were done by both groups.

3.3.3.4 The experimental group evaluate the satisfaction toward the supplementary reading book.

3.3.3.5 The presentation of pretest and posttest of experimental group and control group

R	O ₁	X	O ₂	Experimental Group
	O ₃	(X)	O ₄	Control Group

Where R = Sample Group

O 1 = Learning Achievement of Pretest of Experimental group

O 2 = Learning Achievement of Posttest of Experimental group

O 3 = Learning Achievement of Pretest of Control group

O 4 = Learning Achievement of Posttest of Control group

(X) = No Experiment

Achievement Test done	Read Supplementary Reading Book	Achievement Test done	Evaluation Form of Student Satisfaction done	Experimental Group
Achievement Test done	Not Read Supplementary Reading Book	Achievement Test done	-	Control Group

Chart 6 Supplementary Reading Book on the Topic of “Solar Energy for Electricity Generation” as the Pretest and Posttest Control Group Design

3.3.4 Data Collection and Data Analysis

Analysis the learning achievement of sample group and form of student satisfaction were done, the statistic value were employed as follows:

3.3.4.1 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 (cited in Pungrat Thaweerat. 1988: 176).

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

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

\bar{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 read from the table

3.3.4.2 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 (cited in Pungrat Thaweerat. 1988: 176).

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

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

$\sum D^2$ = Total sum of the difference between average scores of pretest and posttest, squared

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

n = Total number of students

3.3.4.3 The result of test of learning achievement of pretest and posttest of experimental group and control group were determined for mean scores

and test the different of mean scores in order to study the result of use the supplementary reading book.

3.3.4.4 The scores of satisfaction forms of supplementary reading book of students, and of experts were determined the frequency, percentage, and mode.

3.3.4.5 Conclude the research result and recommendations for development of supplementary reading book for further construction.



CHAPTER IV

RESULTS

This was the experimental research for construction and trial on the development of supplementary reading book on “Solar Energy for Electricity Generation” for supplement for teaching on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school. The research design was the Pretest/ Posttest Control Group Design. Data was analyzed to determine the statistic values. The results can be concluded as follows:

- ⊙ Results of Construction and Development of Supplementary Reading Book
- ⊙ Results of Determination of Efficiency of learning Achievement Test
- ⊙ Results of Satisfaction Evaluation of Supplementary Reading Book Quality
- ⊙ Results of trial of Supplementary Reading Book

4.1 Results of Construction and Development of Supplementary Reading Book

The results of study was obtained a supplementary reading book on “Solar Energy for Electricity Generation” for supplement for teaching on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school by defining the concept, scope, and objectives to be relevant to curriculum of upper secondary school B.E. 2544 and teaching plan of on the subject of science (biology) on issue of “Life

and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school. Additionally, characterizing the plot of story by sequencing the contents in order to be easy to understand and be appropriate to the contents in the school textbook on subject of environmental science on the topic of “Energy”, the constructed supplementary reading book had the style of content writing in the term of sections as presented in table 6 (Illustration of Defining the Story Plot of “Solar Energy for Electricity Generation”). After the book was constructed and it was improved and corrected according to the recommendations of thesis advisory committee and experts. They were in the aspects of environmental education media, curricular education, and energy technology. Afterward it was tried out 3 times with students of upper secondary school at 4 level under the control of Department of General Education. The students who were not the sample group and had the similar attributes as sample group were employed. The method was as follows (Chaiyong Promwong, et al, 1978: 139):

The first trial let 1 student who had the learning result at moderate level read the constructed supplementary reading book, he was asked about the ease/difficulty of language, defect of book, and he evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve.

The second trial, after the book was improved, let 9 students who had the learning result at good, moderate, and weak level by dividing 3 students in each group, read the constructed supplementary reading book. After reading finished, they were asked about the content comprehension, defect of book, and they evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve at the second time.

The third trial, after the book was improved, let 30 students read the constructed book about 30 minutes and they were observed and the speed check had done for reading time consumed. Then they did the learning achievement test and evaluated the satisfaction toward the supplementary reading book in order to bring the result to improve at the third time for experimental use.

Afterward the constructed book was improved according the above process, the complete copy will let the aforementioned experts examined again in order to obtain the complete constructed book before it was employed in the experiment with the sample group further.

4.2 Results of Determination of Efficiency of Learning Achievement Test

The researcher developed the tool for learning achievement of supplementary reading book or test. It was tried out the test by the 30 students after reading constructed supplementary reading book for 30 minutes. The 30 students with the combination of good, moderate and weak of learning results were employed for constructed of supplementary reading book qualification at third time of development of supplementary reading book. The test composed of 30 questions. 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, consequently, 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, 1988: 208).

From 38 questions test analysis, it was found that there were 30 questions were in the range of setting criteria. The reliability was determined by the Kuder-Richardson 21 (KR-21) technique. The reliability value is equaled to 0.77 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 21 of Appendix D).

4.3 Results of Evaluation of Supplementary Reading Book Quality

4.3.1 Results of Satisfaction Evaluation of Supplementary Reading Book Quality by Upper Secondary Students at Level 4

4.3.1.1 Result of satisfaction evaluation of supplementary reading book quality by one student.

The result showed that the evaluation of satisfaction about the content by holistic view of knowledge and understanding on “solar energy for electricity generation” had mode at very good in terms of portable size for holding, convenience for open, content to give knowledge and good arranged and clear letters. For the good level were evaluated about on beautiful and interesting form, the appropriate content length, and attractive content to read. The fair levels were about complementary pictures for each section be proper to the content, easy understood and clear pictures, and readable and understandable language.

This student had opinion about the book in term of content as a holistic view was interesting, and he understood in some section of content, and he would use the knowledge from this book in some time in daily life.

4.3.1.2 Result of satisfaction evaluation of supplementary reading book quality by nine students.

The result showed that the evaluation of satisfaction about the content by holistic view of knowledge and understanding on “solar energy for electricity generation” had mode at very good in terms of content to give knowledge, the appropriate content length, and good arranged and clear letters. portable size for holding, convenience for open, For the good level were the rest and no fair level was evaluated as presented in table 8.

The nine students had opinion about the book in term of content as a holistic view were interesting level, and they understood in some section of content, and they would use the knowledge from this book in some time in their daily lives as presented in table 9.

**Table 8 Results of Satisfaction Evaluation of Supplementary Reading Book
Quality by 9 Upper Secondary Students at Level 4**

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
Features of Book Arrangement					
1. Beautiful and interesting form	1	7	1	-	good
2. Portable size for holding	3	6	-	-	good
3. Convenience for open	2	4	3	-	good
Features of Picture Arrangement					
4. Beautiful and interesting covered pictures	2	5	2	-	good
5. Complementary pictures for each section be proper to the content	2	4	3	-	good
6. Easy understood and clear pictures	2	4	3	-	good
Characteristics of Content					
7. Content to give knowledge	5	4	-	-	very good
8. Good comprehensive content	3	4	2	-	good
9. The appropriate content length	1	4	4	-	very good,
10. Attractive content to read	-	6	3	-	good
Characteristics of Used Language					
11. Readable and understandable language	2	6	1	-	good
12. Good arranged and clear letters	4	3	2	-	very good

Table 9 Results of Satisfaction Evaluation on General Opinion about Supplementary Reading Book by 9 Upper Secondary Students at Level 4

Evaluated Items	Very Interesting	Interesting	Not Interesting	Mode
1. How about the opinions of students after reading the content?	-	9	-	Interesting
Evaluated Items	Understand the whole	Understand some Sections	Not Understand at all	Mode
2. How much knowledge and comprehension about the solar energy for electricity generation do students obtain after reading ?	1	7	1	Understand some Sections
Evaluated Items	Certainly Use	Use for some time	Never thought to use	Mode
3. Do the students think to use and practice to be useful in their daily lives or not ?	1	8	-	Use for some time

4.3.1.3 Result of satisfaction evaluation of supplementary reading book quality by thirty students.

The result demonstrated that the evaluation of satisfaction about the content by holistic view of knowledge and understanding on “solar energy for electricity generation” had mode at very good mode on every items of features of book arrangement as beautiful and interesting form, portable size for holding, convenience for open, features of picture arrangement as beautiful and interesting covered pictures, complementary pictures for each section be proper to the content, and easy understood and clear pictures, characteristics of content as content to give knowledge, good comprehensive content excepts items on the appropriate content length and attractive content to read, and characteristics of used language as readable and understandable language, and good arranged and clear letters presented in table 10.

Table 10 Results of Satisfaction Evaluation of Supplementary Reading Book Quality by 30 Upper Secondary Students at Level 4

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
Features of Book Arrangement					
1. Beautiful and interesting form	17	13	-	-	very good
2. Portable size for holding	22	8	-	-	very good
3. Convenience for open	24	6	-	-	very good
Features of Picture Arrangement					
4. Beautiful and interesting covered pictures	18	12	-	-	very good
5. Complementary pictures for each section be proper to the content	16	14	-	-	very good
6. Easy understood and clear pictures	17	13	-	-	very good
Characteristics of Content					
7. Content to give knowledge	24	6	-	-	very good
8. Good comprehensive content	15	15	-	-	very good, good
9. The appropriate content length	14	16	-	-	good
10. Attractive content to read	12	17	1	-	good
Characteristics of Used Language					
11. Readable and understandable language	14	14	2	-	very good, good
12. Good arranged and clear letters	19	11	-	-	very good

The thirty students had opinion about the book in term of content as a holistic view were interesting level, and they understood in some section of content, and they would use the knowledge from this book in some time in their daily lives as showed in table 11.

