CHAPTER IV

RESULTS OF DATA ANALYSIS

The researcher presents the data analysis by the following the subsequent identified objectives.

Part 1: The Development of Integrated Local Curriculum with Process-Oriented Teaching Methods for Grade Level 4 Students

Part 2: The Results of the Implementation of the Created Curriculum

Part 1 The Development of Integrated Local Curriculum with Process-Oriented Teaching Methods for Grade Level 4 Students

1.1 Identification of the Contents for the Curriculum

Identification of the contents of the plan to arrange the learning experience on local environment in both physical and biological environment, both natural and social, is done for the surrounding of students of Chiang Mai Province. Also identified are the problems of the conditions on local environment in Chiang Mai Province. The researcher strives to be consistent with the goals stated by the Basic Education Curriculum of B.E 2544 that focuses on attempts for the learners to build awareness on the conservation of natural resources and environment. This study also adopts thorough study on the acknowledged standards of learning, Sciences for the basic education, learning standard practices at certain grade level, the learning contents and the expected results from learning plans. This study includes the accumulated environmental data for Chiang Mai Province, the reports of the research findings, academic discussion forum, printed documents, and opinions disseminated through mass media and public meetings on various sectors including private sectors and villagers. The researcher brings all these information to prioritize certain information, analyze, and summarize the contents and then arranges the coherent contents to design the learning activity arrangements. These activities cover the contents such as the followings. First, the environment related to the dimension on natural resources (trees, animal, forests, water sources, creeks or waterways in ecological systems rich in diversity such Suthep-Pui, Doi Inthanon, or Pha Daeng National Parks, etc.). Second, the environment related to the dimension of waste and toxic materials such as air pollution, garbage problems, floods in Chiang Mai, as well as water quality in Ping River and its branches. These contents are identified as the contents of the curriculum and then assessed by the expert teams on curriculum and on environment.

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1.2 Arrangement of Definitions or Explanation in Each Subject

Having identified the names and subjects for the course codes and study schedules on the subject of local environment, the researcher assigns a subject code of Vor 40281 (total credit 1.0). The status of this subject is an elective course for the students in grade level 4 in the Science Course Groups. The explanation for each subject is given as the followings.

The explanation of the subject of local environment. This subject offers a study about the natural ecological system, i.e., the meanings or definitions of ecological systems, physical factors on ecological systems, relationships between living things in ecological systems, energy cycle or transformation, diversity of living things in environments in ecological system of each world region. This subject also discusses about the local environment in the national parks in Chiang Mai especially Suthep-Pui National Park, Doi Inthanon National Park, Doi Chiang Dao National Parks, as well as the environment of Muang Chiang Mai district, and its environmental problems which include air pollution, garbage management, waste disposal, water pollution, degradation of resources and environment, analysis on problems, and ethical problem solutions to develop the environment.

Its intention is the development of learners with capabilities of analyses, synthesis, evaluation, and assessment on environmental challenges, and awareness to the natural environment as well as learners with cooperative attitudes in shared learning.

1.3 Making and Arranging the Learning Units

The explanation for each subject to make three learning units is given as the followings.

Learning Unit 1 On the Wonder of Environmental World (5 weeks)
Learning Unit 2 On Local Environment in Chiang Mai (5 weeks)
Learning Unit 3 On Analysis of Problems to Develop Local Environment in Chiang Mai (8 weeks)

1.4 Making Learning Plan

In arranging the Learning Plan, the study focuses on Direct Experience and Integrated Learning with the teaching methods emphasizing the Learning Process. The known learning standards of studying science or basic education, the set learning standard for the grade level, the learning contents and the expected results from the learning are all used to identify the learning activities and the methods of evaluation of the study. The characteristics of these building blocks of the planned study are as given as the followings.

1.4.1 Learning Standards

Content 2: Life and Environment

Standard *Vor 2.1*: The learners' understanding of the local environment as well as the relationship between the environment and livings beings in ecological systems. The students learn the processes in seeking knowledge with scientific mind, and discuss their learning with peers, and bring the gathered knowledge into useful practices.

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Learning Standard Range *Vor 2.1*: Students are able to analyze, discuss, and explain the environmental process (cycles) about the transformation of the living things, the importance of biodiversity, the diversity of ecological system and the equilibrium of ecological systems.

Standard *Vor 2.2*: Students' understanding of the importance of natural resources and proper usage of natural resources at local, national, and the global levels. Students are able to implement the knowledge to be used in managing the natural resources and local environment in sustainable manners.

Learning Standard Range *Vor 2.2*: Students are able to launch surveys to analyze the environmental problems and proper usage of natural resources at local, national, and global levels. Students are able to analyze the general causes of environmental problems, to prepare plans, and to implement schemes in local communities to solve the problems, followed by observation, conservation and management of natural resources and environment.

1.4.2 Expected Results of the Study

1.4.2.1 On the Environmental Knowledge

1) To know and understand the ecological systems in the natural settings.
2) To know and understand the local environment in Chiang Mai City.
3) To know and understand the local environment in Chiang Mai Province.

1.4.2.2 On the Skills and Procedures of Learning Processes

1) To analyze, synthesize and evaluate the ecological systems in the natural settings, diversity of the living things, and the environment of the ecological systems in nature in all world regions.
2) To analyze and compare the diversity of the living beings in the environmental systems in Chiang Mai Province.
3) To analyze and offer solutions for local environmental problems known in Chiang Mai Province.

1.4.2.3 On Attitudes and Values

1) Students are interested in study further and becoming more cooperative in learning. They are willing to build awareness to the environment and awareness to the importance of physical factors in the ecological systems to the living beings in these systems. Students understand relationships between the living beings in the ecological systems including the transformation of energy forms within the ecological systems.
2) Students are aware of the importance of the local environment in Chiang Mai for the well-being of the living beings.

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3) Students build awareness to the local environmental problems in Chiang Mai, behave themselves accordingly, and then practice beneficial deeds to their society in order to reduce the environmental problems in Chiang Mai Province.

1.4.3 Teaching Activities, Teaching Media, and Learning Evaluation Methods of the Study

The learning activities are composed of activities inside the classroom or in the normal periods and outside the classroom or outside the normal schedules, in a kind of process-oriented teaching method. Within every group activity, the groups are divided into the mixed class groups of six to seven students. The group is composed of the students from Mathayom Suksa 4 and 5 with each class is composed of three to four students. Each learning plan can be summarized as the following box.

Learning Unit 1/1
Ecological System of The World

Learning Activities

Inside the Classroom

1. Discussion about general condition of the surrounding environment by using the Power Point media presentation. The ecological systems of the world are presented, with contents about the ecological systems in the nature, types of ecological systems, physical factors in the ecological systems, relationships among living beings in the ecological system, and diagrams to show relationships of the global ecological systems *(Learning Methods: Self-study / Expected Results: Abilities in Analysis of Components and Analysis of Relationships).*

2. The group studies the Worksheet (#1) for the ecological systems of the world, prepares implementation plan, identifies the responsibilities for each member, studies on its own assignments and tasks *(Learning Methods: Self- study / Expected Results: Ability of Syntheses of Environmental Planning).*

3. Presentation of the results of Analyses in the Task Analysis of the group, discussion, exchange of students' opinions on their groups tasks, assessment of correctness and appropriateness of the data, shared summary, and preparation for the presentation of the data to the class *(Learning Methods: Creative Thinking Learning / Expected Results: Cooperative Behavior in Learning, Abilities to Analyze Components, Capacity to Analyze the Issues and Assessment for Correctness and Appropriateness of Data).*

4. Study the Worksheet (#2) on ecological systems in natural settings and diversity of ecological systems. The contents about the ecological systems are physical factors in ecological systems, relationship of living beings in ecological systems, adaptation of livings beings, cycles for transformation of energy, ecological system in nature *(Learning Methods: Learning Cooperation / Expected Results: Ability of Syntheses).*

5. Selection of one of the world's main ecological systems and study the data before practice on summarizing the information. Students plan together on the model of the chosen ecological system and present it in front of the class. Teachers and friends offer their opinions, assess the draft model for possible mistakes, and comment for improvements *(Learning Methods: Creative Thinking Learning / Expected Results: Learning Cooperation, Syntheses for Issues under Discussion, Syntheses for the Plan to Create the Model, and Evaluation and Assessment for Possible Mistakes in the Model).*

Outside the Classroom

6. Creation of the model of ecological systems such as (1) ecological systems along the Thai-Andaman coastline, (2) the ecological systems in the dairy cattle farm, (3) ecological system along beaches and seas, (4) ecological system in the water, (5) ecological systems in the desert, (6) ecological system in mangrove forests *(Expected Results: Ability to Synthesize Outcomes of a Set of Abstract Relationships).*

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Inside the Classroom

7. Presentation of the model for the ecological systems created in classroom. Students evaluate the work by using the agreed criteria *(Expected Results: Internal Evaluation).*

8. Brainstorming or free discussion about the communal concepts on the ecological systems in natural settings. Each group presents their work in the scientific laboratory *(Learning Methods: Creative Thinking Learning / Expected Results: Ability to Analyze Relationships and Awareness to the Ecological Systems in the Nature).*

Learning Media

Materials and Tools

- Worksheet #1 Title: Ecological systems of the World
- Worksheet #2 Title: Ecological System in Nature and Diversity of Ecological Systems
- Handout #1 Title: Ecological System in Nature and Diversity of Ecological Systems
- Department of Environmental Quality Promotion (2546). Knowledge on Environment, Bangkok: Aroon Karn Pim Limited Partnership.
- Preecha Suwanpanit (2001). Life in Ecological Systems. Bangkok: Kurusapa Business Organization.
- Slides Created with Power Point Program and entitled "Ecological System of The World"
- CD-Rom entitled "Ecological Systems and the Environment"
- Equipment to make ecological system for each student group.