Table 11 Results of Satisfaction Evaluation on General Opinion about Supplementary Reading Book by 30 Upper Secondary Students at Level 4

Evaluated Items	Very Interesting	Interesting	Not Interesting	Mode
1. How about the opinions of students after reading the content?	12	18	-	Interesting
Evaluated Items	Understand the whole	Understand some Sections	Not Understand at all	Mode
2. How much knowledge and comprehension about the solar energy for electricity generation do students obtain after reading ?	8	22	-	Understand some Sections
Evaluated Items	Certainly Use	Use for some time	Never thought to use	Mode
3. Do the students think to use and practice to be useful in their daily lives or not ?	12	18	-	Use for some time

4.3.2 Evaluation of Supplementary Reading Book Quality by Experts

After the researcher had produced the supplementary reading book on “Solar Energy for Electricity Generation” for supplement for the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school by defining the concept, scope, and objectives to be relevant to curriculum of upper secondary school B.E. 2544 and teaching plan of on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level

4 of upper secondary school. There were the satisfaction evaluation on the constructed book by three times as mentioned above and the improvement and correction were improved. Then it was examined by the experts again and it was evaluated again by the experts in the aspects of environmental education media, curricular education, and energy technology. Additionally, it was agreed by the thesis advisory committee. Three experts had evaluated the concepts, and objectives of the constructed supplementary reading book at the level of good and very good level and they had also evaluated the content, language used, presentation, usefulness, and attraction of the lessons. Most of the book quality were at good levels and some were fair levels. Therefore there was only one item of objective of lesson two that must be improved or correct according to one expert's recommendation. The details were illustrated in table 12 and table 13.

Table 12 Evaluation of Learning Concepts and Objectives

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
Concept of Supplementary Reading Book					
1. The substitutive energy from sunlight is the natural energy that does not cause the pollution and it is the renewable energy that would be not exhausted so it can be applied to substitute for non-renewable energy.	3	-	-	-	very good
Behavioral Objectives of Learning					
1. Students are able to tell about the sources of solar energy.	2	1	-	-	very good
2. Students are able to tell about the essence and use of solar energy.	2	-	1	-	very good
3. Students are able to tell about that at present the substituted solar energy can be used as electricity generation.	2	1	-	-	very good
4. Students are able to tell about the reason that solar energy must be use for substitution.	2	1	-	-	very good

Table 12 Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
<u>Frame of Story and Concept</u>					
Chapter I Come to Know Energy					
<u>Concept</u>					
Energy is importance as a part of daily life so to know about types of used energy, it will help to know about the energy sources that will create the knowledge, understanding, and realize about the worth of each type of energy. Some types are going to be exhausted. Results of use of some types if energy causes the pollution problems. Searching for the substitutive energy is an interesting issue such as solar energy.	3	-	-	-	very good
<u>Objective</u> : Students know types of energy in terms of renewable and non-renewable energy.	3	-	-	-	very good
<u>Content</u> : Mention about the present used energy, there are some types of used energy causes the pollution to environment, and it is exhausted. Therefore there is searching for other substitutive energy to be used for decreasing of pollution problem and solving the state of energy shortage I the future. Particularly, the substitutive solar energy is the tremendous energy source, and it also the origin of different energy.	2	1	-	-	very good

Table 12 Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
<p>Chapter II Energy Generation from Sun Light</p> <p><u>Concept</u> The sun is the origin of living things on the earth. Whether, it is sources of the light, heat, and energy for al living in the world. Plants produce the food because it can use the benefit from sunlight. Moreover, energy from sunlight cause the natural phenomenon and causes of various cycles such as wind, wave, and tide. Some phenomenon can be used in different benefits.</p>	3	-	-	-	very good
<p><u>Objective</u> : Students are able to know that how does the sun can give incredible energy and it can give benefit in which aspects for us.</p>	1	2	-	-	good
<p><u>Content</u>: Mention about the reaction of nuclear fusion on the sun that is the cause of tremendous energy and this energy transmitted to earth causes the variety of benefit both direct and indirect such as heat, light given, and cause of water cycle as importance for living of living creature on the earth. Furthermore, human being had brought technology for application of sunlight from nature to be benefit for energy aspect in different forms.</p>	1	2	-	-	Good
<p>Chapter III Energy from Sun Light for Electricity Generation</p> <p><u>Concept</u> Present the usefulness of technological application for solar energy to produce electricity energy and thermal energy for utilization of energy as realization of its worth and decreasing the environmental pollution.</p>	2	1	-	-	very good

Table 12 Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
<p>Objective : Students are able to know the usefulness of substitutive energy from sunlight that can be used reality in term of electricity generation and thermal energy production. Moreover, it causes no the environmental pollution.</p>	2	1	-	-	very good
<p>Content : About the usefulness of technological application from solar energy to produce electricity energy and thermal energy for utilization of energy at present are in what forms of energy.</p>	2	1	-	-	very good
<p>Chapter IV Utilization of Solar Energy from Sun Light and Daily Life</p>					
<p>Concept The conclusion and review of content in the aforementioned three lessons with the gist of the matter and a summary of the content about bringing the solar energy to apply for use in different aspect to increase knowledge and understanding about bringing solar energy to use in diverse forms.</p>	3	-	-	-	very good
<p>Objective : To review knowledge and understanding for reader about bringing the solar energy to be applied for use with different invented equipment for used reality whether in term of electricity generation and thermal energy production from solar energy.</p>	2	1	-	-	very good
<p>Content : About brining the solar energy in form of substitutive energy to generate the electrical energy for use in daily life in term of light and heat provided and it is used in different forms.</p>	2	1	-	-	very good

Table 13 Evaluation of Supplementary Reading Book by Experts

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
1. Quality of Content Aspect					
1. Content gives knowledge to be congruent with the problem and demand of society	-	3	-	-	good
2. Content is corrected according to academic principle	-	2	1	-	good
3. Content has continuous sequences, unconnected or confused	-	1	2	-	fair
4. Difficulty/ease of content is appropriate with the level of learners.	-	2	1	-	good
5. The length of content is appropriate to be a supplementary reading book.	1	1	1	-	-
6. Content presents the problems, causes, and guideline for problem solving properly.	-	2	1	-	good
2. Quality of Content Presentation Aspect					
1. Structure of story is sequential appropriately.	-	2	1	-	good
2. Defining topic of story is congruent to the content of that story.	1	2	-	-	good
3. Stressing on the important issue of content for stimulating the intention of reader.	-	2	1	-	good
4. Clear and beautiful complementary pictures are relevant to content.	-	-	3	-	fair
5. Arrangement of page and size of letter are appropriately.	-	1	2	-	fair
3. Quality of Language Used					
1. Vocabulary used is appropriate to level of reader knowledge.	-	3	-	-	good
2. Language used is correctly clear according to principle of language use.	-	2	1	-	good
3. The sequential content is motivated and to followed.	-	2	1	-	good

Table 13 Evaluation of Supplementary Reading Book by Experts (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved	Mode
4. Quality of Usefulness					
1. Make the reader to obtain knowledge, understanding, and good consciousness for environment.	1	2	-	-	good
2. Readers are able to bring the knowledge and understanding to use in daily life.	-	2	1	-	good
3. Take part of promote for prevention and solving the world environmental problems.	1	2	-	-	good
5. Quality of Interesting					
1. The book form is attractive and proper.	-	3	-	-	good
2. Book cover is attractive and communicate to the meaning of book content.	-	1	2	-	fair
3. The method of compiling content make the reader to have good relationship with the writer.	-	2	1	-	good

4.3.3 General Opinion of Experts about Supplementary Reading Book

General opinion of experts about supplementary reading book on “Solar Energy for Electricity Generation”, it was found that all of the experts had the opinion that the book is very appropriate for supplementary reading on teaching-learning for subject of environmental science. For the issue of the book content is able to give knowledge for student in the issue of environment, two of three gave their opinion that the book content can give some more knowledge about knowledge for student in the issue of environment. Their feeling about the book after reading were interest. Theirs recommendation that it should make bigger letter and picture for easy reading, and the others opinions they gave that this book is very useful for students to read for additional knowledge about the energy, particularly the usefulness of solar energy as substitute clean energy for future as presented in table 14.

Table 14 Results of General Opinion of Experts about Supplementary Reading Book

Evaluated Items	Very Appropriate	Appropriate	Not Appropriate	Mode
1. The book is appropriate for supplementary reading on teaching-learning for subject of environmental science.	3	-	-	Very Appropriate
Evaluated Items	Much	Some	Not at All	Mode
2. The book content is able to give knowledge for student in the issue of environment	1	2	-	Some
Evaluated Items	Interest	Indifference	Not interest	Mode
3. . How about your feeling after reading this book?	3	-	-	Interest

4.4 Trial of Supplementary Reading Book

After the quality of supplementary reading book on “Solar Energy for Electricity Generation”, and the achievement test were improved to be efficiency to be use to try out with the target group that were the upper secondary school level 4 of Triam Udom Suksa Patakarn Rachada by simple randomization to get 60 students of Class 4/1 as 30 students for experimental group, and Class 4/2 as 30 students for control group by using the Pretest/ Posttest Control Group Design for research design.