Places or Venues

- School Libraries
- Computer Room

Website

- http://www.tei.or.th
- http://www.greenworld.or.th
- http://www.globe.gov
- http://www.deqp.go.th/index1.jsp
- http://www.envirolink.org
- www.tmd.go.th/
- http://www.environnet.in.th/index.asp
- http://www.krirk.ac.th/graduate/environment/article.html
- http://web.ku.ac.th/schoolnet/snet6/envi1/ecosystem/b2.htm
- http://www.thaigoodview.com/library/ studentshow/st2545/5-4/no02- 44/biosystem.html

Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. The Evaluation Task 1: Ecological Systems of the World
2. The Evaluation Task 2: Ecological System in Nature and the Diversity of Ecological Systems
3. The Evaluation Form for the Model of Ecological System of the World.
4. The Observation Form for the Cooperative Behavior in Learning.
5. The Self-Evaluation Form on the Cooperative Behavior in Learning.

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The outcomes/results of building the model of ecological systems of the six groups of students are shown as the followings.

Group 1 : This group creates a miniature model of the ecological systems along the Thai-Andaman Sea from plastic box with plywood as the base. On the one side of the box wall, the students paste the pictures of underwater ecological systems composed of many kinds of fish species, coral reefs, animals, the sea floor (made of the artificial wax), the living things in the sea (made of wax and the straws used with wax), and real coral reefs and shells added.

Group 2 : This group build a miniature model of the ecological systems in a dairy cattle farm is using the plywood as its base. The dairy cattle and other living

beings in the farm are made of sculpture from papers. The rice fields are made from green Scotchbrite sponge, and the houses, water reservoir, and barns are made from corrugated paper, artificial wax and rice-straw. The students also add a diagram to show the relationships among the living beings in the miniature dairy cattle farm.

Group 3 : This group creates a miniature model of ecological systems of the sea. It is made in the shape of an aquarium. The area of the ecological systems is made from agar baking powder. The seafloor is produced out of small gravels. The living beings both plants and animals are made of wax or artificial clay. When the work is displayed, some fungi appear on the baking powder because the students have made the miniature model several days before the class display.

Group 4 : This group makes a model of ecological system in the Lentic Zone. It is made in the shape of an aquarium with clear boundaries for three zones, which are (1) the Littoral Zone (made of clay), (2) the Limnatic Zone, and (3) the Profundal Zone (made of wax and gel, while plants and animals are made from wax/artificial clay).

Group 5 : The model of ecological system taken by this group is the desert. The base is made of plywood and then soil and sand are used to made mountains and the desert. Some parts of the sand are dyed in certain color and gravel and artificial wax are added to make oasis in the miniaturized desert. The animals living in the desert are made of artificial wax and the plants are made of living cacti.

Group 6 : The model of ecological system made by this group is a rice field. The model is made in a shape of an aquarium. The whole area is represented by clay and some miniatures of plants and animals are added. Some parts use real trees. The rice and living beings in the field are made from artificial wax.

Learning Unit 1/ 2
Miniature of Ecological System

Learning Activities

Inside the Classroom

1. Review of the world ecological systems. The groups study Worksheet #1 on the Miniature Ecological Systems. Teacher begins Brainstorming about the plan, design, and creation of the miniature of ecological systems. The brainstorm is done in group *(Learning Methods: Creative Thinking Learning Through Brainstorming / Expected Results: Cooperative Behavior in Llearning, Abilities in Analysis of Components and Analysis of Relationships Ability).*

2. Plan for the observation, data collection methods, designs, record-keeping methods, data collection, and study or research for data about the physical factors and relationship between living things and ecological systems in natural setting (*Learning Methods: Self-study).*

3. Bring the outcomes of the study to discuss together on the identified issues. Plan to choose the miniature of ecological systems in which the living things can live the longest *(Learning Methods: : Problem-Based Learning / Expected Results: Ability of Syntheses of Ecological Planning, Analysis of Relationships, Analysis of the Ecological Working Principles and Cooperative Behavior in Learning).*

4. Discussion in group according to the topics in the Handouts. Students compare the transformation of energy by using various types of environmental cycles, use the contents from the Handout #3 and present the work outcomes, exchange opinions, and then discuss the gathered data and things that have been learned from the miniature ecological systems *(Learning Methods: Problem-Based Learning / Expected Results: Ability of Syntheses of Environmental Planning and Analysis of Relationships).*

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Outside the Classroom

5. Arranging the miniatures of ecological systems, observing the miniatures and taking note for a week, and comparing the notes with the other groups, and finally answering the questions in the Handouts *(Expected Results: Evaluation by Using External Criteria and Analysis of Relationships).*

Learning Media

Materials and Tools

- Worksheet #1 Title: Miniature Ecological Systems
- Handout #2 Title: Techniques of Arranging Water Ecological System
- Handout #3 Title: Relationships in an Ecological System.
- Equipment for Creating the Ecological System of each group.

Places or Venues

- School Libraries
- Computer Room

Website

- http://school.obec.go.th/maeai/e - learning/buakam/fon2.html
- http://ebook.nfe.go.th/ebook/html/024/147.htm
- http://www.tungsong.com/Environment/Eco/ Eco03. asp
- http://web.ku.ac.th/schoolnet/snet6/envi1/ecosystem/b2.htm
- http://www.thaigoodview.com/library/studentshow/st2545/5-4/no02- 44/biosystem.html

Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. The evaluation form #1 Title: Miniatures of Ecological Systems.
2. Observation form on the cooperative behavior in learning.

The outcomes of creation of miniatures of ecological systems by six groups of students are shown as the followings.

Group 1: An ecological system in an aquarium. The floor of the ecological system is made from gravel taken from the river. The students plant waterweeds into the miniaturized ecosystem and keep four fish.

Group 2: An ecological system of the soil built in an aquarium. The base of the ecological system is made from fertile soil. A cup is used as a pond to keep four fish and plants are planted around the pond.

Group 3: An ecological system put in an aquarium. The floor of this system is made from the gravel collected from the river. The students grow water plants in two areas of the miniaturized ecosystem and keep four fish and two shells.

Group 4: An ecological system of the water is built in liter-sized bottle where students plant water plants and keep two fish.

Group 5: A water ecological system. The floor is built from the gravel taken from the river. Students grow water plants in all three areas marked clearly in the miniaturized ecosystem and they keep five fish.

Group 6: An ecological system of the ground soil in a bottle (5 liter). The floor is made of fertile soil and small plants are planted in four areas of the miniature ecosystem. Students add one snail which grows into another five snails during the observation that devour the trees planted. The big snail eats the paper fence of the “ecological system” and flees.

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The miniaturized ecological systems of every group can be maintained well except that of the Group 6.

Learning Unit 2/ 1
Local Ecological System in Chiang Mai

Learning Activities

Inside the Classroom

1. Reviewing and discussing the slides about the national parks in Chiang Mai Province. The title of the slide presentation is "Characteristics, Location, Plants, Animals, Diversity of Ecological Systems and Relationships of All Components in Ecological Systems," and students preview videos about forestry *(Expected Results: Analysis of Relationships).*

2. Studying the Worksheet #1 entitled "Diversity of Ecological Systems on the Local" and the Media entitled "Ping River…Beginning of Life." Making implementation plan, identifying responsibilities, and studying data and implementing each group assignments *(Learning Methods: Self-study / Expected Results: Ability of Syntheses).*

3. Presentation of the outcomes from analyses of the student groups, discussion together, assessment for the correctness and appropriateness of data, show of opinions toward the students' works, and summary of all the group works. Students join together to find methods and to present their outcomes in front of the class *(Learning Methods: Creative Thinking Learning / Expected Results: Cooperative Behavior in Learning, Abilities in Analysis of Components, Abilities to Analyze Components, Presenting the Data, Evaluation by Using Internal Criteria).*

Outside the Classroom

4. Studying, making revision, summarizing, and planning of presentation of the work in front of the class. *(Learning Methods: Creative Thinking Learning / Expected Results: Cooperative Behavior in Learning, Abilities in Analysis of Components, Abilities to Analyze Components).*

Inside the Classroom

5. Presentation of the works in front of the class. After brainstorming and opinion exchange, the students offer suggestions, and discuss about the main concepts of ecological systems in each area *(Expected Results: Evaluation by Using Internal Criteria, Analysis of Relationships and Part of Awareness to the Ecological Systems in Nature).*

Learning Media

Materials and Tools

- Worksheet #1 Title: Ecological System in Chiang Mai
- The Slides made with Power Point Program about "National Parks in Chiang Mai Province"
- Video about Khon Rak Pha Part 1 (the length 1.03 min)
- Video about Khon Rak Pha Part 2 (the length 1.07 min)
- Video about Khon Kab Pha Part 1 (the length 1.39 min)
- Video about Khon Kab Pha Part 2 (the length 1.07 min)
- CD entitled "Ping River … Beginning of Life."