4.4.1 Level of Knowledge of Posttest of Control Group

It was found that the control group did the achievement test after reading the supplementary reading. The number (frequency) or percentages of right answer for each item were as follows:

Item 1: Which one of the following is the meaning of non-renewable energy, 22 persons of experimental group can give the right answer (73.33%). Item 2: Construction of dam for electricity generation effects to environment in which one of the followings, 21 persons of them can give the right answer (70.00%). Item 3: Which one of the following is the materials that can be used as biomass, 17 persons of them can give the right answer (56.67%). Item 4: Which type of natural gas that is used as cooking gas and fuel gas, 16 persons of them can give the right answer (53.33%). Item 5: Which mean that can help to decrease the toxic substance from the coal, 13 persons of them can give the right answer (43.33%). Item 6: Which one of the following is not usefulness of solar energy, 21 persons of them can give the right answer (70.00%). Item 7: What the renewable energy is, 14 persons of them can give the right answer (46.67%). Item 8: How many types of geothermal energy, 15 persons of them can give the right answer (50.00%). Item 9: What the cause of the greenhouse effect phenomenon is, 22 persons of them can give the right answer (73.33%). Item 10: The tremendous energy of the sun is composed of what types of the following gas, 23 persons of them can give the right answer (76.67%).

Item 11: What reaction that occur from the fusion of light elements to be atom of bigger element, 15 persons of experimental group can give the right answer (50.00%). Item 12: Which one of the following is the correct pattern of solar energy transformation, 24 persons of them group can give the right answer (80.00%). Item 13: Which one of the following is the important factor for photosynthesis, 15 persons of them group can give the right answer (50.00%). Item 14: Why the photosynthesis of plant occur in the day time, 21 persons of them group can give the right answer (70.00%). Item 15: If the skin receive too much amount of ultra violet light, what will happen, 23 persons of them group can give the right answer (76.670%). Item 16: What type of geothermal energy is appropriate for electricity generation, 6 persons of them

group can give the right answer (20.00%). Item 17: Electricity generation from wind energy must depend on which one of the following, 18 persons of them group can give the right answer (60.00%). Item 18: Which one of the following is the cause to make the solar energy to be interesting to be used for electricity generation, 22 persons of them group can give the right answer (73.33%). Item 19: Which one of the following equipment is important to use electricity generation from solar energy, 21 persons of them group can give the right answer (70.00%), and Item 20: What the semi-conductor substance that is used as the structure of solar cell is, 22 persons of them group can give the right answer (73.33%).

Item 21: The solar cell with 5 inches diameter will induce how many amperes of short circuit, 6 persons of experimental group can give the right answer (20.00%). Item 22: Installation of solar cell, it should be placed the plate of solar cell in about how many degrees of inclination, and which direction, 16 persons of them can give the right answer (53.33 %). Item 23: What reason that the solar cell plate must be installed inclined, 15 persons of them can give the right answer (50.00%). Item 24: The system of electricity generation from solar energy, why it is proper of rural area, 16 persons of them can give the right answer (53.33%). Item 25: If there is demand of obtain a large amount of electrical current from solar cell, what it should be done, 7 persons of them can give the right answer (23.33%). Item 26: To maintain the inverter, what it should be done, 17 persons of them can give the right answer (56.67%). Item 27: How many types of solar, 11 persons of them can give the right answer (30.00%). Item 28: What the good point of using the dried oven made of solar cell is, 14 persons of them give the right answer (46.67%). Item 29: Hot water generator made of solar cell will compose of how many important compartments, and what it is, 13 persons of them can give the right answer (43.33%), and Item 30: Which item is not the good point of utilization of electricity generation from solar cell, 7 persons of experimental group can give the right answer (23.33 %) as showed in table 15.

Table 15 Number and Percentage of Correct Answer of Control Group for Each Question

Item of Achievement Test	The correct Answers given by Control Group	
	Number (Person)	Percentage
1. Which one of the following is the meaning of non-renewable energy.	22	73.33
2. Construction of dam for electricity generation effects to environment in which one of the followings.	21	70.00
3. Which on of the following is the materials that can be used as biomass.	17	56.67
4. Which type of natural gas that are used as cooking gas and fuel gas.	16	53.33
5. Which mean that can help to decrease the toxic substance from the coal.	13	43.33
6. Which one of the following is not usefulness of solar energy	21	70.00
7. What is the renewable energy, 16 persons of them can give the right answer.	14	46.67
8. How many type of geothermal energy.	15	50.00
9. What is the cause of the greenhouse effect phenomenon	22	73.33
10. The tremendous energy of the sun is compose what types of gas.	23	76.67
11. What reaction that occur from the fusion of light elements to be atom of bigger element	15	50.00
12. Which one of the following is the correct pattern of solar energy transformation.	24	80.00

Table 15 Number and Percentage of Correct Answer of Control Group for Each Question (Continued)

Item of Achievement Test	The correct Answers given by Control Group	
	Number (Person)	Percentage
13. Which one of the following is the important factor for photosynthesis.	15	50.00
14. Why the photosynthesis of plant occur in the day time.	21	70.00
15. If the skin receive too much amount of ultra violet light, what will happen.	23	76.67
16. What type of geothermal energy is appropriate for electricity generation.	6	20.00
17. Electricity generation from wind energy must depend on which one of the following.	18	60.00
18. Which one of the following is the cause to make the solar energy to be interesting to be used for electricity generation.	22	73.33
19. Which one of the following equipment is important to use electricity generation from solar energy.	21	70.00
20. What is the semi-conductor substance that is used as the structure of solar cell.	22	73.33
21. The solar cell with 5 inches diameter will induce how many amperes of short circuit.	6	20.00
22. Installation of solar cell, it should be placed the plate of solar cell in about how many degrees of inclination.	16	53.33
23. What reason that the solar cell plate must be installed inclined.	15	50.00

Table 15 Number and Percentage of Correct Answer of Control Group for Each Question (Continued)

Item of Achievement Test	The correct Answers given by Control Group	
	Number (Person)	Percentage
24. The system of electricity generation from solar energy, why it is proper of rural area.	16	53.33
25. If there is demand of obtain a large amount of electrical current from solar cell, what it should be done.	7	23.33
26. To maintain the inverter, what it should be done.	17	30.00
27. How many types of solar.	11	30.33
28. The dried oven used of solar cell has what good points.	14	46.67
29. Solar cell hot water machine will compose of how many important compartments, and what it is.	13	43.33
30. Which item is not the good point of utilization of electricity generation from solar cell.	7	23.33
Mean score (\bar{X}) = 20.09 S.D. = 1.95		

4.4.2 Level of Knowledge of Experimental Group after Reading the Book

It was found that the experimental group did the achievement test after reading the supplementary reading. The number (frequency) or percentages of right answer for each item were as follows:

Item 1: Which one of the following is the meaning of non-renewable energy, 26 persons of experimental group can give the right answer (86.67%). Item 2:

Construction of dam for electricity generation effects to environment in which one of the followings, 24 persons of them can give the right answer (80.00%). Item 3: Which one of the following is the materials that can be used as biomass, 25 persons of them can give the right answer (83.33%). Item 4: Which type of natural gas that is used as cooking gas and fuel gas, 17 persons of them can give the right answer (56.67%). Item 5: Which mean that can help to decrease the toxic substance from the coal, 19 persons of them can give the right answer (63.33%). Item 6: Which one of the following is not usefulness of solar energy, 22 persons of them can give the right answer (73.33%). Item 7: What the renewable energy is, 18 persons of them can give the right answer (60.00%). Item 8: How many types of geothermal energy, 20 persons of them can give the right answer (66.67%). Item 9: What the cause of the greenhouse effect phenomenon is, 25 persons of them can give the right answer (83.33%). Item 10: The tremendous energy of the sun is composed of what types of the following gas, 24 persons of them can give the right answer (80.00%).

Item 11: What reaction that occur from the fusion of light elements to be atom of bigger element, 26 persons of experimental group can give the right answer (86.67%). Item 12: Which one of the following is the correct pattern of solar energy transformation, 27 persons of them group can give the right answer (90.00%). Item 13: Which one of the following is the important factor for photosynthesis, 25 persons of them group can give the right answer (83.33%). Item 14: Why the photosynthesis of plant occur in the day time, 27 persons of them group can give the right answer (90.00%). Item 15: If the skin receive too much amount of ultra violet light, what will happen, 27 persons of them group can give the right answer (90.00%). Item 16: What type of geothermal energy is appropriate for electricity generation, 7 persons of them group can give the right answer (23.33%). Item 17: Electricity generation from wind energy must depend on which one of the following, 25 persons of them group can give the right answer (83.33%). Item 18: Which one of the following is the cause to make the solar energy to be interesting to be used for electricity generation, 25 persons of them group can give the right answer (83.33%). Item 19: Which one of the following equipment is important to use electricity generation from solar energy, 26 persons of them group can give the right answer (86.67%), and Item 20: What the semi-

conductor substance that is used as the structure of solar cell is, 24 persons of them group can give the right answer (80.00%).

Item 21: The solar cell with 5 inches diameter will induce how many amperes of short circuit, 8 persons of experimental group can give the right answer (26.67%). Item 22: Installation of solar cell, it should be placed the plate of solar cell in about how many degrees of inclination, and which direction, 19 persons of them can give the right answer (63.33 %). Item 23: What reason that the solar cell plate must be installed inclined, 26 persons of them can give the right answer (86.67%). Item 24: The system of electricity generation from solar energy, why it is proper of rural area, 19 persons of them can give the right answer (63.33%). Item 25: If there is demand of obtain a large amount of electrical current from solar cell, what it should be done, 7 persons of them can give the right answer (23.33%). Item 26: To maintain the inverter, what it should be done, 20 persons of them can give the right answer (66.67%). Item 27: How many types of solar, 10 persons of them can give the right answer (33.33%). Item 28: What the good point of using the dried oven made of solar cell is, 12 persons of them give the right answer (40.00%). Item 29: Hot water generator made of solar cell will compose of how many important compartments, and what it is, 15 persons of them can give the right answer (50.00%), and Item 30: Which item is not the good point of utilization of electricity generation from solar cell, 7 persons of experimental group can give the right answer (23.33 %) as showed in table 16.

Table 16 Number and Percentage of Correct Answer of Experimental Group for Each Question

Item of Achievement Test	The correct Answers given by Experimental Group	
	Number (Person)	Percentage
1. Which one of the following is the meaning of non-renewable energy.	26	86.67
2. Construction of dam for electricity generation effects to environment in which one of the followings.	24	80.00
3. Which one of the following is the materials that can be used as biomass.	25	83.33
4. Which type of natural gas that are used as cooking gas and fuel gas.	17	56.67
5. Which mean that can help to decrease the toxic substance from the coal.	19	63.33
6. Which one of the following is not usefulness of solar energy	22	73.33
7. What is the renewable energy, 16 persons of them can give the right answer.	18	60.00
8. How many type of geothermal energy.	20	66.67
9. What is the cause of the greenhouse effect phenomenon	25	83.33
10. The tremendous energy of the sun is compose what types of gas.	24	80.00
11. What reaction that occur from the fusion of light elements to be atom of bigger element	26	86.67
12. Which one of the following is the correct pattern of solar energy transformation?	27	90.00

Table 16 Number and Percentage of Correct Answer of Experimental Group for Each Question (Continued)

Item of Achievement Test	The correct Answers given by Experimental Group	
	Number (Person)	Percentage
13. Which one of the following is the important factor for photosynthesis.	25	83.33
14. Why the photosynthesis of plant occur in the day time.	27	90.00
15. If the skin receive too much amount of ultra violet light, what will happen.	27	90.00
16. What type of geothermal energy is appropriate for electricity generation.	7	23.33
17. Electricity generation from wind energy must depend on which one of the following.	25	83.33
18. Which one of the following is the cause to make the solar energy to be interesting to be used for electricity generation.	25	83.33
19. Which one of the following equipment is important to use electricity generation from solar energy.	26	86.67
20. What is the semi-conductor substance that is used as the structure of solar cell.	24	80.00
21. The solar cell with 5 inches diameter will induce how many amperes of short circuit.	8	26.67
22. Installation of solar cell, it should be placed the plate of solar cell in about how many degrees of inclination.	19	63.33
23. What reason that the solar cell plate must be installed inclined.	26	86.67

Table 16 Number and Percentage of Correct Answer of Experimental Group for Each Question (Continued)

Item of Achievement Test	The correct Answers given by Experimental Group	
	Number (Person)	Percentage
24. The system of electricity generation from solar energy, why it is proper of rural area.	19	63.33
25. If there is demand of obtain a large amount of electrical current from solar cell, what it should be done.	7	23.33
26. To maintain the inverter, what it should be done.	20	66.67
27. How many types f solar.	10	33.33
28. The dried oven used of solar cell has what good points.	12	40.00
29. Solar cell hot water machine will compose of how many important compartments, and what it is.	15	50.00
30. Which item is not the good point of utilization of electricity generation from solar cell.	7	23.33
Mean score (\bar{X}) = 20.09 S.D. = 1.95		

4.4.3 Learning Achievement of Pretest of Experimental and Control Group

Before the experiment would implemented to reading the supplementary reading book on “Solar Energy for Electricity Generation”. The researcher let experimental group and the control group to do the learning achievement test. The results showed that experimental group had mean score equal to 16.47, standard deviation (S.D.) was 2.03, and the control group had mean score equal to 16.60, standard deviation (S.D.) was 2.90. The mean scores of two groups were tested the

difference between group with the t-test, and it was found that t-value was 0.207, 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 at degree of freedom 58.

It meant the students of two groups had no difference of the prior knowledge before reading supplementary reading book on “Solar Energy for Electricity Generation” (presented in table 17).

Table 17 A Comparison of Knowledge before Reading Supplementary Book between Two Groups

Group	(N)	\bar{X}	SD	t	Sig.
Experimental Group	30	16.47	2.03	0.207	0.837
Control Group	30	16.60	2.90		

4.4.4 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. Afterward the control group who did not read supplementary reading book did the test again. The results demonstrated that mean score of pretest and posttest of control group had the close values that were 16.60 standard deviation (S.D.) was 2.90, and 16.40. standard deviation (S.D.) was 3.01. The mean scores of two times were tested the difference with the t-test, and it was found that t-value was 0.641, which was lesser than t-value from table that was 2.045, so there was no statistically significant difference between pretest and posttest at level 0.05 and degree of freedom=29. It can be concluded that the prior knowledge of pretest and posttest of control group were equal (presented in table 18).

Table 18 A Comparison of Knowledge of Pretest and Posttest of Control Group

Control Group	(N)	\bar{X}	S.D.	t	Sig.
Pre-test	30	16.60	2.90	0.641	0.527
Post- test	30	16.40	3.01		

4.4.5 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. Afterward, the experimental group who read supplementary reading book for 40-50 minute, then they did the posttest again. It was found that mean score of pretest and posttest of experimental group were 16.47, standard deviation (S.D.) was 2.03 for pretest and 20.09, and standard deviation (S.D.) was 1.95. The mean scores of two times were tested to determine the difference with the t-test, and it was found that t-value was 9.553, which was more than t-value from table that was 2.045, so there was statistically significant difference between pretest and posttest at level 0.05 and degree of freedom (df)=29. It can be concluded that the experimental group knowledge increased after reading the supplementary reading book (presented in table 19).

Table 19 A Comparison of Knowledge of Pretest and Posttest of Experimental Group

Experimental Group	N	\bar{X}	S.D.	t	Sig.
Pre-test	30	16.47	2.03	9.553	0.000
Post- test	30	20.09	1.95		

4.4.6 The Learning Achievement of Posttest of Experimental Group and Control Group

A comparison of knowledge of experimental group after reading the supplementary reading book and control group that did not read the book, it was found that that experimental group had mean score equal to 20.09, standard deviation (S.D.) was 1.95, and the control group had mean score equal to 16.40, standard deviation (S.D.) was 3.01. The mean scores of two groups were tested to determine the difference between group with the t-test, and it was found that t-value was 6.964 which was more than t-value from table that was 2.000, so there was statistically significant difference between the posttest of experimental group and control group at level 0.05 $df=58$. It can be concluded that the experimental group knowledge increased due to reading with supplementary reading book when compared with control group that did not read supplementary reading book (presented in table 20).

Table 20 A Comparison of Knowledge of Posttest between Experimental Group and Control Group

Group	N	\bar{X}	S.D.	t	Sig.
Experimental Group	30	20.90	1.95	6.864	0.000
Control Group	30	16.40	3.01		

From the data analysis was done in this study, it can be concluded that the constructed supplementary reading book on “Solar Energy for Electricity Generation” is able to increase the students of experimental group higher than pretest (before reading) and when compared with the control who did not read the book through the learning achievement test which qualified by the statistical analysis to determine for reliability level in the accepted criteria.

CHAPTER V

DISCUSSIONS

This research had objectives to construct and try out on the development of supplementary reading book on “Solar Energy for Electricity Generation” for supplement for teaching on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school.

The researcher made up her mind to construct the supplementary reading book on “Solar Energy for Electricity Generation” with the aim of construction the fundament of knowledge and understanding on solar energy because it becomes more and more important each day as clean, and save substitutive energy in order to substitute the non-renewable that is going to be exhausted in not more than a century, particularly, the exhausted energy such as fossil fuel.

Therefore, the student should have knowledge and understand at one level as foundation for invention and development of the solar energy to be use extensively. The reason to select to construct the book in place of the other modern high technology media such as computer assisted instruction (CAI), or videotape or slide because the book is the most easy to access for all age whether children, adult, and elder because it needs no high technology or equipment to aid for use likes other media. For instance it needs no electricity, projector, computer, radio receiver, television receiver, radio tape or videotape player, so it is the medium that can be access promptly whenever you want. Moreover, it does not use any special knowledge, skill or particular competency such as computer literacy, or equipment skill to access that type body of knowledge. It needs only ability of reading. Even

though, the blind, he might ask someone to read for him. In other words, the book is the most effective, efficiency, save, and cheapest source of knowledge at the present.