Places or Venues

- School Libraries
- Computer Room

Website

- http://www.forru.org
- http://www.doiinthanon.com/index.php
- http://www.dnp.go.th/parkreserve/nationalpark.asp?lg=1
- http://www.thai-tour.com/thai-tour/North/Chiangmai/data/place/npk_doisuthep-pui.htm
- http://www.trekkingthai.com/board/show.php?Category=trekking&forum=4&No=80853

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Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. The Evaluation Task # 1: Ecological System in Chiang Mai
2. The Observation Form for the Cooperative Behavior in Learning.

Learning Unit 2/ 2
Survey of Local Ecological System in Chiang Mai

Learning Activities

Inside the Classroom

1. Study Worksheet #1 entitled "Survey of Ecological Systems in Chiang Mai." The students analyze the information together and decide to survey ecological systems of a chosen place in Chiang Mai *(Learning Methods: Creative Thinking Learning and Learning by Creative Thinking / Expected Results: Ability of Syntheses of Ecological Systems Planning and Learning with Logics).*

2. Students are trained to use the equipment and tools during a survey in the ecological system and to interpret the data and meanings from the equipment and tools. The students also study about "Observation of Birds in Nature" *(Learning Methods: Self-directed Learning / Expected Results: Analysis of Relationships, Analyzing, Identifying, and Marking the Differences in Bird Species and Evaluation by Using External Criteria).*

3. Learning about techniques in interviewing, planning, arranging the tasks (priority), and preparing the tools for surveys. The students design the tools for data collection and the plans for data collection in the field. They practice the interviews, and study the data about the livings things found in the surveyed areas *(Learning Methods: Self-directed Learning and Learning by Project Work / Expected Results: Ability of Syntheses of Survey Area Planning)*.

4. Presentation of the tasks in group reflexive discussion according to the criteria on the evaluation forms that each group creates *(Learning Methods: Learning by Project Work and Cooperative Behavior in Learning / Expected Results: Awareness to the Local Environment, Ability of Syntheses of Planning and Evaluation by Using Internal Criteria).*

Outside the Classroom

5. Practicing the use of telescope to watch birds and to record the information about the birds watched *(Learning Methods: Self-Directed Learning).*

6. Practical training on the "Measuring of Water Quality by using Algae and Water Insects" through the following activities: listening to the lectures about the algae and water insects as indicators of water quality. Students collect the samples of algae and water insects from the reservoir of Mae Jok Luang and Khun Changkien Creek, analyze the quality of the water using the algae and insects, and summarize the water quality by comparing the found water quality with the known standards for water quality.

7. Students listen to the lecture of "Watching Birds and Plants in Chiang Mai National Parks" and study the ecological systems in Doi Suthep-Pui National Parks along the sites near the road to Monthathan Water Fall.

8. Student survey selected ecological systems, interview the locals living in the ecological systems, think of data organization style, prepare to present the organized data, and prepare the interesting issues from the surveys over the ecological systems for further discussion in classroom.

(Learning Methods: Self-directed Learning and Learning by Project Work / Expected Results: Evaluation by Using External Criteria, Ability of Syntheses of Survey Planning, Analyzing and Identifying the Differences in Bird and Plant Species)

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Inside the Classroom

9. Students highlight the interesting issues of problems found during the surveys of ecological systems to discuss and summarize in classroom discussion *(Learning Methods: Learning by Creative Thinking / Expected Results: Analysis of Relationships, Analysis of Relationships and Part of Awareness to the Ecological Systems in Nature).*

Learning Media

Materials and Tools

- Worksheet #1 Title: Survey of Ecological Systems in Chiang Mai
- Equipment or tools for surveys in ecological systems are (1) thermometers, (2) universal indicator, (3) measurement tapes, (4) ropes/strings, (5) pales/buckets, (6) fine nets (catching little organisms), (7) chronometer, (8) densiometer, and (9) telescope
- The manuals of studying living things inside the water.
- The practical training or the follow up for water quality measurement using algae and water insects.
- Kriengkrai Suwannapak. (2005). **Manual on Butterfly,** Bangkok: Documentary.
- Jamasee Chiangthong.(2000).**Dynamic of Community in Natural Management: Situation in Thailand**, Bangkok: The Thailand Research Fund.
- Chitchol Phalaraksh. (2007). **Using Top Soil Animals to Follow Up and Measure Water Quality**, Chiangmai: Chiangmai University.
- Thanya Jan-ard. (2005). **Wildlife Identification Handbook**, Bangkok: Power Print.
- Nanthana Kotchasenee.(1998). **Ecology and Environment,** Bangkok: Amarin Printing and Publishing Company Limited.
- Boonsong Lekagul.(2002). **Nature of Animals, Book 1,** Fourth Edition, Bangkok: Documentary.
- _____. (2002). **Nature of Animals, Book 2**, Fourth Edition, Bangkok: Documentary.
- _____. (2002). **Nature of Animals, Book 3**, Fourth Edition, Bangkok: Documentary.
- Prasit Chansarekorn.(2001). **Manual of Photography and Bird-Watching in Thailand**, First Edition, Bangkok: Tawan-ook, Eastern Printing Public Company Limited.
- Rungroj Jookmongkol.(2000). **Knowledge About Birds,** First Edition, Bangkok: Nan-me Books.
- _____(1999) **Birds**, First Edition, Bangkok : Documentary.
- Verayut Laohajinda.(1983). **Ornithology, Book 1,** Bangkok: Department of Zoology, Faculty of Science, Kasetsart University.
- Opart Khob-khet .(1998) **Birds in Thailand, Book 1,** Bangkok: Sarakadee Press.
- Opart Khob-khet.(1999) **Birds in Thailand, Book 2,** Bangkok: Sarakadee Press.
- Boonsong Lekagul and Philip D. Round.(1991). **A Guide to the Birds of Thailand**, Bangkok: Saha KarnBhact Co., Ltd.

Places or Venues

- Mae Jok Luang Reservoir
- Chiang Mai Canal
- Mok Fa Waterfall, Mae Taeng District
- San Kamphaeng Hot Spring
- Sirikit Park, Mae Rim District
- Orb-khan National Park, Hang Dong District
- Sai Yoi Waterfall
- Regina Coeli College School
- Laboratory, Faculty of Science, Chiang Mai University.
- Doi Suthep-Pui National Park, On route of National Park
- Monthathan Waterfalls, Huai Kaew Waterfall, Khun Chang Kien Creek.

Website

- http://www.forru.org
- http://www.birderjournal.com
- http://www.thaibugs.com
- http://www.tu.ac.th/usr/bird/bird.htm
- http://www.seub.or.th
- http://www.greenpeace.org/seasia/th/
- http://media.deqp.go.th/003_green/Know.php
- http://www.regina.ac.th/webteacher/website_uraiwan/bird/index.html
- http://www.thaimisc.com/freewebboard/php/vboard.php?user=pidjalew

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Persons

- A Team of Nature Interpreter from Doi Suthep Forest
- Banthoon Pankiew, Officer of Suthep-Pui National Park
- Assoc. Prof. Dr. Yuwadee Peerapornpisal, Faculty of Science, Chiang Mai University , Freshwater algae Toxic cyanobacteria Algal cultivation Algae as Bioindicator
- Asst. Prof. Dr. Chitchol Phalaraksh, Faculty of Science, Chiang Mai University, Limnology, Environmental Toxicology

Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. The Evaluation Task #1: Survey of Ecological Systems in Chiang Mai
2. The Observation Form for the Cooperative Behavior in Learning.
3. Self-Evaluation Form on the Cooperative Behavior in Learning.

Learning Unit 3/1
Local Environmental Problems in Chiang Mai

Learning Activities

Outside the Classroom

1. Students study Worksheet #1 entitled "Study of Water Sources in Chiang Mai City," and the design the note-taking or recording methods and other tools to use and issues or questions to inquiry.

2. Students survey along Ping River in Front of Wat Chaimongkol on the North until it reaches San Phi Sua Subdistrict, Muang District (7 km in range).

3. Student groups conduct surveys on waterways such as Mae Kha Canal and Chiang Mai canal and produce summary and comparisons of these water sources. Students create the criteria to evaluate the activities inside their groups and prepare the presentation of their accomplished tasks in the classroom *(Learning Methods: Learning by Project Work / Expected Results: Ability of Syntheses of Planning, Cooperative Behavior in Learning and Analyze Differences).*

Inside the Classroom

4. Discussion about the outcomes of the survey along the waterways and water sources in Chiang Mai City and evaluation of the work results *(Expected Results: Ability of Syntheses of Environmental Planning, Evaluation by Using Internal Criteria and Part of Awareness to the Environmental).*

5. Study of Worksheet #2 entitled "An Inconvenient Truth." The activity involved is review of a movie entitled "An Inconvenient Truth" before student groups show their opinions in brainstorming sessions, build evaluation criteria within the groups, and assist design to create a similar movie based on the questions stated in the Handout. After present their assignments, every group criticizes the appropriateness of their data, adjust the data according to suggestions or advices, and paste the final results on the class board *(Learning Methods: Creative Thinking Learning / Expected Results: Analysis of Relationships, Evaluation by Using Internal Criteria, Abstract Synthesis and Creation of New Issues and Cooperative Behavior in Learning).*

6. Listen to explanation for Worksheet #3 entitled "Chiang Mai Crises of Smog, Floods, Garbage, and Depleted Soil" and then discuss and summarize the results of this learning process. Students create criteria to evaluate others' works and self-evaluate their own achievement *(Expected Results: Analysis of Relationships, Syntheses for Internal Issues under Discussion).*

7. Study Worksheet #4 entitled "Environmental Problems in Chiang Mai," and each student studies chosen environmental conditions in Chiang Mai to cover the identified issues. Then students plan the implementation steps, study them, and practice the tasks according to the assignments *(Learning Methods: Self-Directed Learning /Expected Results: Ability of Syntheses of Environmental Planning).*

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8. Each group proposes the analysis results to the groups, discusses these results together, assesses the correctness of the data, offers opinions to the works of other groups, and brainstorms among the groups to find the proper data presentation methods. After presentation of the data, they exchange learning together to reflect the outcomes of the works by using the set criteria. Students discuss the environmental problems and think for solutions in certain environment *(Learning Methods: Problem-Based Learning / Expected Results: Cooperative Behavior in Learning, Abilities in Analysis of Components, Evaluation by Using Internal Criteria, Syntheses Through Data Presentation, Analysis of Relationships, Syntheses for the Way to Solve the Problems and Part of Awareness to the Environmental).*

Learning Media

Materials and Tools

- Worksheet #1 Title: Study of Water Sources in Chiang Mai City
- Worksheet #2 Title: An Inconvenient Truth
- Worksheet #3 Title: Chiang Mai's Crisis
- Worksheet #4 Title: Environmental Problems in Chiang Mai
- Handout #1 Title: Environmental Problems
- The test form for Water Conservation
- Movie Title: "An Inconvenient Truth"
- Pollution Control Department. (2004). **Summary of Pollution Situation in Thailand in 2003**, Bangkok: Pollution Control Department.
- Department of Environmental Quality Promotion.(1997). **Manual of Environmental Education,** First Edition, Bangkok: Department of Environmental Quality Promotion.
- _____.(1997). **Environmental Conservation**, Fifth Edition, Bangkok: Dokbia Press.
- Duongchan Apavatjrut Charoenmuang.(2005). **Chiang Mai and Water, Proposed Sustainable Solution to Flood Problem in Chiang Mai Proposed by the People,** First Edition, Chiang Mai: Sustainable Cities Research Project, Chiang Mai University.
- _____ .(2005). **Participatory Behaviors in Solving Air Pollution Problem in Chiang Mai City: Complete Report of an Action Research Project,** Bangkok: Thai Health Promotion Foundation and Thailand Research Fund.
- _____.(2003). **Sky-rise Buildings and their Impacts on the Health and Future of Chiang Mai City,** First Edition, Chiangmai: Urban Development Institute Foundation.
- ____.(2549).**Teaching Manual about Weather and Air in Chiang Mai-Lamphun,** First Edition, Chiangmai: Chiangmai Sang Silp Printing House.
- **Green Line Magazine, Book no. 16**, August-November 2005.
- Urban Development Institute Foundation, **Journal of Chiang Mai, Year 7, Book no. 72**, March 2006.
- Urban Development Institute Foundation, **Journal of Chiang Mai, Year 7, Book no. 73**, March 2006.
- Urban Development Institute Foundation, **Journal of Chiang Mai, Year 8, Book no. 84**, March 2007.
- Somyos Manyaem.(1997). **Help to Save the World**, First Edition, Chiang Rai: Muang-roong Printing House.
- Chiangmai Universit.(2004).**Complete Report for Master Planning Project and Conservation Action Plan and Developing the Environment of Ping River and Its Branches**, Chiang Mai: Chiang Mai University.

Places or Venues

- School Libraries
- Computer Room
- Ping River
- Mae Kha canal
- Chiang Mai Canal
- Urban Development Institute Foundation

Website

- http://www.pingriver.org
- http://chiangmainews.co.th/
- http://www.pcd.go.th/
- http://www.localtalk2004.com/

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- http://www.thainews70.com/index-all.php
- http://www.reo01.com/reo/svr.php
- http://chubby.exteen.com/20070214/entry-1
- http://www.cdpm10.com/cmi/anewweb/
- http://www.tei.or.th/mec/th/news/news.html
- http://www.healthsquare.org/news.php?id=447470
- http://www.environnet.in.th/news/index.asp?ntid=1
- http://www.oknation.net/blog/wat/2007/04/09/entry-5
- http://www.tei.or.th/mec/th/news/news/gar_energy.html
- http://202.129.0.133/createweb/00000//00000-1957.html
- http://www.environnet.in.th/news/news_detail.asp?i d=1125
- http://www.deqp.go.th/news/info5/info5%20(5)/minister.doc
- http://www.chumchonthai.or.th/member/writedetail.asp?w_id=5
- http://www.chumchonthai.or.th/member/writedetail.asp?w_id=10
- http://www.prachatai.com/news/show.php?Category=pp&No=2866
- http://www.benjama.ac.th/EBooks/multimedia/enviroment/index.html
- thaigoodview.com/library/studentshow/st2545/5-4/no02- 44/biosystem.html

Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. The test form for Water Conservation
2. Worksheet #2 Title: An Inconvenient Truth (Students create the evaluation task)
3. Worksheet #3 Title: Chiang Mai's Crisis (Students create the evaluation task)
4. The Evaluation Task #4 Title: Environmental Problems in Chiang Mai
5. The Observation Form for the Cooperative Behavior in Learning

Learning Unit 3/2
Managing Local Environmental Problems in Chiang Mai

Learning Activities

Inside the Classroom

1. Review of the problems and solutions to the environmental problems in Chiang Mai Province. Students study Worksheet #1 entitled "Water and Waste Management."

2. Students preview eight videos about water management and seven videos about waste management. They study about the water, garbage, and air management, discuss in group meeting to summarize the learning, build criteria to evaluate activities inside the groups to evaluate the groups themselves (self-evaluation), and present the data (paste on board) *(Learning Methods: Self-directed Learning ,Problem-Based Learning / Expected Results: Cooperative Behavior in Learning , Ability of Syntheses and Evaluation).*

3. Brainstorm within each group about the water and garbage management methods watched from videos in websites *(Learning Methods: Learning by Creative Thinking / Expected Results: Ability of Syntheses).*

4. Students are tested on their environmental awareness on the environmental sanitary. As part of the test, students study Worksheet #2 entitled "Environmental Problem Management" and then they select certain environmental problems that occur in Chiang Mai Province and think about possible solutions in forms of environmental "Project Works." Afterward, they write the implementation plan of the Project Works of the group, present it in front of the class, and evaluate and summarize the works as well as the implementation plan of the group *(Learning Methods: Problem-Based Learning and Learning by Project Work / Expected Results: Ability of Syntheses of Environmental Planning, Cooperative Behavior in Learning, and Part of Awareness to the Environmental, Evaluation by Using Internal Criteria and Analysis of Relationships).*

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5. Students report their progress of the project implementation, analyses of the problems, and offered solutions in order to develop the plan. Each group reports weekly in front of the classroom, summarizes the solutions, and offers a method of sustainable management *(Learning Methods : Problem-Based Learning and Learning by Project Work / Expected Results: Syntheses of the Communicated and Discussed Data, Ability of Syntheses of Environmental Planning, Cooperative Behavior in Learning and Evaluation by Using Internal Criteria).*

Outside the Classroom

6. Implementation of the plan and improvement whenever problems occur.

7. Arrange exhibitions to display their works for friends and communities to know the students' works *(Learning Methods: Problem-Based Learning and Learning by Project Work / Expected Results: Cooperative Behavior in Learning, Analysis of Relationships and Ability of Syntheses of Environmental Planning).*

Learning Media

Materials and Tools

- Test Form on Environmental Sanitary/Cleanliness
- Worksheet #1 Titled : Water and Waste Management
- Worksheet #2 Titled : Environmental Problem Management
- Handout #1 Titled : Project Work
- 8 Videos on Water Management, which are (1) Network of River Branches (Ta Chin River) (2) People who love Ta Chin River Part 1 (3) People who love Ta Chin River Part 2 (4) Return Birds to Forests, Return Fish to Water (Part 1) (5) Return Birds to Forests, Return Fish to Water (Part 2) (6) Together Help Conserve Sawan Canal (7) Rehabilitate Lam Rang Canal (8) Fate Extension of Prem Prachakorn Canal
- 7 Videos on Waste Management, which are (1) Waste Management in Ban Hua Nam School (2) Recycling (3) Garbage Bank of the Wat Klang Community (4) Garbage Saving of On-nuch Children (5) Recycle Village (6) School of Garbage (7) Youth Conserving Environment at Muang Mai Bangpli.
- Pollution Control Department.(2004). **Summary of Pollution Situation in Thailand in 2003,** Bangkok: Pollution Control Department.
- Department of Environmental Quality Promotion.(2003).**Manual of Waste Separation,** Bangkok: Department of Environmental Quality Promotion.
- Department of Environmental Quality Promotion.(2003). **Knowledge on Environment,** Bangkok: Aroon Printing Limited Partnership.
- Department of Environmental Quality Promotion.(2004). **Manual of Waste and Polluted Water Management,** Bangkok: Department of Environmental Quality Promotion.
- Rehabilitation of Natural Resources and Environment along Ping River and Salween River by The Committee for the Protection of the Ping River and the Environment.
- Thitinan Srisathid.(2007).**Global Warming: Be the Change You Want to See in the World,** Bangkok: Green World Foundation, GWF.
- National Metal and Materials Technology Center.(2004). **Plastics in Daily Life,** Bangkok: National Metal and Materials Technology Center (MTEC).
- Thai Environment Consultation Association.(2004). **Developing Chiang Mai Youth to Conserve Ping River, Learning Activity on Environment Education, Participatory Project of Ping Revival of Chiang Mai Citizens**, Mimeographed or Photocopied in parenthesis.
- Forest Restoration Unit Laboratory.(1998). **Forestry for the Future, Planning Local Trees, in Order to Re-habilitate the Ecological Systems of Forest,** Chiang Mai: Forest Restoration Unit Laboratory, Department of Biology, Faculty of Sciences, Chiang Mai University.
- Nongprakhrang Subdistrict Administration Organization.(2000) **Manual of Waste Management,** Chiang Mai: Thapae Printing.