As a result, to construct the supplementary reading book on “Solar Energy for Electricity Generation”, it would be a source of knowledge that can be distributed extensively by only copying. The constructed book is very useful because it provides the knowledge of the essential substitutive energy as solar energy since it is the tremendous energy sources and it is the origin of life on the earth, including the origin of food chain by having the photosynthesis as initial system of food produce. It is going to play more and more important role at present and near future certainly. In order to try out that this constructed book is useful, and interesting for reader to use actually so it was developed ad improvement different time before implementing the experiment with the sample group, including it was determine for the efficiency that it is really effective to increase knowledge and understanding according to the set objectives by construction in accordance wit the principle of book construction and it was evaluated both the user that are the students and the experts about the satisfaction of book and quality of it as well.

In order to accomplish the established research objectives and to obtain the supplementary reading book on “Solar Energy for Electricity Generation”, the results of the experiment showed that the satisfaction of book quality by both experts and students were in the good and very good level mainly as presented in table 10 and 13. Particularly, the students the students satisfaction were in good and very good whether in the aspects of **features of book arrangement** such as beautiful and interesting form, portable size for holding, and convenience for open, **features of picture arrangement** such as beautiful and interesting covered pictures, complementary pictures for each section be proper to the content, and easy understood and clear pictures, **characteristics of content** such as content to give knowledge, good comprehensive content, the appropriate content length, attractive content to read **characteristics of used language** such as readable and understandable language, and good arranged and clear letters.

For experts in different aspects, the book was evaluated about the book quality in different aspects such as content, content presentation, language used, usefulness, and interesting (as presented 13) were most at good level. For the learning concepts and objective of the book, it was found that the experts evaluated at good level almost every items as presented 12 such as The substitutive energy from sunlight is the natural energy that does not cause the pollution and it is the renewable energy that would be not exhausted so it can be applied to substitute for non-renewable energy for instance.

To obtain supplementary reading book on “Solar Energy for Electricity Generation”, for the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school by establishing the content, concepts, scope, and objectives that is congruent to curriculum of upper secondary school B.E. 2544, and teaching plan of subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment”. Since this book had defined the plot of story by sequencing the contents in order to be easy to understand and be appropriate to the contents in the school textbook on subject of environmental science on the topic of “Natural Resources and Environment”, the constructed supplementary reading book had the style of content writing in the term of sections as presented table 6. In order to set the plot of supplementary reading book on “Solar Energy for Electricity Generation”, and after it was constructed, including passing through the correct and improve according to advisory committee and experts in the aspects in the aspects of environmental education media, curricular education, and energy technology would examine and evaluate primarily. The book was improved and corrected according to their recommendations. Afterward, it was tried out three times with the students at level 4 of upper secondary school who were not the sample group but had the similar characteristics. So the constructed book is efficiency to increase knowledge and understand to reader excellently since it was constructed according to principle of supplementary reading book construction of different persons such as Chaweewan Kuhapinant. (1984:4-21) and Chintana Baisukaye (1991:96-99), Pinyo Sathorn (1978, and Campbell A. (1979), for instance.

Moreover, it is also relevant to the concept of Department of Curriculum about supplementary reading book plays an important role for promotion knowledge because the content would relate about knowledge, or skill, concept, principle, or theory in one issue or various issues which are useful for reader in living, and learning, additionally, it creates the growth and development in different aspects. Moreover, it promotes the appropriate attitudes besides it would present the content of body of knowledge and promote the intelligence, and it also intervenes the thinking to stimulate appropriate attitude of the readers. Furthermore, the supplementary reading book is able to endorse the intelligence by providing the chance for reader to develop skill by observation, interpretation, comparison, elucidation the reason, synthesis, and evaluation. It is able to enhance the understanding of reader by presenting the content structure sequentially, and develop the cognitive domain of reader by giving the proper example. The important point that is it is able to encourage to study by oneself. The supplementary reading book is able to use as assisted tool for teachers, and lecturers in different issues such as the Department of Curriculum produced the series of supplementary reading book about the natural resource and environment conservation for secondary school level on “Scenic Pollution” by Itthipon Rasikraingkrai for giving knowledge about the toxic of seeing the dirty scenic view due to the wastes or dirty from making by nature or human being These are the important causes by bringing knowledge to apply in the daily life effectively.

Even though, the experimental group had read the supplementary book on “Solar Energy for Electricity Generation” for students at level 4 of upper secondary school, but most of them had still given the wrong answer such as question number 16, 21, 25, 26, and 30. Besides, it might due to the time restriction so they can not remember all details.

It can be discussed from the research results of the trial of experimental group and control group according to the set hypothesis as follows:

- 1) The students of experimental group learn with the supplementary reading book on the topic of “Solar Energy for Electricity Generation”, will receive knowledge increasingly with statistically significant at level of 0.05.

2) The posttest scores of students of experimental group after learning will have knowledge more than control group statistically significant at level of 0.05.

5.1 Hypothesis 1

It was set that the students of experimental group learn with the supplementary reading book on the topic of “Solar Energy for Electricity Generation”, will receive knowledge increasingly with statistically significant at level of 0.05. From the research result, it was found that the constructed book was able to increase knowledge and understanding to reader showed that the mean scores of posttest of the experimental group was higher than mean scores of pretest with statistically significant at level of 0.000 which is relevant to the hypothesis 1 (presented in table 18).

Therefore, the research result illustrated that it is congruent to the different studies of the various researchers such as Pairat Kulvachirawan (1986: 105), researched on construction and try out the supplementary book as short story style for population education at the upper secondary school level, Orathai Sinprakob, (2000: Abstract). The Development of a Cartoon book on “River and Survival” for complementary use in environmental study of at level 6 of Primary School, Nanthana Saensakorn. (1998: Abstract). Opinions of Teachers and Students about Use of Teaching Media for Learning in the Cognitive Domain according to the Curriculum of Energy and Environment Conservation at Primary School level, and Panida Chalernpornchai. (2003: 68). Development of a learning book on Surveillance on the Rayong River for Subdistrict Administrative Organization.

5.1 Hypothesis 2

It was established that the posttest scores of students of experimental group after learning will have knowledge more than control group statistically significant at level of 0.05.

From the research result, it was found that the constructed book was able to increase knowledge and understanding to reader showed that the mean scores of

posttest of the experimental group was higher than mean scores of posttest of the control group (who did not read the book) with statistically significant at level of 0.000 which is relevant to the hypothesis 2 (presented in table 19). The result was pertinent to the studies of different researches such as Orathai Sinprakob, (2000: Abstract), the development of a cartoon book on “River and Survival” for complementary use in environmental study of at level 6 of primary school, Rabeab Kitimakulnoradet. (1991: 112), the construction and experimentation of supplementary comic book on “Water Pollution” for pratomsuksa three students, Siwaporn Malila. (1992: 149), “the development and experiment of supplementary cartoon book on “wildlife conservation” for pratom sixth students, Ratana Nuankaew. (1992: 104), “Before Too Late” for pratom sixth students, Nattaporn Kraithape (1995: 79) studied on “A Construction and Tryout of Supplementary Reading Book on the Conservation of Mangrove Forest for Prathomsuksa Six Students”. Nattaporn Kraithape (1995: 79) studied on a construction and tryout of supplementary reading book on the Conservation of Mangrove Forest for prathonsuksa six students, and Konkanok Latthnand (1996: 53). Development and Implantation of an Environmental Supplementary Book on “The Story of Forest” for Prathomsuksa Six Students as well.

The construction and trial out the supplementary reading book on “Solar Energy for Electricity Generation” for the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school. The research design was the Pretest/ Posttest Control Group Design. The researcher make decision to study and construct because the book is a medium that can be used most easy and convenient widely without requiring the special skill or knowledge to use the equipment to access this body of knowledge. Moreover, the book has fewer limitation of use than other media because it is able to read whenever one wants since it needs no equipment or electricity to use it. Additionally, it is cheaper and portable to carry, and it can be reused again and again. The use manner is easy by opening only and it can be selected to the part that is wanted to read promptly since it is not require the sequence of use. For other good point, it is simple for maintenance, and the mean to use it not complicate. Besides it is able to provide details as much as the writer wishes to explain. Furthermore, it helps to

stimulate to use the imagination in different dimension that it may differ from the writer' one. It gives a chance for reader to pause to think for the suspected point whenever the reader wants. The reader is able to select to read or stop to read promptly. There is no expense for use in each time of reading because it does not need the electricity or equipment to use (to read) it. From the aforementioned good points and the benefit of the solar cell for daily life, it can be use punctually after one read it such as building the oven with the solar cell by oneself. The construct book also provides the basic knowledge of substitutive energy from sunlight. It may be claimed that the constructed book would assist for energy and environment conservation, and it can alleviate for the problem of energy shortage in the near future, particularly for the country likes Thailand that locates in the tropical zone, the people had experience of use the energy from the sunlight since our prior various generations whether for food preservation, warm our body, sterilization, make the coast dry, and provide the light for doing different activities as well.