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- Al Gore.(2007). **Global Warming, The Unheard Truth,** First Edition, Bangkok: Mathichon.
- "Water, Valuable Resource," **Science in Action.** Year 2, Book No. 2, March 2006.

Places or Venues

- School Libraries
- Computer Room

Website

- http://www.chumchonthai.or.th/
- http://www.forest.pitlok.net/007.htm
- http://www.geocities.com/dekkrabi/clipvdotessaban01.html
- http://www.deqp.go.th/news/info5/info5%20(5)/minister.doc
- http://www.hondagreenschool.com/Download/RayalProjectJunk.pdf
- http://www.hondagreenschool.com/Download/RayalProjectWater.pdf
- http://www.hondagreenschool.com/Download/RayalProjectEnergy.pdf

Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.

1. Worksheet #1 Titled : Water and Garbage Management (Students create the evaluation task)
2. Worksheet #4 Titled : Environmental Solution Management (Students create the evaluation task)
3. Test Form on Environmental Sanitary/Cleanliness
4. Project Evaluation Form
5. Exhibition Evaluation Form
6. The Self-Evaluation Form on the Cooperative Behavior in Learning.

The selected six environmental problems that have been made to be the Project Works are the followings.

Group 1: This group studies the use of artificial chemicals in grape farms and usage of bio-fertilizers in vegetable plots. Surveys on the environmental conditions such as ground water or biodiversity are undertaken in certain grape farms in Doi Saket District and vegetable gardens at homes. Students measure the chemical residues on the grapes and on vegetables. The measurements show that the water and soil in grape farms have high levels of acid, zero toleration for insects, high toxic contamination. The soil and water in the vegetable home gardens, however, are in almost neutral condition (mild acidity) and some levels of toleration for insects.

Group 2: The students study the quality of water sources in Chiang Mai Province through evaluation of the water quality in five water sources using plants (algae). The evaluation shows that water quality in Chiang Mai stand in moderate level. The best quality of water is found in Mae Jok Luang Reservoir (in moderate level), but the water quality in the "700-Year Pond" in Ang Kaew, Chiang Mai University and Chiang Mai Canal are in low to moderate level. The quality of water in Wat Umong Reservoir and the ponds at Regina Coeli College School are found to be in bad level.

Group 3: The group analyzes the levels of air pollution in Chiang Mai Province. The analyses of the air show (levels of dust particle in the air) that the air quality in Chiang Mai has a medium to high amount of dust particles, especially the market near Chiang Mai Gate which has a high level of dust particles. The measurements of dust particle in Maharaj Hospital, Regina Coeli College School, and Nong Hoi Market show that these sites have moderate levels of dust particle.

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Group 4: These students study the air pollution (acidity level in rainfall). The measurement of the acid in rainfall shows that the rainfall collected at the Market around Chiang Mai Gate has considerable level of acidity level (acid rain) (pH = 5) and the rain falls in other areas such as Maharaj Hospital, Chang Klan Road, Mae Jo District and Saraphi District have the acidity levels ranging from mild to moderate levels (pH = 6.5 to 7).

Group 5: This group creates a Project Work related to a campaign of energy saving to reduce global warming. Some students join this Project Work and get trained on how to save electricity in many kinds before they are expected to behave and practice "energy-saving" at homes for a month. These participants record impressive comparison of the electricity usage before and after they join the Project. These participants can reduce their electricity bills averagely about Baht 100 per home from their usual bills.

Group 6: This group learns the methods of waste disposal in Chiang Mai Province. The surveys on waste management methods conducted in Muang District, San Pa Thong district, Mae Rim District, and Saraphi District reveal that the type of garbage disposal can be classified into (1) selling of garbage (bottles, papers, cardboards) and production of fertilizers from the food left over (in the municipality areas with available garbage trucks to collect household garbage), and (2) selling of garbage (bottles, papers, recyclables), burning, disposal in landfills, production of manure and bio-fertilizers (in the areas outside the municipality and other districts).

Learning Unit 3/3
Developing Local Environment in Chiang Mai

Learning Activities

Inside the Classroom

1. Students study Worksheet #1 entitled "Development Environment", and make plans on methods of implementation to manage the environment *(Learning Methods : Problem-Based Learning / Expected Results: Ability of Syntheses of Environmental Planning).*
2. Students write their implementation plans, launch plan to environmental campaign in their society, present their plans to the classroom, assess possible mistakes, and evaluate and summarize the works and the plans of all groups *(Learning Methods : Project work Learning / Expected Results: Analysis of Relationships, Evaluation by Using Internal Criteria and Part of Awareness to the Environmental).*
3. Present the works to the classroom, and assist evaluation and summarizing the development of environmentally healthy management *(Learning Methods: Project work Learning and Self-directed Learning / Expected Results: Cooperative Behavior in Learning and Analysis of Relationships).*
4. Implementation according to the plans and adjustments whenever problems occur.

Learning Media

Materials and Tools

- Worksheet #1 Title : Development Environment

Places or Venues

- School Libraries
- Computer Room

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Evaluation of the Learning

The measurements or the evaluation methods of these activities are explained as the followings.
1. Project Evaluation Form
2. The Observation Form for the Cooperative Behavior in Learning.

Group 1: This group gathers knowledge about bio-fertilizers, distributes their knowledge to the communities in forms of pamphlets, documents, demonstration plots of bio-fertilizer use in farmers' land in Doi Saket District, and then arranges study tour to farming sites with villagers.

Group 2: This group of students launches campaigns on how to use water economically. Methods to save water and reduce the waste water are disseminated through produced postcards about planktons, water sources in Chiang Mai, statements as well as some flyers distributed freely along the walking streets on Sundays (or night markets) and campaign posters posted for students in schools.

Group 3: This group sets up a bicycle-rider group for health and environment in schools in order to spread the knowledge on how to ride bicycle following the traffic rules and the knowledge on bicycle maintenance to the group members and students in schools. The group campaigns for the use of bicycles on walking streets on Sundays and joins the riding activities with community members.

Group 4: To popularize the knowledge on reducing the acid rain, this group gives away pamphlets about maintenance of vehicle engines, reduction of black smoke from vehicles, resting of engines to reduce gas usage, and non-burning methods of management of organic waste (leaves, twigs). This knowledge is given to parents and people on walking streets on Sundays. Students joining the Project Work also cooperate with the Land and Building Division to produce warning signs for motorists to turn engines off when they are unused.

Group 5: This group of students launches campaigns for energy saving. They also urge reduction of paper usage through "re-use", more utilization of recyclable materials like cloth instead of plastic bags, popularization of stickers urging people to turn off fans in classrooms, and accommodation of a drawing competition for posters related to reduction of global warming in schools.

Group 6: This group campaigns and cooperates with the Land and Building Division to arrange a waste management system in schools. They collect garbage to produce manures in schools, as well as campaign and collect garbage in public areas around the school. These students distribute the samples of manure made from garbage accompanied by the written explanation for the manure production processes to people on the walking streets on Sunday.

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Part 2 The Results of the Implementation of the Created Curriculum

2.1 Advanced Thinking Skills

In each learning unit, the students must present a piece of group work that measures their abilities to analyze, synthesize and evaluate information through the evaluation forms over the task either by the teacher or self-evaluation by the six groups of students toward one another. In other words, the group works of each task are evaluated through students' self-evaluation and the teacher's evaluation. The results of these evaluations are given in Table 3 to 5.

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Table 3 Means, Standard Deviations, and Percentage of the Evaluation Scores of the Students' Abilities of Analyzing Information through the Group Works (N = 6 Student Groups)

Tasks	Scores			$\overline{X}$	S.D.	Percentage	Interpretation
	Full Score	Lowest Score	Highest Score				
Learning Unit 1							
- Ecological System of the World	4	3	4	3.52	0.51	88.00	Above the criteria
- Models of Ecological Systems	4	2	4	3.55	0.55	88.75	Above the criteria
- Miniaturized Ecological System	4	2	4	3.55	0.55	88.75	Above the criteria
			Average	**3.54**	**0.02**	**88.50**	Above the criteria
Learning Unit 2							
- Ecological Systems in the Local	4	2	4	3.60	0.54	90.00	Above the criteria
- Surveys of Ecological Systems in the Local	4	2	4	3.48	0.67	87.00	Above the criteria
			Average	**3.54**	**0.08**	**88.50**	Above the criteria
Learning Unit 3							
- Surveys on Water Sources in Chiang Mai	4	2	4	3.57	0.59	89.25	Above the criteria
- An Inconvenient Truth	4	3	4	3.57	0.50	89.25	Above the criteria
- Environmental Problems in Chiang Mai	4	3	4	3.60	0.50	90.00	Above the criteria
- Waste Water and Garbage Management	4	3	4	3.60	0.50	90.00	Above the criteria
- Solutions to Environmental Problems	4	3	4	3.60	0.50	90.00	Above the criteria
- Environmental Management and Development in Chiang Mai	4	3	4	3.62	0.49	90.50	Above the criteria
			Average	**3.59**	**0.02**	**89.83**	Above the criteria

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Table 3 shows that the students from the mixed class groups have the average score on ability to analyze information higher than the accepted criteria on the tasks (in all three Learning Units). The tasks for which the students show the highest average score and means are the tasks on "Environmental Management and Development in Chiang Mai" ($\overline{X}$ = 3.62 or 90.50 percent of maximum score). The next high scores and means recorded by the students ($\overline{X}$ = 3.60 or 90.00 percent of maximum score) are in the tasks of "Ecological Systems in the Local," "Environmental Problems in Chiang Mai," "Waste Water and Garbage Management," and "Solutions to Environmental Problems."