From the aforementioned advantages of supplementary reading book, it was constructed in accordance with the academic principle and it was integrated the concept of environmental education given as holistic view, and the advantages of solar energy is included so it is not only to alleviate the energy shorting but the solar energy is a clean and cheap energy. If there is a full scale research seriously, particularly, for Thailand, the solar energy will help to conserve the environment by decreasing the pollution by using the solar energy as substitutive energy for fossil energy, and it also build the security of economy by do not import the energy from abroad by using the good location of country in the tropical zone for its appropriateness of introducing the clean solar energy to use for substitution if moat of the people can bring knowledge and understanding in the book to seriously apply generally. It would lead the benefit to public people and nation entirely.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This research was a construction and trial on the development of supplementary reading book on “Solar Energy for Electricity Generation” for supplement for teaching on the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school. The results can be concluded and recommended as follows:

- ⊙ Conclusions
 - Results of Construction and Development of Supplementary Reading Book
 - Results of Trail of Supplementary Reading Book
- ⊙ Recommendation from the Research
- ⊙ Recommendation for the further Research

6.1 Conclusions

From the research, it obtained a book of supplementary reading book on “Solar Energy for Electricity Generation”, for the subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment” for students at level 4 of upper secondary school by establishing the content, concepts, scope, and objectives that is congruent to curriculum of upper secondary school B.E. 2544, and teaching plan of subject of science (biology) on issue of “Life and Environment” unit of “Natural Resources and Environment”.

6.1.1 Results of Construction and Development of Supplementary Reading Book

The constructed supplementary reading book on “Solar Energy for Electricity Generation” has the quality according to the standard criteria and is effective to increase knowledge and understanding on substitutive energy, and it contains the details as follows:

1) Concept of Supplementary Reading Book

The substitutive energy from sunlight is the natural energy that does not cause the pollution and it is the renewable energy that would be not exhausted so it can be applied to substitute for non-renewable energy.

2) Chapter I Come to Know Energy

Concept: Energy is importance as a part of daily life so to know about types of used energy, it will help to know about the energy sources that will create the knowledge, understanding, and realize about the worth of each type of energy. Some types are going to be exhausted. Results of use of some types if energy causes the pollution problems. Searching for the substitutive energy is an interesting issue such as solar energy.

3) Chapter II Energy Generation from Sun Light

Concept: The sun is the origin of living things on the earth. Whether, it is sources of the light, heat, and energy for al living in the world. Plants produce the food because it can use the benefit from sunlight. Moreover, energy from sunlight cause the natural phenomenon and causes of various cycles such as wind, wave, and tide. Some phenomenon can be used in different benefits.

4) Chapter III Energy from Sun Light for Electricity Generation

Concept: Present the usefulness of technological application for solar energy to produce electricity energy and thermal energy for utilization of energy as realization of its worth and decreasing the environmental pollution.

5) Chapter IV Utilization of Solar Energy from Sun Light and Daily Life

Concept: The conclusion and review of content in the aforementioned three lessons with the gist of the matter and a summary of the content about bringing the solar energy to apply for use in different aspect to increase knowledge and

understanding about bringing solar energy to use in diverse forms.

6.1.2 Results of Trail of Supplementary Reading Book

After the quality of the constructed book on “Solar Energy for Electricity Generation” and the learning achievement test was improved and corrected until it was efficiency according to the set criteria. It was tried out with the target group that were the students of the Triam Udom Suksa Patakarn Rachada, Huay Khang District, Bangkok Metropolis. The simple random was employed for sampling, It get 30 students of Class 4/1 as experimental group, and Class 4/2 as control group by using the Pretest/ Posttest Control Group Design for research design.

The research results showed that the constructed book was able to increase knowledge and understanding to reader showed that the mean scores of posttest of the experimental group was higher than mean scores of pretest with statistically significant at level of 0.000 which is lower than the set hypothesis 1 at 0.05. Therefore it illustrated that the constructed book is effective and qualified to increase knowledge on solar energy for electricity generation actually.

6.2 Recommendation from the Research

6.2.1 In order to make the constructed book to be more interesting, it should be added the more colorful pictures as cover so it will be attractive the students’ attention.

6.2.2 It should be pay attention to proof the word and correct to be ready before producing, and arrangement of the sequence of ease/difficulty of content to be proper to the target group as much as possible.

6.2.3 For the trial, it must provide the time to be adequate to the competency of each person of target group, and it must explain to them to understand the objectives of research that it will provide which benefit for the public as a whole in order to reach the highest profit of the experiment.

6.2.4 The book construction or other media construction, it should regard on the ease/difficulty of content to be appropriate to age, and competency of learner as centered, and the topic must be interesting and it should be a surplus or extended

content for the learning lesson in the classroom. If it is similar, it should have more extensive or profound than the prior lesson.

6.2.5 Knowledge content must be modern and really extraordinary to attract the attention of learner, and it should be able to apply for the actual life to gain complete benefit besides it gives only knowledge and understand.

6.2.6 In the end of test, it should provide the right answer in order to let the reader to evaluate himself.

6.3 Recommendation for further Research

6.3.1 It should construct the topic of substitutive solar energy for other target groups such as general people, and students in the primary school level in order to be use as a campaign for environmental conservation by applying of the solar energy utilization from the plenty of sunlight in our country to be more subjectively

6.3.2 It should promote research about the invention of bringing solar energy to be extensively used by supporting the budget for research seriously.

6.3.3 It should construct other styles of media to supply more knowledge on solar energy for electricity generation such as construction in forms of videotape, and Computer Assisted Instruction which contain the animation to stimulate more comprehension and attention.

6.3.4 It should construct other styles of media about other types of substitutive energy besides solar energy such as wind energy, hydro energy, and natural thermal energy likes as geothermal energy in order to create the learner to have the fundamental knowledge to compare and apply to use the other substitutive energy to proper with their situation and environment subjectively, particularly, for the daily life activities.

6.3.5 It should study to develop the use of solar energy as substitutive energy to generate the electricity extensively in order to have a capacity to develop more advanced concept for invention of electrical appliance that is appropriate for daily life activities.

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Learning Achievement Test
Supplementary Reading Book, Environmental Science Subject
Upper Secondary School Level 4
Topic “Solar Energy for Electricity Generation”

Name.....Surname.....

Secondary School level.....

Explanation Let the student to mark (X) on the only one most correct answer

1. Which one of the following is the meaning of non-renewable energy?
 - a. Energy that everyone want to use a large amount is non-renewable energy
 - b. Energy that is expensive and rare.
 - c. Energy is exhausted when is used such as raw oil, and coal.
 - d. Energy is able to reuse again such as hydro energy, and wind energy.
2. Construction of dam for electricity generation effects to environment, which one of the followings?
 - a. Cause Flood
 - b. Cause loss of forest area.
 - c. Make the aquatic animal has habitat.
 - d. Make the people who live in that area have water to use.
3. Which one of the following are the materials that can be used as biomass?
 - a. Agricultural waste animal dung wastepaper
 - b. Refuse sugar cane animal manure foam
 - c. animal dung wastepaper chaff
 - d. Firewood chaff Agricultural waste
4. Which type of natural gas that is used as cooking gas and fuel gas?
 - a. Methane gas and Propane gas
 - b. Ethane gas and Methane gas
 - c. Propane gas and Butane
 - d. Ethane gas and propane gas

Answer of No. 1 is c, 2 is b, 3 is d, and 4 is c

5. Which mean can help to decrease the toxic substance from the coal?
 - a. Use the equipment or gas trapped machine before to release the toxic gas to environment
 - b. Use the expensive coal
 - c. Use the coal give the high heat
 - d. Use the coal contained low sulphur
6. Which one of the following is not the usefulness of solar energy?
 - a. Use as thermal energy and light
 - b. Use for charging the battery
 - c. Use for plant photosynthesis
 - d. Use for electricity generation through the solar cell equipment
7. What is the renewable energy?
 - a. Energy that can be reused and it never exhausted.
 - b. Energy that can not be substituted.
 - c. Energy that must be rotated for use.
 - d. Energy that can be searched again.
8. How many types of geothermal energy?
 - a. 4 types
 - b. 3 types
 - c. 2 types
 - d. 1 type
9. What is the cause of the greenhouse effect phenomenon?
 - a. Because the world is warmer.
 - b. Because the world is not able to reflect the heat energy to outside of the world normally.
 - c. Because the variation of weather situation.
 - d. Because the world absorb the heat from the solar energy too much.
10. The tremendous energy of the sun is composed of what types of following gas?
 - a. Hydrogen and Helium
 - b. Oxygen and Hydrogen
 - c. Helium and Nitrogen
 - d. Oxygen and carbon dioxide

Answer of No. 5 is a, 6 is b, 7 is b, 8 is b, 9 is b and 10 is a.

11. What reaction that occur from the fusion of light elements to be atom of bigger element is called?

- Chain reaction
- Nuclear fission reaction
- Nuclear reaction
- Nuclear fusion

12. Which one of the following is the correct pattern of solar energy transformation?

- Sun Solar Energy → Plant Chemical Energy → Animal Mechanical Energy → Objects move
- Sun Chemical Energy → Plant Light Energy → Animal Mechanical Energy → Objects move
- Sun Mechanical Energy → Object move Light Energy → Plant Chemical Energy → Animal
- Sun Chemical Energy → Animal Mechanical Energy → Objects move Light Energy → Plant

13. Which one of the following is the important factor for photosynthesis?

- Oxygen
- Sunlight
- Carbon Monoxide
- Temperature

14. Why the photosynthesis of plant occur in the day time?

- Because it needs the oxygen.
- Because it needs sunlight for photosynthesis
- Because plant needs to evaporate at the night.
- Because there is good ventilation at the day time.

15. If the skin receives too much amount of ultra violet light, what will happen?

- Receive the more vitamin D.
- May cause the skin cancer.
- Cause the some chemical substance under the skin to change to vitamin.
- Make the dark skin.

Answer of No. 11 is b, 12 is a, 13 is b, 14 is b , and 15 is b.