Table 4 Means, Standard Deviations, and Percentage of the Evaluation Scores of the Students' Abilities of Synthesizing Information through the Group Works (N = 6 Student Groups)

Tasks	Scores			$\overline{X}$	S.D.	Percentage	Interpretation
	Full Score	Lowest Score	Highest Score				
Learning Unit 1							
- Ecological System of the World	4	2	4	3.33	0.53	83.25	Above the criteria
- Models of Ecological Systems	4	3	4	3.26	0.45	81.50	Above the criteria
- Miniaturized Ecological System	4	2	4	3.31	0.52	82.75	Above the criteria
			Average	**3.30**	**0.04**	**82.50**	Above the criteria
Learning Unit 2							
- Ecological Systems in the Local	4	3	4	3.36	0.48	84.00	Above the criteria
- Surveys of Ecological Systems in the Local	4	2	4	3.29	0.64	82.25	Above the criteria
			Average	**3.33**	**0.05**	**83.13**	Above the criteria
Learning Unit 3							
- Surveys on Water Sources in Chiang Mai	4	2	4	3.33	0.57	83.25	Above the criteria
- An Inconvenient Truth	4	3	4	3.36	0.48	84.00	Above the criteria
- Environmental Problems in Chiang Mai	4	3	4	3.38	0.49	84.50	Above the criteria
- Waste Water and Garbage Management	4	3	4	3.40	0.50	85.00	Above the criteria
- Solutions to Environmental Problems	4	3	4	3.38	0.49	84.50	Above the criteria
- Environmental Management and Development in Chiang Mai	4	3	4	3.45	0.50	86.25	Above the criteria
			Average	**3.38**	**0.04**	**84.58**	Above the criteria

Table 4 shows that the students from the mixed class groups have the average score on ability to synthesize information higher than the accepted criteria on the tasks (in all three Learning Units). The tasks for which the students show the highest average score and means are the tasks on "Environmental Management and Development in Chiang Mai" ($\overline{X}$= 3.45 or 86.25 percent of maximum score). The next high scores and means recorded by the students ($\overline{X}$= 3.40 or 85.00 percent of maximum score) is in the tasks of "Waste Water and Garbage Management," and then on the task of "Environmental Problems in Chiang Mai" and the task on "Solutions to Environmental Problems ," which share the same means ($\overline{X}$=3.38 or 84.50 percent of maximum score).

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Table 5 Means, Standard Deviations, and Percentage of the Evaluation Scores of the Students' Abilities of Evaluating Information through the Group Works (N = 6 Student Groups)

Tasks	Scores			$\overline{X}$	S.D.	Percentage	Interpretation
	Full Score	Lowest Score	Highest Score				
Learning Unit 1							
- Ecological System of the World	4	3	4	3.21	0.42	80.25	Above the criteria
- Models of Ecological Systems	4	3	4	3.24	0.43	81.00	Above the criteria
- Miniaturized Ecological System	4	3	4	3.26	0.45	81.50	Above the criteria
			Average	**3.24**	**0.03**	**80.92**	Above the criteria
Learning Unit 2							
- Ecological Systems in the Local	4	3	4	3.31	0.47	82.75	Above the criteria
- Surveys of Ecological Systems in the Local	4	2	4	3.21	0.61	80.25	Above the criteria
			Average	**3.26**	**0.07**	**81.50**	Above the criteria
Learning Unit 3							
- Surveys on Water Sources in Chiang Mai	4	2	4	3.26	0.54	81.50	Above the criteria
- An Inconvenient Truth	4	3	4	3.26	0.45	81.50	Above the criteria
- Environmental Problems in Chiang Mai	4	3	4	3.31	0.47	82.75	Above the criteria
- Waste Water and Garbage Management	4	3	4	3.38	0.49	84.50	Above the criteria
- Solutions to Environmental Problems	4	3	4	3.36	0.48	84.00	Above the criteria
- Environmental Management and Development in Chiang Mai	4	3	4	3.38	0.49	84.50	Above the criteria
			Average	**3.33**	**0.07**	**83.13**	Above the criteria

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Table 5 shows that the students from the mixed class groups have the average score on ability to evaluate information higher than the accepted criteria on the tasks (in all three Learning Units). The tasks for which the students show the highest average score and means are in the tasks of "Waste Water and Garbage Management," and "Environmental Management and Development in Chiang Mai" ($\overline{X}$= 3.38 or 84.50 percent of maximum score). The next high scores and means recorded by the students ($\overline{X}$= 3.36 or 84.00 percent of maximum score) are in the tasks of "Solutions to Environmental Problems," and then on the task of "Ecological Systems in the Local" and the task on "Environmental Problems in Chiang Mai" which share the same means ($\overline{X}$=3.31 or 82.75 percent of maximum score).

The average scores and total scores of all the abilities for advanced thinking skills after the evaluation of the task in three Learning Units are shown in Table 6.

Table 6 The Average Total Score on Advanced Thinking Skills from the Evaluation for the Group Works in Three Learning Units (N = 6 Student Groups)

Advanced Thinking Skills	Learning Unit			$\overline{X}$
	1	2	3	
Analysis Ability	3.54	3.54	3.59	3.56
Synthesis Ability	3.30	3.33	3.38	3.34
Ability to Evaluate Information	3.24	3.26	3.33	3.28

Table 6 reveals that all the average scores of the advanced thinking skills on three aspects (and compared with each learning unit), are the highest ($\overline{X}$=3.56). The next highest score is recorded in the students' capabilities to synthesize information ($\overline{X}$=3.34) and then the abilities to evaluate information ($\overline{X}$=3.28).

The average score for each of the advanced thinking skill is shown in Figure 4.

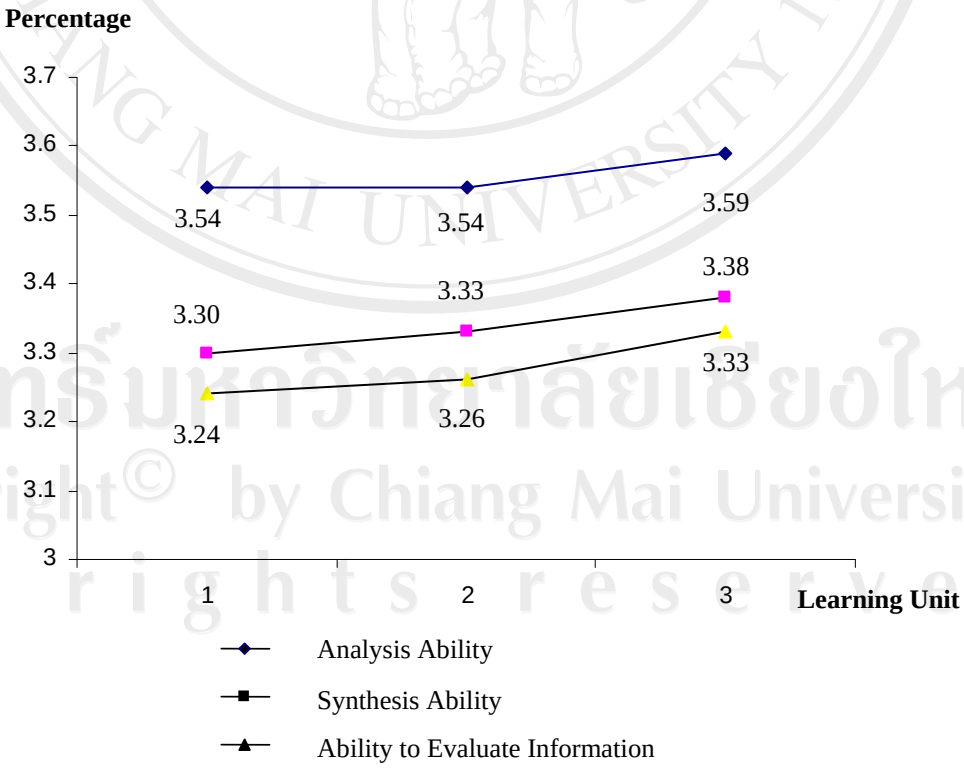

Figure 4 The Average Score on the Advanced Thinking Skills from Evaluation in Three Learning Units (N = 6 Student Groups)

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Figure 4 shows the comparison of the average scores for the levels of advanced thinking skills on three aspects in each learning unit. Figure 4 shows that the scores of advanced thinking skills on three aspects are increasing from Learning Unit 1 to Learning Unit 3 as shown in the scores of abilities to analyze information ($\overline{X}$=3.54, $\overline{X}$=3.54, and $\overline{X}$=3.59 respectively) and the abilities to synthesize information ($\overline{X}$=3.30, $\overline{X}$=3.33, and $\overline{X}$=3.38) and the abilities to evaluate information ($\overline{X}$=3.24, $\overline{X}$=3.26, and $\overline{X}$=3.33).