16. What type of geothermal energy is appropriate for electricity generation?
- General vapor
 - Hot stone
 - Dry vapor
 - Liquid is blocked under ground.
17. Electricity generation from wind energy must depend on which one of the following?
- Direction of wind.
 - blade of a turbine
 - Wind velocity
 - All of the above
18. Which one of the following is the cause to make the solar energy to be interesting to be used for electricity generation?
- It is never exhausted energy.
 - It is the energy that does not cause pollution.
 - It is in the nature.
 - It is the energy that takes a long time to accumulate energy.
19. Which one of the following equipment is important to use electricity generation from solar energy?
- Electrical wire
 - Battery
 - Solar cell
 - Transformer
20. What is the semi-conductor substance that is used as the structure of solar cell?
- Silicon
 - Mineral
 - Silicone
 - Metal

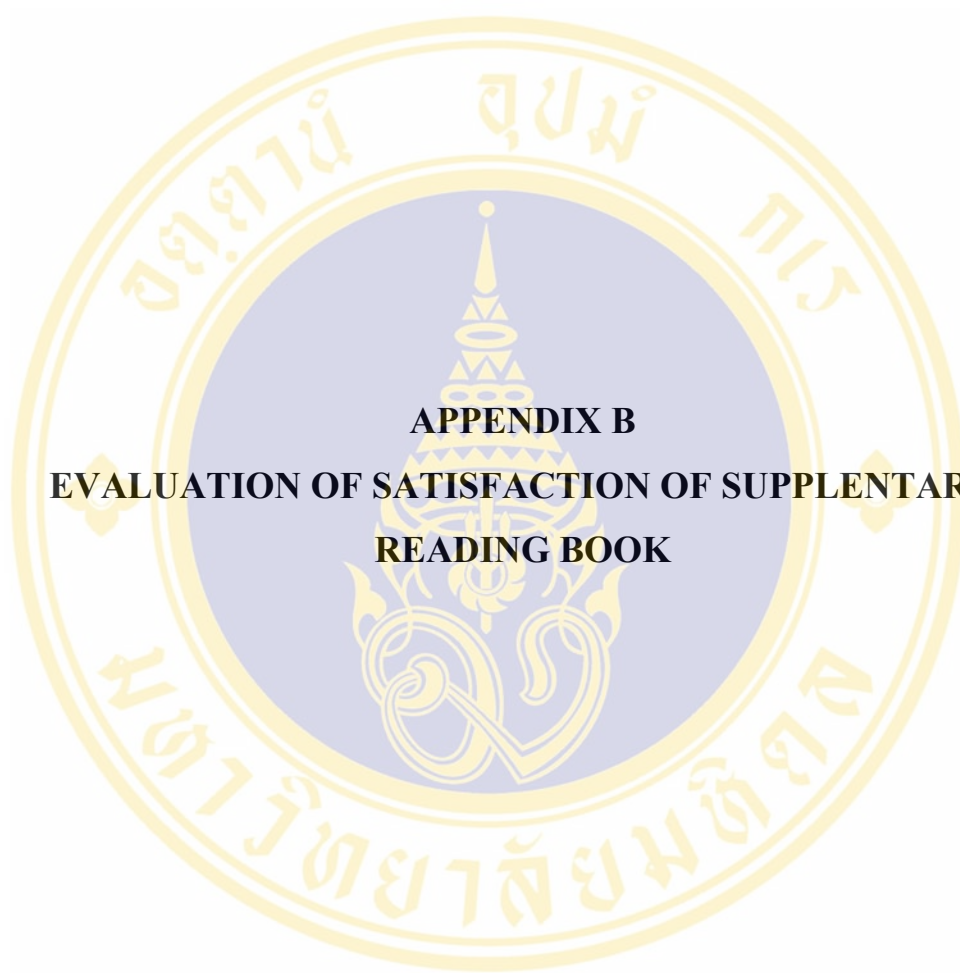
Answer of No. 16 is c, 17 is d, 18 is d, 19 is c , and 20 is c.

21. The solar cell with 5 inches diameter will induce how many amperes of short circuit?
- 5 Amperes
 - 4 Amperes
 - 3 Amperes
 - 2 Amperes
22. Installation of solar cell, it should be placed the plate of solar cell in about how many degrees of inclination, and which direction?
- 15-20 degrees turn the face to East direction
 - 10-15 degrees turn the face to North direction
 - 15-20 degrees turn the face to West direction
 - 10-15 degrees turn the face to South direction
23. What reason that the solar cell plate must be installed inclined?
- In order to help for rain water drainage fast and air ventilation.
 - In order to help for rain water drainage fast and receive a large amount of sunlight.
 - In order to receive the sunlight and air ventilation.
 - In order to heat release and rain water drainage quickly.
24. The system of electricity generation from solar energy, why it is proper of rural area ?
- No electricity to use because the wire is not placed in that area.
 - No electricity for use and in the rural area, there is adequate sunlight.
 - No electricity for use because lack of appropriate equipment.
 - No electricity to use because they had no money to install.
25. If there is demand of obtain a large amount of electrical current from solar cell, what it should be done, 7 persons of them can give the right answer?
- Bring a lot of cells to arrange.
 - Bring cell to connect as alternate order pattern
 - Make the cell is bigger to receive more sunlight
 - Bring cell to connect as alphabetical order pattern

Answer of No. 21 is c, 22 is d, 23 is b, 24 is a , and 25 is b.

26. To maintain the inverter, what it should be done?
- Install in the open area with the good air ventilation.
 - Install in door with the temperature not higher than 40 degree Celsius, and the humidity not more than 60 percent, good air ventilation, have no animal disturbance.
 - Install in door , have no animal such as snake or rat to disturb.
 - Have adequate area for maintenance in door space.
27. How many types of solar?
- 1 type
 - 2 types
 - 3 types
 - 4 types
28. What is the good point of using the dried oven made of solar cell?
- Help to preserve the dried product to be kept longer and cleaner.
 - Help to dry a large amount of agricultural produces.
 - Help to decrease the electricity consumption.
 - Help the raw material to dry faster.
29. Hot water generator made of solar cell will compose of how many important compartments, and what is it?
- 2 parts that are plate to receive the sunlight and tank for heat storage.
 - 2 parts that are tank for heat storage and plate for ray absorption.
 - 2 parts that are plate for ray absorption and a heat insulator
 - 2 part that are a heat insulator and water pipe.
30. Which item is not the good point of utilization of electricity generation from solar cell?
- It is the clean energy that does not destroy the environment.
 - It is the renewable energy that can be reused again.
 - It is safe the petrol and energy conservation.
 - It is extravagant energy consumption from natural energy.

Answer of No. 26 is b, 27 is c, 28 is a, 29 is a , and 30 is d.



Evaluation of Satisfaction of Supplementary Reading Book
Topic “Solar Energy for Electricity Generation”
For Upper Secondary School Level 4

Explanation Form of Evaluation of Satisfaction of Supplementary Reading Book is divided into 3 parts as follows:

Part 1 : General Information of Student

Part 2 : Satisfaction of Supplementary Reading Book on “Solar Energy for Electricity Generation”

Part 3 : Opinion of Supplementary Reading Book on “Solar Energy for Electricity Generation”

Let the student to mark (/) in front of the statement that is pertinent the fact or relevant to the opinions of student and fill statement into the bank completely.

Part 1 : General Information of Student

1. Sex () Male () Female
2. Ageyears
3. The upper secondary school level

Part 2 : Satisfaction of Supplementary Reading Book on “Solar Energy for Electricity Generation”

Evaluated Items	Very Good	Good	Fair	Be Improved
<p><u>Features of Book Arrangement</u></p> <p>1. Beautiful and interesting form</p> <p>2. Portable size for holding</p> <p>3. Convenience for open</p>				
<p><u>Features of Picture Arrangement</u></p> <p>4. Beautiful and interesting covered pictures</p> <p>5. Complementary pictures for each section be proper to the content</p> <p>6. Easy understood and clear pictures</p>				
<p><u>Characteristics of Content</u></p> <p>7. Content to give knowledge</p> <p>8. Good comprehensive content</p> <p>9. The appropriate content length</p> <p>10. Attractive content to read</p>				
<p><u>Characteristics of Used Language</u></p> <p>11. Readable and understandable language</p> <p>12. Good arranged and clear letters</p>				

Part 3 : Opinion of Supplementary Reading Book on “Solar Energy for Electricity Generation”

1. How about the opinions of students after reading the content?

- Very Interesting Interesting Not Interesting

2. How much knowledge and comprehension about the solar energy for electricity generation do students obtain after reading ?

- Understand the whole Understand some Sections Not understand at all

3. Do the students think to use and practice to be useful in their daily lives or not ?

- Certainly Use Use for some time Never thought to use

4. Recommendations for the part that must be improved

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Thank You



Form of Evaluation of Supplementary Reading Book Quality
Topic “Solar Energy for Electricity Generation”
For Experts

Explanation Form of Evaluation of Supplementary Reading Book Quality is divided into 3 parts as follows:

Part 1 : General Information of Experts

Part 2 : Evaluation on the Learning Concepts and Objectives of Supplementary Reading Book on “Solar Energy for Electricity Generation”

Part 3 : Evaluation on the Quality of Supplementary Reading Book on “Solar Energy for Electricity Generation

Part 4 : General Opinion of Supplementary Reading Book on “Solar Energy for Electricity Generation”

Please mark (/) in front of the statement that is pertinent to your opinions and fill statement into the bank completely.