However it is obvious that the increase in the average scores on the advanced thinking skills in each learning unit are not much different as shown by the compared scores of Learning Unit 2 and Learning Unit 1. The differences of the scores from the Learning Unit 1 and 3 for the students' abilities to analyze, synthesize, and evaluate information are 0.05, 0.08, and 0.09 respectively.

After finishing the teaching for three learning units, the researcher evaluates the mixed class group students' abilities to analyze, synthesize and evaluate information using three sets of evaluation forms for the advanced thinking skills. The results of this evaluation are shown in Table 7.

Table 7 Average Score and Standard Deviation of Advanced Thinking Skill Scores of Students in Mixed Class Group after Using the Curriculum (N = 40 Students)

Advanced Thinking Skills	**Full Score**	$\overline{X}$	**S.D.**	**Percentage**	**Interpretation**
Analysis Ability	20	15.53	1.22	77.65	Above the criteria
Synthesis Ability	10	7.73	0.56	77.30	Above the criteria
Ability to Evaluate Information	20	15.38	1.25	76.90	Above the criteria

Table 7 shows that the students' abilities to analyze information stand as the highest score (77.65 percent) followed by their abilities to synthesize information (77.30 percent) and the abilities to evaluate information (76.90 percent).

The information considering the average scores and percentage from the numbers of students who get the scores that pass the criteria (70 percent according to Office for National Education Standard and Quality Assessment (Public Organization)) are shown in Tables 8 to 10.

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Table 8 Percentage of Score and Numbers of Students in Mixed Class Group who have Scores on Ability to Analyze Information after Using Local Curriculum (N = 40 Students, Full Score = 20 Points)

Scores	Percentage of Scores	Numbers of Students (M.4 , M.5)	Percentage of Students	Students Passing the Criteria	
				Total Number	Accumulative Percentage
12	60	(2 , 0)	5	-	-
14	70	(1 , 2)	7.5	3	7.5
15	75	(7 , 5)	30	15	37.5
16	80	(8, 10)	45	33	82.5
17	85	(1 , 2)	7.5	36	90.0
18	90	(1 , 1)	5	38	95.0

Table 8 reveals that the students who get the scores higher than 70 percent record the scores ranging from 14 to 18 points (38 students or 95 percent of all 40 samples). Comparison between the scores with the number of participating students who score them and the criteria given by ONESQA (Public Organization) proves that the majority of the samples show a very good level of ability to analyze information.

After dividing the students into two class levels, Table 8 shows that the students from both class levels have scores ranging from 14 to 18 and majority of them (45 percent) score 16 points. Only few students (two students) of Mathayom Suksa 4 record the score of 12 points, which is considered lower than the criteria of ONESQA (Public Organization).

Table 9 Percentage of the Scores and Numbers of Students in Mixed Class Groups in Scores for Capabilities in Synthesizing Information after Implementation of Local Curriculum (N = 40 Students, Full Score = 20 Points)

Scores	Percentage of Scores	Numbers of Students (M.4 , M.5)	Percentage of Students	Students Passing the Criteria	
				Total Number	Accumulative Percentage
7.33	73.3	(13 , 10)	57.5	23	57.5
8.00	80.0	(5 , 7)	30	35	87.5
8.67	86.7	(2 , 1)	7.5	38	95.0
9.33	93.3	(0 , 2)	5	40	100.0

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Table 9 shows that the students who score higher than 70 percent reach the scores ranging from 7.33 to 9.33 points (40 students or all samples). When comparing the percentage of score and number of the students who achieve those scores with the criteria given by ONESQA (Public Organization), the Table reveals that the majority of samples have ability in synthesizing information in a very good level.

When the students are classified into two levels or classes, their scores are ranging from 7.33 to 8.67 points. The majority of the students (57.5 percent) record the score of 7.33 points and only the students from Mathayom Suksa 5 can reach 9.33 points, which is the highest score.

Table 10 Percentage of Scores for Abilities to Evaluate Information and Numbers of Students Achieving Them in the Post-Implementation Evaluation after Local Curriculum is launched (N = 40 Students, Full Score = 20 Points)

Scores	Percentage of Scores	Numbers of Students (M.4 , M.5)	Percentage of Students	Students Passing the Criteria	
				Total Number	Accumulative Percentage
12	60	(2 , 0)	5	-	-
13	65	(1 , 0)	2.5	-	-
14	70	(2 , 3)	12.5	5	12.5
15	75	(5 , 4)	22.5	14	35
16	80	(8 , 11)	47.5	33	82.5
17	85	(2 , 1)	7.5	36	90.0
18	90	(0, 1)	2.5	37	92.5

Table 10 shows that students who gain scores higher than 70 percent record the scores ranging from 14 to 18 points. Their number is 37 students or 92.5 percent of all samples. When the percentage of scores and the numbers of students achieving them are compared to the criteria provided by ONESQA, it is clear that most of the participating students have a very good level capability on evaluating information.

When classified into class levels, the students from both classes record the scores ranging from 14 to 17 points. The majority of the students (47.5 percent) score 16 points. Only the students from Mathayom Suksa 4 reach the scores of 12 to 13 points, which are lower than the criteria. Only the students from Mathayom Suksa 5 can reach a score of 18 points, which is the highest score.

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2.2 Awareness to the Local Environment

The results of the evaluation for levels of students' awareness to the local environment after finishing the tasks in each learning unit by using the external evaluation form by the teacher and self-evaluation one the group tasks by the students in six groups. Therefore the scores for each task of the group tasks come from the self-evaluation form by the students in six student groups and the teacher. As a part of the evaluation model for the ecological systems and miniaturized ecological systems, the evaluation also scores the students' achievement based on their manners in using materials to accomplish their tasks (the use of ubiquitous and inexpensive materials with the 5R Principles-Reject, Reduce, Reuse, Repair, Recycle. The surveys of the ecological systems in the local environment are scored based on the writing up of students' impressions on the importance, concerns, and guidelines leading to conservation of the surveyed ecological systems. The students' awareness of environmental problems in Chiang Mai are evaluated from their suggestions and opinions regarding those problems, their possible solutions, and suggestions on management of the local environmental in Chiang Mai through solutions in daily life. The results of the plan implementation are shown in Table 11.

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Table 11 Means and Standard Deviations of the Students' Awareness to the Local Environment Evaluated through the Evaluations on the Accomplished Tasks or Project Works (N = 6 Student Groups)

Tasks	Scores			$\overline{X}$	S.D.	Interpretation
	Full Score	Lowest Score	Highest Score			
Learning Unit 1						
- Models of Ecological Systems	4	3	4	3.36	0.48	High
- Miniaturized Ecological System	4	3	4	3.43	0.50	High
Learning Unit 2						
- Surveys of Ecological Systems in the Local	4	3	4	3.40	0.50	High
Learning Unit 3						
- Environmental Problems in Chiang Mai	4	3	4	3.48	0.51	High
- Solutions to Environmental Problems	4	3	4	3.43	0.50	High
- Environmental Management and Development in Chiang Mai	4	3	4	3.45	0.50	High

Table 11 shows that the means of the students' scores on their awareness to the local environment is evaluated as in high level in all tasks. The task in which the students score the highest average of means is the task on "Environmental Problems in Chiang Mai" ($\overline{X}$=3.48). The students gather the next highest score on the task of "Environmental Management and Development in Chiang Mai" ($\overline{X}$=3.45), and then on the task of "Miniaturized Ecological Systems" and the task on "Solutions to Environmental Problem," which share the same means ($\overline{X}$=3.43).

After the curriculum implementation, the researcher studies the samples' awareness to the local environment by using the evaluation forms on awareness that the researcher has created. The results of this evaluation are shown in Table 12.

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Table 12 The Average Scores and Standard Deviations of the Scores on the Awareness to the Local Environment of the Students in Mixed Class Group after Implementation of the Local Curriculum (N = 40 Students)

At	Statement	$\overline{X}$	S.D.	Interpretation
1	Advise members of family to separate garbage before disposal	2.85	0.86	High
2	Collect/select bottles or newspapers to sell as income sources more than throw in garbage bins.	3.48	0.72	High
3*	Agree on land-filling method for toxic waste to increase minerals to the soil	2.80	0.76	High
4*	Agree with idea to fill the forest land with garbage because garbage is good for trees	2.95	0.75	High
5	Agree with popular idea of planting multicrops system with biofertilizers more than monoculture.	3.48	0.82	High
6*	Leave the faucets all the time while cleaning cars to save time	3.38	0.81	High
7	Bring the used water after cleaning for other purposes	2.98	0.62	High
8*	Conserving water from rivers and their branches should be done only in dry seasons with limited water but not in rainy seasons no need for water conservation.	3.23	0.80	High
9	Be leaders in cleaning of schools after the flood	2.83	0.55	High
10	Become participants to clean the canals in Chiang Mai	2.50	0.68	Moderate
11*	Prefer to switch on electricity in Chiang Dao Cave to using lamp because visitors can see the stalagmites clearly	3.23	0.83	High
12*	When visiting forests, often bring wild orchids back home to propagate the varieties	3.65	0.70	Highest
13	Participate in planting tree activities with various sectors occasionally during free times.	2.65	0.53	High
14*	Adjust forest areas to hold the Thai Royal Flora because it is worthy to get beautiful garden from all over the world	2.73	0.72	High
15	Fond of cycling activities to campaign around the canals on Sunday	3.35	0.74	High
16*	When going for picnic, prefer putting foods in plastic bag to food containers	2.95	0.71	High
17*	Fond of sky-rise buildings of hotels near the school when they are finished/done to use their high class service.	3.63	0.49	Highest
18	Campaign for the mothers to use cloth bags to go shopping more than using plastic bags	3.28	0.75	High
19*	Prefer using new papers to do assignments more than using used papers	3.05	0.90	High
20	Schools should arrange activities to clean streets, parks, and other places near the schools	2.95	0.93	High
21*	Hot weather in Chiang Mai is in crisis so there are needs to distribute information	3.28	0.68	High
22	Do not like when junior students ignore garbage falling on school environment and buildings	3.15	0.74	High
23*	Campaign to build reservoirs is boring thing	2.65	0.83	High
24*	Agree with idea of pouring the used washing water into Ping River because it make algae to produce oxygen in water	3.68	0.73	Highest
25*	Conserving environment is annoying because one can not do what one wants to do	3.83	0.38	Highest
	Total Average	**3.14**	**0.36**	High