Part 1 : General Information of Student

1. Name-Surname.....Education Level.....
2. Position
3. Work Place

Part 2: Evaluation of Learning Concepts and Objectives

Evaluated Items	Very Good	Good	Fair	Be Improved
<p><u>Concept of Supplementary Reading Book</u></p> <p>.1The substitutive energy from sunlight is the natural energy that does not cause the pollution and it is the renewable energy that would be not exhausted so it can be applied to substitute for non-renewable energy.</p> <p><u>Behavioral Objectives of Learning</u></p> <p>1. Students are able to tell about the sources of solar energy.</p> <p>2. Students are able to tell about the essence and use of solar energy.</p> <p>.3Students are able to tell about that at present the substituted solar energy can be used as electricity generation.</p> <p>.4Students are able to tell about the reason that solar energy must be use for substitution.</p> <p><u>Frame of Story and Concept</u></p> <p>Chapter I Come to Know Energy</p> <p><u>Concept</u></p> <p>Energy is importance as a part of daily life so to know about types of used energy, it will help to know about the energy sources that will create the knowledge, understanding, and realize about the worth of each type of energy. Some types are going to be exhausted. Results of use of some types if energy causes the pollution problems. Searching for the substitutive energy is an interesting issue such as solar energy.</p>				

Part 2: Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved
<p>Objective : Students know types of energy in terms of renewable and non-renewable energy.</p> <p>Content : Mention about the present used energy, there are some types of used energy causes the pollution to environment, and it is exhausted. Therefore there is searching for other substitutive energy to be used for decreasing of pollution problem and solving the state of energy shortage I the future. Particularly, the substitutive solar energy is the tremendous energy source, and it also the origin of different energy.</p> <p>Chapter II Energy Generation from Sun Light</p> <p>Concept The sun is the origin of living things on the earth. Whether, it is sources of the light, heat, and energy for al living in the world. Plants produce the food because it can use the benefit from sunlight. Moreover, energy from sunlight cause the natural phenomenon and causes of various cycles such as wind, wave, and tide. Some phenomenon can be used in different benefits.</p> <p>Objective : Students are able to know that how does the sun can give incredible energy and it can give benefit in which aspects for us.</p>				

Part 2: Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved
<p><u>Content</u>: Mention about the reaction of nuclear fusion on the sun that is the cause of tremendous energy and this energy transmitted to earth causes the variety of benefit both direct and indirect such as heat, light given, and cause of water cycle as importance for living of living creature on the earth. Furthermore, human being had brought technology for application of sunlight from nature to be benefit for energy aspect in different forms.</p> <p>Chapter III Energy from Sun Light for Electricity Generation</p> <p><u>Concept</u> Present the usefulness of technological application for solar energy to produce electricity energy and thermal energy for utilization of energy as realization of its worth and decreasing the environmental pollution.</p> <p><u>Objective</u> : Students are able to know the usefulness of substitutive energy from sunlight that can be used reality in term of electricity generation and thermal energy production. Moreover, it causes no the environmental pollution.</p> <p><u>Content</u> : About the usefulness of technological application from solar energy to produce electricity energy and thermal energy for utilization of energy at present are in what forms of energy.</p>				

Part 2: Evaluation of Learning Concepts and Objectives (Continued)

Evaluated Items	Very Good	Good	Fair	Be Improved
<p>Chapter IV Utilization of Solar Energy from Sun Light and Daily Life</p> <p><u>Concept</u> The conclusion and review of content in the aforementioned three lessons with the gist of the matter and a summary of the content about bringing the solar energy to apply for use in different aspect to increase knowledge and understanding about bringing solar energy to use in diverse forms.</p> <p><u>Objective</u> : To review knowledge and understanding for reader about bringing the solar energy to be applied for use with different invented equipment for used reality whether in term of electricity generation and thermal energy production from solar energy.</p> <p><u>Content</u> : About brining the solar energy in form of substitutive energy to generate the electrical energy for use in daily life in term of light and heat provided and it is used in different forms.</p>				

Part 3: Evaluation on the Quality of Supplementary Reading Book

Evaluated Items	Very Good	Good	Fair	Be Improved
<p><u>1. Quality of Content Aspect</u></p> <p>.1 Content gives knowledge to be congruent with the problem and demand of society</p> <p>.2 Content is corrected according to academic principle</p> <p>.3 Content has continuous sequences, unconnected or confused</p> <p>.4 Difficulty/ease of content is appropriate with the level of learners.</p> <p>.5 The length of content is appropriate to be a supplementary reading book.</p> <p>.6 Content presents the problems, causes, and guideline for problem solving properly.</p> <p><u>2. Quality of Content Presentation Aspect</u></p> <p>.1 Structure of story is sequential appropriately.</p> <p>.2 Defining topic of story is congruent to the content of that story.</p> <p>.3 Stressing on the important issue of content for stimulating the intention of reader.</p> <p>.4 Clear and beautiful complementary pictures are relevant to content.</p> <p>.5 Arrangement of page and size of letter are appropriately.</p>				

Part 3: Evaluation on the Quality of Supplementary Reading Book**(Continued)**

Evaluated Items	Very Good	Good	Fair	Be Improved
<p>.3Quality of Language Used</p> <p>.1Vocabulary used is appropriate to level of reader knowledge.</p> <p>.2Language used is correctly clear according to principle of language use.</p> <p>3.The sequential content is motivated and to followed.</p> <p><u>4. Quality of Usefulness</u></p> <p>.1Make the reader to obtain knowledge, understanding, and good consciousness for environment.</p> <p>.2Readers are able to bring the knowledge and understanding to use in daily life.</p> <p>.3Take part of promote for prevention and solving the world environmental problems.</p> <p><u>5. Quality of Interesting</u></p> <p>.1The book form is attractive and proper.</p> <p>.2Book cover is attractive and communicate to the meaning of book content.</p> <p>.3The method of compiling content make the reader to have good relationship with the writer.</p>				

Part 4 : General Opinion about Supplementary Reading Book

1. The book is appropriate for supplementary reading on teaching-learning for subject of environmental science.

- Very appropriate Appropriate Not appropriate

2. The book content is able to give knowledge for student in the issue of environment

- Much Some Not at all

3. How about your feeling after reading this book?

- Interest Indifference Not interest

4. Recommendations for the part that must be improved

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5. Other opinions about the supplementary reading book.

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Yours Sincerely



PRETEST AND POSTTEST SCORES OF CONTROL AND EXPERIMENTAL GROUP

**Table 21 Scores of Experimental Group and Control Group of High School
Level 4 before and After Reading the Supplementary Book**

Person Number	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
1	16.00	18.00	18.00	17.00
2	18.00	22.00	16.00	18.00
3	16.00	21.00	17.00	16.00
4	13.00	24.00	17.00	19.00
5	20.00	22.00	20.00	19.00
6	18.00	23.00	15.00	14.00
7	17.00	20.00	20.00	19.00
8	15.00	23.00	18.00	19.00
9	17.00	19.00	18.00	16.00
10	15.00	20.00	15.00	18.00
11	12.00	21.00	14.00	13.00
12	15.00	21.00	17.00	18.00
13	16.00	21.00	18.00	17.00
14	17.00	22.00	17.00	15.00
15	14.00	16.00	13.00	13.00
16	15.00	20.00	19.00	18.00
17	19.00	22.00	16.00	18.00
18	19.00	21.00	21.00	18.00
19	18.00	23.00	20.00	19.00
20	17.00	19.00	23.00	22.00
21	20.00	21.00	12.00	12.00
22	18.00	20.00	17.00	16.00
23	16.00	18.00	16.00	12.00
24	14.00	19.00	12.00	10.00
25	17.00	21.00	13.00	13.00
26	18.00	22.00	16.00	18.00
27	16.00	18.00	19.00	20.00
28	13.00	23.00	16.00	17.00
29	18.00	24.00	15.00	18.00
30	17.00	23.00	10.00	10.00
\bar{X}	16.47	20.90	16.60	16.40
S.D.	2.03	1.95	2.90	3.01



1. Experts of Environmental Education Aspect

1.1 Assoc. Prof. DR. Rachanont Supapongpichate, Ph.D., Assistant professor of Branch of The Environmental Education, Department of Education, Faculty of Social Sciences and Humanities Mahidol University.

1.2 Sornchai Moonkam, M.Ed. (Environmental Education), the Chief of Division of Environmental Campaign, Department of Environmental Quality Promotion, Ministry of Natural Resources and Environment.

2. Experts of Curriculum Aspect

2.1. Ms. Paopun Komolamarn, M.Ed., Academic people of Department of Curriculum, Ministry of Education.

2.2 Assoc.Prof. Sirichai Chinatankul, Ph.D., Dean of Faculty of Education, Silpakorn University.

3. Experts of Solar Energy Aspect

3.1 Mr. Somchai Stakulcharoen, M.Eng., Chief of Design Standard and Testing Section Bureau of Solar Energy Department.

3.2 Proff. Dr. Dr.Dusit Kraungam, Ph.D., Semiconductor Device Research Laboratory, Division of Electrical Engineering, Faculty of Engineering, Chulalongkorn University.

BIOGRAPHY

NAME	Miss Usawadee Seangsawang
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