* Negative Statements

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Table 12 shows that the students in mixed class group generally show high level of awareness. The highest level of awareness is the one about the students do not "feel that conserving environment is annoying because one cannot do one wants to do". The students show disagreement with the idea of pouring used water into Ping River although it enables algae in the river to produce oxygen. When the students go to the forest, they do not bring wild orchids home for propagation and they do not like sky-rise hotels near the school despite its high class service. The means for all of the above four statements are $\overline{X}$=3.83, $\overline{X}$=3.68, $\overline{X}$=3.65 and $\overline{X}$=3.63, respectively. Being the participants in activities to clean canals in Chiang Mai is responded positively by the students in moderate level ($\overline{X}$ = 2.50).

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2.3 Cooperation in Learning

2.3.1 Observing the Cooperative Behavior in Learning

From the observations (twice per Learning Unit) for the shown levels of cooperative behavior in learning among the students of each group, which is composed of students from Mathayom Suksa 4 and 5 in same group to do group activities, the following findings are found (Table 13).

Table 13 The Average Scores and Standard Deviations of the Scores for Students' Cooperative Behavior in Learning during Activities in Each Learning Unit (N = 40 Students)

Behavior	Average Score Each Observation						$\overline{X}$	S.D.	Interpretation
	1	2	3	4	5	6			
1. Express opinions	2.53	2.58	2.68	2.60	2.55	2.68	2.60	0.06	High
2. Planning	2.83	2.85	2.93	2.88	2.83	2.93	2.88	0.05	High
3. Listening to other members' opinions	2.78	2.80	2.78	2.83	2.73	2.83	2.79	0.04	High
4. Accepting opinions of others in group	2.48	2.53	2.50	2.49	2.53	2.54	2.51	0.02	High
5. Willingness to work on group assignments	2.65	2.68	2.68	2.63	2.65	2.73	2.67	0.04	High
6. Working / performing according to the group agreement	3.10	2.85	3.08	2.93	3.13	3.15	3.04	0.12	High
7. Participating in activities	3.25	3.35	3.08	3.43	3.40	3.23	3.29	0.13	High
8. Enthusiasm in working together	3.15	2.53	2.53	2.78	3.00	2.55	2.76	0.27	High
9. Show enjoyment in working with group	2.83	2.78	2.63	2.65	2.70	2.48	2.68	0.12	High
10. Systematic working process	2.75	2.88	2.93	2.83	2.80	2.88	2.85	0.06	High
11. Good relationships to one another	2.63	2.60	2.53	2.55	2.63	2.53	2.58	0.05	High
12. Learning together	3.30	2.95	2.95	2.95	3.23	3.15	3.09	0.16	High
13. Patience in helping each other to solve group problems till the end	3.23	2.93	3.23	3.08	3.03	3.25	3.13	0.13	High
14. Provide help to others in the group	2.63	3.40	3.50	3.65	3.45	3.60	3.37	0.37	High
15. Identifying/dividing responsibilities among members	2.83	3.00	2.90	2.98	2.78	2.93	2.90	0.09	High
					Total Average		**2.88**	**0.26**	High

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Table 13 reveals that the students in mixed class group have high levels of cooperative behavior in learning for all items. The cooperative behavior for which the students score the highest level is “Provide help to others in the group” ($\overline{X}$ = 3.37) followed by “Participating in activities” ($\overline{X}$ = 3.29). The next ones are the “Patience in helping each other to solve group problems till the end” ($\overline{X}$ = 3.13) and “Learning together” ($\overline{X}$ = 3.09).

The kinds of cooperative behavior in learning with the lowest average of means ($\overline{X}$ < 2.70) compared to the other items are five items, which are “Express opinions,” “Accepting opinions of others in group,” “Willingness to work on group assignments,” “Show enjoyment in working with group,” and “Good relationships to one another.”

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2.3.2 Students' Self-Evaluation on Their Cooperative Behavior in Learning

The students' self-evaluation on their cooperative behavior in learning is done three times during the activities in each Learning Unit and the results are shown in Table 14.

Table 14 The Average Scores of Students' Self-Evaluation on Cooperative Behavior in Learning During the Activities (N = 40 Students)

At	Behavior	Average Score on Each Observation			$\overline{X}$	S.D.	Interpretation
		1	2	3			
1	Giving explanations to the groups	2.29	2.60	2.85	2.58	0.28	High
2	Clarifying the words of members of group	2.55	2.93	3.08	2.85	0.27	High
3	Giving examples or illustrations when speaking	2.50	2.93	3.13	2.85	0.32	High
4	Giving useful advices for further application	2.30	2.53	2.70	2.51	0.20	High
5	Giving summary of issues	2.37	2.80	3.00	2.72	0.32	High
6	Inviting friends to speak up	2.78	3.35	3.40	3.18	0.34	High
7	Listening to friends in the group to present opinions till the end	3.11	3.28	3.48	3.29	0.19	High
8	Asking questions for repeat the speaking	2.57	3.05	3.23	2.95	0.34	High
9	Asking for further illustrations or examples	2.24	2.75	2.80	2.60	0.31	High
10	Asking for further explanations	2.57	3.03	3.18	2.93	0.32	High
11	Asking for summarized issues	2.29	2.78	3.00	2.69	0.36	High
12	Studying or searching for data information on works assigned by group	2.88	3.28	3.40	3.19	0.27	High
13	Implementing the roles assigned	2.75	3.33	3.43	3.17	0.37	High
14	Working with group willingly	3.39	3.15	3.40	3.31	0.14	High
15	Presenting the data to the group	2.52	2.98	3.08	2.86	0.30	High
16	Giving cooperation to the group	3.06	3.45	3.58	3.36	0.27	High
17	Asking in order that tasks finished on time	2.68	3.30	3.48	3.15	0.42	High
18	Controlling the working hours of the group	2.32	2.93	3.03	2.76	0.38	High
19	Reconciling/solving conflicts in groups	2.21	2.88	3.00	2.70	0.43	High
20	Asking in order to be able to identify the targets of group	2.37	3.00	3.20	2.86	0.43	High
21	Asking/inquiring in order to be able to plan the work plan of the group	2.37	2.90	3.15	2.81	0.40	High
22	Asking to know/be aware of the problems incurred together	2.39	2.93	3.00	2.77	0.33	High
23	Doing the group work by oneself	2.39	2.78	2.93	2.70	0.28	High
24	Helping friends in group whenever chance appears	2.67	3.08	3.23	2.99	0.29	High
25	Proposing plans for the group	2.39	2.78	3.00	2.72	0.31	High
			Total Average		**2.90**	**0.25**	High

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Table 14 shows that the students in mixed class group self-evaluate their cooperative behavior in learning as in high level in all items. The cooperative behavior to which the students self-evaluate themselves at the highest score is "Giving cooperation to the group" ($\overline{X}$ = 3.36) and the next highest is "Working with the group willingly" ($\overline{X}$ = 3.31), followed by "Listening to friends in group presenting opinions till the end" ($\overline{X}$ = 3.29), and "Studying or searching for data or information on the tasks assigned by the groups" ($\overline{X}$ = 3.19). In addition, it is clearly apparent that the levels of cooperative behaviors have tendency to increase from Learning Unit 1 to Learning Unit 3.

There are also certain issues that should be noticed about the cooperative behaviors in which the students evaluate themselves lower than other items ($\overline{X}$ < 2.70). There are four items belonging to this low evaluation items, which are "Giving explanations to the groups," Giving useful advices for further application," "Asking for further illustrations or examples," and "Asking for summarized issues."

The observation on the students' cooperative behavior during the implementation of the activities in each learning unit exposes certain problems during week 1 to week 3 of arranging learning experience in the groups. One group of students multi-age suffers from lack of cooperation among its members. Sharing experience among the members of the group is very rare and the Group Work is only the results of cooperation among certain members of group, who are two students from Mathayom Suksa 4 and one from Mathayom Suksa 5. The other three members (one student from Mathayom Suksa 4 and two from Mathayom Suksa 5) refuse to cooperate with others. During the activities, since the planning stage onwards, however, the members of group start to adjust to one another, observe the rules or agreements of the groups, willing to work more, and show opinions openly together, and help one another in the works of the group better than before.

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